PREFACE

This book contains the Daily Practice Problems (DPPs) designed for the aspirants JEE(Main+Advanced). It is a collection of problems (Physics, Chemistry & Mathematics in separate booklets) from multiple topics to understand the application of concepts learned in theory. Each DPP is kind of a timed test with marking scheme and prescribed time to be spent on each problem. It is according to the latest pattern of JEE(Advanced) and serves as a great tool for the students to simulate examination conditions at home. It enables a student to practice time management while solving a problem which helps him/her to better prepare for the target exam.

Every effort has been taken to keep this book error free, however any suggestions to improve are welcome at ***smdd@resonance.ac.in.***

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DPP
DAILY PRACTICE PROBLEMS

PHYSICS

TARGET: JEE (Main + Advanced) 2021

COURSE : VISHESH (01JD) **DPPs - B1 to B31**

INDEX

NOTE : ✎ Marked questions are recommended for Revision.

DPP No. : B1 (JEE–Advanced)

Total Marks : 46	Max. Time : 41 min.	
Single choice Objective ('–1' negative marking) Q.1 to Q.2	(3 marks 2 min.)	[06, 04]
One or more than one options correct type ('–1' negative marking) Q.3 to Q.5	(4 marks 2 min.)	[12, 06]
Subjective Questions ('–1' negative marking) Q.6 to Q.10	(4 marks 5 min.)	[20, 25]
Match the Following (no negative marking) Q.11	(8 marks, 6 min.)	[08, 06]

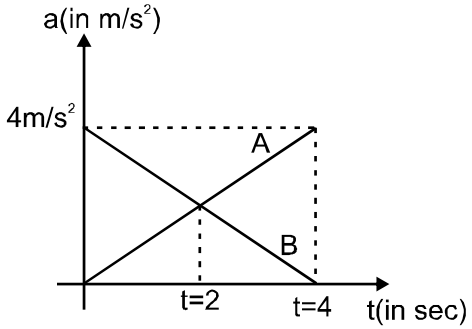
1. A body is projected vertically downwards from A, the top of the tower reaches the ground in t_1 seconds. If it is projected upwards with same speed it reaches the ground in t_2 seconds. At what time it will reach the ground if it is dropped from A.

(A) $\sqrt{t_1^3 / t_2}$ (B) $\sqrt{t_2^3 / t_1}$ (C) $\sqrt{t_1 \ t_2}$ (D) $t_1 t_2$

2. A swimmer crosses a river with minimum possible time 10 second. And when he reaches the other end starts swimming in the direction towards the point from where he started swimming. Keeping the direction fixed the swimmer crosses the river in 15 sec. The ratio of speed of swimmer with respect to water and the speed of river flow is (Assume constant speed of river & swimmer) -

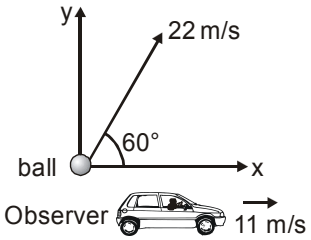
(A) $\frac{3}{2}$ (B) $\frac{9}{4}$ (C) $\frac{2}{\sqrt{5}}$ (D) $\frac{\sqrt{5}}{2}$

3. Acceleration (along x-axis) v/s time graph of two particles A and B starting from rest is shown in figure. Then:



(A) at t = 2 sec. relative velocity of particle A with respect to particle B is zero
(B) at t = 4 sec relative velocity of particle A with respect to particle B is zero
(C) from t = 0 to t = 4 sec. particle A has accelerated motion where as particle B has retarded motion
(D) from t = 0 to t = 4 sec. both particles have accelerated motion

4. A football is kicked with a speed of 22 m/s at an angle of 60º to the positive x direction taken along horizontal. At that instant, an observer moves past the football in a car that moves with a constant speed of 11 m/s in the positive x direction. Take +ve y direction vertically upwards. (g = 10 m/s²)



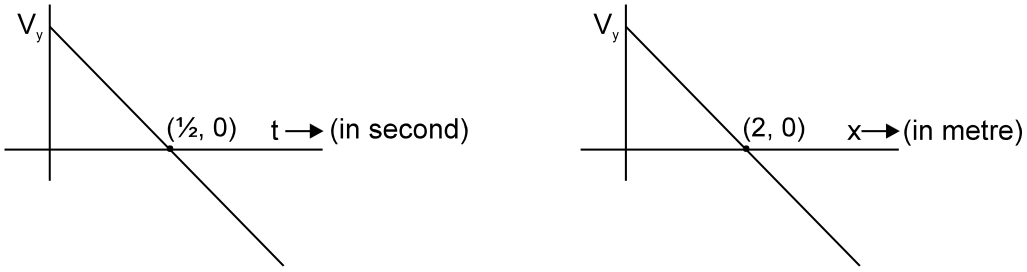
(A) The initial velocity of the ball relative to the observer in the car is $11\sqrt{3}$ m/s in the +y direction
(B) The initial velocity of the ball relative to the observer in the car is 17 m/s at 60º to the +x direction.
(C) According to the observer in the car, the ball will follow a path that is straight up and down in the y direction.
(D) According to the observer in the car, the ball will follow a straight line that is angled (less than 90º) with respect to the observer.

5. Point A (0, 1) and B (12, 5) are object–image pair (one of the point acts as object and the other point as image) x–axis is the principal axis of the mirror. Then this object image pair is:
(A) due to a convex mirror of focal length 2.5 cm
(B) due to a concave mirror having its pole at (2, 0)
(C) real virtual pair
(D) data is insufficient for (A) and (B)

6. A particle has initial velocity $\vec{u} = 2\hat{i} - 3\hat{j} + 4\hat{k}$. It moves with a constant acceleration $\vec{a} = \hat{i} + 2\hat{j} - 2\hat{k}$. Find the speed of particle after a displacement $\vec{s} = 6\hat{i} + 3\hat{j} + \hat{k}$. All parameters in S.I. units.

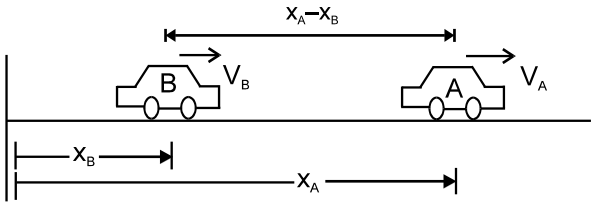
7. A particle is projected horizontally with a speed u from the top of a plane inclined at an angle θ with the horizontal. The particle will strike the plane at a distance $\frac{nu^2}{g}\tan\theta\sec\theta$ from the point of projection. Find the value of n.

8. Two graphs of the same projectile motion (in the xy plane) projected from origin are shown. X axis is along horizontal direction & Y axis is vertically upwards. Take g = 10 m/s^2.

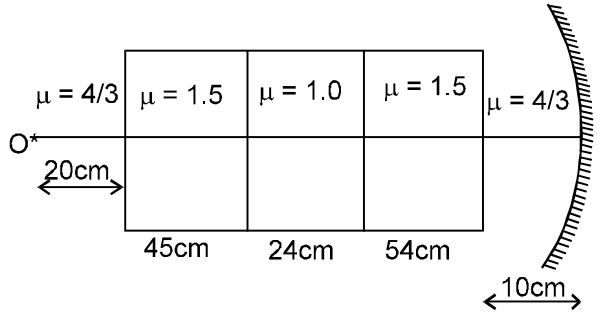


Find (i) Y component of initial velocity and
(ii) X component of initial velocity

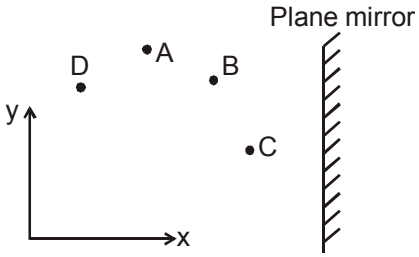
9. Two cars A and B are racing along straight line. Car A is leading, such that their relative velocity is directly proportional to the distance between the two cars. When the lead of car A is ℓ_1 = 10 m, its running 10 m/s faster than car B. Determine the time car A will take to increase its lead to ℓ_2 = 20 m from car B.



10. A composite slab consisting of different media is placed infront of a concave mirror of radius of curvature 150 cm. The whole arrangement is placed in water. An object O is placed at a distance 20 cm from the slab. The R.I. of different media are given in the diagram. Find the position of the final image formed by the system.



11. Four particles are moving with different velocities in front of stationary plane mirror (lying in y-z plane). At t = 0, velocity of A is $\vec{v}_A = \hat{i}$, velocity of B is $\vec{v}_B = -\hat{i} + 3\hat{j}$, velocity of C is $\vec{v}_C = 5\hat{i} + 6\hat{j}$, velocity of D is $\vec{v}_D = 3\hat{i} - \hat{j}$. Acceleration of particle A is $\vec{a}_A = 2\hat{i} + \hat{j}$ and acceleration of particle C is $\vec{a}_C = 2t\hat{j}$. The particle B and D move with uniform velocity (Assume no collision to take place till t = 2 seconds). All quantities are in S.I. Units. Relative velocity of image of object A with respect to object A is denoted by $\vec{V}_{A',A}$. Velocity of images relative to corresponding objects are given in column I and their values are given in column II at t = 2 second. Match column I with corresponding values in column II and indicate your answer.



Column I	**Column II**
(A) $\vec{V}_{A',A}$	(p) $2\hat{i}$
(B) $\vec{V}_{B',B}$	(q) $-6\hat{i}$
(C) $\vec{V}_{C',C}$	(r) $-12\hat{i} + 4\hat{j}$
(D) $\vec{V}_{D',D}$	(s) $-10\hat{i}$

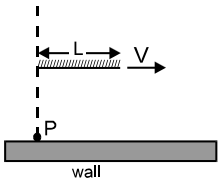
DPP No. : B2 (JEE–Main)

Total Marks : 64	**Max. Time : 40 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.16	**(3 marks 2 min.) [48, 32]**
One or more than one options correct type ('–1' negative marking) Q.17 to Q.20	**(4 marks 2 min.) [16, 08]**

1. A particle is projected up the inclined such that its component of velocity along the incline is 10 m/s. Time of flight is 2 sec and maximum height above the incline is 5 m. Then velocity of projection will be:
(A) 10 m/s (B) $10\sqrt{2}$ m/s (C) $5\sqrt{5}$ m/s (D) none of the above

2. A body travels 200 cm in the first two seconds and 220 cm in the next four seconds. What will be the velocity at the end of 7 second from start?
(A) 10 (B) 20 (C) 30 (D) none of these

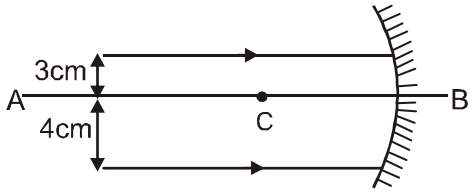
3. The mirror of length L moves horizontally as shown in the figure with a velocity v. The mirror is illuminated by a point source of light 'P' placed on the ground. The rate at which the length of the light spot on the ground increases is :



(A) v (B) zero
(C) 2v (D) 3v

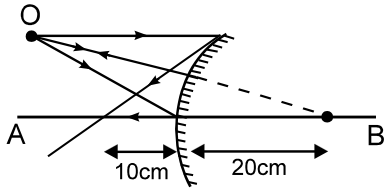
4. Two plane mirrors are inclined to each other at 90º. A ray of light is incident on one mirror and the reflected light goes to the other mirror. The ray will undergo a total deviation of :
(A) 180º (B) 90º (C) 45º
(D) cannot be found because angle of incidence is not given.

5. Two rays are incident on a spherical concave mirror of radius R = 5 cm and rays are parallel to a line AB which passes through the centre C. The rays are at perpendicular distances 3 cm and 4 cm from AB respectively as shown. Find the distance between the points at which these rays intersect the line AB after reflection -



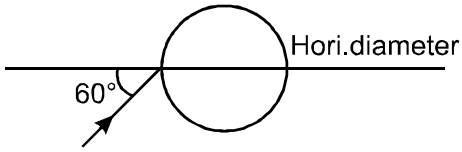
(A) $\frac{25}{24}$cm (B) $\frac{24}{25}$cm (C) zero (D) $\frac{1}{3}$cm

6. In the figure shown a convex mirror of radius of curvature 20 cm is shown. An object O is placed in front of this mirror. Its ray diagram is shown. How many mistakes are there in the ray diagram (AB is its principal axis):



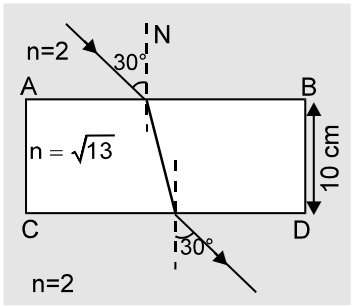
(A) 3 (B) 2 (C) 1 (D) 0

7. A ray of light falls on a transparent sphere as shown in figure. If the final ray emerges from the sphere parallel to the horizontal diameter, then the refractive index of the sphere is (consider that sphere is kept in air) :



(A) $\sqrt{2}$ (B) $\sqrt{3}$ (C) $\frac{3}{\sqrt{2}}$ (D) 2

8. Find the displacement of the ray after it emerges from CD

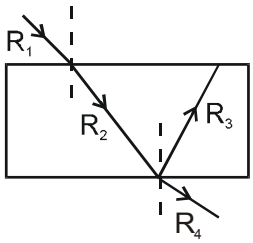


(A) 2.5 cm (B) 5 cm (C) 1 cm (D) $\frac{\sqrt{13}}{3}$ cm

9. A mango tree is at the bank of a river and one of the branch of tree extends over the river. A tortoise lives in river. A mango falls just above the tortoise. The acceleration of the mango falling from tree appearing to the tortoise is (Refractive index of water is 4/3 and the tortoise is stationary)

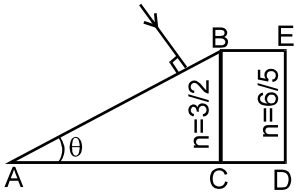
(A) g (B) $\frac{3g}{4}$ (C) $\frac{4g}{3}$ (D) None of these

10. A ray R_1 is incident on the plane surface of the glass slab (kept in air) of refractive index $\sqrt{2}$ at angle of incident equal to the critical angle for this air glass system. The refracted ray R_2 undergoes partial reflection & refraction at the other surface. The angle between the reflected ray R_3 and the refracted ray R_4 at that surface is:



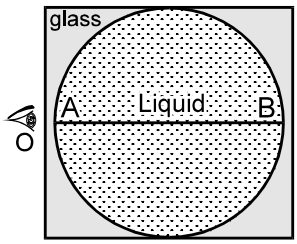
(A) 45º (B) 135º
(C) 105º (D) 75º

11. In the figure ABC is the cross section of a right angled prism and BCDE is the cross section of a glass slab. The value of θ so that light incident normally on the face AB does not cross the face BC is (given $\sin^{-1}(3/5) = 37^\circ$)



(A) $\theta \le 37^\circ$ (B) $\theta < 37^\circ$
(C) $\theta \le 53^\circ$ (D) $\theta < 53^\circ$

12. The observer 'O' sees the distance AB as infinitely large. If refractive index of liquid is μ_1 and that of glass is μ_2, then $\frac{\mu_1}{\mu_2}$ is :



(A) 2 (B) 1/2
(C) 4 (D) None of these

13. A diverging lens of focal length –10 cm is moving towards right with a velocity 5 m/s.An object ,placed on Principal axis is moving towards left with a velocity 3 m/s. The veocity of image at the instant when the lateral magification produced is 1/2 is : (All velocities are with respect to ground)
(A) 3 m/s towards right (B) 3 m/s towards left
(C) 7 m/s towards right (D) 7 m/s towards left

14. A thin prism of glass is placed in air and water respectively. If $n_g = \frac{3}{2}$ and $n_w = \frac{4}{3}$, then the deviation produced by the prism for a small angle of incidence when placed in air and water separately is :
(A) 9 : 8 (B) 4 : 3 (C) 3 : 4 (D) 4 : 1

15. The focal length of the objective and eyepiece of a microscope are 2 cm and 5 cm respectively. Object is placed at 3 cm from objective then find the magnification and lenth of the tube for normal adjustment.
(A) 10, 7 cm (B) 10, 11 cm (C) 10, 7 cm (D) 12, 55/6 cm

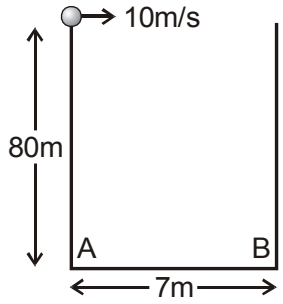
16. The xz plane separates two media A and B with refractive indices μ_1 & μ_2 respectively. A ray of light travels from A to B. Its directions in the two media are given by the unit vectors, $\vec{r}_A = a\hat{i} + b\hat{j}$ & $\vec{r}_B = \alpha\hat{i} + \beta\hat{j}$ respectively where $\hat{i}$ & $\hat{j}$ are unit vectors in the x & y directions. Then:
(A) $\mu_1 a = \mu_2 \alpha$ (B) $\mu_1 \alpha = \mu_2 a$ (C) $\mu_1 b = \mu_2 \beta$ (D) $\mu_1 \beta = \mu_2 b$

17. A particle is projected vertically upwards in vacuum with a speed u.
(A) When it rises to half its maximum height, its speed becomes u/2.
(B) When it rises to half its maximum height, its speed becomes $u/\sqrt{2}$.
(C) The time taken to rise to half its maximum height is half the time taken to reach its maximum height.
(D) The time taken to rise to three-fourth of its maximum height is half the time taken to reach its maximum height.

18. A projectile is thrown with a velocity of 20 m/s at an angle of 60º with the horizontal. After how much time the velocity vector will make an angle of 45º with the horizontal (take g = 10 m/s^2) :

(A) $\sqrt{3}$ sec (B) $1/\sqrt{3}$ sec (C) $(\sqrt{3}+1)$sec (D) $(\sqrt{3}-1)$sec

19. A ball is projected horizontally from top of a 80 m deep well with velocity 10 m/s. Then particle will fall on the bottom at a distance of (all the collisions with the wall are elastic) :



(A) 5 m from A (B) 5 m from B (C) 2 m from A (D) 2 m from B

20. A particle moves with an initial velocity v_0 and retardation βv, where v is its velocity at any time t (β is a positive constant).

(A) the particle will cover a total distance of v_0/β

(B) the particle will continue to move for a very long time

(C) the particle will stop shortly

(D) the velocity of particle will become $v_0/2$ after time $1/\beta$.

DPP No. : B3 (JEE–Advanced)

Total Marks : 40	**Max. Time : 33 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.4	**(3 marks, 2 min.) [12, 08]**
One or more than one options correct type ('–1' negative marking) Q.5 to Q.6	**(4 marks 2 min.) [08, 04]**
Subjective Questions ('–1' negative marking) Q.7 to Q.9	**(4 marks 5 min.) [12, 15]**
Match the Following (no negative marking) Q.10	**(8 marks, 6 min.) [08, 06]**

1. At t = 0, a particle at (1,0,0) moves towards point (4,4,12) with a constant velocity of magnitude of 65 m/s. The position of the particle is measured in metres and time in sec. Assuming constant velocity, the position of the particle at t = 2 sec is :

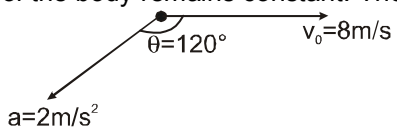
(A) $(13\ \hat{i}-120\hat{j}+40\ \hat{k})$m (B) $(40\ \hat{i}+31\ \hat{j}-120\ \hat{k})$ m

(C) $(13\ \hat{i}-40\ \hat{j}+12\ \hat{k})$ m (D) $(31\ \hat{i}+40\ \hat{j}+120\ \hat{k})$m

2. The displacement 'x' and time of travel 't' for a particle moving an a straight line are related as $t^2 = x^2 - 1$ Its acceleration at a time t is

(A) $\frac{1}{x}-\frac{1}{x^2}$ (B) $\frac{1}{x^3}$ (C) $\frac{-t^2}{x^3}$ (D) $\frac{-t}{x^2}$

3. The figure shows the velocity and acceleration of a point like body at the initial moment of its motion. The acceleration vector of the body remains constant. The time after which its speed is 8 m/s again.



(A) 2 s (B) 4 s (C) 8 s (D) 16 s

4. A particle is projected from ground at some angle with horizontal. If P is the point at maximum height H. Then the height above the point p where the particle should be aimed to have range equal to maximum height is :

(A) H (B) 2H (C) H/2 (D) 3H

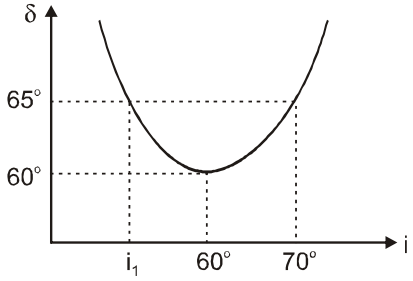
5. The angle of deviation (δ) vs angle of incidence (i) is plotted for a prism. Pick up the correct statements.

(A) The angle of prism is 60°

(B) The refractive index of the prism is n = $\sqrt{3}$

(C) For deviation to be 65° the angle of incidence i_1 = 55°

(D) The curve of 'δ' vs 'i' is parabolic



6. White light travelling in air is refracted by water

(A) It is possible that dispersion does not take place.

(B) Dispersion necessarily takes place.

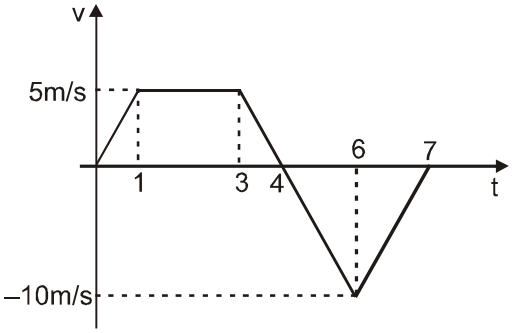
(C) Red colour has highest speed in water

(D) If light is dispersed than violet colour undergoes maximum deviation.

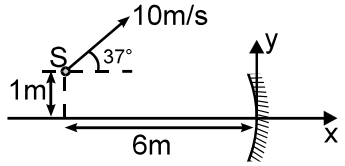
7. Velocity time graph of a particle which is moving rectilinearly is given below. Calculate

(a) Distance travelled by particle in 7 sec.

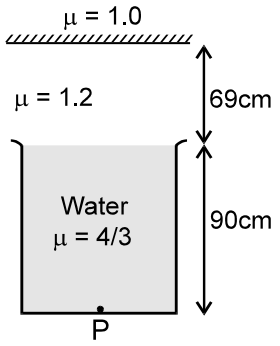
(b) Average acceleration of the particle in first 6 sec.



8. A point source S is moving with a speed of 10 m/s in x-y plane as shown in the figure. The radius of curvature of the concave mirror is 4m. Determine the velocity vector of the image formed by paraxial rays.

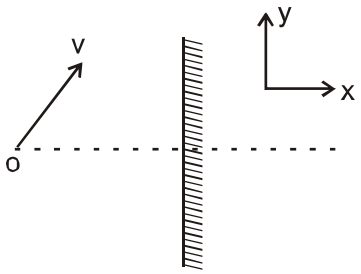


9. A particle lies on the bottom of a tank T filled with water upto a height of 90 cm. The medium above the surface of water is of R.I. = 1.2 above which there is mirror M. Beyond the mirror M the region contains air (μ = 1). The distance of the image formed by the mirror after reflection of the rays coming from P is _____ cm (w.r.t mirror).

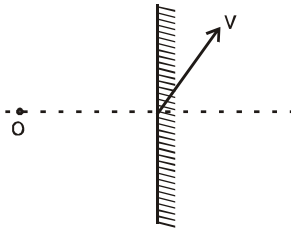


10. In coloumn-I a point object 'O' an object and a mirror are shown in which one of them is moving with velocity v as shown in figure. Column–II gives the information about velocity of image at the given instant.

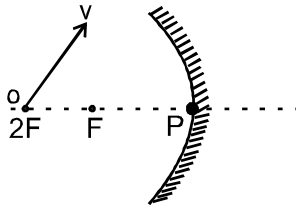
Column–I **Column–II**

(A) 

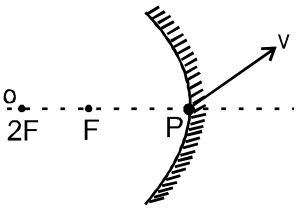
(p) x–component of velocity of Image will be positive

(B) 

(q) x–component of velocity of Image will be negative

(C) 

(r) y–component of velocity of Image will be positive

(D) 

(s) y–component of velocity of Image will be negative

(t) Image will not move

DPP No. : B4 (JEE–Advanced)

Total Marks : 37	**Max. Time : 26 min.**
Single choice Objective ('–1' negative marking) Q.1	**(3 marks, 2 min.) [03, 02]**
One or more than one options correct type ('–1' negative marking) Q.2 to Q.6	**(4 marks 2 min.) [20, 10]**
Comprehension ('–1' negative marking) Q.7 to Q.8	**(3 marks 2 min.) [06, 04]**
Subjective Questions ('–1' negative marking) Q.9 to Q.10	**(4 marks 5 min.) [08, 10]**

1. A particle is moving along a straight line. Its velocity varies as v = 6 – 2t where v is in m/s and t in seconds. The difference between distance covered and magnitude of displacement in first 4 seconds is.
(A) 8 (B) 10 (C) 6 (D) 2

2. A particle moves along positive branch of the curve $y = \frac{x}{2}$, where $x = \frac{t^3}{3}$. {x is in meter t in sec}. Then:

(A) The velocity of the particle at t = 1 sec. is $(\hat{i} + \frac{1}{2}\hat{j})$ m/s

(B) The acceleration of the particle at t = 1 sec. is $(2\hat{i} + \hat{j})$ m/s^2

(C) The particle is speeding up at t = 1 sec.

(D) The particle is slowing down at t = 1 sec.

3. Which of the following is (are) correct.
(A) The image and object are never on opposite side of focus in a spherical mirror
(B) A virtual image must be erect
(C) An image formed in a plane mirror must have same speed as the object has
(D) Laws of reflection are same for all wave lengths.

4. Which of the following statements is/are correct about the refraction of light from a plane surface when light ray is incident in denser medium. [C is critical angle]

(A) The maximum angle of deviation during refraction is $\frac{\pi}{2} - C$, it will be at angle of incidence is C.

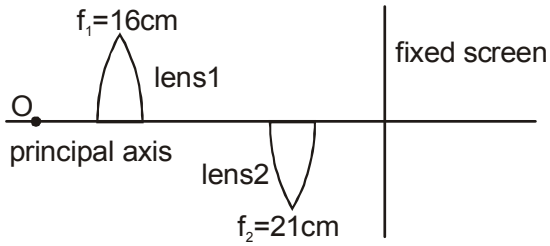
(B) The maximum angle of deviation for all angle of incidences is $\pi - 2C$, when angle of incidence is slightly greater than C.
(C) If angle of incidence is less than C then deviation increases if angle of incidence is also increased.
(D) If angle of incidence is greater than C then angle of deviation decreases if angle of incidence is increased.

5. A point object is placed at 30 cm from a convex glass lens ($n = \frac{3}{2}$) of focal length 20 cm. The final image of object will be formed at infinity if :
(A) another concave lens of focal length 60 cm is placed in contact with the convex lens
(B) another convex lens of focal length 60 cm is placed at 30 cm from the first lens

(C) the convex lens is immersed in a liquid of refractive index $\frac{4}{3}$

(D) The convex lens is immersed in a liquid of refractive index $\frac{9}{8}$

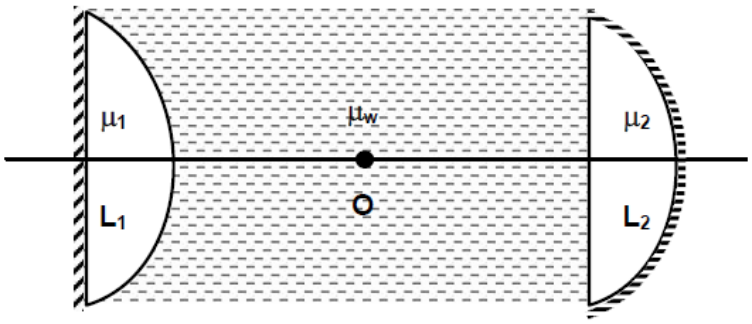
6. Two half convex lenses of focal lengths f_1 = 16 cm and f_2 = 21 cm respectively are placed such that their principal axes coincide. Both the lenses form image of a real point object O on a fixed screen as shown. The distance between object and screen is 100 cm. Then pick up the correct statement(s)



(A) The distance of lens1 from object O can be 20 cm
(B) The distance of lens 1 from object O can be 80 cm
(C) The distance of lens 2 from object O can be 30 cm
(D) The distance of lens 2 from object O can be 70 cm

Comprehension

A cylindrical tube filled with water (μ_w = 4/3) is closed at its both ends by two thin silvered plano convex lenses as shown in the figure. Refractive index of lenses L_1 and L_2 are 2.0 and 1.5 while their radii of curvature are 5 cm and 9 cm respectively. A point object is placed some where at a point O on the axis of cylindrical tube. It is found that the object and image coincide each other.

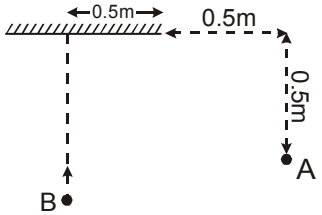


7. The distance of object O from
(A) lens L_1 is 10 cm (B) lens L_2 is 10 cm (C) lens L_1 is 8 cm (D) lens L_2 is 8 cm

8. If $\mu_1 = \mu_2 = \mu_w$ then image after two reflection (once from each) will coincide with object if distance of O from (distance between two lenses remain same)
(A) L_1 is $9\sqrt{2}$ cm (B) L_2 is $9\sqrt{2}$ cm (C) L_1 is 9 cm (D) L_2 is 9 cm

9. The vector along the incident ray on a mirror is $-2\hat{i}+3\hat{j}+4\hat{k}$. Considering the x-axis to be along the normal. Find the unit vector along the reflected ray.

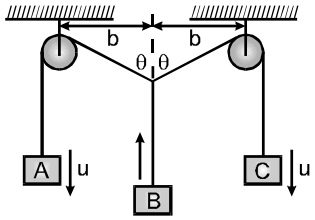
10. A man 'A' stands at the position shown in the figure and a second man 'B' approaches the mirror along the line perpendicular to it which passes through its centre. At what distance from the mirror will 'B' be at the moment when 'A' and 'B' first see each other in the mirror _____.



DPP No. : B5 (JEE–Main)

Total Marks : 60		**Max. Time : 40 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.20	**(3 marks 2 min.)**	**[60, 40]**

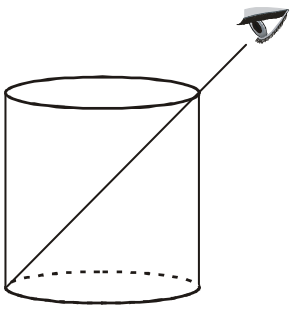
1. In the figure shown the blocks A & C are pulled down with constant velocities u . Acceleration of block B is :



(A) $\frac{u^2}{b}\tan^2\theta\sec\theta$ (B) $\frac{u^2}{b}\tan^3\theta$ (C) $\frac{u^2}{b}\sec^2\theta\tan\theta$ (D) zero

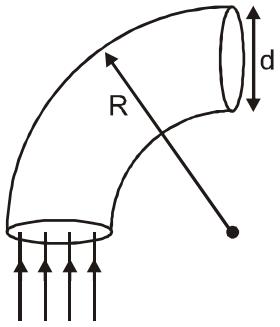
2. Two points, A and B, are located on the ground at a certain distance d apart. Two stones are launched simultaneously from points A and B with equal speeds but at different angles. Each stone lands at the launch point of the other. Knowing that one of the stone is launched at an angle $\theta > 45^\circ$ with the horizontal. Then the minimum distance between the stones during the flight will be:
(A) d $\sin\theta$ (B) d $\sin(\theta - 45^\circ)$ (C) d $\cos(\theta - 45^\circ)$ (D) d $\cos\theta$

3. A glass beaker has diameter 4cm wide at the bottom. An observer observes the edge of bottom when beaker is empty as shown in figure. When the beaker is completely filled with liquid of refractive index n = $\sqrt{5/2}$, he can just see the centre of bottom, then the height of glass beaker is:



(A) 4 cm (B) $\sqrt{5/2}$ cm
(C) 16 cm (D) None of these

4. A cylindrical optical fibre (quarter circular shape) of refractive index n = 2 and diameter d = 4mm is surrounded by air. A light beam is sent into the fibre along its axis as shown in figure. Then the smallest outer radius R (as shown in figure) for which no light escapes during first refraction from curved surface of fibre is :

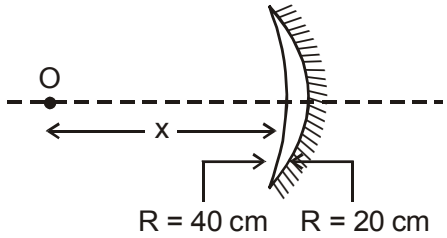


(A) 2mm
(B) 4mm
(C) 8 mm
(D) 6 mm

5. A concave spherical surface of radius of curvature 10 cm separates two mediums X and Y of refractive indices 4/3 and 3/2 respectively. Centre of curvature of the surface lies in the medium X. An object is placed in medium X.
(A) Image is always real
(B) Image is real if the object distance is greater than 90 cm.
(C) Image is always virtual
(D) Image is virtual only if the object distance is less than 90 cm.

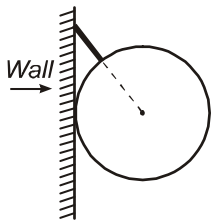
6. Both ends of a solid cylidrical glass rod of diameter 10 cm are made hemispherical. When a luminous object is placed on axis of the rod at a distance 20 cm from one end its real image is obtained at a distance 40 cm from the other end. If refractive index of glass μ = 1.5, then the length of the rod will be :
(A) 70 cm (B) 60 cm (C) 50 cm (D) 40 cm

7. Radii of curvature of a concavo-convex lens (refractive index = 1.5) are 40 cm (concave side) and 20 cm (convex side) as shown. The convex side is silvered. The distance x on the principal axis where an object is placed so that its image is created on the object itself, is equal to :



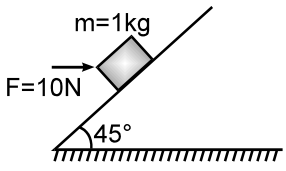
(A) 12 cm (B) 15 cm (C) 16 cm (D) 24 cm

8. A uniform sphere of weight w and radius 3 m is being held by a string of length 2 m. attached to a frictionless wall as shown in the figure. The tension in the string will be:



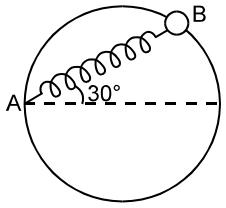
(A) 5 w/4
(B) 15 w/4
(C) 15 w/16
(D) none of these

9. A body of mass 1 kg lies on smooth inclined plane. The block of mass m is given force F = 10 N horizontally as shown. The magnitude of net normal reaction on the block is: (g = 10m/s^2)



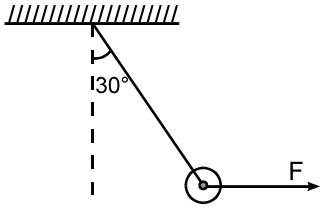
(A) 10 $\sqrt{2}$ N (B) $\frac{10}{\sqrt{2}}$ N
(C) 10 N (D) none of these

10. A bead of mass m is attached to one end of a spring of natural length R and spring constant k = $\frac{(\sqrt{3}+1)mg}{R}$. The other end of the spring is fixed at point A on a smooth vertical ring of radius R as shown in figure. The normal reaction at B just after it is released to move is



(A) $\frac{mg}{2}$ (B) $\sqrt{3}$ mg (C) $3\sqrt{3}$ mg (D) $\frac{3\sqrt{3}\ mg}{2}$

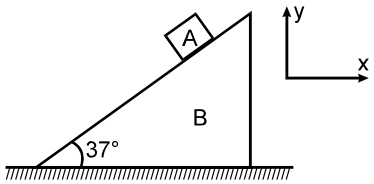
11. A heavy particle of mass 1kg is suspended from a massless string attached to a roof. A horizontal force F is applied to the particle such that in the equilibrium position the string makes an angle 30^0 with the vertical. The magnitude of the force F equals



(A) 10 N (B) $10\sqrt{3}$ N

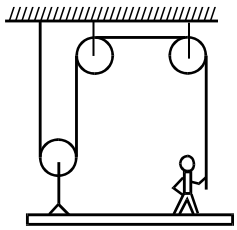
(C) 5 N (D) $\frac{10}{\sqrt{3}}$ N

12. In the figure shown the acceleration of A is, $\vec{a}_A = 15\hat{i} + 15\hat{j}$ then the acceleration of B is: (A remains in contact with B)



(A) $6\hat{i}$ (B) $-15\hat{i}$ (C) $-10\hat{i}$ (D) $-5\hat{i}$

13. A 50kg person stands on a 25 kg platform. He pulls on the rope which is attached to the platform via the frictionless pulleys as shown in the fig. The platform moves upward at a steady rate if the force with which the person pulls the rope is :



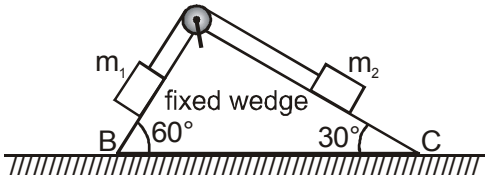
(A) 500 N (B) 250 N

(C) 25 N (D) 50 N

14. A man stands on a weighing machine kept inside a lift. Initially the lift is ascending with the acceleration 'a' due to which the reading is W. Now the lift decends with the same accleration and reading is 10 % of initial. Find the acceleration of lift ?

