1to1 GURU

Learn to Lead, Learn to Succeed

Date :-11/02/2022 **Time :-120 Minutes** **Exam Name :-1to1Guru-TestSeries#1** **Mark :- 200**

1. The linear momentum of a particle varies with time t as $p = a + bt + ct^2$ Which of the following statements is correct?

(A) Force varies with time in a quadratic manner (B) Force is time-dependent (C) The velocity of the particle is proportional to time (D) The displacement of the particle is proportional to t

Ans:-(B)

Solution:-(b) $F = \frac{d}{dt}(p)$

$F = \frac{d}{dt}(a + bt + ct^2)$ or $F = b + 2ct$

Clearly, the force is time-dependent

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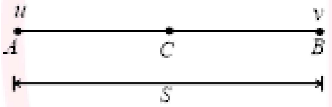
2. A particle is moving with constant acceleration from A to B in a straight line AB . If u and v are the velocities at A and B respectively then its velocity at the midpoint C will be

(A) $\left(\frac{u^2+v^2}{2u}\right)^2$ (B) $\frac{u+v}{2}$ (C) $\frac{v-u}{2}$ (