(A) $\frac{g}{19}$ m/sec^2 (B) $\frac{9g}{11}$ m/sec^2 (C) 0 m/sec^2 (D) g m/sec^2

15. Two small masses m_1 and m_2 are at rest on a frictionless, fixed triangular wedge whose angles are 30° and 60° as shown. They are connected by a light inextensible string. The side BC of wedge is horizontal and both the masses are 1 metre vertically above the horizontal side BC of wedge. There is no friction between the wedge and both the masses. If the string is cut, which mass reaches the bottom of the wedge first? (Take g = 10m/s^2)



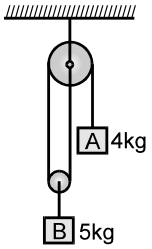
(A) Mass m_1 reaches the bottom of the wedge first.

(B) Mass m_2 reaches the bottom of the wedge first.

(C) Both reach the bottom of the wedge at the same time.

(D) It's impossible to determine from the given information.

16. The acceleration of the blocks (A) and (B) respectively in situation shown in the figure is: (pulleys & strings are massless)



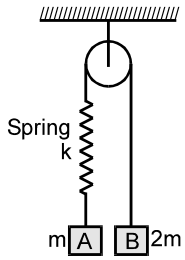
(A) $\frac{2g}{7}$ downward, $\frac{g}{7}$ upward

(B) $\frac{2g}{3}$ downward, $\frac{g}{3}$ upward

(C) $\frac{10}{13}$ g downward, $\frac{5g}{13}$ upward

(D) none of these

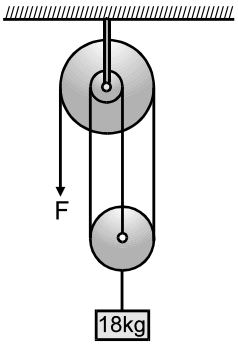
17. Two blocks A and B of masses m & 2m respectively are held at rest such that the spring is in natural length. Find out the accelerations of blocks A and B respectively just after release (pulley, string and spring are massless).



(A) g ↓, g ↓ (B) $\frac{g}{3}$ ↓, $\frac{g}{3}$ ↑

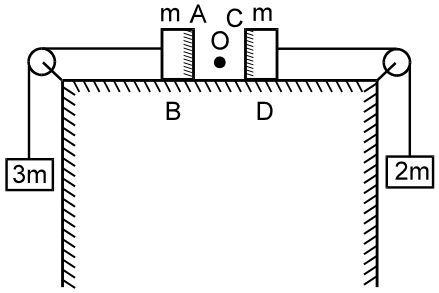
(C) 0, 0 (D) g ↓, 0

18. In the figure, at the free end of the light string, a force F is applied to keep the suspended mass of 18 kg at rest. Then the force exerted by the ceiling on the system (assume that the string segments are vertical and the pulleys are light and smooth) is: (g= 10 m/s^2)



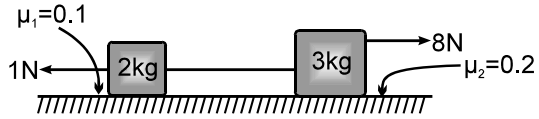
(A) 60 N
(B) 120 N
(C) 180 N
(D) 240 N

19. Two blocks each of mass m lie on a smooth table. They are attached to two other masses as shown in the figure. The pulleys and strings are light. An object O is kept at rest on the table. The sides AB & CD of the two blocks are made reflecting. The acceleration of two images formed in those two reflecting surfaces w.r.t. each other is:



(A) 5g/6 (B) 5g/3 (C) g/3 (D) 17 g/6

20. In the shown arrangement if f_1, f_2 and T be the frictional forces on 2 kg block, 3kg block & tension in the string respectively, then their values are:

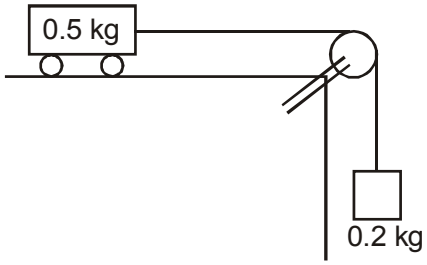


(A) 2 N, 6 N, 3.2 N (B) 2 N, 6 N, 0 N
(C) 1 N, 6 N, 2 N (D) data insufficient to calculate the required values.

DPP No. : B6 (JEE–Advanced)

Total Marks : 35		**Max. Time : 28 min.**
One or more than one options correct type ('–1' negative marking) Q.1 to Q.3	**(4 marks 2 min.)**	**[12, 06]**
Comprehension ('–1' negative marking) Q.4 to Q.6	**(3 marks 2 min.)**	**[09, 06]**
Subjective Questions ('–1' negative marking) Q.7 to Q.8	**(4 marks 5 min.)**	**[08, 10]**
Match the Following (no negative marking) Q.9	**(8 marks, 6 min.)**	**[08, 06]**

1. A cart of mass 0.5 kg is placed on a smooth surface and is connected by a string to a block of mass 0.2 kg. At the initial moment the cart moves to the left along a horizontal plane at a speed of 7 m/s. (Use g = 9.8 m/s^2)



(A) The acceleration of the cart is $\frac{2g}{7}$ towards right.

(B) The cart comes to momentary rest after 2.5 s.

(C) The distance travelled by the cart in the first 5s is 17.5 m.

(D) The velocity of the cart after 5s will be same as initial velocity.

2. There are two massless springs A and B of spring constant K_A and K_B respectively and $K_A > K_B$. If W_A and W_B be denoted as work done on A and work done on B respectively, then

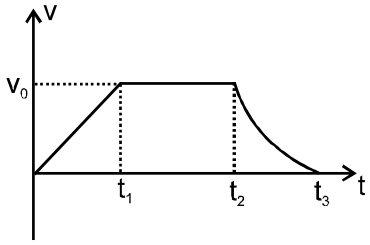
(A) If they are compressed to same distance, $W_A > W_B$

(B) If they are compressed by same force (upto equilibrium state) $W_A < W_B$

(C) If they are compressed by same distance, $W_A = W_B$

(D) If they are compressed by same force (upto equilibrium state) $W_A > W_B$

3. For a particle moving along a straight line velocity-time graph is shown. Which of the following is/are **incorrect** for motion from t = 0 to t = t_3.



(A) Particle has changed it's direction 2 time in it's motion

(B) Through-out the motion displacement is increasing.

(C) Acceleration is always either positive or zero.

(D) Total displacement is 3/4th of the distance travelled.

Comprehension

The driver of a car travelling at a speed of 20 m/s, wishes to overtake a truck that is moving with a constant speed of 20 m s^{-1} in the same lane. The car's maximum acceleration is 0.5 m s^{-2}. Initially the vehicles are separated by 40 m, and the car returns back into its lane after it is 40 m ahead of the truck. The car is 3 m long and the truck 17m long.

4. Find the minimum time required for the car to pass the truck and return back to its lane?

(A) 10 second (B) 20 second, (C) 15 second (D) none of these.

5. What distance does the car travel during this time?

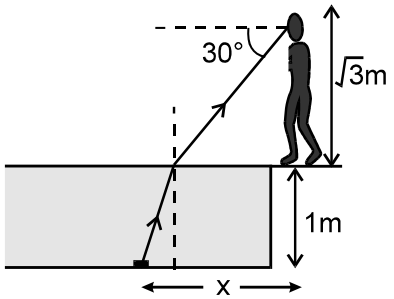
(A) 500 m (B) 600 m (C) 200 m (D) 300 m

6. What is the final speed of the car ?

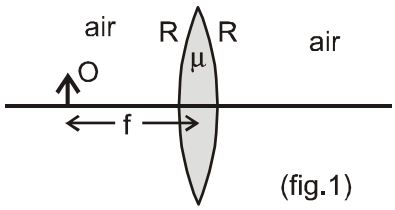
(A) 40 m/s (B) 20 m/s (C) 45 m/s (D) 30 m/s

7. A transparent solid cube of side ' a ' has refractive index 3/2. A point source of light is embedded in it at its centre. Find the minimum area of the surface of the cube which must be painted black so that the source is not visible from outside.

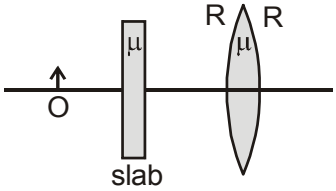
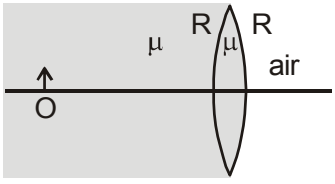
8. A man is standing at the edge of a 1m deep swimming pool, completely filled with a liquid of refractive index $\sqrt{3/2}$. The eyes of the man are $\sqrt{3}$ m above the ground. A coin located at the bottom of the pool appears to be at an angle of depression of 30^0 with reference to the eye of man. Then horizontal distance (represented by x in the figure) of the coin from the eye of the man is _____ mm.



9. An object O (real) is placed at focus of an equi-biconvex lens as shown in figure 1. The refractive index of lens is μ = 1.5 and the radius of curvature of either surface of lens is R. The lens is surrounded by air. In each statement of column-I some changes are made to situation given above and information regarding final image formed as a result is given in column-II. The distance between lens and object is unchanged in all statements of column-I. Match the statements in column-I with resulting image in column-II.



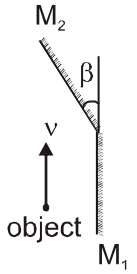
(fig.1)

Column-I	Column-II
(A) If the refractive index of the lens is doubled (that is, made 2 μ) then	(p) final image is real
(B) If the radius of curvature is doubled (that is, made 2R) then	(q) final image is virtual
(C) If a glass slab of refractive index μ = 1.5 is introduced between the object and lens as shown, then 	(r) final image becomes smaller in size in comparison to size of image before the change was made
(D) If the left side of lens is filled with a medium of refractive index μ = 1.5 as shown, then 	(s) final image is of same size of object.

DPP No. : B7 (JEE–Advanced)

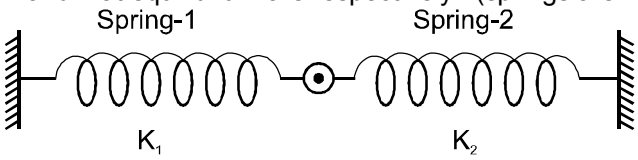
Total Marks : 38		**Max. Time : 32 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.2	**(3 marks 2 min.)**	**[06, 04]**
One or more than one options correct type ('–1' negative marking) Q.3 to Q.6	**(4 marks 2 min.)**	**[16, 08]**
Subjective Questions ('–1' negative marking) Q.7 to Q.10	**(4 marks 5 min.)**	**[16, 20]**

1. A object is moving with velocity v (w.r.t. earth) parallel to plane mirror M_1. Another plane mirror M_2 makes an angle β with the vertical as shown in figure. Then velocity of image in mirror M_2 w.r.t. the image in M_1 is-



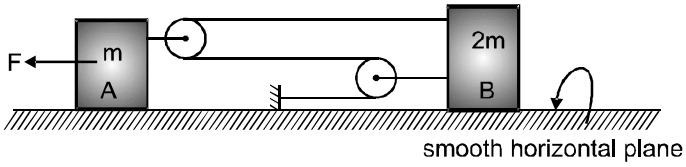
(A) $2v \sin \beta$ (B) $v \cos 2\beta$ (C) $2v \sin \beta$ (D) $v\sqrt{2}$

2. Spring 1 has a natural length of 0.5 meter and force constant K_1 = 25 N/m and spring – 2 has a natural length of 1 meter and a force constant K_2 = 10 N/m. They are joined together and their free ends are stretched so that the ends are fixed to the two walls 2 meter apart as shown in figure. The stretched lengths of the spring 1 and 2 at equilibrium are respectively : (springs are massless)



(A) $\frac{9}{14}$m, $\frac{19}{14}$m (B) $\frac{8}{14}$m, $\frac{20}{14}$m (C) $\frac{7}{14}$m, $\frac{21}{14}$m (D) $\frac{16}{14}$m , $\frac{12}{14}$m

3. An external force 'F' is applied to a system of two blocks placed on a smooth surface as shown :



(A) Acceleration of block A is $\frac{9F}{17m}$ (B) Acceleration of block A is $\frac{9F}{20m}$

(C) Acceleration of block B is $\frac{6F}{17m}$ (D) Acceleration of block B is $\frac{7F}{20m}$

4. An air India flight made an emergency landing with its wheel locked, due to locked wheels, horizontal component of acceleration is $a = -B_0 + B_1 t$ from touch down at t = 0, until the plane comes to rest at $t = t_0$, $B_0 > 0$ and $B_1 > 0$. Then which of following options is/are correct ?

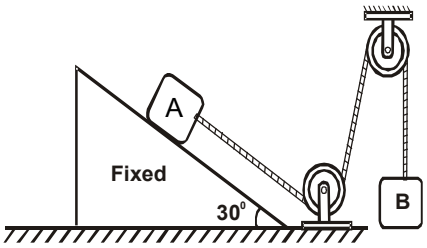
(A) Horizontal speed of plane at t = 0 when it first touched down is $B_0 t_0$

(B) Horizontal speed of plane at t = 0 when it first touched down is $B_0 t_0 - \frac{B_1 t_0^2}{2}$

(C) Distance traveled by plane from t = 0 to $t = t_0$ is $\frac{B_0 t_0^2}{2} - \frac{B_1 t_0^3}{3}$.

(D) Distance traveled by plane from t = 0 to $t = t_0$ is $B_0 t_0^2 - \frac{B_1 t_0^3}{3}$

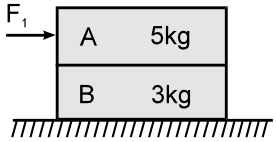
5. Two blocks A and B of equal mass m are connected through a massless string and arranged as shown in figure. The wedge is fixed on horizontal surface. Friction is absent everywhere. When the system is released from rest.

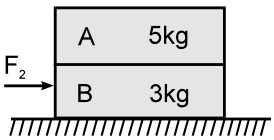


(A) tension in string is $\frac{mg}{2}$ (B) tension in string is $\frac{mg}{4}$

(C) acceleration of A is g/2 (D) acceleration of A is $\frac{3}{4}g$

6. A block A (5 kg) rests over another block B (3 kg) placed over a smooth horizontal surface. There is friction between A and B. A horizontal force F_1 gradually increasing from zero to a maximum is applied to A so that the blocks move together without relative motion. Instead of this another horizontal force F_2, gradually increasing from zero to a maximum is applied to B so that the blocks move together without relative motion. Then

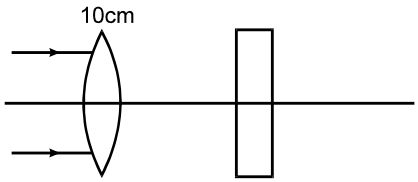




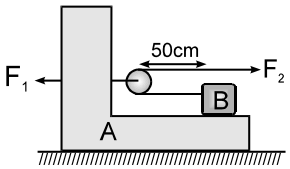
(A) F_1 (max) = F_2 (max) (B) F_1 (max) > F_2 (max)

(C) F_1 (max) < F_2 (max) (D) F_1 (max): F_2 (max) = 5: 3

7. A parallel beam of light is incident on a lens of focal length 10 cm. A parallel slab of refractive index 1.5 and thickness 3 cm is placed on the other side of the lens. Find the distance of the final image from the lens.

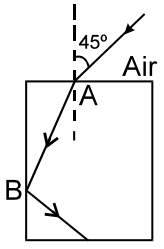


8. A 1 kg block 'B' rests as shown on a bracket 'A' of same mass. Constant forces F_1 = 20 N and F_2 = 8 N start to act at time t = 0 when the distance of block B from pulley is 50 cm.Time when block B reaches the pulley is _____. (Assume that friction is absent every where. Pulley and string are light).



9. An object lies in front of a thick parallel glass slab, the bottom of which is polished. If the distance between first two images formed by bottom surface is 4cm then find the thickness of the slab. [Assume n_{glass} = 3/2 and paraxial rays]

10. A ray of light is incident from air to a glass rod at point A the angle of incidence being 45^0. The minimum value of refractive index of the material of the rod so that T.I.R. takes place at B is _____.



DPP No. : B8 (JEE–Main)

Total Marks : 60 **Max. Time : 40 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.20 **(3 marks 2 min.) [60, 40]**

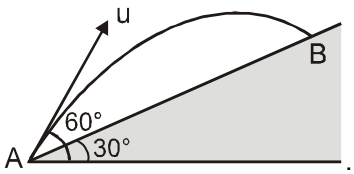
1. A plane is flying with an air speed 10 m/s toward north but suddenly encounters a wind of 10 m/s at 30º north of east. If angle made by new direction of velocity of plane with respect to ground from north direction is $\frac{\pi}{n}$ then value of n is :

(A) 3 (B) 4 (C) 5 (D) 6

2. A man is moving with 10 m/s towards west on a horizontal ground. He observed that the rainfall is falling vertically down wards. Now he increases his speed to 15 m/s and find that now the rainfall is falling at an angle of 45° towards him. The speed of the rain with respect to ground is :

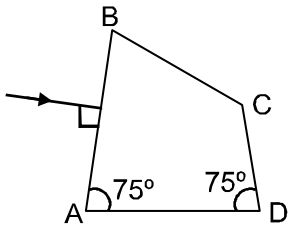
(A) $10\sqrt{5}$ m/s (B) 10 m/s (C) $5\sqrt{5}$ m/s (D) None of these

3. A stone is projected from point A with speed u making an angle 60° with horizontal as shown. The fixed inclined surface makes an angle 30° with horizontal. The stone lands at B after time t. Then the distance AB is equal to



(A) $\frac{ut}{\sqrt{3}}$ (B) $\frac{\sqrt{3}ut}{2}$ (C) $\sqrt{3}ut$ (D) 2 ut

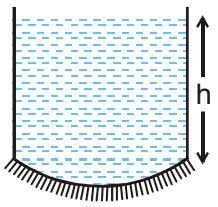
4. A ray is incident perpendicularly on the surface AB of a transparent glass slab & is totally reflected at the surface CD. The minimum refractive index of the material of the slab is-



(A) $\frac{2}{\sqrt{3}}$ (B) $\sqrt{2}$

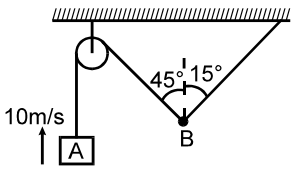
(C) 2 (D) $\frac{3}{2}$

5. A beaker is filled with water as shown. The bottom surface of the beaker is a concave mirror of large radius of curvature and small aperture. The height of water is h = 40 cm. It is found that when an object is placed 4 cm above the water surface, the image coincides with the object. Now the water level h is reduced to zero (there will still be water left in the concave part of the mirror). The new height of the object above the new water surface so that the image again coincides with the object, will be (refractive index of water = 4/3)



(A) 34 cm (B) 10 cm (C) 74 cm (D) zero

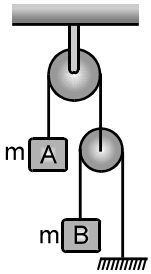
6. A system is shown in the figure. Block A moves with velocity 10 m/s. The speed of the mass B will be: ($\sin 15^\circ = \frac{\sqrt{3}-1}{2\sqrt{2}}$)



(A) $10\sqrt{2}$ m/s (B) $5\sqrt{3}$ m/s

(C) $\frac{20}{\sqrt{3}}$ m/s (D) 10 m/s

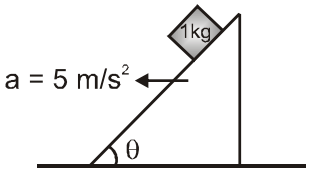
7. In the figure shown neglecting friction and mass of pulleys, what is the acceleration of mass B?



(A) $\frac{g}{3}$ (B) $\frac{5g}{2}$

(C) g (D) $\frac{2g}{5}$

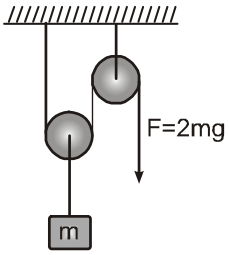
8. A block of mass 1 kg is at rest relative to a smooth wedge being moved leftwards with constant acceleration $5 m/s^2$. Let N be the normal reaction between the block and the wedge. Then N and $\tan\theta$ are :



(A) N = $5\sqrt{5}$ N and $\tan\theta = \frac{1}{2}$ (B) N = 15 N and $\tan\theta = \frac{1}{2}$

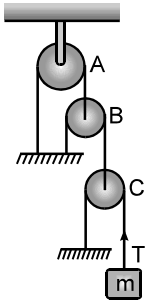
(C) N = $5\sqrt{5}$ N and $\tan\theta = 2$ (D) N = 15 N and $\tan\theta = 2$

9. In the shown mass pulley system, pulleys and string are massless. The one end of the string is pulled by the force F = 2mg. The acceleration of the block will be



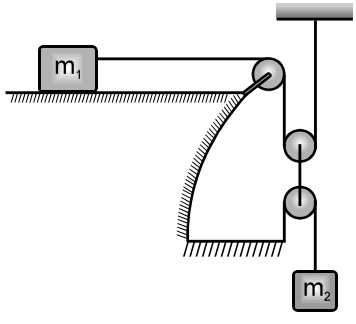
(A) g/2
(B) 0
(C) g
(D) 3g

10. Pulleys A, B, C are connected to the mass as shown in figure. Tension in the rope connecting A to the wall is :



(A) m g
(B) 4 m g
(C) 8 m g
(D) none of these

11. Two blocks of masses m_1 and m_2 are connected as shown in the figure. The acceleration of the block m_2 is (pullyes and strings are ideal) :

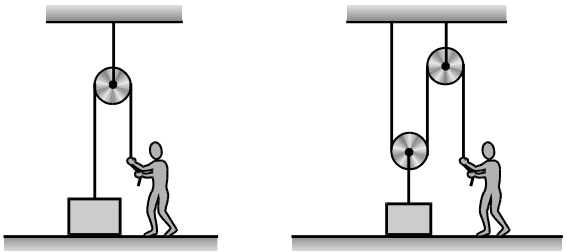


(A) $\frac{m_2 g}{m_1 + m_2}$ (B) $\frac{m_1 g}{m_1 + m_2}$ (C) $\frac{4m_2 g - m_1 g}{m_1 + m_2}$ (D) $\frac{m_2 g}{m_1 + 4m_2}$

12. Figure shows a 5 kg ladder hanging from a string that is connected with a ceiling and is having a spring balance connected in between. A boy of mass 25 kg is climbing up the ladder at acceleration 1 m/s^2. Assuming the spring balance and the string to be massless and the spring to show a constant reading, the reading of the spring balance is: (Take g = 10 m/s^2)

(A) 30 kg
(B) 32.5 kg
(C) 35 kg
(D) 37.5 kg

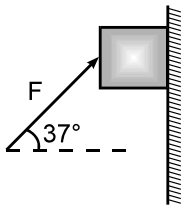
13. In the figure shown, a person wants to raise a block lying on the ground to a height h. In both the cases if time required is same then in which case he has to exert more force. Assume pulleys and strings to be light.



(i) (ii)

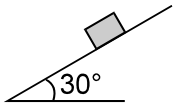
(A) (i) (B) (ii) (C) same in both
(D) Cannot be determined

14. A 1 kg block is being pushed against a wall by a force F = 75 N as shown in the Figure. The coefficient of friction is 0.25. The magnitude of acceleration of the block is:



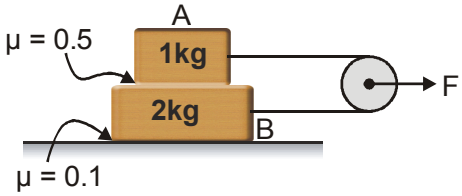
(A) 10 m/s^2 (B) 20 m/s^2
(C) 5 m/s^2 (D) none of these

15. Figure shows a block kept on a rough inclined plane. The maximum external force along the plane downwards for which the block remains at rest is 1N while the maximum external force along the incline upwards for which the block is at rest is 7 N. The coefficient of static friction μ is :



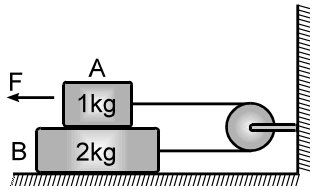
(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{1}{\sqrt{6}}$ (C) $\sqrt{3}$ (D) $\frac{4}{3\sqrt{3}}$

16. Find the maximum horizontal force F which can be applied such that sliding does not occur between A and B.



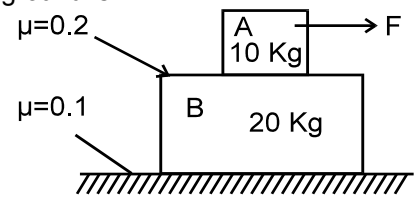
(A) 20 N (B) 24 N (C) 30 N (D) 332 N

17. Two blocks A (1 kg) and B (2 kg) are connected by a string passing over a smooth pulley as shown in the figure. B rests on rough horizontal surface and A rest on B. The coefficient of friction between A & B is the same as that between B and the horizontal surface. The minimum horizontal force F required to move A to the left is 25N. The coefficient of friction is: [g = 10 m/s^2]



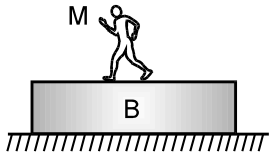
(A) 0.67 (B) 0.5 (C) 0.4 (D) 0.25

18. In given diagram what is the minimum value of a horizontal external force F on Block 'A' so that block 'B' will slide on ground is:



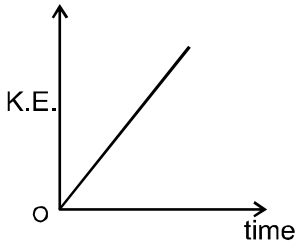
(A) 30 N (B) 20 N (C) 10 N (D) Not possible

19. As shown in the figure, M is a man of mass 60 kg standing on a block of mass 40 kg kept on ground. The co-efficient of friction between the feet of the man and the block is 0.3 and that between B and the ground is 0.1. If the man accelerates with an acceleration 2 m/s^2 in the forward direction, then



(A) it is not possible
(B) B will move backwards with an acceleration 0.5 m/s^2
(C) B will not move
(D) B will move forward with an acceleration 0.5 m/s^2.

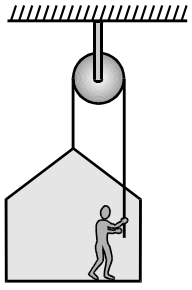
20. A body moves along a straight line and the variation of its kinetic energy with time is linear as depicted in the figure below :
Then force acting on the body is :
(A) directly proportional to velocity
(B) inversely proportional to velocity
(C) zero
(D) constant



DPP No. : B9 (JEE–Advanced)

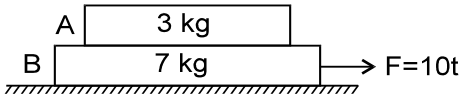
Total Marks : 41	Max. Time : 33 min.
One or more than one options correct type ('–1' negative marking) Q.1 to Q.3	(4 marks 2 min.) [12, 06]
Comprehension ('–1' negative marking) Q.4 to Q.6	(3 marks 2 min.) [09, 06]
Subjective Questions ('–1' negative marking) Q.7 to Q.9	(4 marks 5 min.) [12, 15]
Match the Following (no negative marking) Q.10	(8 marks 6 min.) [08, 06]

1. A painter is applying force himself to raise him and the box with an acceleration of 5 m/s^2 by a massless rope and pulley arrangement as shown in figure. Mass of painter is 100 kg and that of box is 50 kg. If g = 10 m/s^2, then:



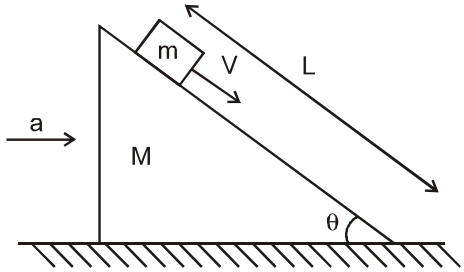
(A) tension in the rope is 1125 N
(B) tension in the rope is 2250 N
(C) force of contact between the painter and the floor is 375 N
(D) none of these

2. A variable force F = 10 t is applied to block B placed on a smooth surface. The coefficient of friction between A & B is 0.5. (t is time in seconds. Initial velocities are zero)



(A) block A starts sliding on B at t = 5 seconds
(B) the heat produced due to friction in first 5 seconds is 312.5J
(C) the heat produced due to friction in 5 seconds is (625/8) J
(D) acceleration of A at 10 seconds is 5 m/s^2.

3. A wedge of mass M is pushed with an constant acceleration of a = gtanθ along a smooth horizontal surface and a block of mass m is projected down the smooth incline of the wedge with a velocity V relative to the wedge.



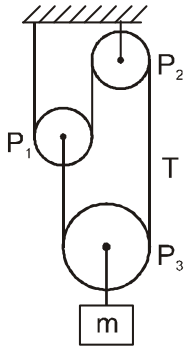
(A) The time taken by the block to cover distance L on the incline plane is $\frac{L}{V}$

(B) The time taken by the block to cover distance L on the incline plane is $\sqrt{\frac{2L}{g\sin\theta}}$

(C) The normal reaction between the block and wedge is mg secθ
(D) The horizontal force applied on the wedge to produce acceleration a is (M + m) g tanθ.

Comprehension

Three smooth pulleys are connected by a light string. A mass m is attached to the pulley P_3. Assume the strings between two pulleys and between the pulley and the support to be vertical.



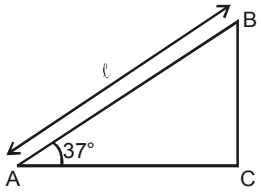
4. If all the pulleys are massless then the tension in the string connecting the pulleys is
(A) T = 0 (B) mg (C) 2 mg (D) mg/2

5. The relation between the magnitudes of acceleration of pulley P_1 (a_{P_1}) and that of pulley P_3 (a_{P_3}) is
(A) $a_{P_1} = a_{P_3}$ (B) $a_{P_1} = 2a_{P_3}$ (C) 2 $a_{P_1} = a_{P_3}$ (D) $a_{P_1} = 3a_{P_3}$

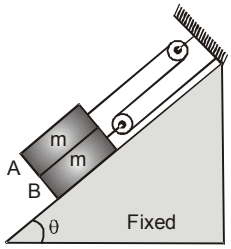
6. The tension in the string will be non zero when
(A) mass of pulley P_1 is zero (B) mass of pulley P_2 is zero
(C) mass of pulley P_1 is non zero (D) mass of pulley P_2 is non zero.

7. A bullet is fired with speed 50 m/s at 45° angle find the height of the bullet when its direction of motion makes angle 30° with the horizontal.

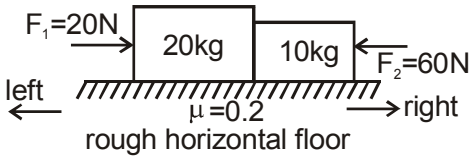
8. Two particles initially situated at A & B as shown in figure. A and B both start moving towards C simultaneously. A moves with constant velocity v_0 and B starts moving from rest with constant acceleration a_0. They reach at point C simultaneously. Radius of curvature of the path followed by B as seen by A just after they start moving toward C is $\frac{P}{Q}\ell$ Find minimum value of Q – P.



9. Two block each of mass m are connected as shown in figure. Pulley are smooth and light. If the coefficient of static friction at all surfaces is μ_s. If inclination θ is increased gradually then 'θ' at which the blocks begins to slide is given by $\theta = \tan^{-1}(\alpha\mu_s)$. Find value of α.



10. Two blocks of masses 20 kg and 10 kg are kept or a rough horizontal floor. The coefficient of friction between both blocks and floor is μ = 0.2. The surface of contact of both blocks are smooth. Horizontal forces of magnitude 20 N and 60 N are applied on both the blocks as shown in figure. Match the statement in column-I with the statements in column-II.

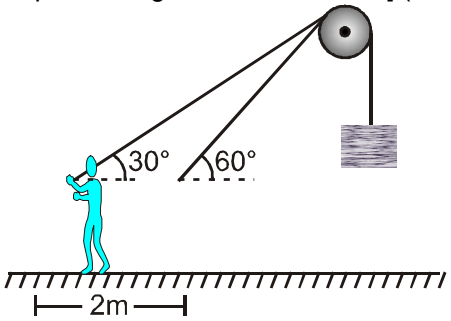


Column-I	Column-II
(A) Frictional force acting on block of mass 10 kg	(p) has magnitude 20 N
(B) Frictional force acting on block of mass 20 kg	(q) has magnitude 40 N
(C) Normal reaction exerted by 20 kg block on 10 kg block	(r) is zero
(D) Net force on system consisting of 10 kg block and 20 kg block	(s) is towards right (in horizontal direction).

DPP No. : B10 (JEE–Advanced)

Total Marks : 39	**Max. Time : 30 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.2	**(3 marks, 2 min.) [06, 04]**
One or more than one options correct type ('–1' negative marking) Q.3 to Q.4	**(4 marks 2 min.) [08, 04]**
Comprehension ('–1' negative marking) Q.5 to Q.7	**(3 marks 2 min.) [09, 06]**
Subjective Questions ('–1' negative marking) Q.8 to Q.9	**(4 marks 5 min.) [08, 10]**
Match the Following (no negative marking) Q.10	**(8 marks 6 min.) [08, 06]**

1. A person lifts a 25 kg block hanging over a fixed light frictionless small pulley by walking horizontally, as shown in figure. As the person walks 2 metres, the angle of the rope to the horizontal changes from 60° to 30°. If the block rises at constant speed, the work done by rope on the person as the person moves by 2 metres is : [consider the rope to be light and inextensible] (Take g = 10m/s^2)



(A) $500(\sqrt{3}-1)$J (B) $500(1-\sqrt{3})$ J (C) $500(\sqrt{3})$J (D) None of these

2. A force which varies with time t as $\vec{F} = \left(3t\hat{i} + 5\hat{j}\right)$N acts on a body due to which its position varies with time t as $\vec{s} = \left(2t^2\hat{i} - 5\hat{j}\right)$ where t is in seconds. Work done by this force in initial 2s is:

(A) 23 J (B) 32 J (C) zero (D) can't be obtained

3. The potential energy U (in joule) of a particle of mass 1 kg moving in x-y plane obeys the law U = 3x + 4y, where (x, y) are the co-ordinates of the particle in metre. If the particle is at rest at (6, 4) at time t = 0, then:

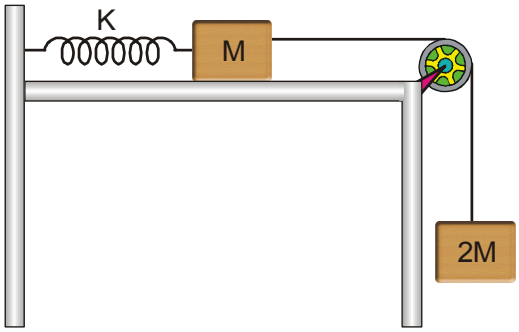
(A) the particle has constant acceleration

(B) the particle has zero acceleration

(C) the speed of particle when it crosses the y-axis is 10 m/s

(D) coordinates of the particle at t = 1 sec are (4.5, 2)

4. Two blocks, of masses M and 2M, are connected to a light spring of spring constant K that has one end fixed, as shown in figure. The horizontal surface and the pulley are frictionless. The blocks are released from rest when the spring is non deformed. The string is light.



(A) Maximum extension in the spring is $\frac{4Mg}{K}$.

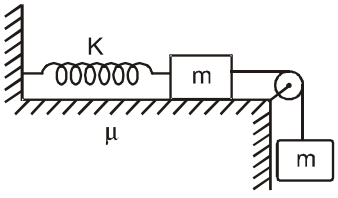
(B) Maximum kinetic energy of the system is $\frac{2M^2g^2}{K}$

(C) Maximum energy stored in the spring is four times that of maximum kinetic energy of the system.

(D) When kinetic energy of the system is maximum, energy stored in the spring is $\frac{4M^2g^2}{K}$

Comprehension

Consider the system shown below, with two equal masses m and a spring with spring constant K. The coefficient of friction between the left mass and horizontal table is μ, and the pulley is frictionless. The string connecting both the blocks is massless and inelastic. The system is held with the spring at its unstretched length and then released.



5. The extension in spring when the masses come to momentary rest for the first time is (if μ = 1/4)

(A) $\frac{3mg}{2K}$ (B) $\frac{mg}{2K}$ (C) $\frac{mg}{K}$ (D) $\frac{2mg}{K}$

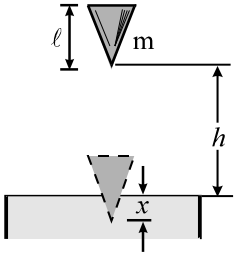
6. The values of μ for which the system remains at rest once it has stopped for the first time is

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{3}$ (C) $\frac{1}{2}$ (D) $\frac{1}{\sqrt{2}}$

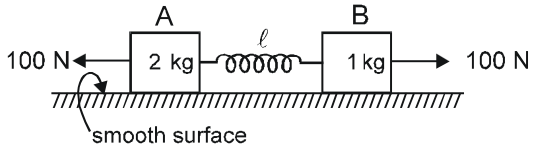
7. If the string connecting both the masses is cut just at the instant both masses came to momentary rest for the first time in the first question of paragraph, then maximum compression of spring during resulting motion is (Take $\mu = 1/4$)

(A) $\frac{2mg}{3k}$ (B) $\frac{mg}{2k}$ (C) $\frac{mg}{k}$ (D) $\frac{1mg}{3k}$

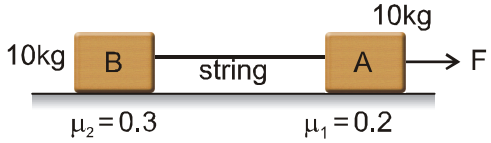
8. A cone of mass 'm' falls from a height 'h' and penetrates into sand. The resistance force R of the sand is given by $R = kx^2$. If the cone penetrates upto a distance x = d where $d < \ell$, then find the value of 'k'.



9. In the figure shown initially spring is in relexed state & blocks are at rest. Now 100 N force is applied on block A & B as shown in figure. After some time velocity of 'A' becomes 2 m/s and that of 'B' 4 m/s and block A displaced by amount 10 cm towards left and spring is stretched by amount 30 cm. Then work done by spring force on A is W_0 Joule. Find $|W_0|$.



10. Two blocks of same mass m = 10 kg are placed on rough horizontal surface as shown in figure. Initially tension in the massless string is zero and string is horizontal. A horizontal force $F = 40 \sin\left(\frac{\pi}{6}t\right)$ is applied as shown on the block A for a time interval t = 0 to t = 6 sec. Here F is in Newton and t in second. Friction coefficient between block A and ground is 0.20 and between block B and ground is 0.30. (Take g = 10 m/sec^2). Match the statements in column-I with the time intervals (in seconds) in column-II.



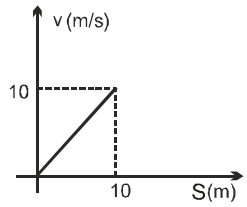
Column I	Column II
(A) Friction force between block B and ground is zero in the time interval	(p) $0 < t < 1$
(B) Tension in the string is non zero in the time interval	(q) $1 < t < 3$
(C) Acceleration of block A is zero in the time interval	(r) $3 < t < 5$
(D) Magnitude of friction force between A and ground is decreasing in the time interval	(s) $5 < t < 6$

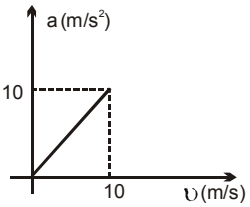
DPP No. : B11 (JEE–Main)

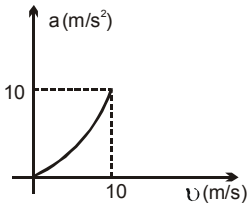
Total Marks : 60 **Max. Time : 40 min.**

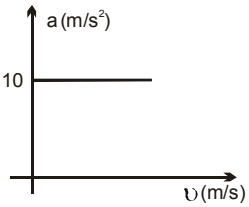
Single choice Objective ('–1' negative marking) Q.1 to Q.20 **(3 marks 2 min.)** **[60, 40]**

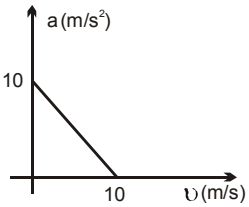
1. Velocity (v) versus displacement (S) graph of a particle moving in a straight line is shown in figure. Corresponding acceleration (a) versus velocity (v) graph will be



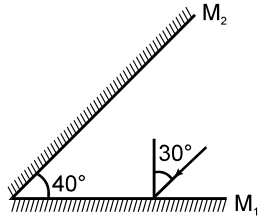
(A) 

(B) 

(C) 

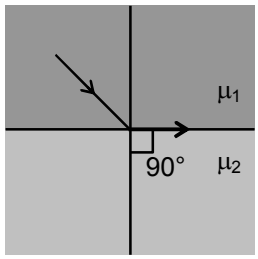
(D) 

2. In the figure shown, the maximum number of reflections will be :



(A) 2 (B) 3 (C) 4 (D) 1

3. A ray is incident on interface of two media at critical angle as shown in the figure.



(A) If μ_1 and μ_2 both are increased by same amount the ray will suffer total internal reflection

(B) If μ_1 and μ_2 both are increased by same amount the ray will suffer refraction and angle of refraction will be less then 90°.

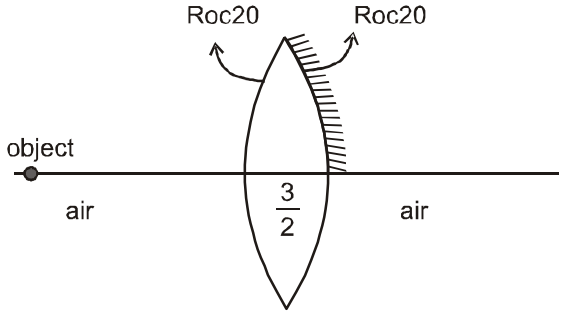
(C) If μ_1 and μ_2 both are doubled ray will suffer total internal reflection

(D) If μ_1 and μ_2 both are doubled ray will suffer refraction and angle of refraction will be less then 90°.

4. For a prism kept in air it is found that for an angle of incidence 60°, the angle of refraction 'A', angle of deviation 'δ' and angle of emergence 'e' become equal. Then the refractive index of the prism is

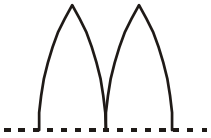
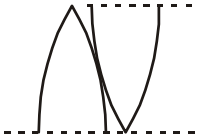
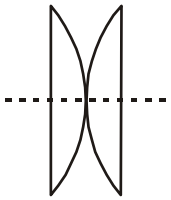
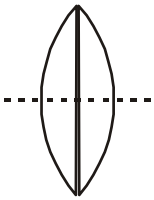
(A) 1.73 (B) 1.15 (C) 1.5 (D) 1.33

5. Distance between two images formed by upper and lower part of the point object placed at 30 cm from given lens.



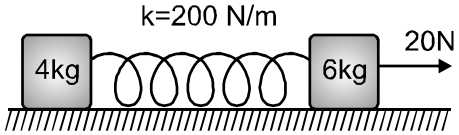
(A) 66 cm (B) 36 cm (C) 72 cm (D) 42 cm

6. A convex lens is cut into two parts in different ways that are arranged in four manners, as shown. Which arrangement will give maximum optical power ?

(A)  (B)  (C)  (D) 

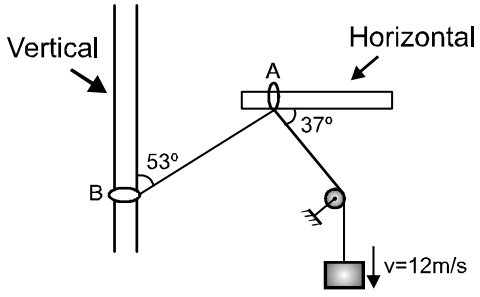
7. The following data are given for a crown glass prism ;
refractive index for blue light $n_b = 1.521$
refractive index for red light $n_r = 1.510$
refractive index for yellow light $n_y = 1.550$
Dispersive power of a parallel glass slab made of the same material is :
(A) 0.01 (B) 0.02 (C) 0.03 (D) 0

8. Two blocks of mass 4 kg and 6kg are attached by a spring of spring constant k = 200 N/m, both blocks are moving with same acceleration. Find elongation in spring :



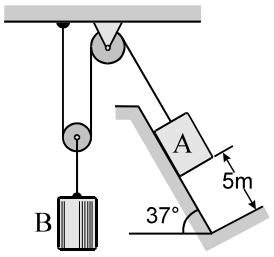
(A) 2 cm (B) 6 cm (C) 4 cm (D) 10 cm

9. Two smooth rings A and B are connected by a string. A another string connect Ring A and block, if strings are tight then at given moment :



(A) $v_B = 15$ m/s (B) $v_B = 24$ m/s (C) $v_B = 20$ m/s (D) $v_B = 12$ m/s

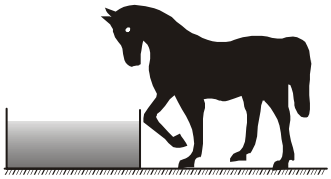
10. The blocks A and B shown in the figure have masses M_A = 5 kg and M_B = 4 kg. The system is released from rest. The speed of B after A has travelled a distance 1 m along the incline is



(A) $\frac{\sqrt{3}}{2}\sqrt{g}$ (B) $\frac{\sqrt{3}}{4}\sqrt{g}$

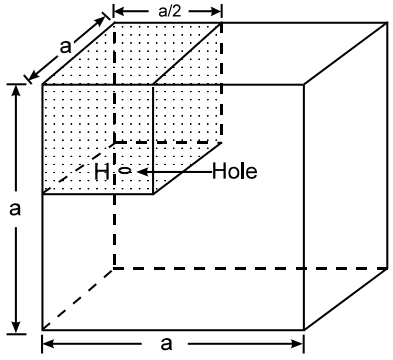
(C) $\frac{\sqrt{g}}{2\sqrt{3}}$ (D) $\frac{\sqrt{g}}{2}$

11. A horse drinks water from a cubical container of side 1 m. The level of the stomach of horse is at 2 m from the ground. Assume that all the water drunk by the horse is at a level of 2 m from the ground. Then minimum work done by the horse in drinking the entire water of the container is (Take ρ_{water} = 1000 kg/m^3 and g = 10 m/s^2) :



(A) 10 kJ (B) 15 kJ (C) 20 kJ (D) zero

12. The figure shows a hollow cube of side 'a' of volume V. There is a small chamber of volume $\frac{V}{4}$ in the cube as shown. This chamber is completely filled by m kg of water. Water leaks through a hole H and spreads in the whole cube. Then the work done by gravity in this process assuming that the complete water finally lies at the bottom of the cube is :

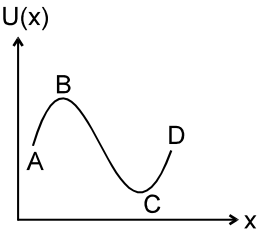


(A) $\frac{1}{2}$mg a (B) $\frac{3}{8}$mg a (C) $\frac{5}{8}$mga (D) $\frac{1}{8}$mga

13. A body is projected with kinetic energy k at angle ϕ with the vertical. Neglecting friction, its potential energy at the highest point will be

(A) k cos^2 ϕ (B) k sin^2 ϕ (C) k (D) zero

14. The potential energy of a particle varies with distance x as shown in the graph.



The force acting on the particle is zero.

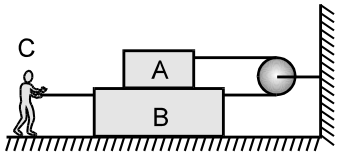
(A) at position C

(B) at position B and D

(C) at positions B and C

(D) at positions A and D.

15. In the figure m_A = m_B = m_C = 60 kg. The co-efficient of friction between C and ground is 0.5, B and ground is 0.3, A & B is 0.4. C is pulling the string with the maximum possible force without moving. Then tension in the string connected to A will be:



(A) 120 N (B) 60 N (C) 100 N (D) zero

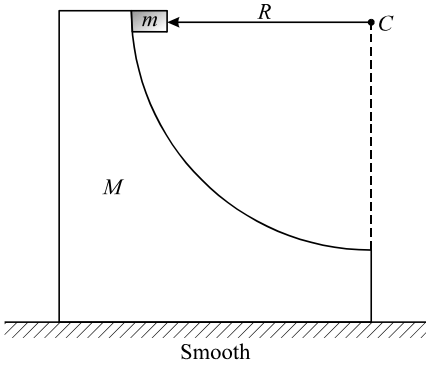
16. The focal length of a lens of refractive index 3/2 is 10 cm in air. The focal length of that lens in a medium of refractive index 7/5 is:

(A) – 70 cm (B) 10/7 cm (C) 70 cm (D) none of these

17. A body of mass m is moving in a circle of radius r with a constant speed *v*. The force on the body is mv^2/r and is directed towards the centre. What is the work done by the force in moving the body half the circumference of the circle.

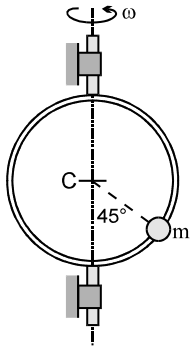
(A) $\frac{m\,v^2}{r} \times \pi\, r$ (B) $m\,v^2$ (C) $\frac{1}{2} m\,v^2$ (D) zero

18. A small mass *m* is placed and released from the vertical portion of a quarter circular arc as shown in figure. As it slides, the acceleration of the mass M on the smooth horizontal surface :



(A) Continuously increases (B) Continuously decreases
(C) First increases then decreases (D) First decreases then increases

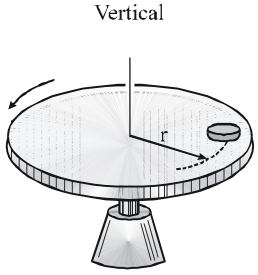
19. A small bead of mass m = 1 kg is carried by a circular hoop having centre at C and radius r = 1 m which rotates about a fixed vertical axis. The coefficient of friction between bead and hoop is μ = 0.5. The maximum angular speed of the hoop for which the bead does not have relative motion with respect to hoop.(Take g = 10 m/s^2)



(A) $\left(5\sqrt{2}\right)^{1/2}$ (B) $\left(10\sqrt{2}\right)^{1/2}$

(C) $\left(15\sqrt{2}\right)^{1/2}$ (D) $\left(30\sqrt{2}\right)^{1/2}$

20. A small coin of mass 40 g is placed on the horizontal surface of a rotating disc. The disc starts from rest and is given a constant angular acceleration α = 2 rad/s^2. The coefficient of static friction between the coin and the disc is μ_s = 3/4 and coefficient of kinetic friction is μ_k = 0.5. The coin is placed at a distance r = 1 m from the centre of the disc. The magnitude of the resultant force on the coin exerted by the disc just before it starts slipping on the disc is : (Take g = 10 m/s^2)



(A) 0.2 N (B) 0.3 N (C) 0.4 N (D) 0.5 N

DPP No. : B12 (JEE-Advanced)

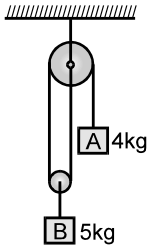
Total Marks : 37		**Max. Time : 30 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.5	**(3 marks, 2 min.)**	**[15, 10]**
Comprehension ('–1' negative marking) Q.6 to Q.7	**(3 marks 2 min.)**	**[06, 04]**
Subjective Questions ('–1' negative marking) Q.8 to Q.9	**(4 marks 5 min.)**	**[08, 10]**
Match the Following (no negative marking) Q.10	**(8 marks, 6 min.)**	**[08, 06]**

1. An object approaches a fixed diverging lens with a constant velocity from infinity along the principal axis. The relative velocity between object and its image will be :

(A) increasing (B) decreasing

(C) first increases then decreases (D) first decreases and then increases.

2. The acceleration of the blocks (A) and (B) respectively in situation shown in the figure is: (pulleys & strings are massless)



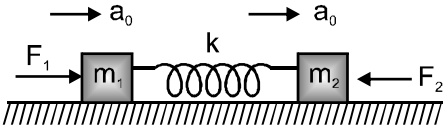
(A) $\frac{2g}{7}$ downward, $\frac{g}{7}$ upward

(B) $\frac{2g}{3}$ downward, $\frac{g}{3}$ upward

(C) $\frac{10}{13}$ g downward, $\frac{5g}{13}$ upward

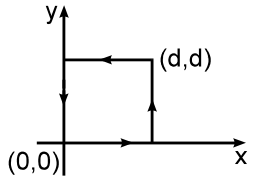
(D) none of these

3. Two blocks of masses m_1 and m_2 connected with a light spring of spring constant k are acted by forces F_1 and F_2 on a frictionless horizontal surface. Find the spring force at this instant provided that at this instant the acceleration of both the blocks are same :



(A) $\frac{F_1m_2 - F_2m_1}{(m_1+m_2)}$ (B) $\frac{F_1 - F_2}{2}$ (C) $\frac{m_1F_1 + m_2F_2}{(m_1+m_2)}$ (D) $\frac{F_1m_2 + F_2m_1}{m_1+m_2}$

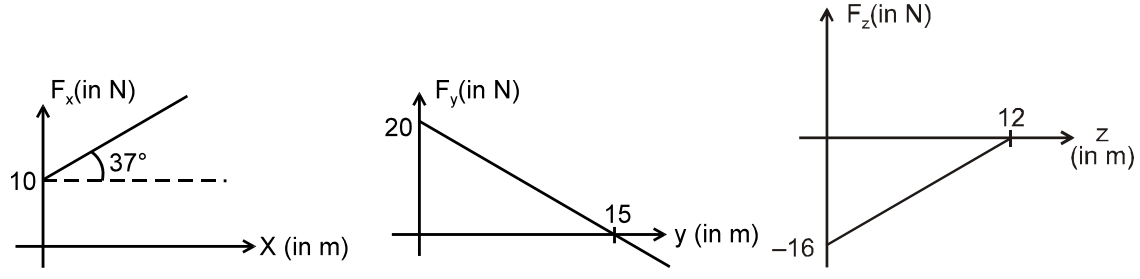
4. The work done by the force $\vec{F} = A\ (y^2\hat{i} + 2x^2\hat{j})$, where A is a constant and x & y are in meters around the path shown is:



(A) zero (B) A d

(C) A d^2 (D) A d^3

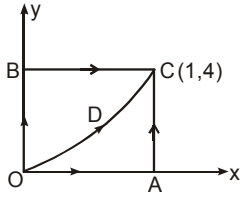
5. The components of a force acting on a particle are varying according to the graphs shown. When the particle moves from (0, 5, 12) to (4, 20, 0) then the work done by this force is :



(A) 192 J (B) 400/3 J (C) 0 (D) None of these

Comprehension

A particle is moved along the different paths OAC, OBC & ODC as shown in the fig. Path ODC is a parabola, $y = 4x^2$. A force $\vec{F} = 3x^2\hat{i}$ acts on the particle.
Now answer the following questions :



6. Choose the incorrect options

(A) The work done by the force $\vec{F}$ on the particle on the path OAC is 8 J

(B) The work done by the force $\vec{F}$ on the particle on the path ODC is 64J

(C) The work done by the force $\vec{F}$ on the particle on the path ODC is $\frac{19}{3}$J

(D) The work done by the force $\vec{F}$ on the particle on the path OAC is 1 J

7. For the force $\vec{F} = xy\hat{i} + x^2y\hat{j}$ choose the correct option (s)

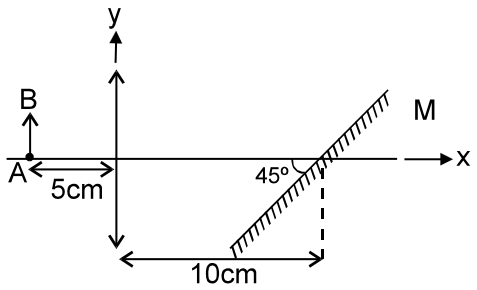
(A) is conservative

(B) is non-conservative

(C) The work done by the force $\vec{F}$ on the particle on the path OBC is 2J

(D) The work done by the force on the particle on the path OBC is 8J

8. An object AB of height 5 mm is kept to the left and on the axis of a converging lens of focal length 10 cm as shown in the figure. A plane mirror M is placed inclined at 45^0 to the lens axis at a distance of 10 cm to the right of the lens. Find the size of the image of object AB and the coordinates of the image of points A & B formed by this combination (take the centre of the lens as the origin and the lens axis as the positive x-axis). Consider the image after one refraction from lens and then one reflection from mirror only.

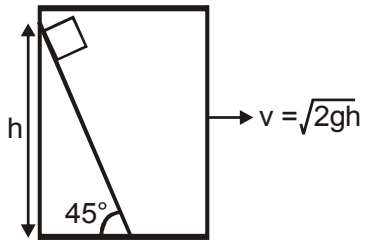


9. A particle of mass m = 1 kg is lying at rest on x-axis, experiences a net force given by law F = x (3x – 2) Newton, where x is the x-coordinate of the particle in meters. The magnitude of minimum velocity in negative x-direction to be imparted to the particle placed at x = 4 meters such that it reaches the origin is $\sqrt{\frac{P}{27}}$ m/s. Find the value of P.

10. Figure shows four situations in which a small block of mass 'm' is released from rest (with respect to smooth fixed wedge) as shown in figure. Column-II shows work done by normal reaction with respect to an observer who is stationary with respect to ground till block reaches at the bottom of inclined wedge, match the appropreate column (Assume that there is infinite friction between block and floor of cabin) :

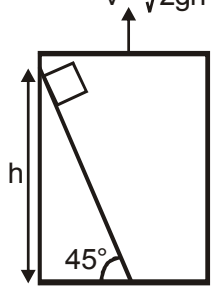
Column–I **Column–II**

(A)



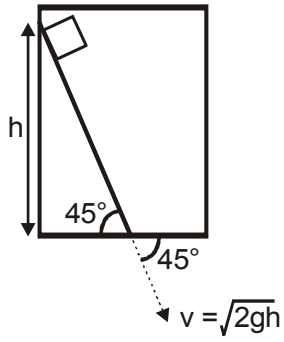
(p) Positive

(B)



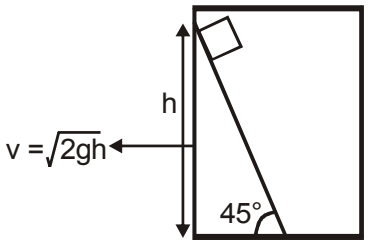
(q) Negative

(C)



(r) equal to mgh in magnitude

(D)



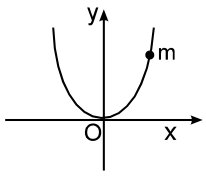
(s) equal to zero

(t) equal to $\sqrt{2}$ mgh in magnitude

DPP No. : B13 (JEE-Advanced)

Total Marks : 36		**Max. Time : 26 min.**
Single choice Objective ('–1' negative marking) Q.1	**(3 marks, 2 min.)**	**[03, 02]**
One or more than one options correct type ('–1' negative marking) Q.2 to Q.5	**(4 marks 2 min.)**	**[16, 08]**
Comprehension ('–1' negative marking) Q.6 to Q.8	**(3 marks 2 min.)**	**[09, 06]**
Subjective Questions ('–1' negative marking) Q.9 to Q.10	**(4 marks 5 min.)**	**[08, 10]**

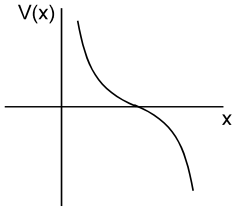
1. A bead of mass m is located on a parabolic wire with its axis vertical and vertex at the origin as shown in figure and whose equation is $x^2 = 4ay$. The wire frame is fixed in vertical plane and the bead can slide on it without friction. The bead is released from the point y = 4a on the wire frame from rest. The tangential acceleration of the bead when it reaches the position given by y = a is :

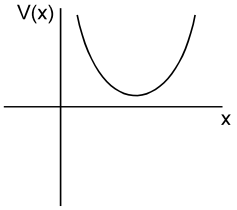


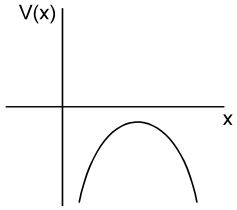
(A) $\frac{g}{2}$ (B) $\frac{\sqrt{3}g}{2}$ (C) $\frac{g}{\sqrt{2}}$ (D) $\frac{g}{\sqrt{5}}$

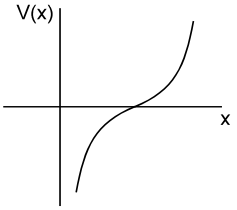
2. A point object 'O' is placed at focus of a diverging lens of focal length ' f '. When a converging lens of focal length (f/2) is placed in between object and lens at distance f/2 from diverging lens then:
(A) The final image will be found at second focus of the converging lens
(B) Final image will be formal on the object itself.
(C) Final image is real.
(D) Final image is virtual.

3. Which graph(s) show(s) the correct distribution of potential (at the points bewteen them) due to two like point charges. [x = distance from the charge on left]

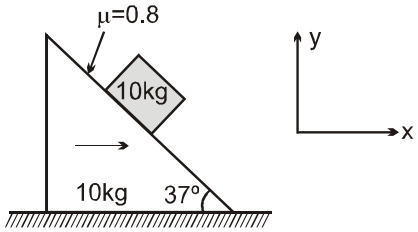
(A) 

(B) 

(C) 

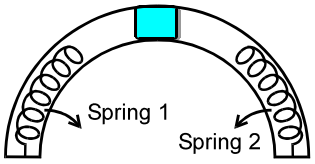
(D) 

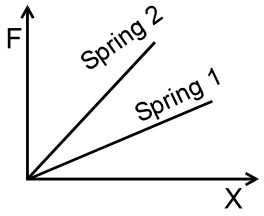
4. A wedge is moving rightwards on which a block of mass 10kg is placed on it. Friction coefficient between the wedge and the block is 0.8. [Take g = 10 m/s^2]. Select correct alternative(s) among the following options.



(A) If wedge is moving with constant velocity then friction acting on block is 64N.
(B) If wedge is moving with constant velocity then acceleration of block is zero.
(C) If wedge is moving with $\vec{a} = 2(\hat{i})$ m/s^2 then friction acting on block is 44N.
(D) If wedge is moving with $\vec{a} = 10(\hat{i})$ m/s^2 then friction is 20N, downward on the wedge along the inclined.

5. In the figure, a block rests on the top of a smooth fixed hemispherical tube of radius R in which it can just fit. Two springs are connected to the base as shown. The block is given a small jerk so that it can slide on the hemisphere. The F-X (F is magnitude of force and x is compression) graph for the springs is given below. Which of the following may be possible :

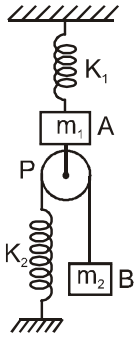




(A) Maximum compression in both springs will be same.
(B) Maximum compressions in the springs during its to and fro motion about its original position will be different.
(C) The block will perform to and fro motion along the hemispherical surface about the original position.
(D) The block can never come to the original position.

Comprehension :

Two blocks A and B having masses m_1 and $m_2 = 2m_1$ are connected in a vertical plane as shown. Both the springs are massless and ideal. The pulley is smooth and massless. The spring 1 has spring constant K_1 and the spring 2 has spring constant K_2. Strings are ideal and massless. The tension in spring 1 is T_1 and in spring 2 is T_2



6. When the string between block B and the pulley P is cut, then acceleration of m_1 and m_2 are a_1 and a_2 respectively.

(A) $a_1 = 4g \uparrow$, $a_2 = g \downarrow$ (B) $a_1 = 0$, $a_2 = 0$

(C) $a_1 = 0$, $a_2 = g \downarrow$ (D) $a_1 = 2g \downarrow$, $a_2 = g \uparrow$

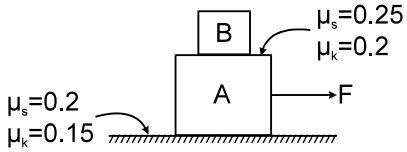
7. The string between pulley P and block B is cut. Then

(A) $T_1 = 0$, $T_2 = 0$ (B) $T_1 \neq 0$, $T_2 = 0$ (C) $T_1 \neq 0$, $T_2 \neq 0$ (D) $T_1 = 0$, $T_2 \neq 0$

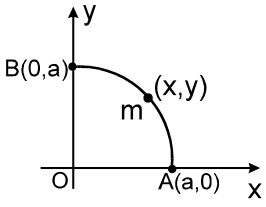
8. If the string connecting block A and spring 1 is cut tensions in the springs are

(A) $T_1 = 0$; $T_2 = 0$ (B) $T_1 \neq 0$; $T_2 = 0$ (C) $T_1 = 0$; $T_2 \neq 0$ (D) $T_1 \neq 0$; $T_2 \neq 0$

9. Block B of mass 2 kg rests on block A of mass 10 kg. All surfaces are rough with the value of coefficient of friction as shown in the figure. Find the minimum force F that should be applied on block A to cause relative motion between A and B. ($g = 10\ m/s^2$)



10. A particle of mass 'm' moves along the quarter section of the circular path whose centre is at the origin. The radius of the circular path is 'a'. A force $\vec{F} = y\hat{i} - x\hat{j}$ newton acts on the particle, where x, y denote the coordinates of position of the particle. Calculate the work done by this force in taking the particle from point A (a, 0) to point B (0, a) along the circular path.



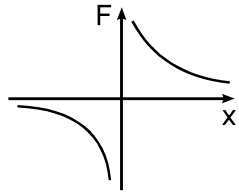
DPP No. : B14 (JEE-Main)

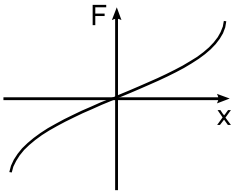
Total Marks : 57 **Max. Time : 38 min.**

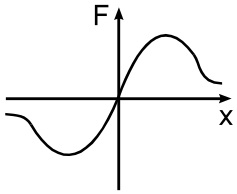
Single choice Objective ('–1' negative marking) Q.1 to Q.11 **(3 marks, 2 min.)** **[33, 22]**

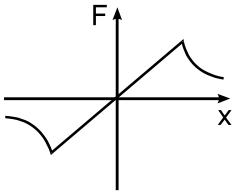
Comprehension ('–1' negative marking) Q.12 to Q.19 **(3 marks 2 min.)** **[24, 16]**

1. Which of the following graphs best represents the force acting on a charged particle kept at distance x from the centre of a square and on the axis of the square whose corners have equal charges.

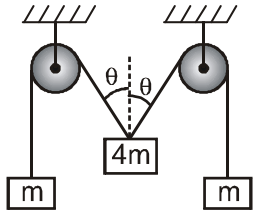
(A) 

(B) 

(C) 

(D) 

2. In the figure shown, the pulleys and strings are massless. The acceleration of the block of mass 4m just after the system is released from rest is ($\theta = \sin^{-1}\frac{3}{5}$)



(A) $\frac{2g}{5}$ downward (B) $\frac{2g}{5}$ upwards

(C) $\frac{5g}{11}$ upwards (D) $\frac{5g}{11}$ downwards

3. Which of the following statement is correct?

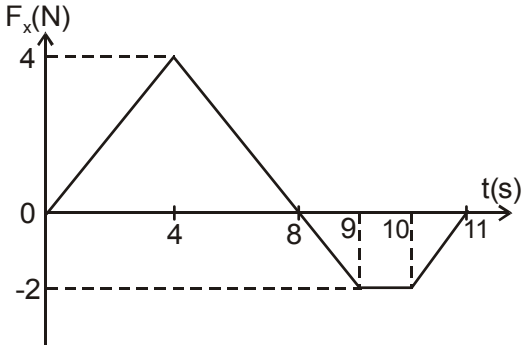
(A) Two forces on the body which happen to be equal and opposite, constitute an action reaction pair.

(B) The mutual actions of two bodies upon each other are always equal and directed to contrary parts.

(C) Newton's second law is valid in all frames.

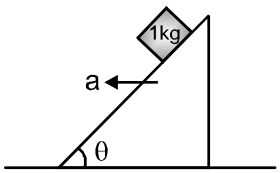
(D) Pseudo forces are applicable in inertial frames.

4. A 2 kg toy car can move along x axis. Graph shows resultant force F_x, acting on the car which begins at rest at time t = 0. The velocity of the particle at t = 10 s is :



(A) – i m/s (B) – 1.5 i m/s (C) 6.5 i m/s (D) 13 i m/s

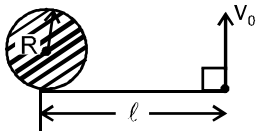
5. A block of mass 1 kg is at rest relative to a smooth wedge being moved leftwards with constant acceleration 5m/s^2. Let N be the normal reaction between the block and the wedge. Then N and tanθ are :



(A) N = $5\sqrt{5}$ N and $\tan\theta = \frac{1}{2}$ (B) N = 15 N and $\tan\theta = \frac{1}{2}$

(C) N = $5\sqrt{5}$ N and $\tan\theta = 2$ (D) N = 15 N and $\tan\theta = 2$

6. A bead is connected at one end of an inextensible massless string whose other end is fixed to a fixed cylinder. Cylinder does not rotate. The bead can move on a horizontal smooth surface. The bead is given a velocity v_0 perpendicular to the string. The bead moves on a curve and consequently collides on the cylinder after sometime. Then, before it collides :



(A) Work done by string on the bead is positive (B) The average speed of the bead is v_0.
(C) The tension in the string remains constant. (D) Kinetic energy of bead increases gradually.

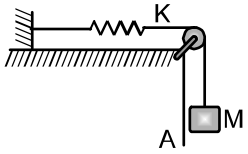
7. Two objects are initially at rest on a frictionless surface. Object 1 has a greater mass than object 2. The same constant force starts to act on each object. The force is removed from each object after it accelerates over a distance d. After the force is removed from both objects, which statement is correct (p : momentum; K: kinetic energy) ?

(A) $p_1 < p_2$ (B) $p_1 > p_2$ (C) $K_1 > K_2$ (D) $K_1 < K_2$

8. A particle is projected vertically upwards with a speed of 16 m/s, after some time, when it again passes through the point of projection, its speed is found to be 8 m/s. It is known that the work done by air resistance is same during upward and downward motion. Then the maximum height attained by the particle is (Take g = 10 m/s^2) :

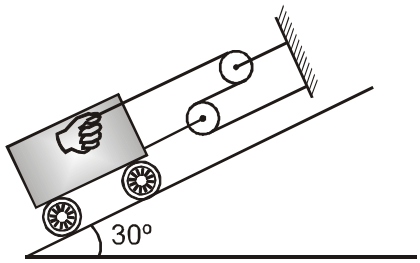
(A) 8 m (B) 4.8 m (C) 17.6 m (D) 12.8 m

9. Block A in the figure is released from rest when the extension in the spring is x_0. (x_0 < Mg/k). The maximum downwards displacement of the block is (there is no friction) :



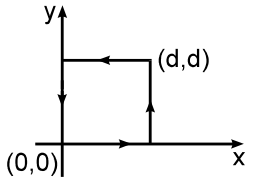
(A) $\frac{2Mg}{K} - 2x_0$ (B) $\frac{Mg}{2K} + x_0$ (C) $\frac{2Mg}{K} - x_0$ (D) $\frac{2Mg}{K} + x_0$

10. A trolley is being pulled up an incline plane by a man inside the trolley. He applied a force of 500 N. If the mass of the man is 50 kg and trolley is 150 kg, then the acceleration of the trolley will be :
(g = 10 m/s^2)



(A) 5 m/s^2 (B) 1 m/s^2 (C) 1.5 m/s^2 (D) 2.5 m/s^2

11. The work done by the force $\vec{F} = A\ (y^2\,\hat{i} + 2x^2\,\hat{j})$, where A is a constant and x & y are in meters around the path shown is:



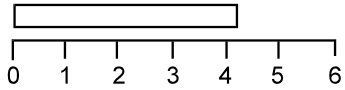
(A) zero (B) A d (C) A d^2 (D) A d^3

Comprehension–1 :

ERRORS IN MEASUREMENT AND SIGNIFICANT FIGURES

To get some overview of error, least count and significant figures, lets consider the example given below. Suppose we have to measure the length of a rod. How can we!

(a) Lets use a cm scale: (a scale on which only cm marks are there)



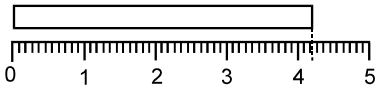
We will measure length = 4 cm

Although the length will be a bit more than 4, but we cannot say its length to be 4.1 cm or 4.2 cm, as the scale can measure upto cm only, not closer than that.

* It (this scale) can measure upto cm accuracy only.
* so we'll say that its **<u>least count</u>** is 1 cm

To get a closer measurement,
We have to use a more minute scale, that is mm scale

(b) Lets use an mm scale : (a scale on which mm marks are there)



We will measure length "ℓ"= 4.2 cm, which is a more closer measurement. Here also if we observe closely, we'll find that the length is a bit more than 4.2, but we cannot say its length to be 4.21, or 4.22, or 4.20 as this scale can measure upto 0.1 cms (1 mm) only, not closer than that.

* It (this scale) can measure upto 0.1 cm accuracy

Its **<u>least count</u>** is 0.1 cm

Max **<u>uncertainty</u>** in "ℓ"can be = 0.1cm

<u>Max possible error</u> in "ℓ" can be = 0.1cm

Measurement of length = 4.2 cm. has two **<u>significant figures</u>** ; 4 and 2, in which 4 is absolutely correct, and 2 is reasonably correct (Doubtful) because uncertainty of 0.1 cm is there.

From the above example , we can conclude that ,in a measured quantity,
Significant figures are = Figures which are absolutely correct + The first uncertain figure

Common rules of counting significant figures :

Rule 1 : All non-zero digits are significant

e.i. 123.56 has five S.F.

Rule 2 : All zeros occurring between two non-zeros digits are significant (obviously)

e.i. 1230.05 has six S.F.

Rule 3 :

ℓ = 3.5 cm	ℓ = 3.50 cm	ℓ = 3.500 cm
↓	↓ closer!	↓ more closer!
0.1 cm accuracy	0.01 cm accuracy	0.001 cm accuracy
↓	↓	↓
ℓ lies between(3.4 – 3.6)	ℓ lies between (3.49 – 3.51)	ℓ lies between (3.499 – 3.501)

So trailing zeroes after decimal place are significant (Shows the further accuracy)

3.5 cm	3.50 cm	3.500 cm
↓	↓	↓ more closer!
Two S.F	Three S.F	Four S.F

Once a measurement is done, significant figures will be decided according to closeness of measurement. Now if we want to display the measurement in some different units, the S.F. shouldn't change (S.F. depends only on accuracy of measurement)

Number of S.F. is always conserved, change of units cannot change S.F.

Suppose measurement was done using mm scale, and we get ℓ = 85 mm (Two S. F.)

If we want to display it in other units.

85 mm ⟶ 8.5 cm ⟶ 0.085 m

↓ ↓

85000 mm = 8.5×10^4 mm 0.000085 km = 8.5×10^{-5} km

All should have two S.F.

The following rules support the conservation of S.F.

Rule 4: From the previous example, we have seen that,

0.000085 km ⟶ also should has two S.F.; 8 and 5, So leading Zeros are not significant.

Not significant

In the number less than one, all zeros after decimal point and to the left of first non-zero digit are insignificant (arises only due to change of unit)

0.000305 has three S.F.

$\Rightarrow$ 3.05×10^{-4} has three S.F.

Rule 5 : From the previous example, we have also seen that

85000 μm ⟶ should also has two S.F., 8 and 5. So the trailing zeros are also not significant.

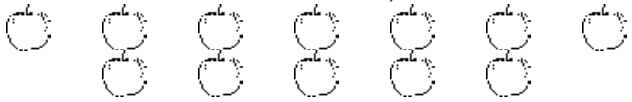
Not significant

The terminal or trailing zeros in a number without a decimal point are not significant. (Also arises only due to change of unit)

154 m = 15400 cm = 15400 mm = 154×10^9 nm

all has only three S.F. all trailing zeros are insignificant

Rule 6 : There are certain measurement, which are exact i.e.



Number of apples are = 12 (exactly) = 12.000000..... ∞

This type of measurement is infinitely accurate so, it has ∞ S.F.

* Numbers of students in class = 125 (exact)
* Speed of light in the vacuum = 299,792,458 m/s (exact)

12. Count total number of S.F. in 3.0800

(A) 4 (B) 6 (C) 5 (D) 2

13. Count total number of S.F. in 0.00418

(A) 3 (B) 6 (C) 4 (D) 5

14. Count total number of S.F. in 3500

(A) 2 (B) 3 (C) 4 (D) 5

15. Count total number of S.F. in 300.00

(A) 1 (B) 3 (C) 5 (D) 2

16. Count total number of S.F. in 5.003020

(A) 5 (B) 3 (C) 7 (D) 6

17. Count total number of S.F. in 6.020×10^{23}

(A) 2 (B) 3 (C) 4 (D) 27

18. Count total number of S.F. in 1.60×10^{-19}

(A) 2 (B) 3 (C) 22 (D) None of these

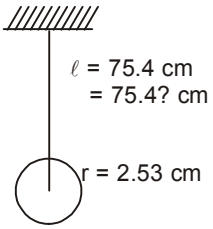
Comprehension–2

Operations according to significant figures:

Now lets see how to do arithmetic operations ie. addition, subtraction, multiplication and division according to significant figures

(a) Addition ⟷ subtraction

For this, lets consider the example given below. In a simple pendulum, length of the thread is measured (from mm scale) as 75.4 cm. and the radius of the bob is measured (from vernier) as 2.53 cm.



Find $\ell_{eq} = \ell + r$

ℓ is known upto 0.1 cm(first decimal place) only. We don't know what is at the next decimal place. So we can write ℓ =75.4 cm = 75.4? cm and the radius r = 2.53 cm.

If we add ℓ and r, we don't know which number will be added with 3. So we have to leave that position.

ℓ_{eq} = 75.4? + 2.53 = 77.9? cm = 77.9 cm

Rules for Addition ⟷ subtraction : (based on the previous example)

* First do the addition/subtraction in normal manner.
* Then round off all quantities to the decimal place of least accurate quantity.

423.5 + 20.23 + 10.15 | 486.2 – 35.18

i.e.

$$\begin{array}{r} 423.5 \\ +\ 20.23 \\ +\ 10.15 \\ \hline 453.8\textcircled{8} \end{array} \xrightarrow[\text{to one decimal place}]{\text{Round off}} 453.9 \qquad \begin{array}{r} 486.2 \\ -\ 35.18 \\ \hline 451.0\textcircled{2} \end{array} \xrightarrow[\text{to one decimal place}]{\text{Round off}} 451.0$$

Rules for Multiply ⟷ Division

Suppose we have to multiply 2.11 x 1.2 = 2.11 ? x 1.2 ?

$$\begin{array}{r} 2\ .\ 11\ ? \\ \times\ 1.2\ ? \\ \hline ?\ \ ?\ ?\ ? \\ 4\ 2\ 2\ ?\ \times \\ 2\ 1\ 1\ ?\ \times\ \times \\ \hline 2.5\ ?\ ?\ ?\ ? \end{array} = 2.5$$

So answer will come in least significant figures out of the two numbers.

✪ Multiply divide in normal manner.

✪ Round off the answer to the weakest link (number having least S.F.)

312.65 × 26.4 = 8253.960
5 S.F. 3 S.F

round off to three S.F. ↓

8250

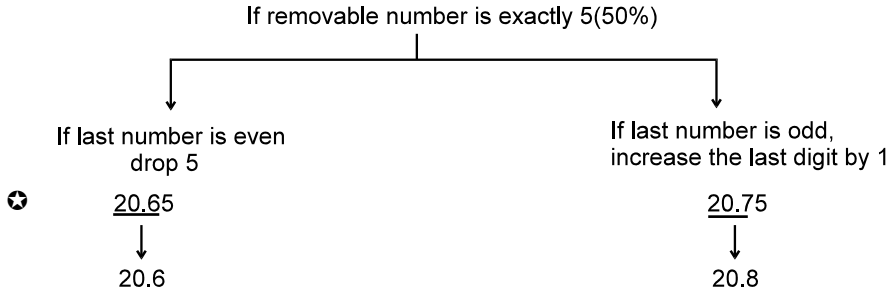
Rules of Rounding off

✪ If removable digit is less than 5 (50%) ; drop it.

47.833 $\xrightarrow[\text{till one decimal place}]{\text{Round off}}$ 47.8

✪ If removable digit is greater than 5(50%), increase the last digit by 1.

47.862 $\xrightarrow[\text{till one decimal place}]{\text{Round off}}$ 47.9



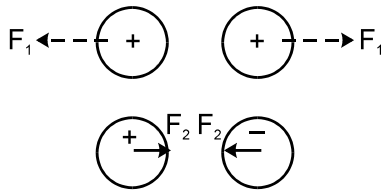
19. A cube has a side $\ell = 1.2 \times 10^{-2}$ m. Calculate its volume
(A) 1.728×10^{-6} m^3 (B) 1.7×10^{-6} m^3
(C) 1.73×10^{-6} m^3 (D) 1.70×10^{-6} m^3

20. In ohm's law exp., reading of voltmeter across the resistor is 12.5 V and reading of current i = 0.20 Amp. Estimate the resistance in correct S.F.
(A) 62.5 Ω (B) 62 Ω (C) 62.0 Ω (D) 63 Ω

DPP No. : B15 (JEE-Advanced)

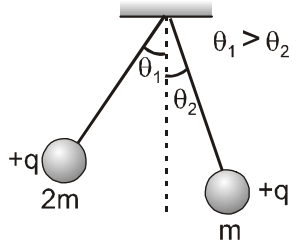
Total Marks : 39		**Max. Time : 35 min.**
Single choice Objective ('–1' negative marking) Q.1	**(3 marks, 2 min.)**	**[03, 02]**
One or more than one options correct type ('–1' negative marking) Q.2 to Q.5	**(4 marks 2 min.)**	**[16, 08]**
Subjective Questions ('–1' negative marking) Q.6 to Q.10	**(4 marks 5 min.)**	**[20, 25]**

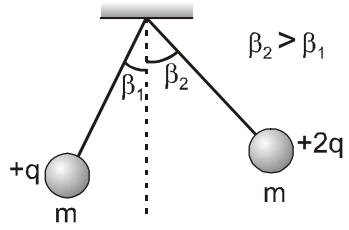
1. In two cases, two identical conducting spheres are given equal charges, in one case of the same type whereas in another case of opposite type. The distance between the spheres is not large comparing with the diameter. Let F_1 and F_2 be the magnitude of the force of interaction between the spheres, as shown, then

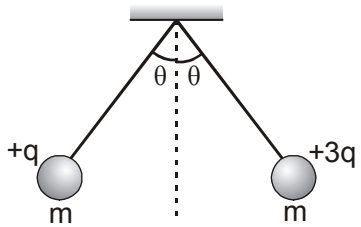


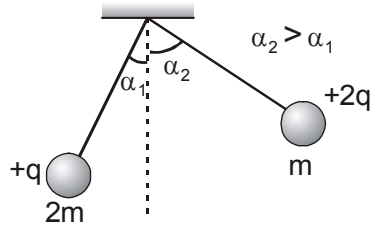
(A) $F_1 > F_2$ (B) $F_1 = F_2$ (C) $F_1 < F_2$
(D) information is not sufficient to draw the conclusion

2. If two balls of given masses and charges are released, which of the following is incorrect arrangement in equilibrium ? (Lenths are same)

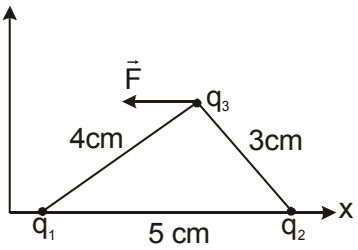
(A)


(B)


(C)


(D)


3. Three charges q_1, q_2 and q_3 are placed as shown. The magnitude of q_1 , is 2μC, but its sign and the value of the charge q_2 are not known. Charge q_3 is +4μC, and the net force $\vec{F}$ on q_3 is in the negative x direction.



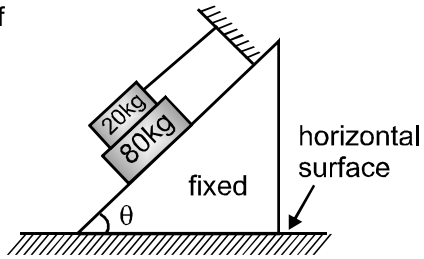
(A) Charge q_1 is negative.

(B) Charge q_2 is positive.

(C) The magnitude of charge q_2 is $\frac{27}{32}$ μC.

(D) The magnitude of net force on charge q_3 is $\frac{45}{22}$ mN.

4. The system shown is in limiting equilibrium. The coefficient of friction for all contact surfaces is $\frac{1}{4}$.



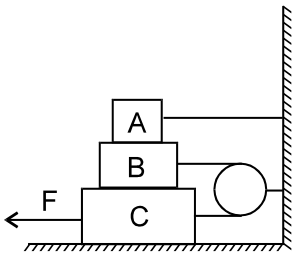
(A) $\tan\theta = \frac{3}{8}$

(B) Tension in the string = $\left(\frac{100}{3} g\sin\theta\right)$ N

(C) Net frictional force on 80 kg block is (80 g $\sin\theta$)N

(D) Force exerted by 20 kg block on 80 kg block is (20 g $\cos\theta$)

5. M_A = 3 kg, M_B = 4 kg and M_C = 8 kg. μ between any two surface is 0.25. Pulley is frictionless and string is massless. A is connected to the wall through a massless rigid rod.($g=10 m/s^2$)



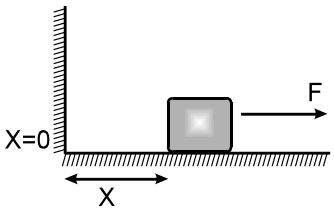
(A) the value of F to keep C moving with constant speed is 80 N

(B) the value of F to keep C moving with constant speed is 120 N

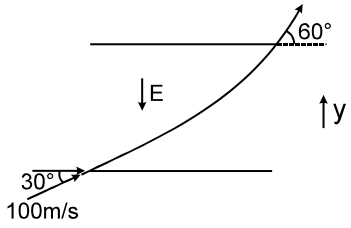
(C) if F is 200 N then acceleration of B is 10 m/s^2

(D) to slide C towards left, F should be atleast 50 N.

6. The block of mass m initially at x = 0 is acted upon by a horizontal force at any position x is given as $F = a - bx^2$(where $a > \mu mg$), as shown in the figure. The co-efficient of friction between the surfaces of contact is μ. The net work done on the block is zero, if the block travels a distance of _____.

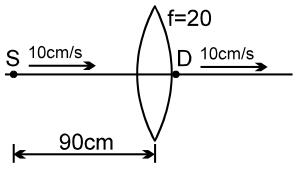


7. Find the magnitude of uniform electric field E in N/C (direction shown in figure) if an electron entering with velocity 100m/s making 30° comes out making 60° (see figure), after a time numerically equal to $\frac{m}{e}$ of electron.



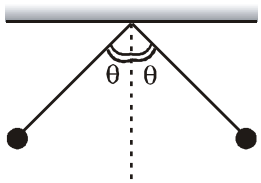
8. A point charge Q is located at centre of a fixed thin ring of radius R with uniformly distributed charge-Q. The magnitude of the electric field strength at the point lying on the axis of the ring at a distance x from the centre is (x >> R) _____.

9. The figure shows initial positions of a point source of light S and a light detector D (of negligible size). Both S & D move with velocity 10 cm/s, as shown. The converging lens of focal length 20 cm is fixed. Find the time instants when the detector will detect maximum light.



10. In the figure shown two small balls of same mass m and same charge are tied to ends of two light, inextensible strings of equal lengths. They are released in the positions shown, $\theta = \tan^{-1}\left(\frac{4}{3}\right)$.

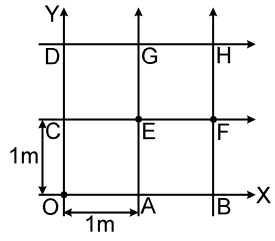
Strings are in the same vertical plane. The magnitude of electrostatic force initially is equal to weight of ball. Find the tension in the string in terms of 'm' and 'g'.



DPP No. : B16 (JEE-Advanced)

Total Marks : 37		**Max. Time : 27 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.4	**(3 marks, 2 min.)**	**[12, 08]**
One or more than one options correct type ('–1' negative marking) Q.5	**(4 marks 2 min.)**	**[04, 02]**
Comprehension ('–1' negative marking) Q.6 to Q.8	**(3 marks 2 min.)**	**[09, 06]**
Subjective Questions ('–1' negative marking) Q.9	**(4 marks 5 min.)**	**[04, 05]**
Match the Following (no negative marking) Q.10	**(8 marks, 6 min.)**	**[08, 06]**

1. The grid (each square of 1m × 1m), represents a region in space containing a uniform electric field. If potentials at points O, A, B, C, D, E, F, G & H are respectively 0, – 1, – 2, 1, 2, 0, – 1, 1, and 0 volts, find the electric field intensity in vector form.



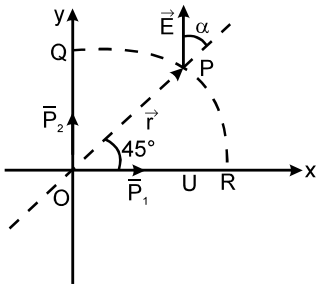
(A) $(\hat{i}+\hat{j})$ V/m (B) $(\hat{i}-\hat{j})$ V/m

(C) $(-\hat{i}+\hat{j})$ V/m (D) $(-\hat{i}-\hat{j})$ V/m

2. A α particle is released from rest 10 cm from a large sheet carrying a surface charge density of -2.21×10^{-9} C/m^2. It will strike the sheet after the time. ($\in_0 = 8.84 \times 10^{-12}$ C^2/Nm^2)

(A) 4 μs (B) 2 μs (C) $2\sqrt{2}$ μs (D) $4\sqrt{2}$ μs.

3. For a system of two dipoles $\vec{P}_1$ and $\vec{P}_2$ as shown in the figure (both are at origin and perpendicular to each other along x and y axes respectively)



(A) Work done in taking electron from P to R on QPR = 0

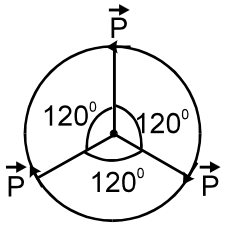
(B) $\tan\alpha = \frac{(P_1+P_2)}{2(P_1-P_2)}$

(C) $\tan\alpha = \frac{(P_1-P_2)}{2(P_1+P_2)}$

(D) $\int_{\infty}^{\vec{r}} \vec{E}\,.d\vec{r} = \frac{P_1+P_2}{4\sqrt{2}\,\pi\varepsilon_0 r^2}$

(P_1 and P_2 denotes magnitudes of $\vec{P}_1$ and $\vec{P}_2$ and r is quite large in comparison to dimensions of dipoles, $\vec{E}$ is resultant electric field and QPR is a quarter of circle whose centre is at O)

4. Three dipoles each of dipole moment of magnitude p are placed tangentially on a circle of radius R in its plane positioned at equal angle from each other as shown in the figure. The magnitude of electric field intensity at the centre of the circle will be :



(A) $\frac{4kp}{R^3}$ (B) $\frac{2kp}{R^3}$

(C) $\frac{kp}{R^3}$ (D) 0

5. The electric field produced by a positively charged particle, placed in an xy-plane is 7.2 (4i + 3j) N/C at the point (3 cm, 3cm) and $100\,\hat{i}$ N/C at the point (2 cm, 0).

(A) The x-coordinate of the charged particle is –2cm.

(B) The charged particle is placed on the x-axis.

(C) The charge of the particle is 10×10^{-12} C.

(D) The electric potential at the origin due to the charge is 9V.

Comprehension :

An uncharged ball of radius R is placed at a point in space and the region out side (from R to ∞ measured from centre of the ball) the ball is non uniformly charged with a charge density $\rho = \frac{C}{r^3}$ coul/m^3 where 'C' is a positive constant and r is the distance of a point measured from centre of the ball.

6. Electric potential at the centre of the ball is :

(A) Directly proportional to R (B) Directly proportional to R^2

(C) Inversely proportional to R (D) Inversely proportional to R^2

7. Electric field intensity at a distance x from centre of the ball (x > R) is :

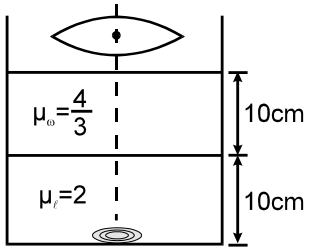
(A) $\frac{C}{\epsilon_0 R^2}\ell n\frac{x}{R}$ (B) $\frac{C}{2\epsilon_0 R^2}\ell n\left(\frac{x-R}{R}\right)$ (C) $\frac{C}{2\epsilon_0 R^2}(R^2 - x^2)$ (D) $\frac{C}{\epsilon_0 x^2}\ell n\frac{x}{R}$

8. As we move away from ball's surface, electric potential :

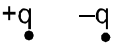
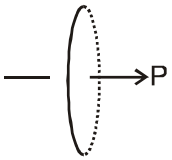
(A) decreases. (B) increases.

(C) decreases then increases. (D) increases then decreases.

9. An insect is placed at the base (at centre) of a cylindrical vessel and oil of refractive index μ_ℓ = 2 is filled upto height 10 cm. Then water is poured in vessel upto height 20 cm (length of water column 10 cm). If a convex lens of focal length 50 cm is placed just above the surface of water. Then find location of final image of the insect by this system. If the insect starts moving up with speed 18 m/s, then what will be the speed of the final image just after it leaves the bottom.



10. In the Column-I a system of two charges/dipoles/other charges are released (released from rest) in gravity free space. They move due to their mutual electrostatic interaction only. In Column-II change in some physical quantities in the system is mentioned for some time interval in which no one reveses its direction nor they collide. Match the situations correctly.

Column–I	**Column-II**
(A)  (point charges)	(p) Kinetic energy of system increases
(B)  (where P_1 is a short dipole)	(q) Electric potential energy of system decreases
(C)  (where P_1 and P_2 are short dipoles)	(r) Linear momentum of system remains conserved
(D)  Uniform ring having positive charge and dipole even dipole P is placed symmetrically and lying along axis of ring.	(s) Seperation between elements of syste increases (in case of dipole and ring sepration to be measured from centre)
	(t) Separation between elements of system decreases (in case of dipole and ring to be measured from centre) separation

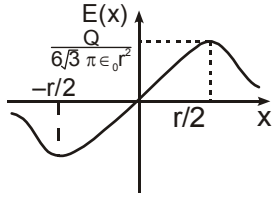
DPP No. : B17 (JEE-Main)

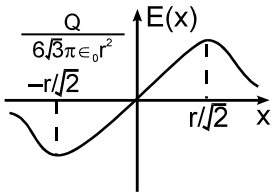
Total Marks : 60		**Max. Time : 40 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.10	**(3 marks, 2 min.)**	**[30, 20]**
Comprehension ('–1' negative marking) Q.11 to Q.20	**(3 marks 2 min.)**	**[30, 20]**

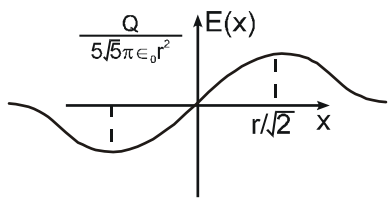
1. A lens is placed between a source of light and a wall. It forms images of area A_1 and A_2 on the wall, for its two different positions. The area of the source of light is (source and wall are fixed)-

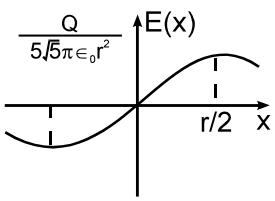
(A) $(A_1A_2)^{1/2}$ (B) $\frac{A_1+A_2}{2}$ (C) $\left(\frac{1}{A_1}+\frac{1}{A_2}\right)^{-1}$ (D) $\left(\frac{\sqrt{A_1}+\sqrt{A_2}}{2}\right)^2$

2. Which of the following graphs shows the correct variation of electric field as a function of x along the axis of a uniformly and positively charged ring of radius R and charge Q.

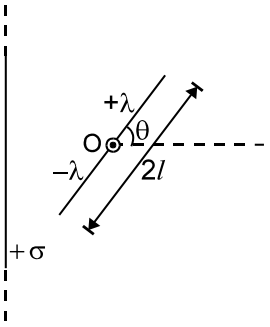
(A) 

(B) 

(C) 

(D) 

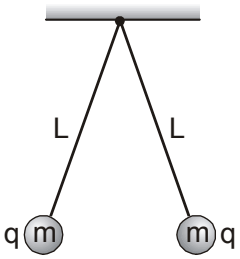
3. A large sheet carries uniform surface charge density σ. A rod of length 2ℓ has a linear charge density λ on one half and $-\lambda$ on the second half. The rod is hinged at mid-point O and makes angle θ with the normal to the sheet. The electric force experienced by the rod is :



(A) 0 (B) $\frac{\sigma\lambda\ell^2}{2\epsilon_0}\sin\theta$

(C) $\frac{\sigma\lambda\ell^2}{\epsilon_0}\sin\theta$ (D) None of these

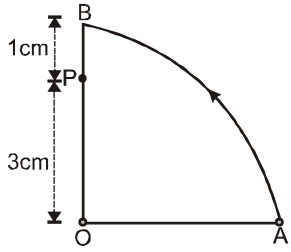
4. Two small balls, each having equal positive charge Q are suspended by two insulating strings of equal length L from a hook fixed to a stand. If the whole set-up is transferred to a satellite in orbit around the earth, the tension in equilibrium in each string is equal to



(A) zero (B) $\frac{kQ}{L^2}$

(C) $\frac{kQ^2}{2L^2}$ (D) $\frac{kQ^2}{4L^2}$

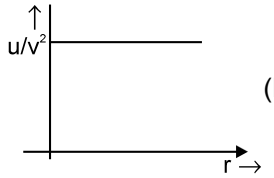
5. A point charge of 5 C is placed at point P (as shown). A unit positive charge is taken from A to B along the circular path shown, then the net work done by electrostatic forces is: [O is the centre of the circular path] [Where $k = 9 \times 10^9\ N m^2/c^2$]

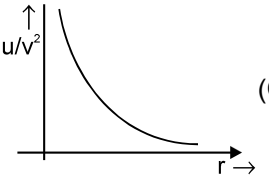


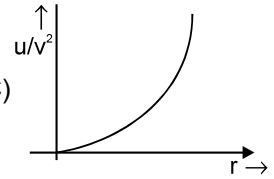
(A) + 400 k (B) + 4 k

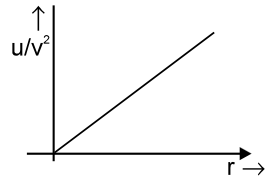
(C) – 400 k (D) – 4 k

6. At distance ' r ' from a point charge, the ratio $\frac{u}{v^2}$ (where ' u ' is energy density and ' v ' is potential) is best represented by :

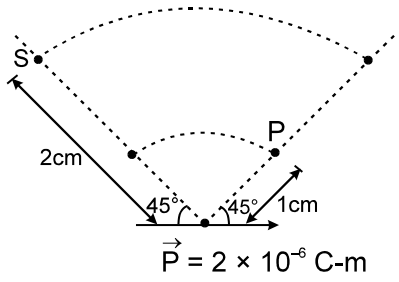
(A) 

(B) 

(C) 

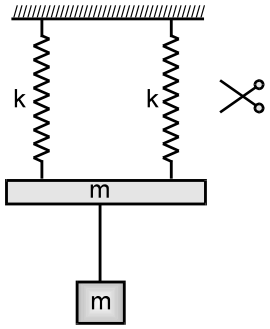
(D) 

7. Find out work done by electric field in shifting a point charge $\frac{4\sqrt{2}}{27}\mu C$ from point P to S which are shown in the figure :



(A) $\frac{100}{3}$ J (B) $\frac{200}{3}$ J (C) 100 J (D) 200 J

8. System shown in figure is in equilibrium. The magnitude of change in tension in the string just before and just after, when one of the spring is cut. Mass of both the blocks is same and equal to m and spring constant of both springs is k. (Neglect any effect of rotation)



(A) $\frac{mg}{2}$ (B) $\frac{mg}{4}$

(C) $\frac{3mg}{4}$ (D) $\frac{3mg}{2}$

9. Two blocks each of mass m are joined together using an ideal spring of force constant K and natural length ℓ_0. The blocks are touching each other when the system is released from rest on a rough horizontal surface. Both the blocks come to rest simultaneously first when the extension in the spring is $\frac{\ell_0}{4}$. The coefficient of friction between each block and the surface assuming it to be same for both blocks & surface is :

(A) $\frac{K\ell_0}{40mg}$ (B) $\frac{K\ell_0}{8mg}$ (C) $\frac{3K\ell_0}{8mg}$ (D) $\frac{17}{20}\frac{K\ell_0}{mg}$

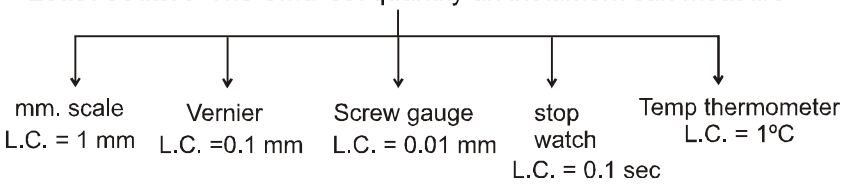
10. Work done by all forces on a system of particles is equal to
(A) Change in kinetic energy of the system
(B) Change in potential energy of the system
(C) Change in total energy of the system
(D) Change in kinetic energy only if the forces acting are conservative.

Comprehension :

LEAST COUNT

We have studied (from page 1) that no measurement is perfect. Every instrument can measure upto a certain accuracy; called least count.

Least count : The Smallest quantity an instument can measure



PERMISSIBLE ERROR

Error in measurement due to the limitation (least count) of the instrument, is called permissible error. From mm scale $\rightarrow$ we can measure upto 1 mm accuracy (least count = 1mm). From this we will get measurement like ℓ = 34 mm

$\downarrow$

Max uncertainty can be 1 mm.

Max permissible error ($\Delta\ell$) = 1 mm.

But if from any other instrument, we get ℓ = 34.5 mm then max permissible error ($\Delta\ell$) = 0.1 mm

and if from a more accurate instrument, we get ℓ = 34.527 mm then max permissible error ($\Delta\ell$) = 0.001 mm

= place value of last number

Max permissible error in a measured quantity = least count of the measuring instrument and if nothing is given about least count then Max permissible error = place value of the last number

MAX. PERMISSIBLE ERROR IN RESULT DUE TO ERROR IN EACH MEASURABLE QUANTITY :

Let Result f(x, y) contains two measurable quantity x and y

Let error in $x = \pm \Delta x$ i.e. $x \in (x - \Delta x, x + \Delta x)$

error in $y = \pm \Delta y$ i.e. $y \in (y - \Delta y, y + \Delta y)$

Case - (I) : If $f(x, y) = x + y$

$df = dx + dy$

error in $f = \Delta f = \pm \Delta x \pm \Delta y$

max possible error in $f = (\Delta f)_{max}$ = max of $(\pm \Delta x \pm \Delta y)$

$(\Delta f)_{max} = \Delta x + \Delta y$

Case - (II) : If $f = x - y$

$df = dx - dy$

$(\Delta f) = \pm \Delta x \mp \Delta y$

max possible error in $f = (\Delta f)_{max}$ = max of $(\pm \Delta x \mp \Delta y)$

$\Rightarrow (\Delta f)_{max} = \Delta x + \Delta y$

For getting maximum permissible error , sign should be adjusted, so that errors get added up to give maximum effect

i.e. $f = 2x - 3y - z$

$(\Delta f)_{max} = 2\Delta x + 3\Delta y + \Delta z$

Example. In resonance tube exp. we find $\ell_1 = 25.0$ cm and $\ell_2 = 75.0$ cm. The least count of of the scale used to measure ℓ is 0.1 cm. If there is no error in frequency. What will be max permissible error in speed of sound (take $f_0 = 325$ Hz.)

Solution : $V = 2f_0 (\ell_2 - \ell_1)$

$(dV) = 2f_0 (d\ell_2 - d\ell_1)$

$(\Delta V)_{max}$ = max of $[2f_0(\pm \Delta\ell_2 \mp \Delta\ell_2] = 2f_0 (\Delta\ell_2 + \Delta\ell_1)$

$\Delta\ell_1$ = least count of the scale = 0.1 cm

$\Delta\ell_2$ = least count of the scale = 0.1 cm

So max permissible error in speed of sound $(\Delta V)_{max} = 2(325\text{Hz})\ (0.1\text{ cm} + 0.1\text{ cm}) = 1.3$ m/s

Value of $V = 2f_0 (\ell_2 - \ell_1) = 2(325\text{Hz})\ (75.0\text{ cm} - 25.0\text{ cm}) = 325$ m/s

so $V = (\ 325 \pm 1.3\ )$ m/s

Case-(III) : If $f(x, y, z) = (\text{constant})\ x^a y^b z^c$ to scatter all the terms, Lets take log on both sides

$\ell n\ f = \ell n\ (\text{constant}) + a\ \ell n\ x + b\ \ell n\ y + c\ \ell n\ z$

$\downarrow$ Differentiating both sides

$$\frac{df}{f} = 0 + a\frac{dx}{x} + b\frac{dy}{y} + c\frac{dz}{z}$$

$$\frac{\Delta f}{f} = \pm a\ \frac{\Delta x}{x} \pm b\frac{\Delta y}{y} \pm c\frac{\Delta z}{z}$$

$$\left(\frac{\Delta f}{f}\right)_{max} = \text{max of } (\pm a\ \frac{\Delta x}{x} \pm b\ \frac{\Delta y}{y} \pm c\frac{\Delta z}{z})$$

i.e. $f = 15\ x^2\ y^{-3/2}\ z^{-5}$

$$\frac{df}{f} = 0 + 2\frac{dx}{x} - \frac{3}{2}\ \frac{dy}{y} - 5\frac{dz}{z}$$

$$\frac{\Delta f}{f} = \pm 2\frac{\Delta x}{x} \mp \frac{3}{2}\ \frac{\Delta y}{y} \mp 5\ \frac{\Delta z}{z}$$

$$\left(\frac{\Delta f}{f}\right)_{max} = \text{max of } (\pm 2\frac{\Delta x}{x} \mp \frac{3}{2}\ \frac{\Delta y}{y} \mp 5\frac{\Delta z}{z}\ )$$

$$\left(\frac{\Delta f}{f}\right)_{max} = 2\frac{\Delta x}{x} + \frac{3}{2}\ \frac{\Delta y}{y} + 5\ \frac{\Delta z}{z}$$

✪ **sign should be adjusted, so that errors get added up**

Example. In some observations, value of 'g' are coming as 9.81, 9.80, 9.82, 9.79, 9.78, 9.84, 9.79, 9.78, 9.79 and 9.80 m/s^2. Calculate absolute errors and percentage error in g.

Solution :

S.N.	Value of g	Absolute error $\Delta g = \lvert g_i - \bar{g} \rvert$
1	9.81	0.01
2	9.80	0.00
3	9.82	0.02
4	9.79	0.01
5	9.78	0.02
6	9.84	0.04
7	9.79	0.01
8	9.78	0.02
9	9.79	0.01
10	9.80	0.00
	$g_{mean} = 9.80$	$\Delta g_{mean} = \frac{\sum \Delta g_i}{10} = \frac{0.14}{10} = 0.014$

percentage error = $\frac{\Delta g_{mean}}{g_{mean}} \times 100 = \frac{0.014}{9.80} \times 100\ \% = 0.14\ \%$

so 'g' = (9.80 ± 0.014) m/s^2

11. If measured value of resistance R = 1.05 Ω, wire diameter d = 0.60 mm, and length ℓ = 75.3 cm. If maximum error in resistance measurment is 0.01 Ω and least count of diameter and length measuring device are 0.01 mm and 0.1 cm respectively, then find max. permissible error in resistivity $\rho = \frac{R\left(\frac{\pi d^2}{4}\right)}{\ell}$

(A) 4.3 % (B) 5.3 % (C) 3.7 %. (D) 6.3 %

12. In ohm's law experiment, potential drop across a resistance was measured as v = 5.0 volt and current was measured as i = 2.0 amp. If least count of the voltmeter and ammeter are 0.1 V and 0.01A respectively then find the maximum permissible error in resistance.

(A) 3.5 % (B) 1.5 % (C) 2.5 % (D) None of these

13. In Searle's exp to find Young's modulus, the diameter of wire is measured as D = 0.050 cm, length of wire is L = 125 cm, and when a weight, m = 20.0 kg is put, extension in the length of the wire was found to be 0.100 cm. Find maximum permissible error in young's modulus (Y).

(A) 4.3% (B) 6.3% (C) 4.3% (D) None of these

14. To find the value of 'g' using simple pendulum T = 2.00 sec ; ℓ = 1.00 m was measured. Estimate maximum permissible error in 'g'. Also find the value of 'g'. (Use $\pi^2 = 10$)

(A) (10.0 ± 0.2) m/s^2 (B) (10.0 ± 0.3) m/s^2

(C) (9.0 ± 0.2) m/s^2 (D) (10.0 ± 0.1) m/s^2

15. Using screw gauge, the observation of the diameter of a wire are 1.324, 1.326, 1.334, 1.336 cm respectively. Find the average diameter, the mean error, the relative error and % error.

16. If a tuning fork of frequency (f_0) 340 Hz and tolerance $\pm$ 1% is used in resonance column method [v = 2f_0 ($\ell_2 - \ell_1$)], the first and the second resonance are measured at ℓ_1 = 24.0 cm and ℓ_2 = 74.0 cm. Find max. permissible error in speed of sound.

17. The length of a rectangular plate is measured by a meter scale and is found to be 10.0 cm. Its width is measured by vernier callipers as 1.00 cm. The least count of the meter scale and vernier callipers are 0.1 cm and 0.01 cm respectively (Obviously). Maximum permissible error in area measurement is -
(A) + 0.2 cm^2 (B) + 0.1 cm^2 (C) + 0.3 cm^2 (D) Zero

18. In the previous question, minimum possible error in area measurement can be -
(A) + 0.02 cm^2 (B) + 0.01 cm^2 (C) + 0.03 cm^2 (D) Zero

19. For a cubical block, error in measurement of sides is + 1% and error in measurement of mass is + 2%, then maximum possible error in density is -
(A) 1% (B) 5% (C) 3% (D) 7%

20. To estimate 'g' (from $g = 4\pi^2 \frac{L}{T^2}$), error in measurement of L is + 2% and error in measurement of T is + 3%. The error in estimated 'g' will be -
(A) + 8% (B) + 6% (C) + 3% (D) + 5%

DPP No. : B18 (JEE-Advanced)

Total Marks : 34	**Max. Time : 29 min.**	
Single choice Objective ('–1' negative marking) Q.1 to Q.6	**(3 marks, 2 min.)**	**[18, 12]**
One or more than one options correct type ('–1' negative marking) Q.7	**(4 marks 2 min.)**	**[04, 02]**
Subjective Questions ('–1' negative marking) Q.8 to Q.10	**(4 marks 5 min.)**	**[12, 15]**

1. The external and internal diameters of a hollow cylinder are measured to be (4.23 ± 0.01) cm and (3.89 ± 0.01) cm. The thickness of the wall of the cylinder is
(A) (0.34 ± 0.02) cm (B) (0.17 ± 0.02) cm (C) (0.17 ± 0.01) cm (D) (0.34 ± 0.01) cm

2. The mass of a ball is 1.76 kg. The mass of 25 such balls is
(A) 0.44×10^3 kg (B) 44.0 kg (C) 44 kg (D) 44.00 kg

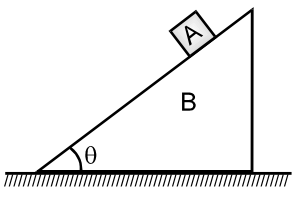
3. A lens of focal length 20.0 cm and aperture radius 2.0 cm is placed at a distance 30.0 cm from a point source of light. On the other side a screen is placed at a distance 50.0 cm from the lens. The radius of spot of light formed on screen is. (Neglect spherical abberation through lens)
(A) 0.5 cm (B) 0.3 cm (C) 0.2 cm (D) 1.0 cm

4. For a cubical block, error in measurement of sides is + 1% and error in measurement of mass is + 2%, then maximum possible error in density is -
(A) 1% (B) 5% (C) 3% (D) 7%

5. To estimate 'g' (from $g = 4\pi^2 \frac{L}{T^2}$), error in measurement of L is + 2% and error in measurement of T is + 3%. The error in estimated 'g' will be -
(A) + 8% (B) + 6% (C) + 3% (D) + 5%

6. The least count of a stop watch is 0.2 second. The time of 20 oscillations of a pendulum is measured to be 25 seconds. The percentage error in the time period is
(A) 16% (B) 0.8 % (C) 1.8 % (D) 8 %

7. In the figure shown, A & B are free to move. All the surfaces are smooth. ($0 < \theta < 90^o$)

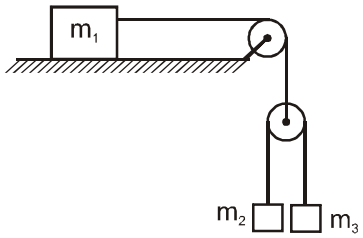


(A) the acceleration of A will be more than g sin θ
(B) the acceleration of A will be less than g sin θ
(C) normal force on A due to B will be more than mg cos θ
(D) normal force on A due to B will be less than mg cos θ

8. Using screw gauge, the observation of the diameter of a wire are 1.324, 1.326, 1.334, 1.336 cm respectively. Find the average diameter, the mean error, the relative error and % error.

9. If a tuning fork of frequency (f_0) 340 Hz and tolerance $\pm$ 1% is used in resonance column method [$v = 2f_0 (\ell_2 - \ell_1)$], the first and the second resonance are measured at ℓ_1 = 24.0 cm and ℓ_2 = 74.0 cm. Find max. permissible error in speed of sound.

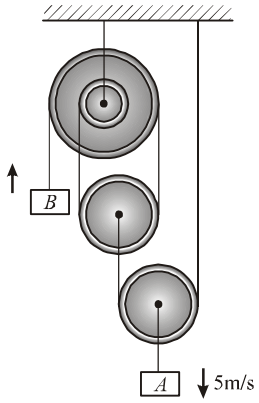
10. Three blocks of mass m_1 = 4 kg, m_2 = 2 kg and m_3 = 4 kg are connected as shown in figure. All surfaces are smooth and pulley is massless, find the acceleration of mass m_1?



DPP No. : B19 (JEE-Advanced)

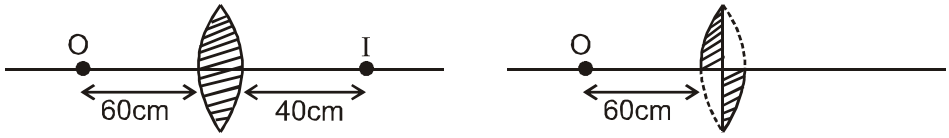
Total Marks : 39	**Max. Time : 29 min.**
Single choice Objective ('–1' negative marking) Q.1	**(3 marks, 2 min.) [03, 02]**
One or more than one options correct type ('–1' negative marking) Q.2 to Q.7	**(4 marks 2 min.) [24, 12]**
Subjective Questions ('–1' negative marking) Q.8 to Q.10	**(4 marks 5 min.) [12, 15]**

1. In the pulley system shown in figure, at an instant if block *A* is going down at 5 m/s, find speed of block B : (In step pulley the ratio of radii is 1 : 2)



(A) 5 m/s (B) 20 m/s (C) 40 m/s (D) 80 m/s

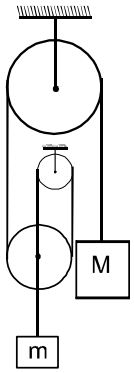
2. A converging equiconvex lens forms real image of a particle as shown in case I. If now lens is cut as shown in case II then select the correct alternative/alternatives :



Case I Case II

(A) Image in case II will be at 240 cm from lens.
(B) Image is real.
(C) Image in case II will be at the same location of case I.
(D) There will be two distinguished images.

3. All pulleys are light & smooth, strings are light & inextensible. Consider the case when $M \to \infty$ (see fig.)



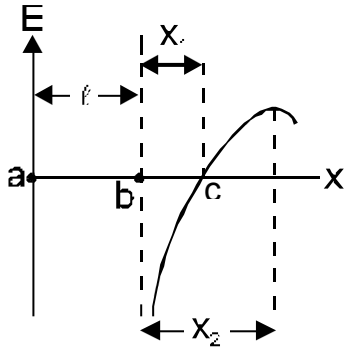
(A) acceleration of m is g upward
(B) Net force on m is mg/3 upward
(C) Tension in the string connecting M is $\frac{4mg}{9}$
(D) Tension in the string connecting m is 2 mg

4. Two infinite, parallel, non–conducting sheets carry equal positive charge density σ. One is placed in the yz plane and the other at distance x = a. Take potential V = 0 at x = 0.

(A) For $0 \le x \le a$, potential $V_x = 0$.
(B) For $x \ge a$, potential $V_x = -\frac{\sigma}{\epsilon_0}(x-a)$
(C) For $x \ge a$, potential $V_x = \frac{\sigma}{\epsilon_0}(x-a)$
(D) For $x \le 0$ potential $V_x = \frac{\sigma}{\epsilon_0}x$

Comprehension :

Two point charges are placed at point a and b. The field strength to the right of the charge Q_b on the line that passes through the two charges varies according to a law that is represented graphically in the figure. The electric field is taken positive if its direction is towards right and negative if its direction is towards left.



5. Choose the correct statement regarding the signs of the charges.
(A) Charge at point a is positive and charge at point b is negative.
(B) Charge at point a is negative and charge at point b is positive.
(C) Point C is position of stable equilibrium for small displacement along x–axis of positive test charge
(D) Point C is position of unstable equilibrium for small displacement along x–axis of positive test charge

6. Ratio of magnitudes of charges $\left|\frac{Q_a}{Q_b}\right|$ will be equal to :

(A) $\left(1+\frac{\ell}{x_1}\right)$ (B) $\left(1+\frac{\ell}{x_1}\right)^2$ (C) $1+\left(\frac{\ell}{x_1}\right)^2$ (D) $\left(1+\frac{\ell}{x}\right)^4$

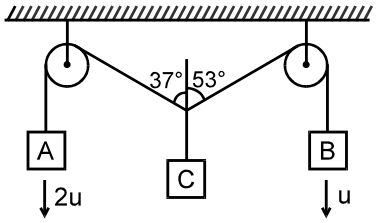
7. Choose the correct option

(A) The distance x_2 from point b where the field is maximum, will be $\frac{\ell}{\left(\frac{\ell+x_1}{x_1}\right)^{2/3}-1}$

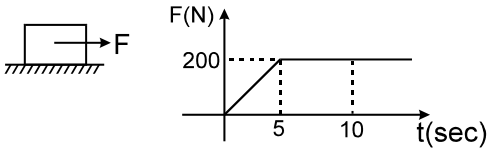
(B) The distance x_2 from point b where the field is maximum, will be $\frac{\ell}{\left(\frac{\ell+x_1}{x_1}\right)^{1/3}-1}$

(C) At point C potential due to system of charges at a and b is maximum in region x > b
(D) At point C potential due to system of charges at a and b is minimum in region x > b

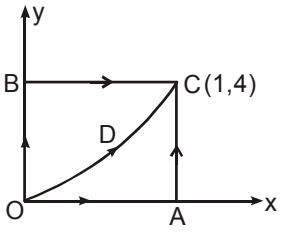
8. Two blocks A and B move down with speeds u m/s and 2u m/s respectively. It is given that u = $\sqrt{5}$ m/s. Find the speed (in m/s) of block C at the instant shown in the diagram.



9. A 20 kg block is originally at rest on a horizontal surface for which the coefficient of friction is 0.6, If a horizontal force F is applied such that it varies with time as shown in figure. Determine speed of block at 10 sec.



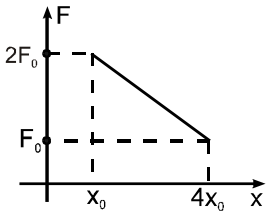
10. A particle is moved along the different paths OAC, OBC & ODC as shown in the fig. Path ODC is a parabola, $y = 4x^2$. Find the work done by a force $\vec{F} = xy\,\hat{i} + x^2y\,\hat{j}$ on the particle along these paths. Is this force a conservative force ?



DPP No. : B20 (JEE-Main)

Total Marks : 60		**Max. Time : 40 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.10	**(3 marks, 2 min.)**	**[30, 20]**
Comprehension ('–1' negative marking) Q.11 to Q.20	**(3 marks 2 min.)**	**[30, 20]**

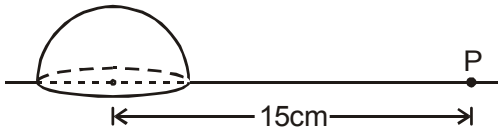
1. A particle of mass m moving along a straight line experiences force F which varies with the distance x travelled as shown in the figure. If the velocity of the particle at x_0 is $\sqrt{\frac{2F_0x_0}{m}}$, then velocity at $4x_0$ is:



(A) $2\sqrt{\frac{2F_0x_0}{m}}$ (B) $2\sqrt{\frac{F_0x_0}{m}}$

(C) $\sqrt{\frac{F_0x_0}{m}}$ (D) none of these

2. Figure shows a solid hemisphere with a charge of 5 nC distributed uniformly through its volume. The hemisphere lies on a plane and point P is located on the plane, along a radial line from the centre of curvature at distance 15 cm. The electric potential at point P due to the hemisphere, is :



(A) 150 V (B) 300 V (C) 450 V (D) 600 V

3. An experiment measures quantities x, y, z and then t is calculated from the data as $t = \frac{xy^2}{z^3}$. If percentage errors in x, y and z are respectively 1%, 3%, 2%, then percentage error in t is :

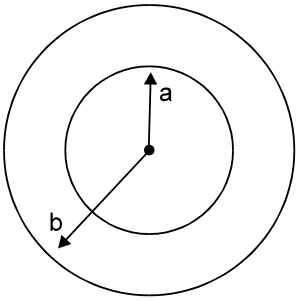
(A) 10 % (B) 4 % (C) 7 % (D) 13 %

4. An electron (of charge –e) revolves around a long wire with uniform charge density λ in a circular path of radius r. Its kinetic energy is given by :

(A) $\frac{\lambda e}{2\pi\epsilon_0 r}$ (B) $\frac{\lambda e}{4\pi\epsilon_0 r}$ (C) $\frac{\lambda e}{2\pi\epsilon_0}$ (D) $\frac{\lambda e}{4\pi\epsilon_0}$

5. If the electric potential of the inner shell is 10 volt & that of the outer shell is 5 volt, then the potential at the centre will be: (the shells are uniformly charged)

(A) 10 volt
(B) 5 volt
(C) 15 volt
(D) 0



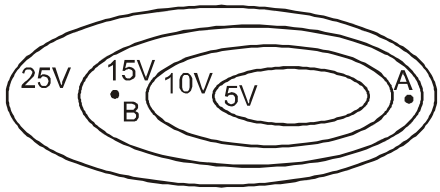
6. A mercury drop of water has potential 'V' on its surface. 1000 such drops combine to form a new drop. Find the potential on the surface of the new drop.

(A) V (B) 10V (C) 100V (D) 1000V

7. Potential difference between centre and the surface of sphere of radius R and having uniform volume charge density ρ within it will be :

(A) $\frac{\rho R^2}{6\epsilon_0}$ (B) $\frac{\rho R^2}{4\epsilon_0}$ (C) 0 (D) $\frac{\rho R^2}{2\epsilon_0}$

8. The figure shows several equipotential lines. Comparing between points A and B, pick up the best possible statement

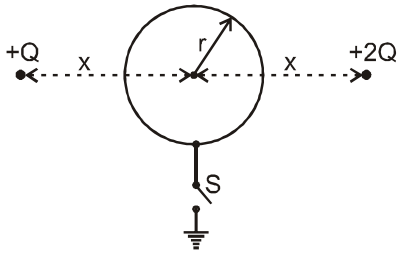


(A) the electric field has a greater magnitude at point A and is directed to left.
(B) the electric field has a greater magnitude at point A and is directed to right.
(C) the electric field has a greater magnitude at point B and is directed to left.
(D) the electric field has a greater magnitude at point B and is directed to right.

9. An electric dipole is kept on the axis of a uniformly charged ring at distance $\frac{R}{\sqrt{2}}$ from the centre of the ring. The direction of the dipole moment is along the axis. The dipole moment is P, charge of the ring is Q & radius of the ring is R. The force on the dipole is

(A) $\frac{4\,k\,P\,Q}{3\sqrt{3}\,R^2}$ (B) $\frac{4\,k\,P\,Q}{3\sqrt{3}\,R^3}$ (C) $\frac{2\,k\,P\,Q}{3\sqrt{3}\,R^3}$ (D) zero

10. Two particles having positive charges +Q and +2Q are fixed at equal distance x from centre of an conducting sphere having zero net charge and radius r as shown. Initially the switch S is open. After the switch S is closed, the net charge flowing out of sphere is:

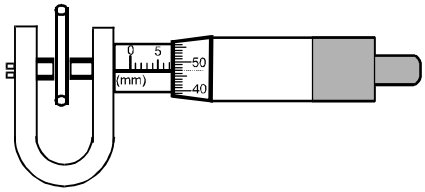


(A) $\frac{Qr}{x}$ (B) $-\frac{Qr}{x}$ (C) $\frac{3Qr}{x}$ (D) $-\frac{3Qr}{x}$

Comprehension :

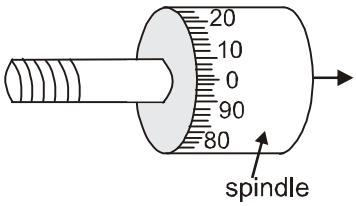
EXPERIMENT - 1

Screw gauge (Micrometer)



Screw gauge is used to measure closely upto $\left(\frac{1\ mm}{100}\right)$. How can it divide 1 mm in 100 parts !

To divide 1 mm in 100 parts, a screw is used. In one rotation, the screw (spindle) moves forward by 1 mm. (Called pitch of the screw)
The rotation of the screw (spindle) is divided in 100 parts (called circular scale), hence 1 mm is divided in 100 parts



1 rotation ≡ 1 mm

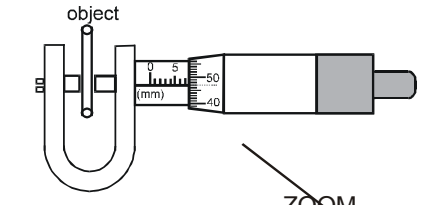
100 circular parts ≡ 1 mm

so 1 circular part ≡ $\frac{1 \text{ mm}}{100}$ = Least count of screw gauge

So lets generalize it

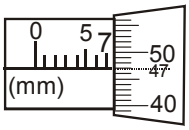
$$\text{Least count of a screw gauge} = \frac{1 \text{ mm}}{100} = \frac{\text{pitch of screw}}{\text{number of divisions on circular scale}}$$

How to find thickness of an object by screw gauge !



Object is inserted between the jaws

ZOOM



1 circular part = $\frac{1 \text{ mm}}{100}$

47 circular part = $47 \times \frac{1 \text{ mm}}{100}$

Object thickness = 7. - - - - -

= 7 mm + 47 circular devisions

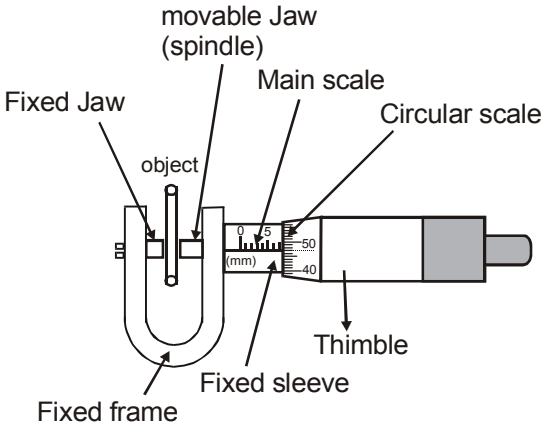
= 7 mm + 47 ($\frac{1 \text{ mm}}{100}$)

Main scale Reading | Circuler scale Reading | Least Count

$$\text{Thickness of object} = \text{Reading of Screwgauge} = [\text{Main scale Reading}] + [\text{Circular scale Reading}] \times [\text{Least Count}]$$

Least Count = $\frac{\text{Pitch}}{\text{Numbers of devisions on Circular Scale}}$

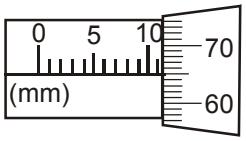
Description of screw gauge :



The object to be measured is put between the jaws. The sleeve is hollow part, fixed with the frame and main scale is printed on it.

The spindle and thimble are welded, and move together by means of a screw. The circular scale is printed on the thimble as shown. It generally consists of 100 divisions (sometime 50 divisions also)
The main scale has mm marks (Sometimes it also has 1/2 mm marks below mm marks.)
(Usually if pitch of the screw gauge is 1mm then there are 1mm marks on main scale and if pitch is 1/2 mm then there are 1/2 mm marks also)
This instrument can read upto 0.01 mm (10 μm) accuracy that is why it is called micrometer

Example. Read the normal screwgauge
*Main scale has only mm marks.
*In a complete rotation, the screw advances by 1 mm.
*Circular scale has 100 divisions



Solution :

Soln: Object thickness = 11 mm + 65 $\left(\frac{1\text{ mm}}{100}\right)$
= 11.65 mm

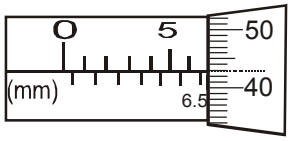
Example. Read the screwgauge

* Main scale has $\frac{1}{2}$ mm marks.

* In complete rotation, the screw advances by $\frac{1}{2}$ mm.

* Circular scale has 50 division.

Solution :



Soln: Object thickness = 6.5 - - - -
Object thickness = 6.5 mm + 43 $\left(\frac{1/2\text{ mm}}{50}\right)$
= 6.93 mm

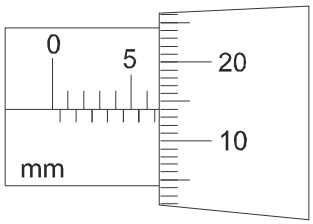
Example. Read the screwgauge shown bellow:

* Main scale has $\frac{1}{2}$ mm marks.

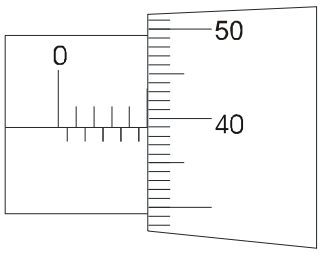
* In complete rotation, the screw advances by $\frac{1}{2}$ mm.

* Circular scale has 50 division.

Solution :



Object thickness = 6.5 mm + 14 $\left(\frac{1/2\text{ mm}}{50}\right)$
= 6.64 mm



Object thickness = 4.5 mm + 39 $\left(\frac{1/2\text{ mm}}{50}\right)$
= 4.89 mm

11. A wire of resistance R = 100.0 Ω and length l = 50.0 cm is put between the jaws of screw gauge. Its reading is shown in figure. Pitch of the scruegauge is 0.5 mm and there are 50 divisio on circular scale. Find its resistivity in correct significant figures and maximum permissible error in ρ (resistivity).

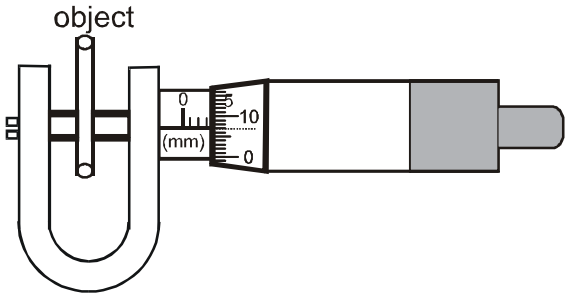
12. In a complete rotation, spindle of a screw gauge advances by $\frac{1}{2}$ mm. There are 50 divisions on circular scale. The main scale has $\frac{1}{2}$ mm marks $\rightarrow$ (is graduated to $\frac{1}{2}$ mm or has least count = $\frac{1}{2}$ mm)

If a wire is put between the jaws, 3 main scale divisions are clearly visible, and 20 division of circular scale co-inside with the reference line. Find diameter of wire in correct S.F.

13. In the previous question if the mass of the wire is measured as 0.53 kg and length of the wire is measured by an mm scale and is found to be 50.0 cm, find the density of the wire in correct significant figures.

14. Two measure diameter of a wire, a screwgauge is used. The main scale division is of 1 mm. In a complete rotation, the screw advances by 1 mm and the circular scale has 100 devisions. The reading of screwgauge is as shown in figure.

If there is no error in mass measurement, but error in length measurement is 1%, then find max. Possible error in density.

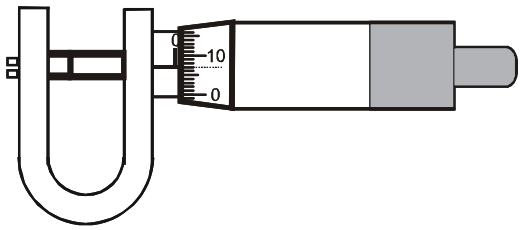


Comprehension :

Zero Error :

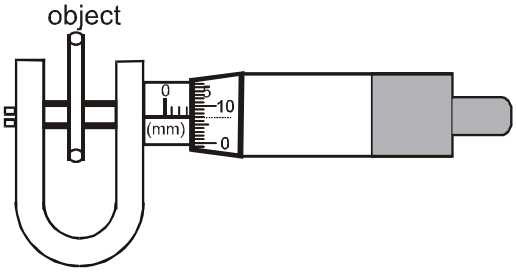
If there is no object between the jaws (i.e. jaws are in contact), the screwgauge should give zero reading. But due to extra material on jaws, even if there is no object, it gives some excess reading. This excess.

Reading is called **zero error :**



Excess reading = 0.07 mm
(Zero error)

If we put a wire between jaws



it gives 3.07 mm

In which there is 0.07 mm excess reading which has to be substructed

so actual thickness = 3.07 – 0.07 = 3.00 mm

Observed reading

excess reading (zero error)

Actual reading =	observed reading	–	excess reading (zero error)

ZERO CORRECTION :

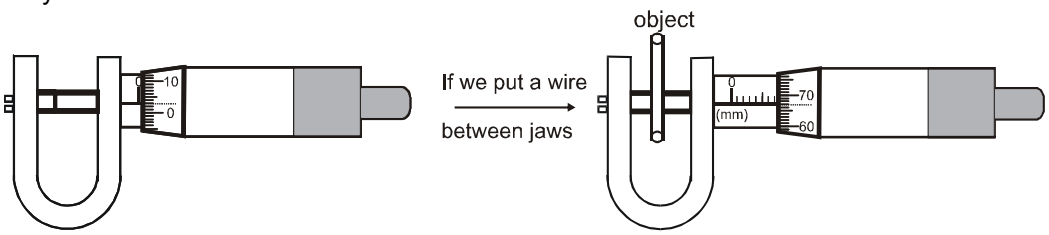
Zero correction is invert of zero error :

zero correction = - (zero error)

Actual reading = observed reading - zero error

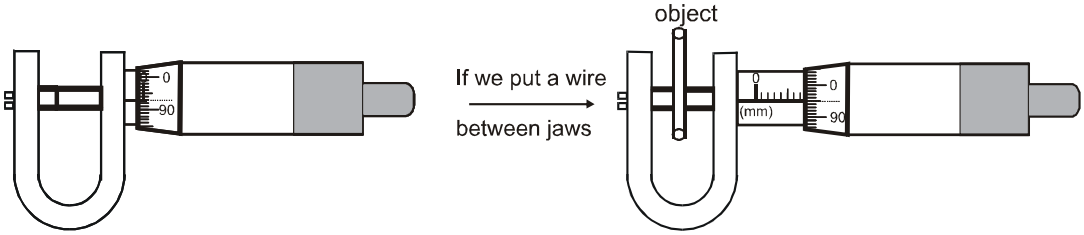
= observed reading + Zero correction

15. Find the thickness of the wire. The main scale division is of 1 mm. In a complete rotation, the screw advances by 1 mm and the circular scale has 100 devisions.



(A) 7.64 mm (B) 7.58 mm (C) 7.70 mm (D) 7.6 mm

16. Find the thickness of the wire. The main scale division is of 1 mm. In a complete rotation, the screw advances by 1 mm and the circular scale has 100 devisions. If no object is placed between the jaws, the zero of main scale is barely visible and 93rd circular devision matches with the main scale line.



(A) 8.02 mm (B) 7.87 mm (C) 7.80 mm (D) None of these

17._ A screw gauge with a pitch of 1mm has 100 divisions on its circular scale. When the screw gauge is used to measure the diameter of a uniform wire of length 5.6 cm, the main scale reading is 1 mm and the circular scale reading is 47. Calculate the area of the curved surface of the wire in cm^2 to appropriate significant figures, using $\pi = \frac{22}{7}$. There is no zero error in the screw gauge.

(A) 2.2 cm^2 (B) 2.6 cm^2 (C) 3.6 cm^2 (D) 4.6 cm^2

18. The pitch of a screw gauge is 0.5 mm and there are 100 divisions on it circular scale. The instrument reads +2 circular scale divisions when nothing is put in-between its jaws. In measuring the diameter of a wire, there are 8 divisions on the main scale and 83rd circular scale division coincides with the reference line. Then the diameter of the wire is

(A) 4.05 mm (B) 4.405 mm (C) 3.05 mm (D) 1.25 mm

19. The pitch of a screw gauge is 1 mm and there are 50 divisions on its circular scale. When the two jaws of the screw gauge are in contact with each other, the zero of the circular scale lies 6 division above the line of graduation. When a wire is placed between the jaws, 3 main scale divisions are clearly visible while 31st division on the circular scale coincide with the reference line. The diameter of the wire is :

(A) 3.62 mm (B) 3.50 mm (C) 3.5 mm (D) 3.74 mm

20. To measure the diameter of a wire, a screwgauge is used. In a complete rotation, spindle of the screw gauge advances by $\frac{1}{2}$ mm and its circular scale has 50 deviations. The main scale is graduated to $\frac{1}{2}$ mm. If the wire is put between the jaws, 4 main scale divisions are clearly visible and 10 devisions of circular scale co–inside with the reference line. The resistance of the wire is measured to be ($10\Omega \pm 1\%$). Length of the wire is measured to be 10 cm using a scale of least count 1mm. Maximum permissible error in resistivity measurement is :

(A) 1.5% (B) 2% (C) 2.9% (D) 3%

DPP No. : B21 (JEE-Advanced)

Total Marks : 34		**Max. Time : 23 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.4	**(3 marks, 2 min.)**	**[12, 08]**
One or more than one options correct type ('–1' negative marking) Q.5 to Q.7	**(4 marks 2 min.)**	**[12, 06]**
Comprehension ('–1' negative marking) Q.8 to Q.9	**(3 marks 2 min.)**	**[06, 04]**
Subjective Questions ('–1' negative marking) Q.10	**(4 marks 5 min.)**	**[04, 05]**

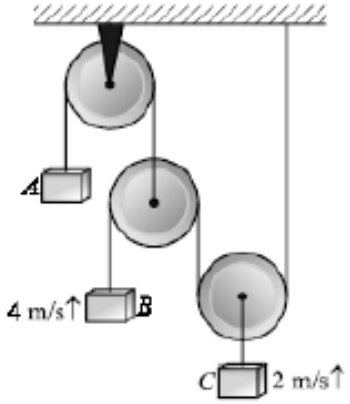
1. The pitch of a screw gauge is 0.5 mm and there are 100 divisions on it circular scale. The instrument reads +2 circular scale divisions when nothing is put in-between its jaws. In measuring the diameter of a wire, there are 8 divisions on the main scale and 83rd circular scale division coincides with the reference line. Then the diameter of the wire is

(A) 4.05 mm (B) 4.405 mm (C) 3.05 mm (D) 1.25 mm

2. The pitch of a screw gauge is 1 mm and there are 50 divisions on its circular scale. When the two jaws of the screw gauge are in contact with each other, the zero of the circular scale lies 6 division above the line of graduation. When a wire is placed between the jaws, 3 main scale divisions are clearly visible while 31st division on the circular scale coincide with the reference line. The diameter of the wire is :

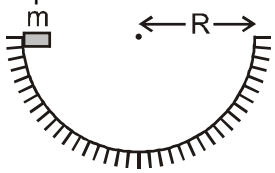
(A) 3.62 mm (B) 3.50 mm (C) 3.5 mm (D) 3.74 mm

3. In the pulley system shown in figure, block C is going up at 2 m/s and block B is going up at 4 m/s, then the velocity of block A on the string shown in figure, is equal to :



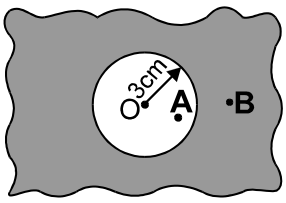
(A) 2 m/s ↓ (B) 4 m/s ↓ (C) 6 m/s ↓ (D) 8 m/s ↓

4. In the figure shown, a small block of mass m moves in fixed semicircular smooth track of radius R in vertical plane. It is released from the top. The resultant force on the block at the lowest point of track is.



(A) 3 mg (B) 2 mg (C) mg (D) zero

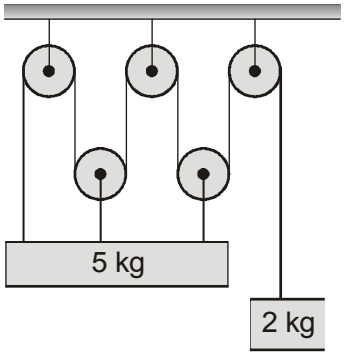
5. The figure shows a point charge of 0.5×10^{-6}C at the centre of a spherical cavity of radius 3cm in a large piece of metal. The electric field at



(A) A (2 cm from the charge)is O (B) A (2cm from the charge)is 1.125×10^7N/c

(C) B (5 cm from the charge) is O (D) B (5 cm from the charge) is 1.8×10^6 N/c

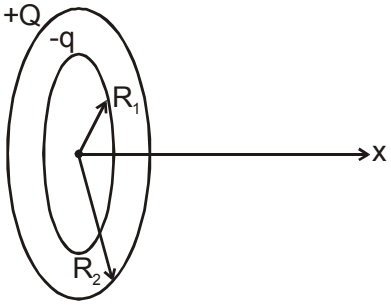
6. In the figure shown, two blocks one of mass 5 kg and the other of mass 2 kg are connected by light and inextensible string. Pulleys are light and frictionless. Choose the **correct** statement.



(A) The acceleration of 5 kg mass is $\frac{5g}{11}$ m/s^2 (B) The acceleration of 2 kg mass is $\frac{5g}{11}$ m/s^2

(C) Tension in the string is $\frac{12g}{11}$ N (D) Tension in the string is $\frac{10g}{11}$ N

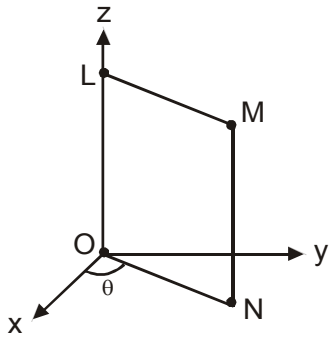
7. Two concentric fixed rings of radii $R_1 = \sqrt{6}$ m and $R_2 = 4$m are placed in y-z plane with their centres at origin. They have uniform charge –q and +Q = $2\sqrt{2}$ q on the inner and outer rings respectively. Consider the electrostatic potential to be zero at infinity. Then



(A) The electric potential is zero at origin.
(B) The electric field intensity is zero at r = 2 m.
(C) A positive charged particle disturbed from origin along the x-axis will restore back to origin.
(D) Where potential is maximum on the x-axis, field intensity is zero.

Comprehension :

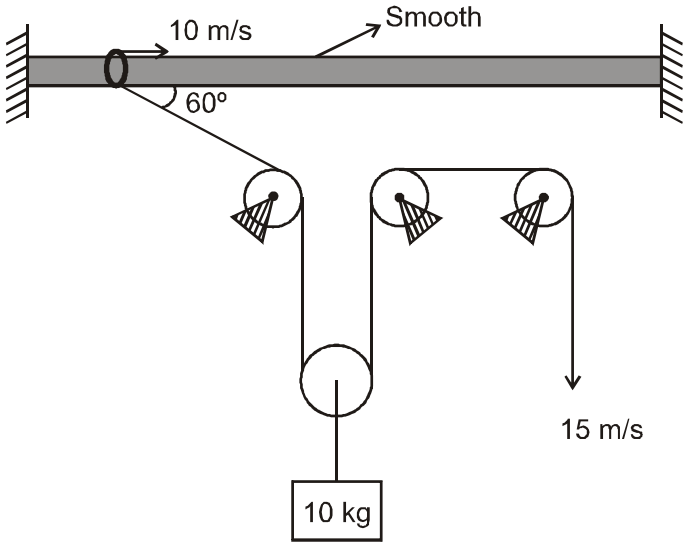
The electric field intensity at all points in space is given by $\vec{E} = \sqrt{3}\,\hat{i} - \hat{j}$ volts/metre. A square frame LMNO of side 1 metre is shown in figure. The point N lies in x-y plane. The initial angle between line ON and x-axis is $\theta = 60°$



8. The magnitude of electric flux through area enclosed in square frame LMNO is -
(A) 0 volt metre (B) 1 volt metre (C) 2 volt metre (D) 4 volt metre

9. The square frame LMNO is now rotated about z-axis by an angle 30°, such that θ either increases or decreases. Then pick up the correct statement .
(A) The magnitude of electric flux increases from initial value as θ is increased.
(B) The magnitude of electric flux increases from initial value as θ is decreased.
(C) The magnitude of electric flux may increase or decrease from initial value as θ is changed.
(D) The magnitude of electric flux will decrease from initial value as θ is changed.

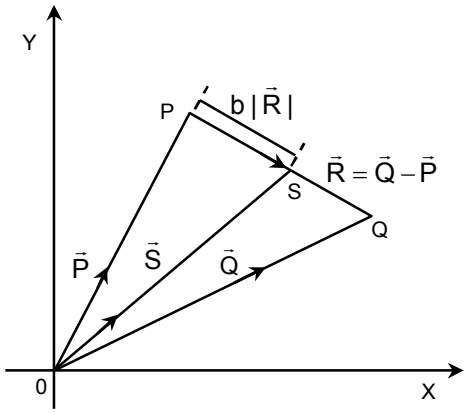
10. All the pulleys are ideal, string is massless then rate of work done by gravity at the given instant is $(-x \times 10^2)$ W then calculate x :



DPP No. : B22 (JEE-Advanced)

Total Marks : 38		**Max. Time : 26 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.2	**(3 marks, 2 min.)**	**[06, 04]**
One or more than one options correct type ('–1' negative marking) Q.3 to Q.8	**(4 marks 2 min.)**	**[24, 12]**
Subjective Questions ('–1' negative marking) Q.9 to Q.10	**(4 marks 5 min.)**	**[08, 10]**

1. Three vectors $\vec{P}$, $\vec{Q}$ and $\vec{R}$ are shown in the figure. Let S be any point on the vector $\vec{R}$. The distance between the point P and S is $b|\vec{R}|$. The general relation among vectors $\vec{P}$, $\vec{Q}$ and $\vec{S}$ is :



(A) $\vec{S} = (b-1)\vec{P} + b\vec{Q}$ (B) $\vec{S} = (1-b^2)\vec{P} + b\vec{Q}$ (C) $\vec{S} = (1-b)\vec{P} + b^2\vec{Q}$ (D) $\vec{S} = (1-b)\vec{P} + b\vec{Q}$

2. A person measures the depth of a well by measuring the time interval between dropping a stone and receiving the sound of impact with the bottom of the well. The error in his measurement of time is $\delta T = 0.01$ seconds and he measures the depth of the well to be L = 20 meters. Take the acceleration due to gravity g = 10ms^{-2} and the velocity of sound is 300 ms^{-1}. Then the fractional error in the measurement $\frac{\delta L}{L}$, is closest to :

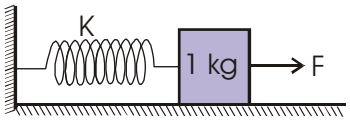
(A) 0.2 % (B) 3% (C) 5% (D) 1%

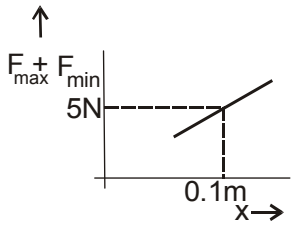
3. Which of the following is/are conservative force(s) ?

(A) $\vec{F} = 2r^3\hat{r}$ (B) $\vec{F} = -\frac{5}{r}\hat{r}$ (C) $\vec{F} = \frac{3(x\hat{i}+y\hat{j})}{(x^2+y^2)^{3/2}}$ (D) $\vec{F} = \frac{3(y\hat{i}+x\hat{j})}{(x^2+y^2)^{3/2}}$

Comprehension

A block of mass 1 kg is placed on a rough horizontal surface. A spring is attached to the block whose other end is joined to a rigid wall,as shown in the figure. A horizontal force is applied on the block so that it remains at rest while the spring is elongated by x $\left(x \geq \frac{\mu mg}{k}\right)$. Let F_{max} and F_{min} be the maximum and minimum values of force F for which the block remains in equilibrium. For a particular x, $F_{max} - F_{min} = 2$ N. Also shown is the variation of $F_{max} + F_{min}$ versus x, the elongation of the spring.





4. The coefficient of friction between the block and the horizontal surface is :
(A) 0.1 (B) 0.2 (C) 0.3 (D) 0.4

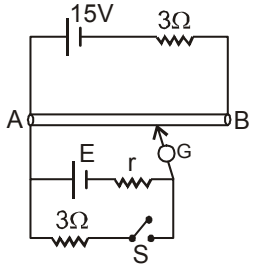
5. The spring constant of the spring is:
(A) 25 N/m (B) 20 N/m (C) 2.5 N/m (D) 50 N/m

6. The value of F_{min} , if x = 3 cm is :
(A) 0 (B) 0.2N (C) 5N (D) 1N

Comprehension

A wire AB (of length 1m , area of cross section πm^2) is used in potentiometer experiment to calculate emf and internal resistance (r) of battery.

The emf and internal resistance of driving battery are 15 V and 3Ω respectively. The resistivity of wire AB varies as $\rho=\rho_0 x$ (where x is distance from A in meters and $\rho_0 = 24\pi\ \Omega$)



The distance of null point from A is obtained at $\sqrt{\frac{2}{3}}$ m when switch 'S' is open and at $\frac{1}{\sqrt{2}}$ m when switch is closed.

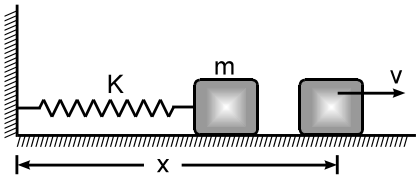
7. Which of the following option(s) is/are correct :
(A) The resistance of whole wire AB is 18Ω
(B) The resistance of whole wire AB is 12Ω
(C) The current through 15 V battery is 1 A only when switch S is closed
(D) The current through 15 V battery is 1A in both cases

8. Which of the following option(s) is/are correct :
(A) The emf (E) of battery is 8V
(B) The emf (E) of battery is 6V
(C) Internal resistance of battery E is 2Ω
(D) Internal resistance of battery E is 1Ω

9. A trinary star system has time period T = 3 year, while the distance between its components is 2 astronomical unit. If mass of the sun is represented by M_S, then the total mass of this multiple star system will be $\frac{\alpha}{\beta}M_S$. Find minimum value of $\beta - \alpha$.

Note: **(1) System of three star, orbiting around centre of mass of system, is called trinary star system, for simplicity assume all three components to be identical.**
(2) 1 astronomical unit = distance between earth and sun.
(3) 1 year = time period of earth to complete one full revolution around sun

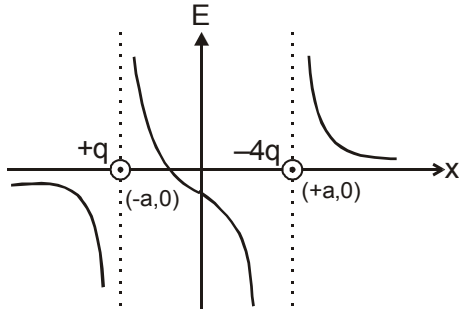
10. A block of mass ' m ' is pushed against a spring of spring constant ' k ' fixed at one end to a wall. The block can slide on a frictionless table as shown in the figure. The natural length of the spring is L_0 and it is compressed to one-fourth of natural length and the block is released. Find its velocity as a function of its distance (x) from the wall and maximum velocity of the block. The block is not attached to the spring.

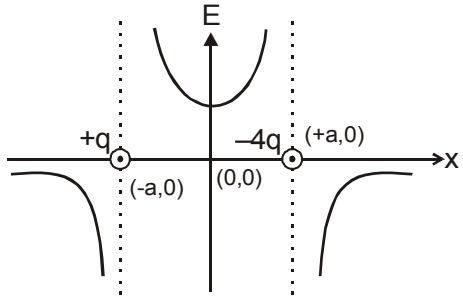


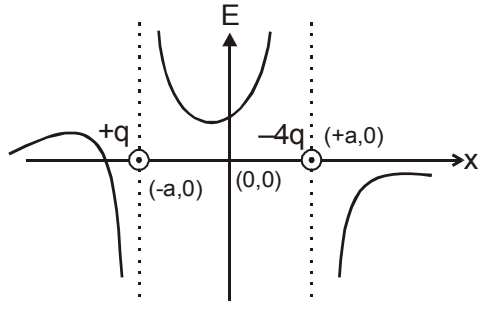
DPP No. : B23 (JEE-Main)

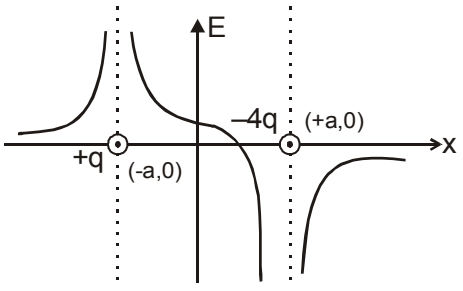
Total Marks : 60		**Max. Time : 40 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.12	**(3 marks, 2 min.)**	**[36, 24]**
Comprehension ('–1' negative marking) Q.13 to Q.20	**(3 marks 2 min.)**	**[24, 16]**

1. Two point charges +q and –4q are placed at (–a, 0) and (+a, 0). Take electric field intensity to be positive if it is along positive x-direction. The variation of the electric field intensity as one moves along the x-axis is

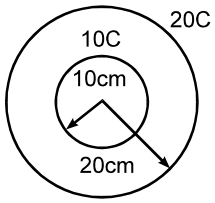
(A)


(B)


(C)


(D)


2. Two concentric uniformly charged spheres of radius 10 cm & 20 cm are arranged as shown in the figure. Potential difference between the spheres is :

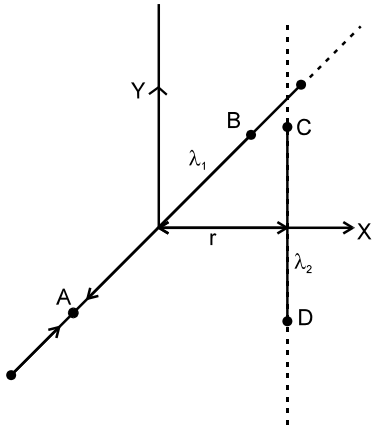


(A) 4.5×10^{11} V (B) 2.7×10^{11} V
(C) 0 (D) none of these

3. Weight of an object is :
(A) Normal reaction between ground and the object
(B) Gravitational force exerted by earth on the object.
(C) dependent on frame of reference.
(D) net force on the object

4. A diverging lens of focal length –10 cm is moving towards right with a velocity 5 m/s.An object ,placed on Principal axis is moving towards left with a velocity 3 m/s. The veocity of image at the instant when the lateral magification produced is 1/2 is : (All velocities are with respect to ground)
(A) 3 m/s towards right (B) 3 m/s towards left
(C) 7 m/s towards right (D) 7 m/s towards left

5. AB and CD are uniform line charges of infinite length having charge density λ_1 and λ_2 and lying along the z axis and y–axis respectively. The force between them depends on the perpendicular distance between them, 'r' as, $F = \frac{\lambda_1.\lambda_2}{2\varepsilon_0 r^n}$, then the value of n is :

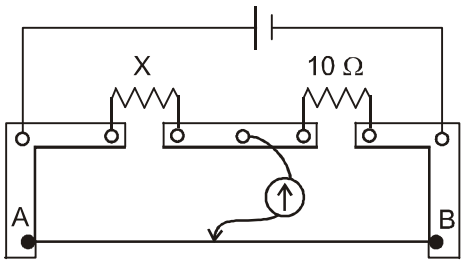


(A) 0 (B) 1/2 (C) 1 (D) 2

6. Assuming the earth to be a homogeneous sphere of radius R, its density in terms of G (constant of gravitation) and g (acceleration due to gravity on the surface of the earth)
(A) $3g/(4\pi RG)$ (B) $4\pi g/(3RG)$ (C) $4\pi Rg/(3G)$ (D) $4\pi RG/(3g)$

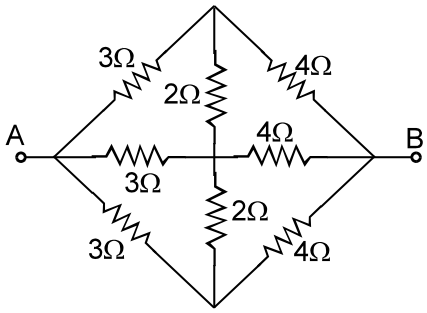
7. A meter bridge is set-up as shown, to determine an unknown resistance 'X' using a standard 10 ohm resistor. The galvanometer shows null point when tapping-key is at 52 cm mark. The end-corrections are 1 cm and 2 cm respectively for the ends A and B. The determined value of 'X' is

[JEE 2011, 3/160,–1]



(A) 10.2 ohm (B) 10.6 ohm (C) 10.8 ohm (D) 11.1 ohm

8. The equivalent resistance between A and B will be (in Ω)



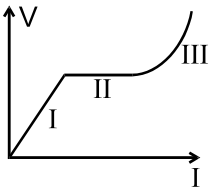
(A) 2/7 (B) 8 (C) 4/3 (D) 7/3

9. A small hoop of mass m is given an initial velocity of magnitude v_0 on the horizontal circular ring of radius 'r'. If the coefficient of kinetic friction is μ_k the tangential acceleration of the hoop immediately after its release is (assume the horizontal ring to be fixed and not in contact with any supporting surface)

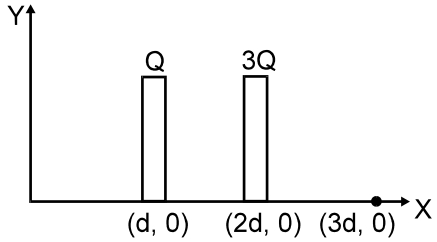
(A) $\mu_k g$ (B) $\mu_k \frac{v_0^2}{r}$ (C) $\mu_k \sqrt{g^2 + \frac{v_0^2}{r}}$ (D) $\mu_k \sqrt{g^2 + \frac{v_0^4}{r^2}}$

10. Voltage V v/s I graph is shown in the figure.

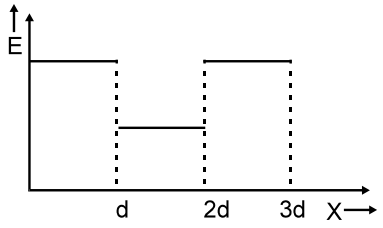
(A) resistance in region I is ohmic, II & III are non-ohmic
(B) resistance in region II is zero and III is ohmic
(C) resistance in region II is zero and III is non-ohmic
(D) in I it is ohmic, in II it is non-ohmic.



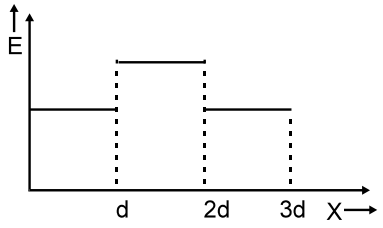
11. Two very large thin conducting plates having same cross-sectional area are placed as shown in figure they are carrying charges 'Q' and '3Q' respectively. The variation of electric field as a function of x (for x = 0 to x = 3d) will be best represented by.



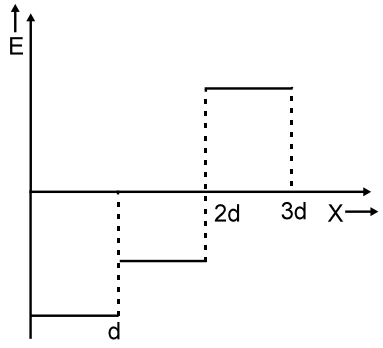
(A)



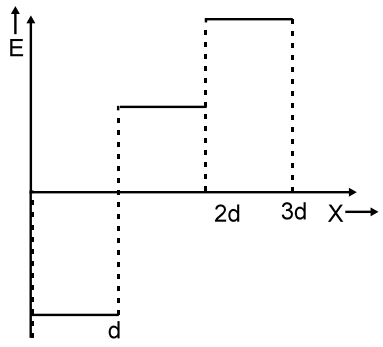
(B)



(C)



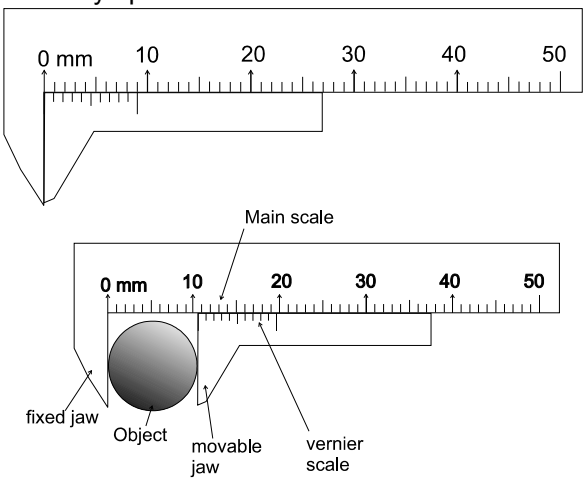
(D)



12. The diameter of a cylinder is measured using a vernier callipers with no zero error. It is found that the zero of the vernier scale lies between 5.10 cm and 5.15 cm of the main scale. The vernier scale has 50 division equivalent to 2.45 cm. The 24th division of the vernier scale exactly coincides with one of the main scale divisions. The diameter of the cylinder is :
(A) 5.112 cm (B) 5.124 cm (C) 5.136 cm (D) 5.148 cm

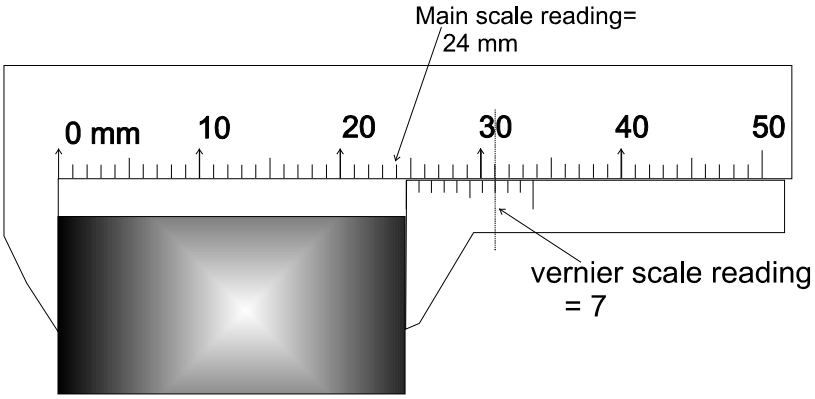
Comprehension :

It is used to measure accurately upto 0.1 mm.



*On the upper plate, main scale is printed which is simply an mm scale.
*On the lower plate, vernier scale is printed, which is a bit compressed scale. Its one part is of 0.9 mm.
(10 vernier scale divisions = 9 mm $\Rightarrow$ 1 vernier scale division = 0.9 mm)
The object which is to be measured, is fitted between the jaws as shown.

How to read Vernier Callipers:



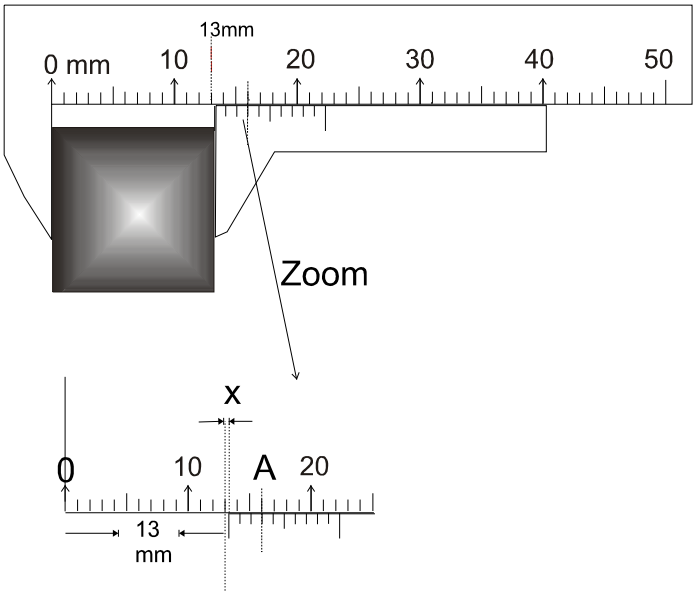
Thickness of the object = 24. - - - - - - -
= 24 mm + 7 (0.1 mm)

Formula says
Thickness of the object = [Main Scale Reading] + [Vernier Scale Reading] [least count]

[Mark on vernier scale which exactly co-insides with some mark of main scale]

[1 main scale devision] - [1 vernier scale devision]
= 1 mm - 0.9 mm
= 0.1 mm

Now lets see How the slight difference between 1 MSD and 1 VSD reflects as least count



Required length = 13 mm + x = ?
at point 'A' , main scale and vernier scale are matching
so length OA along main Scale = length OA along Vernier Scale
13 mm +3 (Main scale division) = (13 mm + x) + 3 (vernier Scale division)
Get 13 mm + x = 13 mm + 3 (Main scale division - vernier Scale division)
= 13 mm + 3 (1 mm – 0.9 mm)
= 13 mm + 3 (0.1 mm) = 13.3 mm

$$\begin{pmatrix}\text{main}\\ \text{scale}\\ \text{reading}\end{pmatrix} + \begin{pmatrix}\text{vernier}\\ \text{scale}\\ \text{reading}\end{pmatrix} \begin{pmatrix}\text{Least}\\ \text{count}\end{pmatrix}$$

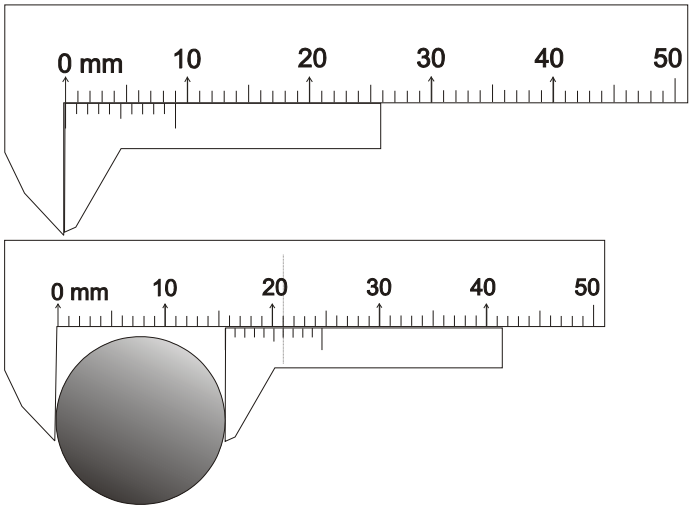
↓

(1 Main scale division – 1 vernier Scale division)

Hence the slight difference between 1 MSD (1 mm) and 1 VSD (0.9 mm) reflects as least count (0.1 mm)

$$\begin{matrix}\text{Thicknes of object}\\ = \\ \text{Reading of vernier callipers}\end{matrix} = \begin{pmatrix}\text{main}\\ \text{scale}\\ \text{reading}\end{pmatrix} + \begin{pmatrix}\text{vernier}\\ \text{scale}\\ \text{reading}\end{pmatrix} \begin{pmatrix}\text{Least}\\ \text{count}\end{pmatrix}$$

Example. Read the vernier. 10 division of vernier scale are matching with 9 divisions of main scale.



Solution : 10 vernier scale divisions = 9 mm

1 vernier scale division = 0.9 mm

$\Rightarrow$ least count = (Main scale division - vernier Scale division)

= 1 mm - 0.9 mm (from figure)

= 0.1 mm

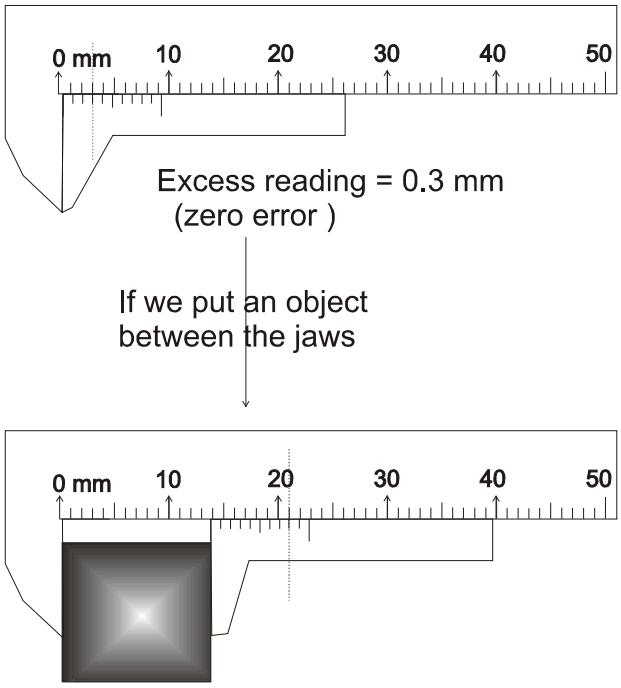
Thickness of the object = (main scale reading) + (vernier scale Reading) (least count)

So thickness of the object = 15 mm + (6) (0.1mm) = 15.6 mm **Ans.**

Zero Error:

If there is no object between the jaws (ie. jaws are in contact),the vernier should give zero reading. But due to some extra material on jaws, even if there is no object between the jaws, it gives some excess Reading. This excess reading is called **zero error**

Example. In the vernier caliperse, 9 main scale divisions matches with 10 vernier scale divisions. The thickness of the object using the defected vernier calliperse will be :



It gives 13.8 mm reading

In which there is 0.3 mm excess reading, which has to be removed (substructed)

So actual thickness = 13.8 - 0.3 = 13.5 mm

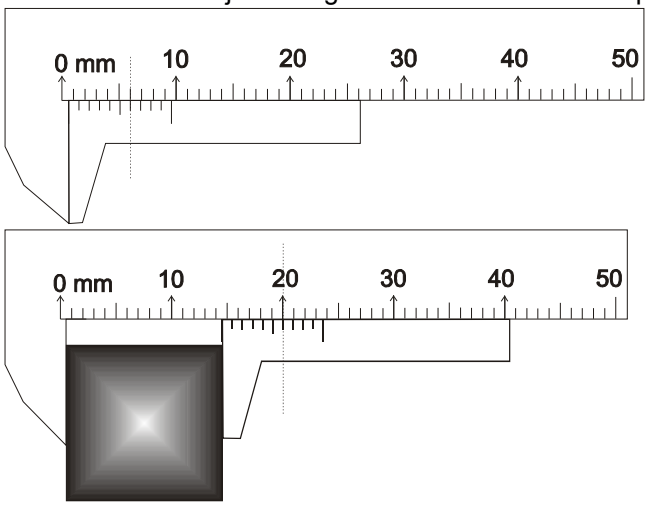
Observed reading

excess reading (zero error)

So we can formulate it as

Actual reading = observed reading - excess reading (Zero error)

Example. In the vernier caliperse, 9 main scale divisions matches with 10 vernier scale divisions. The thickness of the object using the defected vernier calliperse will be :



Solution : From first figure, Excess reading (zero error) = 0.6 mm

If an object is placed, vernier gives 14.6 mm in which there is 0.6 mm excess reading, which has to be subtracted. So actual thickness = 14.6 – 0.6 = 14.0 mm we can also do it using the formula

Actual reading = observed reading - excess reading (Zero error)

= 14.6 – 0.6 = 14.0 mm **Ans.**

Zero Correction :

Zero correction is invert of zero error.

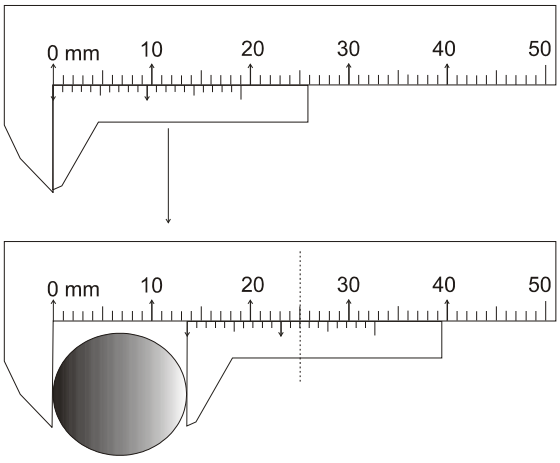
Zero correction = – (zero error)

Actual reading = observed reading - excess reading (Zero error)
= observed + zero corraction Reading

In example 28, zero error was 0.6 mm, so zero correction will be – 0.6 mm

In example 29, zero error was -0.4 mm, so zero correction will be + 0.4 mm

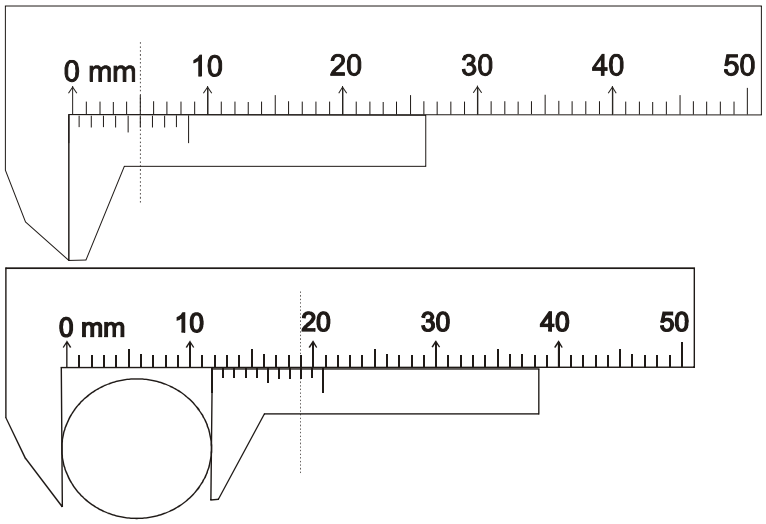
13. Read the special type of vernier. 20 division of vernier scale are matching with 19 divisions of main scale.



14. The main scale of a vernier callipers reads 10 mm in 10 divisions. 10 divisions of Vernier scale coincide with 9 divisions of the main scale. When the two jaws of the callipers touch each other, the fifth division of the vernier coincides with some main scale divisions and the zero of the vernier is to the right of zero of main scale. When a cylinder is tightly placed between the two jaws, the zero of vernier scale lies slightly behind 3.2 cm and the fourth vernier division coincides with a main scale division. The diameter of the cylinder is.

15. In the previous question if the length of the cylinder is measured as 25 mm, and mass of the cylinder is measured as 50.0 gm, find the density of the cylinder (gm/cm^3) in proper significant figures.

16. The least count of main scale is 1mm. In the vernier caliperse, 9 main scale divisions matches with 10 vernier scale divisions. When no object is placed between the jaws, the zero of vernior scale is slightly behind the zero of main scale. When a sphere is placed between the jaws, the reading of the vernier is shown in the figure. The thickness of the object using the defected vernier calliperse will be :



17. In the determination of Young's modulus Y by Searle's method, the diameter of the wire is measured by a screw gauge (least count = 0.001 cm) as 0.050 cm. The length of the wire is measured by a scale (least count = 0.1 cm) as 110.0 cm. When a weight of 50 N is applied on the wire, The micrometer (least count = 0.001 cm) reading gives the extension in its length as 0.125 cm. Determine the maximum possible error in Y, using $\pi = \frac{22}{7}$.

18. Side of a cube is measured with the help of vernier calliper. Main scale reading is 10 mm and vernier scale reading is 1. It is known that 9 M.S.D. = 10 V.S.D. Mass of the cube is 2.735 g. Find density of the cube upto appropriate significant figure.

19. The smallest division on the main scale of a vernier callipers is 1 mm, and 10 vernier divisions coincide with 9 main scale divisions. While measuring the diameter of a sphere, the zero mark of the vernier scale lies between 20 and 21 mm and the fifth division of the vernier scale coincide with a main scale division. Then diameter of the sphere is :
(A) 20.5 mm (B) 21.5 mm (C) 21.50 mm (D) 20.50 mm

20. A vernier calliper has 1 mm marks on the main scale. It has 20 equal division on the Vernier scale which match with 16 main scale divisions. For this Vernier calliper, the least count is :
(A) 0.02 mm (B) 0.05 mm (C) 0.1 mm (D) 0.2 mm

DPP No. : B24 (JEE-Advanced)

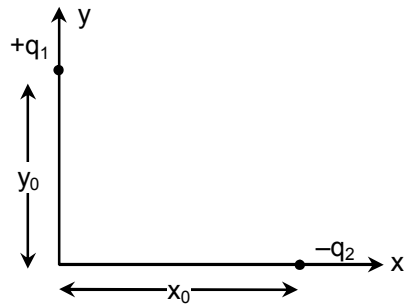
Total Marks : 42		**Max. Time : 30 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.2	**(3 marks, 2 min.)**	**[06, 04]**
One or more than one options correct type ('–1' negative marking) Q.3 to Q.7	**(4 marks 2 min.)**	**[20, 10]**
Subjective Questions ('–1' negative marking) Q.8 to Q.9	**(4 marks 5 min.)**	**[08, 10]**
Match the Following (no negative marking) Q.10	**(8 marks, 6 min.)**	**[08, 06]**

1. Two resistors R_1 (24 ± 0.5) Ω and R_2 (8 ± 0.3) Ω are joined in series. The equivalent resistance is :
(A) 32 ± 0.33 Ω (B) 32 ± 0.8 Ω (C) 32 ± 0.2 Ω (D) 32 ± 0.5 Ω

2. To measure the diameter of a wire, a screwgauge is used. In a complete rotation, spindle of the screw gauge advances by $\frac{1}{2}$ mm and its circular scale has 50 deviations. The main scale is graduated to $\frac{1}{2}$ mm. If the wire is put between the jaws, 4 main scale divisions are clearly visible and 10 devisions of circular scale co–inside with the reference line. The resistance of the wire is measured to be (10Ω ± 1%). Length of the wire is measured to be 10 cm using a scale of least count 1mm. Maximum permissible error in resistivity measurement is :
(A) 1.5% (B) 2% (C) 2.9% (D) 3%

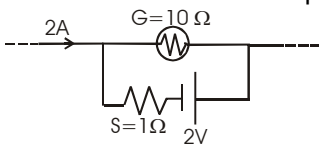
3. The linear momentum of a particle is given by $\vec{P} = (a\sin t\ \hat{i} - a\cos t\vec{j})$ kg–m/s. A force $\vec{F}$ is acting on the particle. Select correct alternative/s :
(A) Linear momentum $\vec{P}$ of particle is always parallel to $\vec{F}$
(B) Linear momentum $\vec{P}$ of particle is always perpendicular to $\vec{F}$
(C) Linear momentum $\vec{P}$ is always constant
(D) Magnitude of linear momentum is constant with respect to time.

4. Two point charges $+q_1$ and $-q_2$, each of same mass are kept on x and y-axis respectively in gravity free space, such that they are constrained to move on x-axis and y-axis respectively. They are released from their initial position as shown in figure. (Given that $y_0 < x_0$)



Considering only electrostatic interaction between the charges at any instant, (neglect gravity) choose the correct option(s):
(A) Magnitude of net external force acting on the system of 2 charges at any instant is equal to the magnitude of electrostatic force between the charges.
(B) Magnitude of net external force acting on the system of 2 charges at any instant is greater than the magnitude of electrostatic force between the charges.
(C) Both the charges will reach at origin simultaneously.
(D) q_1 will reach at origin first.

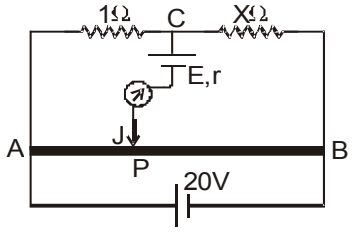
5. The galvanometer shown in the figure has resistance 10Ω .It is shunted by a series combination of a resistance S = 1Ω and an ideal cell of emf 2V. A current 2A passes as shown.



(A) The reading of the galvanometer is 1A
(B) The reading of the galvanometer is zero
(C) The potential difference across the resistance S is 1.5 V
(D) The potential difference across the resistance S is 2 V

Comprehension

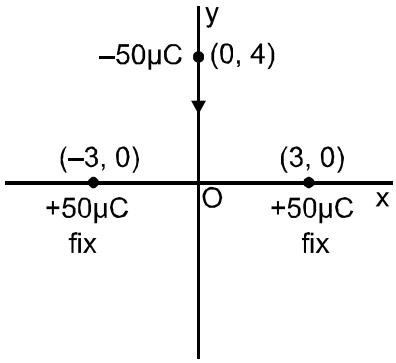
AB is a uniform wire of meter bridge, across which an ideal 20 volt cell is connected as shown. Two resistor of 1 Ω and X Ω are inserted in slots of metre bridge. A cell of emf E volts and internal resistance r Ω and a galvanometer is connected to jockey J as shown.



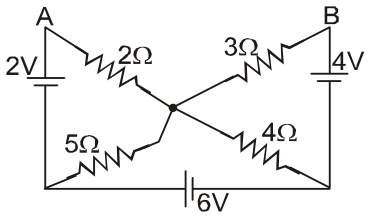
6. If E = 16 volts, r = 4 Ω and distance of balance point P from end A is 90 cm, then:
(A) the value of X is 9 Ω
(B) the current in X is 2A
(C) at the balanced condition the current through jockey is zero and the potential at C and P becomes equal
(D) If we short the cell of emf E by a thick wire then the current through galvanometer remains zero.

7. Choose the correct option(s)
(A) If E = 16 volts, r = 8Ω and X = 9Ω, then the location of balance point P will not change
(B) If E = 12 volts, r = 4Ω and X = 9Ω, then the location of balance point P will not change
(C) If E = 12 volts and X = 9Ω , then the distance of balance point P from end A is 70 cm
(D) If the resistance X is heated by some external source then the balance point P will shift towards end B.

8. The figure shows two equal, positive charges, each of magnitude 50 μC, fixed at points (3m, 0) and (–3m, 0) respectively. A charge – 50 μC, moving along y-axis has a kinetic energy of 4J at the instant, it reaches point (0, 4m). If the distance from origin where it returns and start moving along positive y-direction is $\sqrt{2}$ d, then find the value of d.



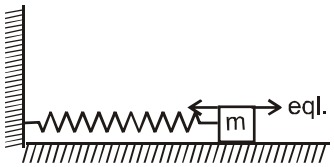
9. Potential difference between points A and B (i.e. $V_A - V_B$) is _ _ _ _ _ _ _ _ .



10. In **column-II**, some situations of particle of mass m are given. Direction in which it can be displaced is also shown in figure. In **column-I**, types of equilibria are given. Match the column according to the type of equilibrium for the given situations.

Column-I **Column-II**

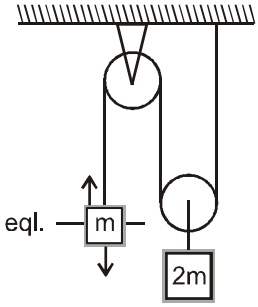
(A)



The block of mass m is at rest on a frictionless horizontal ground surface and spring is in its natural length.

(p) Stable equilibrium

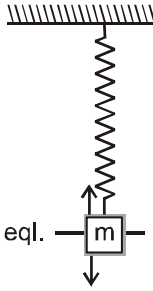
(B)



Two blocks of mass m and 2m are connected by the strings as shown. The strings and the pulleys are smooth and light. The block of mass m is at rest.

(q) Unstable equilibrium

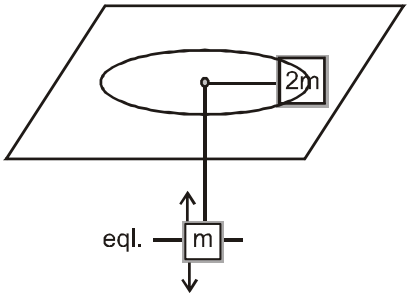
(C)



A block of mass m is suspended from a massless spring of spring constant k. It is vibrating in the vertical plane. At some instant, the stretching in the spring is $x = \frac{mg}{k}$.

(r) Neutral equilibrium

(D)



A block of mass 2m is rotating on a smooth table. Its speed is V and is any how maintained constant. A block of mass m is suspended with it as shown, and is in rest and equilibrium.

(s) Static equilibrium

(t) Dynamic equilibrium

DPP No. : B25 (JEE-Main)

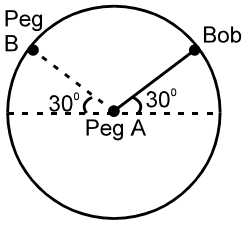
Total Marks : 58		**Max. Time : 38 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.9	**(3 marks, 2 min.)**	**[27, 18]**
One or more than one options correct type ('–1' negative marking) Q.10	**(4 marks 2 min.)**	**[04, 02]**
Comprehension ('–1' negative marking) Q.11 to Q.19	**(3 marks 2 min.)**	**[27, 18]**

1. A particle tied with a string moves in a vertical circular path. If X_1 and X_2 are the extreme left and right positions of the particle on the path, whereas Y_1 and Y_2 the extreme upper and lower positions, then the tension(s) in the string at the position(s)

(A) X_1 is greater than that at X_2 (B) Y_2 is greater than that at Y_1

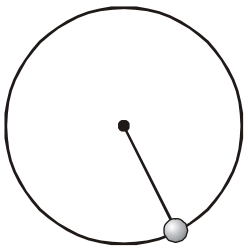
(C) Y_1 and Y_2 are the same (D) Y_1, Y_2, X_1 and X_2 are equal

2. A bob is attached to one end of a string other end of which is fixed at peg A. The bob is taken to a position where string makes an angle of 30^0 with the horizontal. On the circular path of the bob in vertical plane there is a peg 'B' at a symmetrical position with respect to the position of release as shown in the figure. If V_c and V_a be the minimum speeds in clockwise and anticlockwise directions respectively, given to the bob in order to hit the peg 'B' then ratio $V_c : V_a$ is equal to :



(A) 1 : 1 (B) 1 : $\sqrt{2}$ (C) 1 : 2 (D) 1 : 4

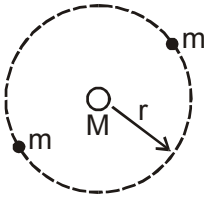
3. A particle is whirled in a vertical circle of radius 1.0 m using a string with one end fixed. If the ratio of maximum and minimum tension in the string is $\frac{5}{3}$, the minimum velocity of the particle is :



(A) $\sqrt{10}$ m/s (B) $\sqrt{50}$ m/s

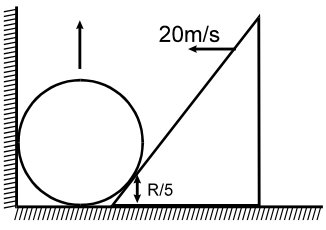
(C) 10 m/s (D) $10\sqrt{5}$ m/s

4. An isolated triple star system consists of two identical stars, each of mass m and a fixed star of mass M. They revolve around the central star in the same circular orbit of radius r. The two orbiting stars are always at opposite ends of a diameter of the orbit. The time period of revolution of each star around the fixed star is equal to :



(A) $\frac{4\pi r^{3/2}}{\sqrt{G(4M+m)}}$ (B) $\frac{2\pi r^{3/2}}{\sqrt{GM}}$ (C) $\frac{2\pi r^{3/2}}{\sqrt{G(M+m)}}$ (D) $\frac{4\pi r^{3/2}}{\sqrt{G(M+m)}}$

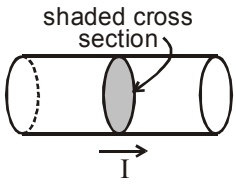
5. A sphere of radius R is in contact with a wedge. The point of contact is R/5 from the ground as shown in the figure. Wedge is moving with velocity 20 m/s, then the velocity of the sphere at this instant will be:



(A) 20 m/s (B) 15 m/s

(C) 5 m/s (D) 10 m/s

6. A current I flows through a cylindrical rod of uniform cross-section area A and resistivity ρ. The electric flux through the shaded cross-section of rod as shown in figure is :



(A) $\frac{\rho}{I}$ (B) ρI

(C) $\frac{\rho I}{A}$ (D) $\frac{\rho A}{I}$

7. Two wires each of radius of cross section r but of different materials are connected together end to end (i.e. in series). If the densities of charge carriers in the two wires are in the ratio 1: 4, the drift velocity of electrons in the two wires will be in the ratio:

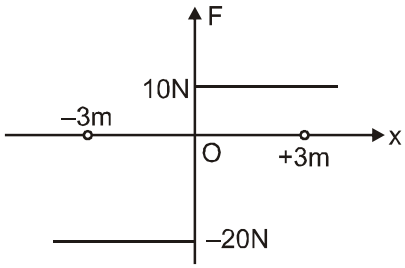
(A) 1 : 2 (B) 2 : 1 (C) 4 : 1 (D) 1 : 4

8. A simple pendulum is oscillating in a vertical plane. If resultant acceleration of bob of mass m at a point A is in horizontal direction, find the tangential force at this point in terms of tension T and mg.

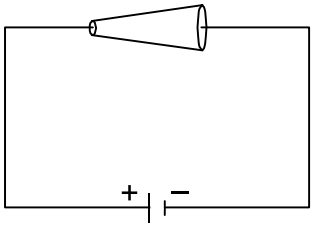
(A) mg (B) $\frac{mg}{T}\sqrt{T^2-(mg)^2}$ (C) $\frac{mg}{T}\sqrt{(mg)^2+T^2}$ (D) $\frac{T}{mg}\sqrt{(mg)^2+T^2}$

9. A particle is displaced from x = +3 m to x = –3 m. Variation of force with position is given in graph. Work done by this force during this above displacement is :

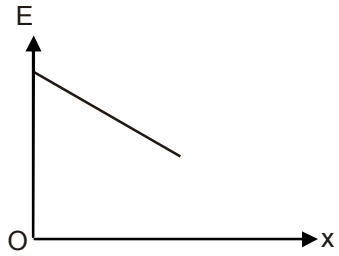
(A) –30 J
(B) 90 J
(C) 30 J
(D) –90 J

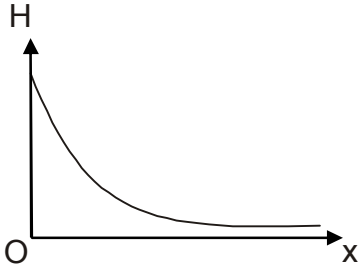


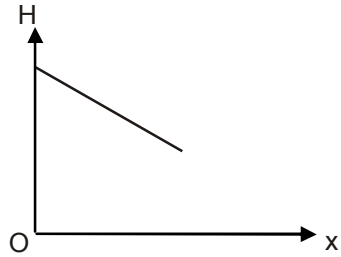
10. A conductor is made of an isotropic material and has the shape of a truncated cone.

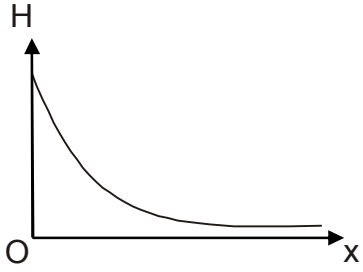


A battery of constant emf is connected across it. If at a distance x from left end, electric field intensity and the rate of generation of heat per unit length are E and H respectively, which of the following graphs is/are correct?

(A)


(B)


(C)


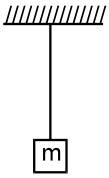
(D)


Comprehension

Determining Young's Modulus of a given wire by "Searle's Method" :

An elementary method :

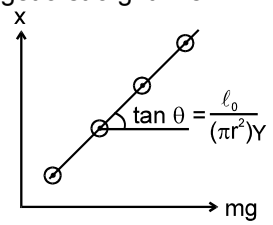
To determine Young's Modulus, we can perform an ordinary experiment. Lets hang a weight 'm' from a wire



from Hook's law: $\frac{mg}{A} = Y\left(\frac{x}{\ell_0}\right)$ $x = \left(\frac{\ell_0}{\pi r^2 Y}\right) mg$

If we change the weight, the elongation of wire will increase proportionally.

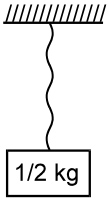
If we plot elongation v/s mg, we will get a straight line.



By measuring its slope and equating it to $\left(\frac{\ell_0}{\pi r^2 Y}\right)$, we can estimate Y.

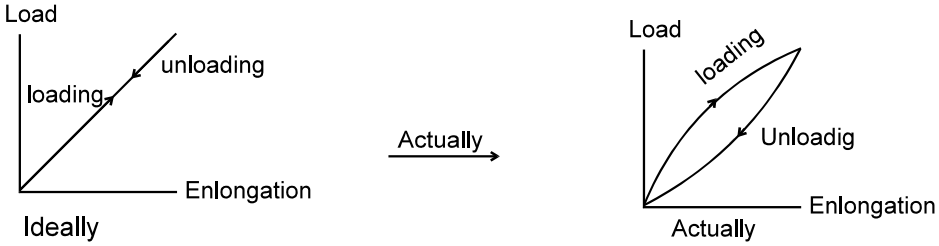
Limitations in this ordinary method

(1) For small load, there may be some bends or kinks in wire.

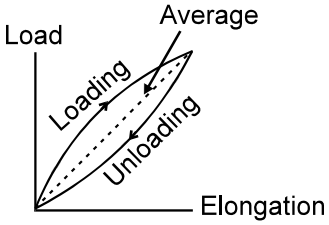


So we had batter start with some initial wt (say 2 kg). So that wire become straight.

(2) There is slight difference in behavior of wire under loading and unloading

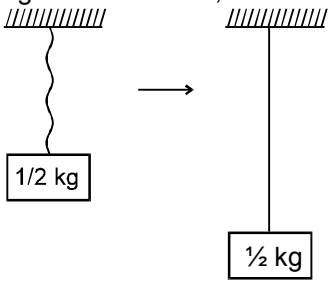


So we had better take average during loading and unloading. The average load will be more and more linear or accurate.



Modification done in "Searle's Method".

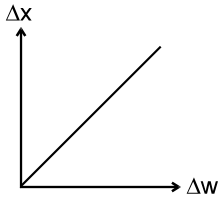
To keep the experimental wire straight and kink free, we start with some dead weight (2 kg)



Now we gradually add more and more weight. The extra elongation (Δx) will be proportional to extra weight (Δw).

$$x = \frac{\ell_0}{\pi r^2 Y} w \quad \Rightarrow \quad \Delta x = \frac{\ell_0}{\pi r^2 Y} (\Delta w)$$

so let's plot Δx v/s Δw, the slope of which will be = $\left(\frac{\ell_0}{\pi r^2 Y}\right)$



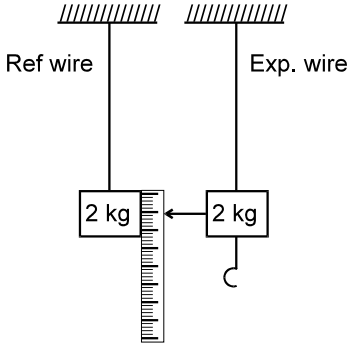
Measurement of Young's modulus.

To measure extra elongation, compared to initial loaded position, we use a reference wire, also carrying 2 kg load (dead weight). This method of measuring elongation by comparison, also cancels the side effect of tamp and yielding of support.

Observations:

(i) Initial Reading = x_0 = 0.540 mm. (Micrometer Reading without extra load)

(ii) Radius of wire = 0.200 mm. (using screw gauge)

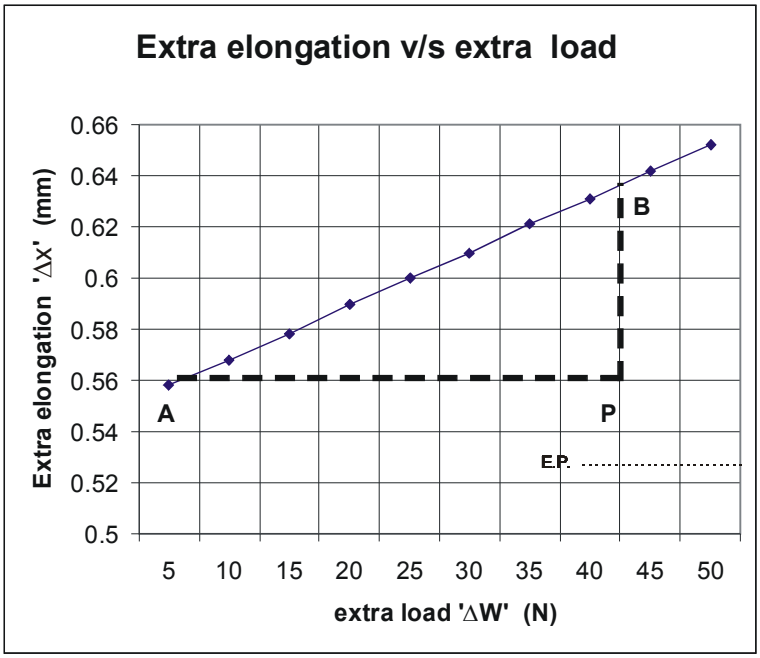


Measurement of extra extension due to extra load.

S.No.	Extra load on hanger Δm (kg)	Micrometer reading		Mean reading (x) (p + q)/2 (mm)	Δx extra elongation $(x–x_0)$ (mm)
		Load increasing (p) (mm)	Load decreasing (q) (mm)		
1	0.5	0.555	0.561	0.558	0.018
2	1.0	0.565	0.571	0.568	0.028
3	1.5	0.576	0.580	0.578	0.038
4	2.0	0.587	0.593	0.590	0.050
5	2.5	0.597	0.603	0.600	0.060
6	3.0	0.608	0.612	0.610	0.070
7	3.5	0.620	0.622	0.621	0.081
8	4.0	0.630	0.632	0.631	0.091
9	4.5	0.641	0.643	0.642	0.102
10	5.0	0.652	0.652	0.652	0.112

Method-1

Plot Δx v/s Δw ($=\Delta m\, g$)



* slope = $\frac{BP}{AP}$ = ... = $\frac{\ell}{Y(\pi r^2)}$ $\Rightarrow$ Y = ...

Method-2

Between observation (1) $\longrightarrow$ (6)
and (2) $\longrightarrow$ (7)
and (3) $\longrightarrow$ (8) 2.5 kg extra weight is added
and (4) $\longrightarrow$ (9)
and (5) $\longrightarrow$ (10)

So elongation from observation (1)$\longrightarrow$(6), (2)$\longrightarrow$(7), (3)$\longrightarrow$(8), (4)$\longrightarrow$(9), and (5)$\longrightarrow$ (10) will be due to extra 2.5 kg wt.

So we can find elongation due to 2.5 kg wt from $x_6 - x_1$, $x_7 - x_2$, $x_8 - x_3$, or $x_{10} - x_5$ and hense we can find average elongation due to 2.5 kg wt.

S.No.	Extra load on hanger Δm (kg)	Micrometer reading		Mean reading (x) (p + q)/2 (mm)	Δx extra elongation due to 2.5 kg extra load (mm)
		Load increasing (p) (mm)	Load decreasing (q) (mm)		
1	0.5	0.555	0.561	0.558	0.052
2	1.0	0.565	0.571	0.568	0.053
3	1.5	0.576	0.580	0.578	0.053
4	2.0	0.587	0.593	0.590	0.052
5	2.5	0.597	0.603	0.600	0.052
6	3.0	0.608	0.612	0.610	
7	3.5	0.620	0.622	0.621	
8	4.0	0.630	0.632	0.631	
9	4.5	0.641	0.643	0.642	
10	5.0	0.652	0.652	0.652	

for $\Delta w = 2.5$ g , average elongation = $\Delta x = 0.052$ mm

$\Delta x = \left(\frac{\ell_0}{\pi r^2 Y}\right)(\Delta w)$ where $\Delta w = \Delta m\, g = 25$ N and (Δx) average = 0.5 cm

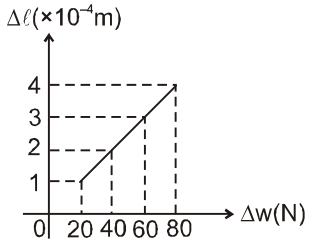
Putting the values find Y = ...

Maximum permissible error in 'Y' due to error in measuring m, ℓ_0, r, x :

$Y = \frac{\ell_0}{\pi r^2 x} mg$

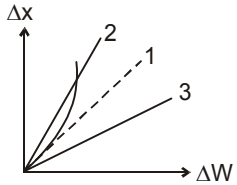
If there is no tolerance in mass ; max permissible error in Y is $\left(\frac{\Delta y}{Y}\right)_{max} = \frac{\Delta \ell_0}{\ell_0} + 2\frac{\Delta r}{r} + \frac{\Delta x}{x}$

11. The adjacent graph shows the extra extension (Δx) of a wire of length 1m suspended from the top of a roof at one end with an extra load Δw connected to the other end. If the cross sectional area of the wire is 10^{-6} m^2, calculate the Young's modulus of the material of the wire.



(A) 2×10^{11} N/m^2 (B) 2×10^{-11} N/m^2
(C) 3×10^{13} N/m^3 (D) 2×10^{16} N/m^2

12. In the experiment, the curve between Δx and Δw is shown as dotted line (1). If we use an another wire of same material, but with double length and double radius. Which of the curve is expected.



(A) 1 (B) 2
(C) 3 (D) 4

13. **Assertion :** In Searle's experiment to find young's modulus, a reference wire is also used along with the experiment wire.
Reason : Reference wire neutralizes the effect of temperature, yielding of support and other external factors
(A) If both Assertion and Reason are true and the Reason is a correct explanation of Assertion
(B) If both Assertion and Reason and true but Reason is not a correct explanation of Assertion.
(C) If Assertion is true but Reason is false.
(D) If both Assertion and Reason are false.

14. If we use very thin and long wire
(A) Sensitivity $\left(\frac{\text{output}}{\text{input}} = \frac{\Delta x}{\Delta w}\right)$ of experiment will increase.
(B) Young's modulus will remain unchanged
(C) Wire may break or yield during loading.
(D) All of the above.

15. In Searle's experiment to find Young's modulus the diameter of wire is measured as d = 0.050 cm, length of wire is ℓ = 125 cm and when a weight, m = 20.0 kg is put, extension in the length of wire was found to be 0.100cm. Find maximum permissible error in Young's modulus (Y).
Use : $Y = \frac{mg\ell}{(\pi/4)d^2x}$. Least count for mass, length, diameter and extension measurement are respectively 0.1 kg, 1 cm, 0.001 cm and 0.001 cm.

16. A student performs an experiment to determine the Young's modulus of a wire, exactly 2 m long, by Searle's method. In a particular reading, the student measures the extension in the length of the wire to be 0.80 mm with an uncertainty of ±0.05 mm at a load of exactly 1.0 kg. The student also measures the diameter of the wire to be 0.4 mm with an uncertainty of ±0.01 mm. Take g = 9.8 m/s^2 (exact). The Young's modulus obtained from the reading is
(A) $(2.0 \pm 0.3) \times 10^{11}$ N/m^2 (B) $(2.0 \pm 0.2) \times 10^{11}$ N/m^2
(C) $(2.0 \pm 0.1) \times 10^{11}$ N/m^2 (D) $(2.0 \pm 0.05) \times 10^{11}$ N/m^2

17. In the determination of Young's modulus $\left(Y = \frac{4MLg}{\pi ld^2}\right)$ by using Searle's method, a wire of length L = 2 m and diameter d = 0.5 mm is used. For a load M = 2.5 kg, an extension ℓ = 0.25 mm in the length of the wire is observed. Quantities d and ℓ are measured using a screw gauge and a micrometer, respectively. They have the same pitch of 0.5 mm. The number of divisions on their circular scale is 100. The contributions to the maximum probable error of the Y measurement

(A) due to the errors in the measurements of d and ℓ are the same.

(B) due to the error in the measurement of d is twice that due to the error in the measurement of ℓ.

(C) due to the error in the measurement of ℓ is twice that due to the error in the measurement of d.

(D) due to the error in the measurement of d is four time that due to the error in the measurement of ℓ.

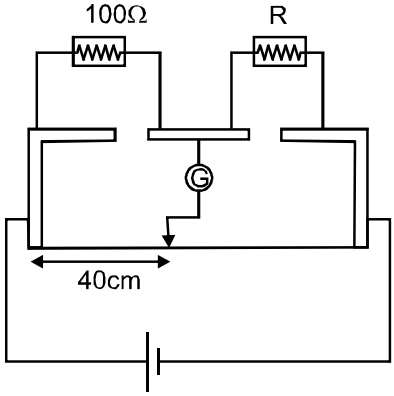
18. Durring Searle's experiment, zero of the Vernier scale lies between 3.20×10^{-2} m and 3.25×10^{-2} m of the main scale. The 20th division of the Vernier scale exactly coincides with one of the main scale divisions. When an additional load of 2 kg is applied to the wire, the zero of the Vernier scale still lies between 3.20×10^{-2} m and 3.25×10^{-2} m of the main scale but now the 45th division of Vernier scale coincides with one of the main scale divisions. The length of the thin metallic wire is 2m and its cross-sectional area is 8×10^{-7} m^2. The least count of the Vernier scale is 1.0×10^{-5} m. The maximum percentage error in the Young's modulus of the wire is

19. A steel wire of diameter 0.5 mm and Young's modulus 2×10^{11} Nm^{-2} carries a load of mass M. The length of the wire with the load is 1.0 m. A vernier scale with 10 divisions is attached to the end of this wire. Next to the steel wire is a reference wire to which a main scale, of least count 1.0 mm, is attached. The 10 divisions of the vernier scale correspond to 9 divisions of the main scale. Initially, the zero of vernier scale coincides with the zero of main scale. If the load on the steel wire is increased by 1.2 kg, the vernier scale division which coincides with a main scale division is _____. Take g = 10 ms^{-2} and π = 3.2.

DPP No. : B26 (JEE-Advanced)

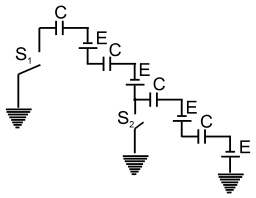
Total Marks : 38		**Max. Time : 27 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.3	**(3 marks, 2 min.)**	**[09, 06]**
One or more than one options correct type ('–1' negative marking) Q.4 to Q.5	**(4 marks 2 min.)**	**[08, 04]**
Comprehension ('–1' negative marking) Q.6 to Q.8	**(3 marks 2 min.)**	**[09, 06]**
Subjective Questions ('–1' negative marking) Q.9	**(4 marks 5 min.)**	**[04, 05]**
Match the Following (no negative marking) Q.10	**(8 marks, 6 min.)**	**[08, 06]**

1. In a meter bridge circuit, the known resistance used in resistance box is 100 Ω (without any error, and the unknown resistor is put in right arm). The null point is found to be 40 cm from left end. If mm scale is used in the meter bridge then resistance of the unknown resistor is :



(A) $150\Omega \pm \frac{3}{8}\Omega$ (B) $150\Omega \pm \frac{3}{8}\Omega$ (C) $150\Omega \pm \frac{5}{8}\Omega$ (D) $150\Omega \pm \frac{7}{16}\Omega$

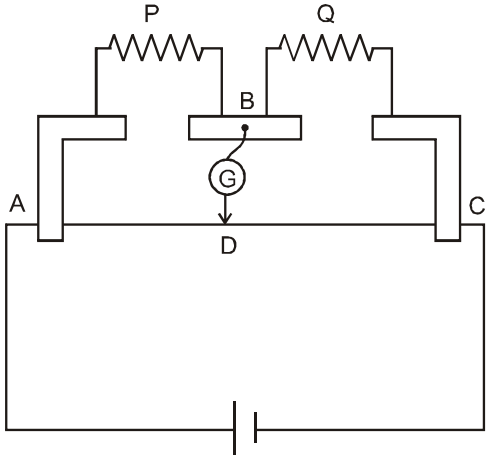
2. In the given circuit, all the capacitors are initially uncharged. After closing the switch S_1 for a long time suddenly S_2 is also closed and kept closed for a long time. Total heat produced after closing S_2 will be :



(A) $4\ C\varepsilon^2$ (B) $\frac{1}{2}\ C\varepsilon^2$
(C) $2\ C\varepsilon^2$ (D) 0

3. In a metre bridge experiment null point is obtained at 20 cm from one end of the wire when resistance X is balanced against another resistance Y. If X < Y, then where will be the new position of the null point from the same end, if one decides to balance a resistance of 4X against Y ?
(A) 50 cm (B) 80 cm (C) 40 cm (D) 70 cm

4. In the meter bridge circuit, the point D is the balance point.

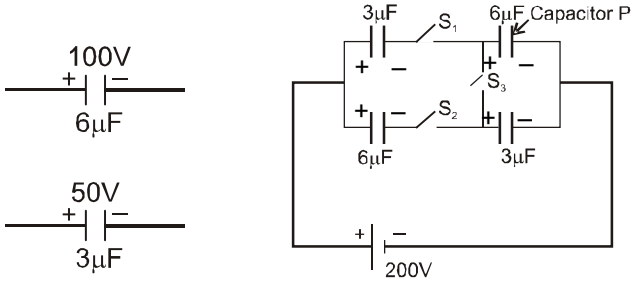


(A) If the jockey is shifted to the left of D, current will flow from the meter bridge wire to the point B.
(B) If jockey is shifted to the right of D, current will flow from point B to the meter bridge wire.
(C) If the jockey is at point D, but now the resistance P is heated, then the current will flow from point B to the meter bridge wire.
(D) If the jockey is at point D, but now the resistance P is heated, then the current will flow from the meter bridge wire to the point B.

5. The potential energy of a particle of mass 1 kg in a conservative field is given as $U = (3x^2y^2 + 6x)$ J, where x and y are measured in meter. Initially particle is at (1,1) & at rest then :
(A) Initial acceleration of particle is $6\sqrt{5}\ ms^2$
(B) Work done to slowly bring the particle to origin is 9 J
(C) Work done to slowly bring the particle to origin is – 9 J
(D) If particle is left free it moves in straight line

Comprehension

A capacitor circuit consists of two 6 μF and two 3 μF capacitors which are initially charged to 100 V and 50 V respectively. They are connected to a source of emf 200 V through the switches S_1,S_2 & S_3 as shown in figure below :

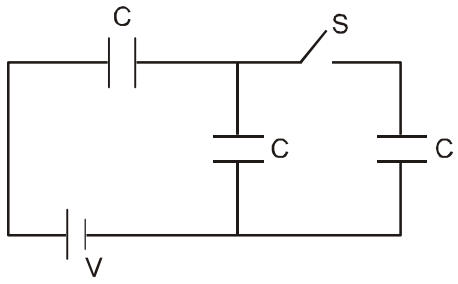


6. Charge on capacitor 'P' in steady state when S_1 is closed :
(A) 300 μC (B) 700 μC (C) 600 μC (D) 100 μC

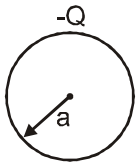
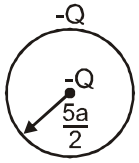
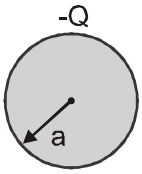
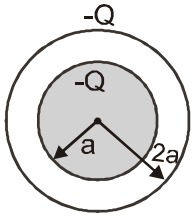
7. Now, switch S_2 is also connected, then charge on capacitor 'P' is :
(A) 300 μC (B) 700 μC (C) 600 μC (D) 100 μC

8. Now, switch S_3 is also connected, charge on capacitor 'P' is equal to :
(A) 300 μC (B) 600 μC (C) 700 μC (D) 100 μC

9. Given circuit is in steady state. Potential energy stored in the capacitors is U. Now switch S is closed. Heat produced after closing the switch S is H. Find $\frac{U}{H}$.



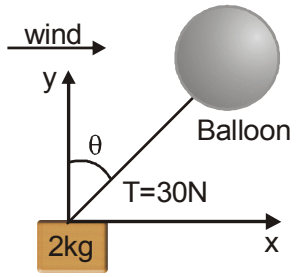
10. In each situation of column-I, some charge distributions are given with all details explained. In column -II The electrostatic potential energy and its nature is given situation in column -II. Then match situation in column-I with the corresponding results in column-II

Column–I		Column–II
(A) A thin shell of radius a and having a charge – Q uniformly distributed over its surface as shown		(p) $\frac{1}{8\pi\epsilon_0}\frac{Q^2}{a}$ in magnitude
(B) A thin shell of radius $\frac{5a}{2}$ and having a charge – Q uniformly distributed over its surface and a point charge – Q placed at its centre as shown.		(q) $\frac{3}{20\pi\epsilon_0}\frac{Q^2}{a}$ in magnitude
(C) A solid sphere of radius a and having a charge – Q uniformly distributed throughout its volume as shown.		(r) $\frac{2}{5\pi\epsilon_0}\frac{Q^2}{a}$ in magnitude
(D) A solid sphere of radius a and having a charge –Q uniformly distributed throughout its volume. The solid sphere is surrounded by a concentric thin uniformly charged spherical shell of radius 2a and carrying charge –Q as shown		(s) Positive in sign

DPP No. : B27 (JEE-Advanced)

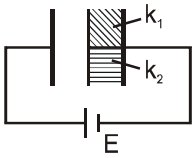
Total Marks : 41		**Max. Time : 36 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.3	**(3 marks, 2 min.)**	**[09, 06]**
One or more than one options correct type ('–1' negative marking) Q.4 to Q.5	**(4 marks 2 min.)**	**[08, 04]**
Subjective Questions ('–1' negative marking) Q.6 to Q.9	**(4 marks 5 min.)**	**[16, 20]**
Match the Following (no negative marking) Q.10	**(8 marks, 6 min.)**	**[08, 06]**

1. A balloon is tied to a block. The mass of the block is 2kg. The tension of the string between the balloon and the block is 30N. Due to the wind, the string has an angle θ relative to the vertical direction. $\cos\theta = 4/5$ and $\sin\theta = 3/5$. Assume the acceleration of gravity is g = 10 m/s^2. Also assume the block is small so the force on the block from the wind can be ignored. Then the x-component and the y-component of the acceleration a of the block.



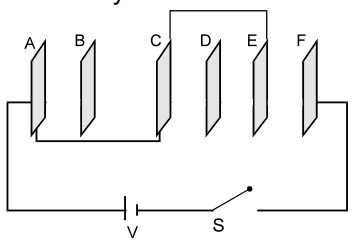
(A) 9 m/s^2, 2 m/s^2 (B) 9 m/s^2, 12 m/s^2
(C) 18 m/s^2, 2 m/s^2 (D) 18 m/s^2, 12 m/s^2

2. A capacitior is filled with dielectrics as shown in the diagram. Which of the options is correct.



(A) electric field inside dielectric k_1 is equal to that of k_2.
(B) Surface change density on the plates is uniform.
(C) Potential difference across k_1 is equal to the potential difference across k_2.
(D) electric field inside the free space is nonuniform.

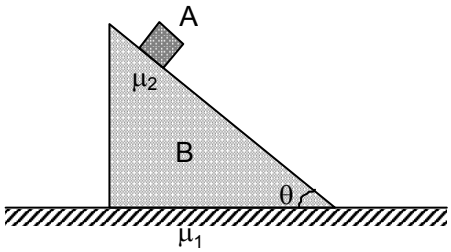
3. A, B, C, D, E, F are conducting plates each of area A and any two consecutive plates separated by a distance d. The net energy stored in the system after the switch S is closed is:



(A) $\frac{3\varepsilon_0 A}{2d}V^2$ (B) $\frac{5\varepsilon_0 A}{12d}V^2$ (C) $\frac{\varepsilon_0 A}{2d}V^2$ (D) $\frac{\varepsilon_0 A}{d}V^2$

Comprehension :

A wedge 'B' of mass 2m is placed on a rough horizontal surface. The coefficient of friction between wedge and the horizontal surface is μ_1. A block of mass m is placed on wedge as shown in the figure. The coefficient of friction between block and wedge is μ_2. The block and wedge are released from rest.



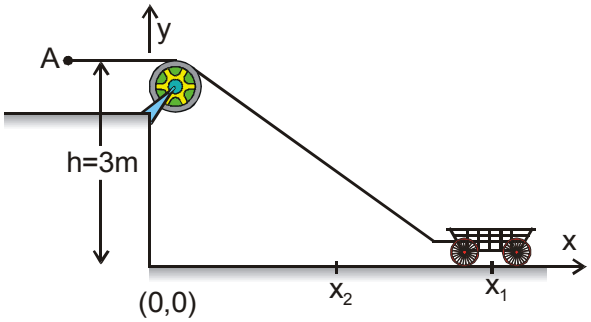
4. Suppose the inclined surface of the wedge is at $\theta = 37°$ angle from horizontal and $\mu_2 = 0.9$ then the wedge :

(A) will remain in equilibrium if $\mu_1 = 0.5$
(B) will accelerate towards left if $\mu_1 = 0$
(C) will acceleration toward left if $\mu_1 = 0.25$
(D) will remain in equilibrium if $\mu_1 = 0.3$

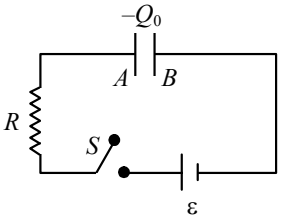
5. Suppose the inclined surface of the wedge is at θ = 37° from angle from horizontal and μ_2 = 0 the wedge will remain in equilibrium if :

(A) μ_1 = 0.1 (B) μ_1 = 0.2 (C) μ_1 = 0.3 (D) μ_1 = 0.4

6. Figure shows a light, inextensible string attached to a cart that can slide along a frictionless horizontal rail aligned along an x axis. The left end of the string is pulled over a small pulley, of negligible mass and friction and fixed at height h = 3m from the ground level. The cart slides from $x_1 = 3\sqrt{3}$ m to x_2 = 4 m and during the move, tension in the string is kept constant 50 N. Find change in kinetic energy of the cart in joules. (Use $\sqrt{3}$ = 1.7)

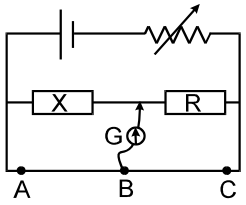


7. The figure shows an *RC* circuit with a parallel plate capacitor. Before switching on the circuit, plate *A* of the capacitor has a charge $-Q_0$ while plate *B* has no net charge. Now, at *t* = 0, the circuit is switched on. How much time (in second) will elapse before the net charge on plate *A* becomes zero. (Given *C* = 1μF, Q_0 = 1mC, ε = 1000 V and $R = \frac{2\times10^6}{\ln 3}\Omega$)



8. A screw gauge with a pitch of 1mm has 100 divisions on its circular scale. When the screw gauge is used to measure the diameter of a uniform wire of length 5.6 cm, the main scale reading is 1 mm and the circular scale reading is 47. Calculate the area of the curved surface of the wire in cm^2 to appropriate significant figures, using $\pi = \frac{22}{7}$. There is no zero error in the screw gauge.

9. For the three values of resistances R namely R_1, R_2 and R_3 the balanced positions of jockey are at A, B and C respectively. Which position will show most accurate result for calculation of X. Give reason. B is near the mid point of the wire.



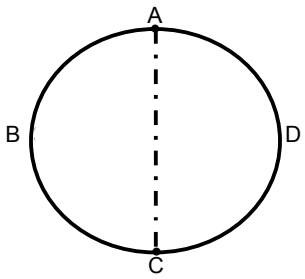
10. Consider a system of particles (it may be rigid or non rigid). In the column-I some condition on force and torque is given. Column-II contains the effects on the system. (Letters have usual meaning)

Column-I	**Column-II**
(A) $\vec{F}_{resultant} = 0$	(p) $\vec{P}_{system}$ will be constant
(B) $\vec{\tau}_{resultant} = 0$	(q) $\vec{L}_{system}$ will be constant
(C) $\vec{\tau}_{resultant} = 0$ External force is absent	(r) total work done by all forces will be zero
(D) No nonconservative force acts.	(s) total mechanical energy will be constant.

DPP No. : B28 (JEE-Main)

Total Marks : 60		**Max. Time : 40 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.11	**(3 marks, 2 min.)**	**[33, 22]**
Comprehension ('–1' negative marking) Q.12 to Q.20	**(3 marks 2 min.)**	**[27, 18]**

1. A ring is formed by joining two uniform semi circular rings as shown. Mass of ABC part is thrice of part ADC. If the ring is hanged vertically by hinging at A about which ring can rotate freely. Find the value of $\tan\theta$, where θ is angle made by the line AC with vertical in equilibrium :



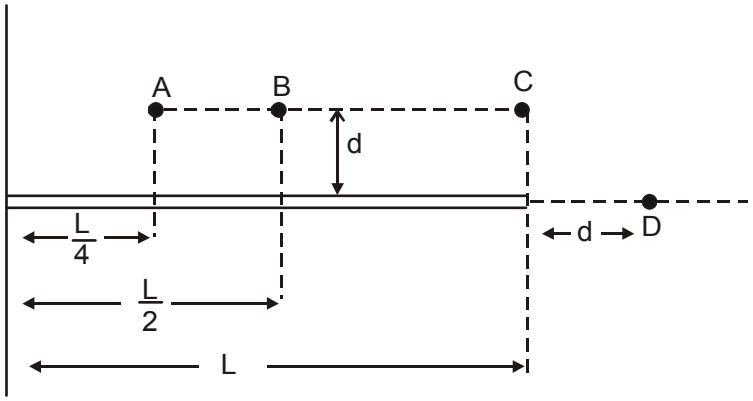
(A) $\frac{1}{\pi}$ (B) $\frac{2}{\pi}$

(C) $\frac{3}{2\pi}$ (D) π

2. Electric field in a region is given as $\vec{E} = x\hat{i} + 2y\hat{j} + 3\hat{k}$ in this region point A(3,3,1) and point B (4,2,1) are there.The magnitude of work done by the electric field, if 2 coulomb charge is moved from A to B. All values given and asked are in SI units.

(A) 3 (B) 4 (C) 5 (D) 6

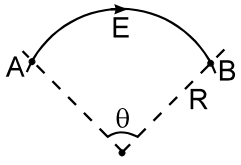
3. Figure given below shows uniformly positively charged, thin rod of length L and four points A, B, C and D at the same distance d from the rod, with position as marked. If V_A, V_B, V_C and V_D are their respective potentials then :



(A) $V_B > V_A > V_C > V_D$ (B) $V_B > V_A > V_C = V_D$

(C) $V_A = V_B > V_C = V_D$ (D) $V_D > V_B > V_A > V_C$

4. Figure shows an electric line of force which curves along a circular arc. The magnitude of electric field intensity is same at all points on this curve and is equal to E. If the potential at A is V, then the potential at B is :



(A) $V - ER\theta$ (B) $V - E2R\sin\frac{\theta}{2}$ (C) $V + ER\theta$ (D) $V + 2ER\sin\frac{\theta}{2}$

5. In a binary star system one star has thrice the mass of other. The stars rotate about their common centre of mass then :

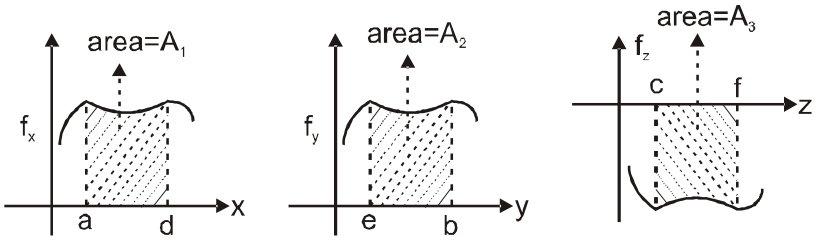
(A) Both stars have same angular momentum about common centre of mass.

(B) Both stars have angular momentum of same magnitude about common centre of mass.

(C) Both stars have same angular speeds.

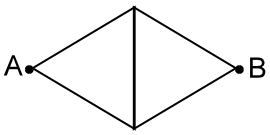
(D) Both stars have same linear speeds.

6. A force given by $\vec{F} = f_x\hat{i} + f_y\hat{j} + f_z\hat{k}$ acts on a particle which moves from (a,b,c) to (d,e,f) . The work done by the force F is : (Here A_1 , A_2, A_3 are magnitude of area bounded)



(A) $A_1 + A_2 + A_3$ (B) $A_1 - A_2 - A_3$ (C) $-A_1 + A_2 - A_3$ (D) $A_1 - A_2 + A_3$

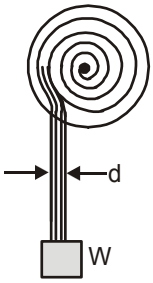
7. A uniform wire of resistance R is stretched uniformly n times & then cut to form five identical wires. These wires are arranged as shown in the figure. The effective resistance between A & B will be:



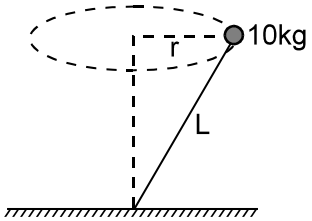
(A) $\frac{nR}{5}$ (B) $\frac{R}{5n^2}$ (C) $\frac{n^2R}{5}$ (D) $\frac{n^2R}{2}$

8. A weight W attached to the end of a flexible rope of diameter d=0.75cm is raised vertically by winding the rope on a reel as shown. If the reel is turned uniformly at the rate of 2 r.p.s. What is the tension in rope. The inertia of rope may be neglected.

(A) 1.019W
(B) 0.51W
(C) 2.04W
(D) W



9. A 10kg ball attached at the end of a rigid rod of length 1m rotates at constant speed in a horizontal circle of radius 0.5m and time period 1.57 s as shown in the figure. The force exerted by the rod on the ball is: ($g = 10\ ms^{-2}$)



(A) 158 N (B) 128 N (C) 110 N (D) 98 N

10. A uniform horizontal meter scale (length = 1m) of mass m is suspended by two vertical strings attached to its two ends. A small body of mass 2 m is placed on the 75 cm from one end . The tension in the two strings are respectively :

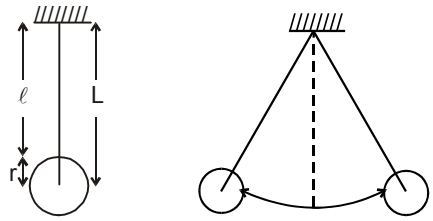
(A) $T_1 = mg$, $T_2 = 2mg$ (B) $T_1 = 2mg$, $T_2 = mg$
(C) $T_1 = 3mg/2$, $T_2 = 3mg/2$ (D) $T_1 = 2mg/3$, $T_2 = 7mg/3$

11. A person measures the depth of a well by measuring the time interval between dropping a stone and receiving the sound of impact with the bottom of the well. The error in his measurement of time is $\delta T = 0.01$ seconds and he measures the depth of the well to be L = 20 meters. Take the acceleration due to gravity $g = 10ms^{-2}$ and the velocity of sound is 300 ms^{-1}. Then the fractional error in the measurement $\frac{\delta L}{L}$, is closest to :

(A) 0.2 % (B) 3% (C) 5% (D) 1%

Comprehension–1

Determining the value of 'g' using a simple pendulum



In this exp. a small spherical bob is hanged with a cotton thread. This arrangement is called sample pendulum. The bob is displaced slightly and allowed to oscillate. To find time period, time taken for 50 oscillations is noted using a stop watch.

Theoretically $T = 2\pi\sqrt{\frac{L}{g}}$ $\Rightarrow$ $g = 4\pi^2 \frac{L}{T^2}$ .....(1)

where L = Equivalent length of pendulum = length of thread (ℓ) + radius (r) of bob,

T = time period of the simple pendulum = $\frac{\text{Time taken for 50 oscillations}}{50}$

so 'g' can be easily determined by equation ...(1).

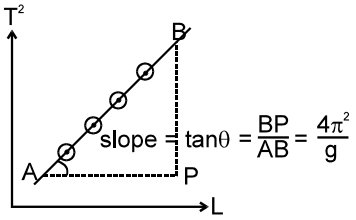
Graphical method to find 'g' :

$T^2 = \left(\frac{4\pi^2}{g}\right) L$ .....(2) so, $T^2 \propto L$

* Find T for different values of L.

* Plot T^2 v/s L curve. From equation (2), it should be a straight line, with slope = $\left(\frac{4\pi^2}{g}\right)$.

Find slope of T^2 v/s L graph and equate it to $\left(\frac{4\pi^2}{g}\right)$ and get 'g' .



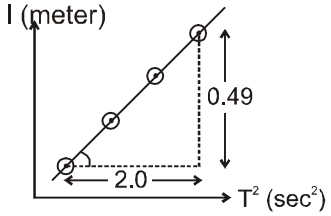
Maximum permissible error in 'g' due to error in measurement of ℓ, r and T.

$g = 4\pi^2 \frac{L \to \ell + r}{T^2 \to t/50}$ $g = 4\pi^2 \frac{(\ell + r)}{(t/50)^2} = 4\pi^2 (2500) \frac{\ell + r}{t^2}$

$\ln g = \ln 4\pi^2 (2500) + \ln (\ell + r) - 2 \ln (t)$ $\left(\frac{\Delta g}{g}\right)_{max} = \frac{\Delta\ell + \Delta r}{\ell + r} + 2\frac{\Delta t}{t}$

12. In certain observation we got ℓ = 23.2 cm, r = 1.32 cm, and time taken for 10 oscillation was 10.0 sec. Estimate the value of 'g' in proper significant figure. (take π^2 = 10)

13. For different values of L, we get different values of 'T'. The curve between L v/s T^2 is shown. Estimate 'g' from this curve. (take $\pi^2 = 10$)



14. In certain observation we got ℓ = 23.2 cm, r = 1.32 cm, and time taken for 10 oscillation was 10.0 sec. Find maximum permissible error in (g)

15. Time is measured using a stop watch of least count 0.1 second. In 10 oscillation, time taken is 20.0 second. Find maximum permissible error in time period.

16. A student performs an experiment for determination of $g\left(=\frac{4\pi^2\ell}{T^2}\right)$, "$\ell$" $\approx$ 1m, and he commits an error of "$\Delta\ell$". For T he takes the time of n oscillations with the stop watch of least count Δt. For which of the following data, the measurement of g will be most accurate ?

(A) ΔL = 0.5, Δt = 0.1, n = 20 (B) ΔL = 0.5, Δt = 0.1, n = 50

(C) ΔL = 0.5, Δt = 0.02, n = 20 (D) ΔL = 0.1, Δt = 0.05, n = 50

17. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 20.0 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 90s using a wrist watch of 1s resolution. The accuracy in the determination of g is :

(A) 2% (B) 3% (C) 1% (D) 5%

18. A student measures the time period of 100 oscillations of a simple pendulum four times. That data set is 90 s, 91 s, 95 s and 92 s. If the minimum division in the measuring clock is 1 s, then the reported mean time should be :

(A) 92 ± 5.0 s (B) 92 ± 1.8 s (C) 92 ± 3 s (D) 92 ± 2 s

Comprehension–2

If the measurement errors in all the independent quantities are known, then it is possible to determine the error in any dependent quantity. This is done by the use of series expansion and truncating the expansion at the first power of the error. For example, consider the relation z = x/y. If the errors in x, y and z are Δx, Δy and Δz, respectively, then

$$z \pm \Delta z = \frac{x + \Delta x}{y \pm \Delta y} = \frac{x}{y}\left(1 \pm \frac{\Delta x}{x}\right)\left(1 \pm \frac{\Delta y}{y}\right)^{-1}.$$

The series expansion for $\left(1 \pm \frac{\Delta y}{y}\right)^{-1}$, to first power in Δy/y, is $1 \mp \left(\frac{\Delta y}{y}\right)$. The relative errors in independent variables are always added. So the error in z will be

$$\Delta z = z\left(\frac{\Delta x}{x} + \frac{\Delta y}{y}\right).$$

The above derivation makes the assumption that $\Delta x/x << 1$, $\Delta y/y << 1$. Therefore, the higher powers of these quantities are neglected.

(There are two questions based on PARAGRAPH "A", the question given below is one of them)

19. Consider the ratio $r = \frac{(1-a)}{(1+a)}$ to be determined by measuring a dimensionless quantity a. If the error in the measurement of a is Δa ($\Delta a/a << 1$), then what is the error Δr in determining r ?

(A) $\frac{\Delta a}{(1+a)^2}$ (B) $\frac{2\Delta a}{(1+a)^2}$ (C) $\frac{2\Delta a}{(1-a^2)}$ (D) $\frac{2a\Delta a}{(1-a^2)}$

20. In an experiment the initial number of radioactive nuclei is 3000. It is found that 1000 ± 40 nuclei decayed in the first 1.0 s. For $|x| << 1$, $\ell n(1 + x) = x$ up to first power in x. The error $\Delta\lambda$, in the determination of the decay constant λ, in s^{-1}, is

(A) 0.04 (B) 0.03 (C) 0.02 (D) 0.01

DPP No. : B29 (JEE-Advanced)

Total Marks : 37	**Max. Time : 29 min.**	
Single choice Objective ('–1' negative marking) Q.1	**(3 marks, 2 min.)**	**[03, 02]**
One or more than one options correct type ('–1' negative marking) Q.2 to Q.5	**(4 marks 2 min.)**	**[16, 08]**
Comprehension ('–1' negative marking) Q.6 to Q.7	**(3 marks 2 min.)**	**[06, 04]**
Subjective Questions ('–1' negative marking) Q.8 to Q.10	**(4 marks 5 min.)**	**[12, 15]**

1. You are given two unknown resistors X and Y. These resistances are to be determined, using an ammeter of R_A = 0.5 Ω and a voltmeter of R_v = 20 kΩ. It is known that X is in range of a few ohms and Y is in the range of several kilo ohm's. Which circuit is preferable to measure X and Y :

Resistor	Circuit
x	(a)
y	(b)

(A) $x \to$ (a), $y \to$ (b) (B) $x \to$ (b), $y \to$ (a)

(C) $x \to$ (a), $y \to$ (a) (D) $x \to$ (b), $y \to$ (b)

2. A particle moving with constant speed u inside a fixed smooth spherical bowl of radius a describes a horizontal circle at a distance $\frac{a}{2}$ below its centre.

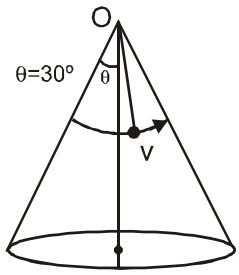
(A) The radius of the circular motion is $\frac{a\sqrt{3}}{2}$

(B) The value of u is $\sqrt{\frac{3ag}{2}}$

(C) The normal reaction of the spherical surface on the particle is $\frac{mg}{2}$

(D) The magnitude of the resultant force acting on the particle is zero, in an inertial frame.

3. A bob of mass 2 kg is suspended from point O of a cone with an inextensible string of length $\sqrt{3}$ m. It is moving in horizontal circle over the surface of cone as shown in the figure. Then : ($g = 10\ m/s^2$)



(A) bob looses contact with cone if $v > \sqrt{5}$ m/s

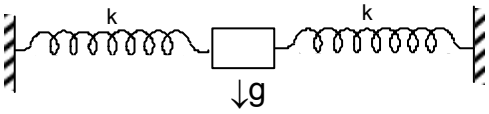
(B) normal force on bob is 19 N when v = 2 m/s

(C) tension in string is $\frac{38}{\sqrt{3}}$ N when v = 2 m/s

(D) normal force on bob is $\frac{17}{\sqrt{3}}$ N when v = 2m/s

Comprehension–1

A block is tied within two springs, each having spring constant equal to k. Initially the springs are in their natural length and horizontal as shown in the figure, the block is released from rest. The springs are ideal, acceleration due to gravity is g downwards. Air resistance is to be neglect. The natural length of spring is ℓ_0. The decrease in height of the block till it reaches equilibrium is $\sqrt{3}\,\ell_0$.



4. Choose the correct option(s)

(A) The mass of the block is $\dfrac{\sqrt{3}k\ell_0}{g}$

(B) Velocity of the blocks becomes zero at the equilibrium postion.

(C) Maximum speed of the block in motion when it is released from the shown horizontal position is $\sqrt{\dfrac{4g\ell_0}{\sqrt{3}}}$

(D) The acceleration of the block, just after cutting any one of the strings (at the shown instant), is less than g.

5. Now suppose that the block is at its equilbrium position initially.

(A) The block will perform SHM for any vertical displacement

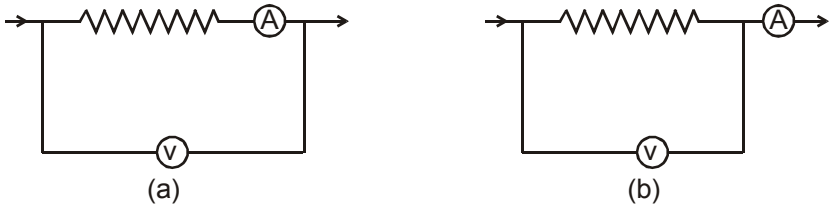
(B) Time period of the block is $4\pi\sqrt{\dfrac{m}{6k}}$ for small displacement in the vertical direction

(C) The total energy stored in both the springs at the equilibrium postiion is $4k\ell_0^2$

(D) The acceleration of the block, just after any one of the springs is cut, is $\dfrac{g}{\sqrt{3}}$

Comprehension –2

In the Ohm's law experiment to find resistance of unknown resistor R, following two arrangements (a) and (b) are possible.



The resistance measured is given by

$$R_{measured} = \frac{V}{i}$$

V = voltage reading of voltmeter, i = current reading of ammeter.

But unfortunately the ammeters and voltmeter used are not ideal, but having resistance R_A and R_v respectively.

6. For arrangement (a), the measured resistance is

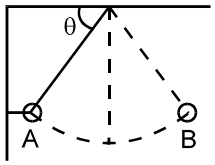
(A) $R + R_v$ (B) $R + R_A$ (C) $\dfrac{RR_v}{R+R_v}$ (D) $\dfrac{RR_v}{R+R_v} + R_A$

7. For arrangement (b), the measured resistance is

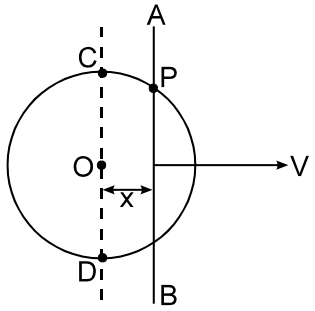
(A) $R + R_v$ (B) $R + R_A$ (C) $\dfrac{RR_v}{R+R_v}$ (D) $\dfrac{RR_v}{R+R_v} + R_A$

8. A satellite is orbiting around the earth in a circular orbit and in this orbit magnitude of its acceleration is 'a_1'. Now a rocket is fired in the direction of motion of satellite from the satellite due to which its speed instantaneously becomes half of initial, just after the rocket is fired acceleration of satellite has magnitude 'a_2' . Then the ratio $\frac{a_1}{a_2}$ is (Assume there is no external force other than the gravitational force of earth before and after the firing of rocket from the satellite)

9. A ball is held at rest in position A by two light cords (as in figure). The horizontal cord is cut and the ball starts swinging as pendulum. The ratio of the tension in the supporting cord in position B (after cut) to that in position A (before cut) will be _____.



10. A rod AB is moving on a fixed circle of radius R with constant velocity 'v' as shown in figure. P is the point of intersection of the rod and the circle. At an instant the rod is at a distance x = $\frac{3R}{5}$ from centre of the circle. The velocity of the rod is perpendicular to the rod and the rod is always parallel to the diameter CD.

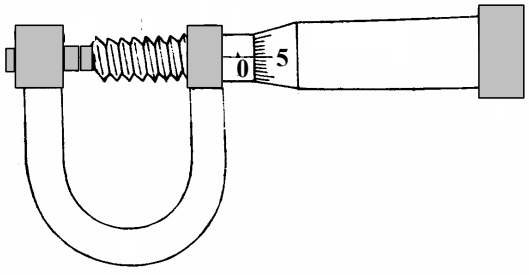


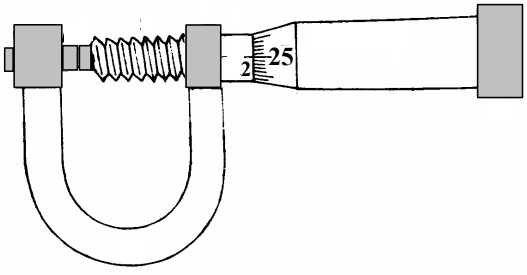
(a) Find the speed of point of intersection P.
(b) Find the angular speed of point of intersection P with respect to centre of the circle.

DPP No. : B30 (JEE-Advanced)

Total Marks : 41		**Max. Time : 30 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.3	**(3 marks, 2 min.)**	**[09, 06]**
One or more than one options correct type ('–1' negative marking) Q.4 to Q.7	**(4 marks 2 min.)**	**[16, 08]**
Subjective Questions ('–1' negative marking) Q.8 to Q.9	**(4 marks 5 min.)**	**[08, 10]**
Match the Following (no negative marking) Q.10	**(8 marks, 6 min.)**	**[08, 06]**

1. The number of circular divisions on the shown screw gauge is 50. It moves 0.5 mm on main scale for one complete rotation. Main scale reading is 2. The diameter of the ball is :





(A) 2.25 mm (B) 2.20 mm (C) 1.20 mm (D) 1.25 mm

2. A student performs an experiment for determination of $g\left(=\frac{4\pi^2\ell}{T^2}\right)$, $\ell \approx 1$m, and he commits an error of $\Delta\ell$. For T he takes the time of n oscillations with the stop watch of least count ΔT and he commits a human error of 0.1 sec. For which of the following data, the measurement of g will be most accurate ?

(A) $\Delta L = 0.5$, $\Delta T = 0.1$, n = 20 (B) $\Delta L = 0.5$, $\Delta T = 0.1$, n = 50

(C) $\Delta L = 0.5$, $\Delta T = 0.01$, n = 20 (D) $\Delta L = 0.1$, $\Delta T = 0.05$, n = 50

3. A pilot plane of total mass M is taking a circular loop of radius r in a horizontal plane at a height where acceleration due to gravity is g_0. The speed of the plane is constant and equal to v.

(A) force exerted by air on the plane is mg_0

(B) force exerted by air on the plane is $\frac{mv^2}{r}$

(C) force exerted by air on the plane is $mg_0 + \frac{mv^2}{r}$

(D) force exerted by air on the plane is $\sqrt{(mg_0)^2 + \left(\frac{mv^2}{r}\right)^2}$

4. A ball of mass 1.6 kg is projected with a velocity of 20 m/s at an angle of 37º above the horizontal. After 1.2 sec., gravitational field vanishes and a force of constant magnitude is applied after that, force being always perpendicular to the direction of motion till it strikes the ground. When it strikes the ground it is moving vertically. Choose the correct option ($g = 10$ m/s^2) :

(A) Initially path is parabolic and later on it becomes hyperbolic

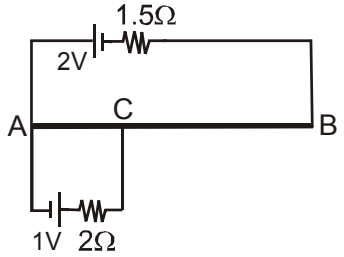
(B) The radius of the circle will be 7.2 m and constant magnitude of force applied is $\frac{512}{9}$N

(C) The speed during circular motion will be 16 m/s

(D)The time it takes to strike the ground is less than that it would have taken in projectile motion

Comprehension

AB is a uniform wire of length 70 cm and resistance 7Ω. Part AC is 20 cm long.Two resistors and two ideal cells are connected as shown.



5. Potential gradient of the part CB of the wire is :

(A) 2.5V/m (B) 2V/m (C) $\frac{10}{3}$V/m (D) 7.5V/m

6. Potential gradient of the part AC is :

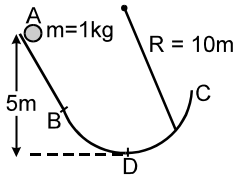
(A) $\frac{5}{6}$V/m (B) 2V/m (C) 5 V/m (D) 7.5V/m

7. Of the points A, B and C the potential is maximum at point:

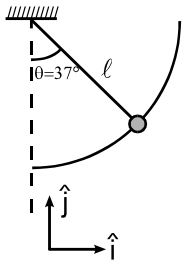
(A) A (B) B

(C) C (D) same at all of these three points.

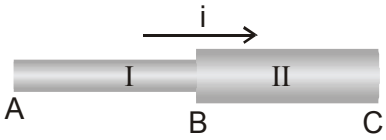
8. A particle of mass 1 kg slides down a track as shown in figure. Part BC of the track is circular with radius R = 10m. Part DC of the track is rough with coefficient of kinetic friction = 0.2. What is the total force acting on the particle when it has just passed point D



9. A ball attached with massless rope of the length ℓ swings in vertical circle as shown in figure. The total acceleration of the ball is $-a\hat{i}+b\hat{j}$ m/sec^2 when it is at angle θ = 37º; (where a and b are positive constant). Find the magnitude of centripetal acceleration of the ball at the instant shown. The axis system is shown in figure.



10. Column I gives physical quantities of a situation in which a current i passes through two rods I and II of equal length that are joined in series. The ratio of free electron density (n), resistivity (ρ) and cross-section area (A) of both are in ratio $n_1 : n_2 = 2 : 1$, $\rho_1 : \rho_2 = 2 : 1$ and $A_1 : A_2 = 1 : 2$ respectively. Column II gives corresponding results. Match the ratios in Column I with the values in Column II and indicate your answer.



	Column I	**Column II**
(A)	$\frac{\text{Drift velocity of free electron in rod I}}{\text{Drift velocity of free electron in rod II}}$	(p) 0.5
(B)	$\frac{\text{Electric field in rod I}}{\text{Electric field in rod II}}$	(q) 1
(C)	$\frac{\text{Potential difference across rod I}}{\text{Potential difference across rod II}}$	(r) 2
(D)	$\frac{\text{Average time taken by free electron to move from A to B}}{\text{Average time taken by free electron to move from B to C}}$	(s) 4

DPP No. : B31 (JEE-Main)

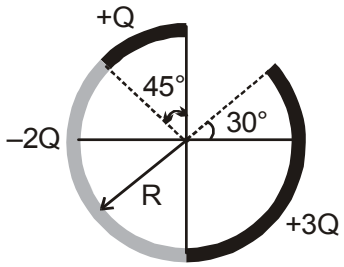
Total Marks : 60 **Max. Time : 40 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.20 **(3 marks, 2 min.)** **[60, 40]**

1. A simple pendulum of mass m and charge + q is suspended vertically by a massless thread of length ℓ. At the point of suspension, a point charge + q is also fixed. If the pendulum is displaced slightly from equilibrium position, its time period will be

(A) $T = 2\pi\sqrt{\dfrac{\ell}{g+\dfrac{kq^2}{m\ell^2}}}$ (B) $T = 2\pi$

(C) $T = 2\pi\sqrt{\dfrac{\ell}{g}}$ (D) will be greater than $2\pi\sqrt{\dfrac{\ell}{g}}$

2. Figure shows three circular arcs, each of radius R and total charge as indicated. The net elecric potential at the centre of curvature is :

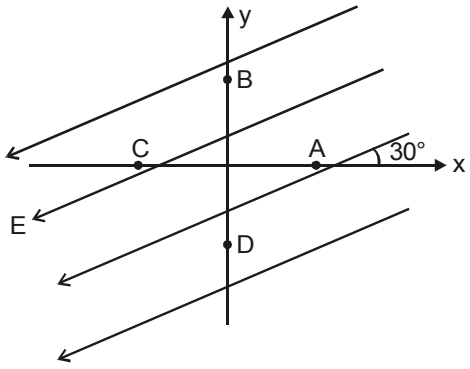


(A) $\dfrac{Q}{2\pi\varepsilon_0 R}$ (B) $\dfrac{Q}{4\pi\varepsilon_0 R}$ (C) $\dfrac{2Q}{\pi\varepsilon_0 R}$ (D) $\dfrac{Q}{\pi\varepsilon_0 R}$

3. Two identical spheres of same mass and specific gravity (which is the ratio of density of a substance and density of water) 2.4 have different charges of Q and – 3Q. They are suspended from two strings of same length ℓ fixed to points at the same horizontal level, but distant ℓ from each other. When the entire set up is transferred inside a liquid of specific gravity 0.8, it is observed that the inclination of each string in equilibrium remains unchanged. Then the dielectric constant of the liquid is

(A) 2 (B) 3 (C) 1.5 (D) None of these

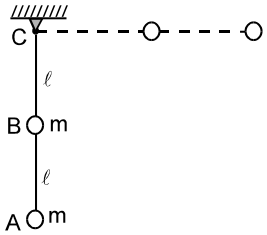
4. There exists a uniform electric field in the space as shown. Four points A, B, C and D are marked which are equidistant from the origin. If V_A, V_B, V_C and V_D are their potentials respectively, then



(A) $V_B > V_A > V_C > V_D$ (B) $V_A > V_B > V_D > V_C$

(C) $V_A = V_B > V_C = V_D$ (D) $V_B > V_C > V_A > V_D$

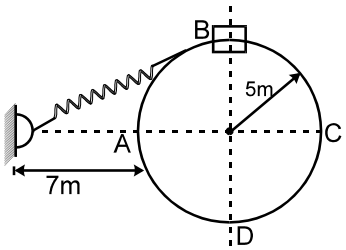
5. A weightless rod of length 2ℓ carries two equal masses 'm', one tied at lower end A and the other at the middle of the rod at B. The rod can rotate in vertical plane about a fixed horizontal axis passing through C. The rod is released from rest in horizontal position. The speed of the mass B at the instant rod, become vertical is :



(A) $\sqrt{\frac{3g\ell}{5}}$ (B) $\sqrt{\frac{4g\ell}{5}}$

(C) $\sqrt{\frac{6g\ell}{5}}$ (D) $\sqrt{\frac{7g\ell}{5}}$

6. A collar 'B' of mass 2 kg is constrained to move along a horizontal smooth and fixed circular track of radius 5 m. The spring lying in the plane of the circular track and having spring constant 200 N/m is undeformed when the collar is at 'A'. If the collar starts from rest at 'B', the normal reaction exerted by the track on the collar when it passes through 'A' is :



(A) 360 N (B) 720 N (C) 1440 N (D) 2880 N

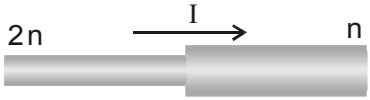
7. A particle is projected along a horizontal field whose coefficient of friction varies as $\mu = \frac{A}{r^2}$ where r is the distance from the origin in meters and A is a positive constant. The initial distance of the particle is 1 m from the origin and its velocity is radially outwards. The minimum initial velocity at this point so that particle never stops is :

(A) ∞ (B) $2\sqrt{gA}$ (C) $\sqrt{2gA}$ (D) $4\sqrt{gA}$

8. A chain of mass M and length ℓ is held vertically such that its bottom end just touches the surface of a horizontal table. The chain is released from rest. Assume that the portion of chain on the table does not form a heap. The momentum of the portion of the chain above the table after the top end of the chain falls down by a distance $\frac{\ell}{8}$.

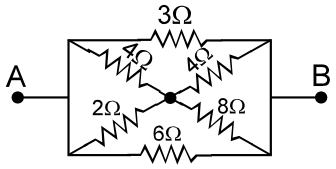
(A) $\frac{3}{14}M\sqrt{g\ell}$ (B) $\frac{3}{16}M\sqrt{g\ell}$ (C) $\frac{7}{16}M\sqrt{g\ell}$ (D) $\frac{9}{14}M\sqrt{g\ell}$

9. Two cylindrical rods of uniform cross-section area A and 2A, having free electrons per unit volume 2n and n respectively are joined in series. A current I flows through them in steady state. Then the ratio of drift velocity of free electron in left rod to drift velocity of electron in the right rod is $\left(\frac{v_L}{v_R}\right)$ is :



(A) $\frac{1}{2}$ (B) 1 (C) 2 (D) 4

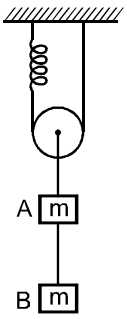
10. The equivalent resistance between A & B is:



(A) $\frac{4}{3}\Omega$ (B) $\frac{17}{24}\Omega$

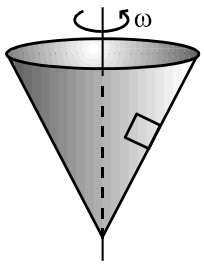
(C) 29Ω (D) $\frac{24}{17}\Omega$

11. Two mass A and B, each of mass m, are initially in equilbrium as shown in figure. The acceleration of block A just after string between A and B is cut will be : (g = acceleration due to gravity).



(A) 2g downward
(B) 2g upward
(C) g downward
(D) g upward

12. A smooth and vertical cone-shaped funnel is rotated with a constant angular velocity ω in such a way that an object on the inner wall of the funnel is at rest w.r.t. the funnel. If the object is slightly displaced along the slope from this position and released :

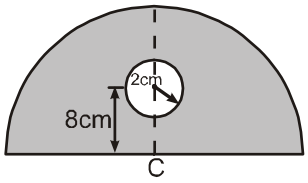


(A) it will be in equilibrium at its new position.
(B) it will execute SHM
(C) it will oscillate but the motion is not SHM
(D) none of these

13. The centre of mass of a system of particles is at (x_0, y_0, z_0) where $x_0 \le 0$, $y_0 \le 0$. It is known that no particle lies in the region $y < 0$ and $x < 0$ then the position of centre of mass can be

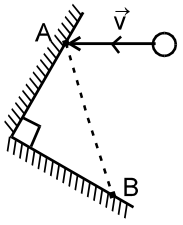
(A) (0, 0, 4) (B) (0, – 4, 0) (C) (– 4, 0, 0) (D) (– 4, – 4, 4,)

14. In the figure shown a hole of radius 2 cm is made in a semicircular disc of radius 6 π cm at a distance 8 cm from the centre C of the disc. The distance of the centre of mass of this system from point C is:



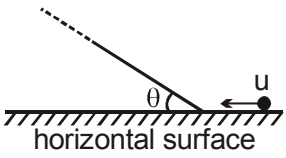
(A) 4 cm (B) 8 cm
(C) 6 cm (D) 12 cm

15. AB is an L shaped obstacle fixed on a horizontal smooth table. A ball strikes it at A, gets deflected and restrikes it at B. If the velocity vector before collision is $\vec{v}$ and coefficient of restitution of each collision is 'e', then the velocity of ball after its second collision at B is



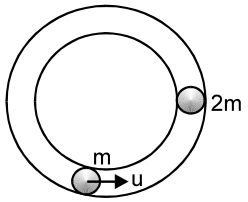
(A) $e^2\vec{v}$ (B) $-e^2\vec{v}$
(C) $-e\vec{v}$ (D) data insufficient

16. A particle of mass m is given initial horizontal velocity of magnitude u as shown in the figure. It transfers to the fixed inclined plane without a jump, that is, its trajectory changes sharply from the horizontal line to the inclined line. All the surfaces are smooth and $90° \ge \theta > 0°$. Then the height to which the particle shall rise on the inclined plane (assume the length of the inclined plane to be very large)



(A) increases with increase in θ (B) decreases with increase in θ
(C) is independent of θ (D) data insufficient

17. Two masses ' m ' and ' 2 m ' are placed in fixed horizontal circular smooth hollow tube as shown. The mass ' m ' is moving with speed 'u' and the mass ' 2 m ' is stationary. After their first collision, the time elapsed for next collision. (coefficient of restitution e = 1/2)



(A) $\frac{2\pi r}{u}$ (B) $\frac{4\pi r}{u}$ (C) $\frac{3\pi r}{u}$ (D) $\frac{12\pi r}{u}$

18. The density of a solid ball is to be determined in an experiment. The diameter of the ball is measured with a screw gauge, whose pitch is 0.5 mm and there are 50 divisions on the circular scale. The reading on the main scale is 2.5 mm and that on the circular scale is 20 divisions. If the measured mass of the ball has a relative error of 2%, the relative percentage error in the density is **[JEE 2011, 3/160,–1]**

(A) 0.9% (B) 2.4% (C) 3.1% (D) 4.2%

19. A moving particle is acted upon by several forces F_1, F_2, F_3,..... etc. One of the force is chosen, say F_2, then which of the following statement about F_2 will be true.

(A) Work done by F_2 will be negative if speed of the particle decreases.

(B) Work done by F_2 will be positive if speed of the particle increases

(C) Work done by F_2 will be equal to the work done by other forces if speed of the particle does not change

(D) If F_2 is a conservative force, then work done by all other forces will be equal to change in potential energy due to force F_2 when speed remains constant.

20. An object is moving along a straight line path from P to Q under the action of a force $(4\hat{i} - 3\hat{j} + 2\hat{k})$ N. If the co-ordinate of P & Q in metres are (3, 2, –1) & (2, –1, 4) respectively. Then the work done by the force is:

(A) – 15 J (B) + 15 J (C) 1015 J (D) $(4\hat{i} - 3\hat{j} + 2\hat{k})$

ANSWERS

DPP No. : B1

6. v = 7 **7.** n = 2
8. u_y = 5 m/s, u_x = 4 m/s
9. t = ($\log_e 2$) sec
10. On the object itself

DPP No. : B3

7. **(a)** s = 30 m, **(b)** $-\frac{5}{2}$ m/s^2
8. $\vec{V}_i = V_{ix}\,\hat{i} + V_{iy}\hat{j} = -2\hat{i} - 4\hat{j}$
9. 150 cm

DPP No. : B4

9. $\frac{2\hat{i}+3\hat{j}+4\hat{k}}{\sqrt{29}}$ **10.** 0.5 m

DPP No. : B6

7. $\frac{6\pi a^2}{5}$ **8.** d = 4000 mm

DPP No. : B7

7. 11 cm **8.** 0.5 sec.
9. t = 2 cm **10.** $\sqrt{3/2}$

DPP No. : B9

7. h = $\frac{125}{3}$ m above point of projection
8. 7 **9.** 5

DPP No. : B10

8. k = $\frac{3mg}{d^3}(h+d)$ **9.** 6

DPP No. : B12

8. A (10, – 20) and B (11 cm, – 20 cm), size = 1cm **9.** 2600

DPP No. : B13

9. 48 N **10.** $\omega = -\frac{\pi a^2}{2}$ J

DPP No. : B15

6. x = $[3(a - \mu mg)/b]^{1/2}$ **7.** 100
8. $\frac{3QR^2}{8\pi \in_0 x^4}$
9. t = 3 sec & t = 6 sec. **10.** T = $\frac{7mg}{5}$

DPP No. : B16

9. V = – 50/3 cm ; V_i = 16 m/s

DPP No. : B18

8. $\bar{D} = 1.330$ cm , $\overline{\Delta D} = 0.005$ cm ,
Relative error = + 0.004 %, error = 0.4%
9. 1.4% **10.** $a_o = \frac{4g}{7}$ m/s^2

DPP No. : B19

8. 5 **9.** 24 m/sec
10. w_{OAC} = 8 J, w_{OBC} = 2 J; w_{ODC} = 19/3 J, No

DPP No. : B21

10. 5

DPP No. : B22

9. 1 **10.** x = L_0 and $v_{max} = \frac{3L_0}{4}\sqrt{\frac{k}{m}}$

DPP No. : B24

8. d = 6 **9.** 4V

DPP No. : B26

9. 3

DPP No. : B27

6. 50 **7.** 2
8. The area is 2.6 cm^2
9. fractional error in x is least if (100 – ℓ)ℓ is maximum and it is when ℓ = 50 cm.

DPP No. : B29

8. 1 **9.** $\sin^2\theta$
10. **(a)** V cosec θ **(b)** $\omega = \frac{5V}{4R}$

DPP No. : B30

8. $2\sqrt{29}$ N **9.** $\left|\frac{3a}{5}+\frac{4b}{5}\right|$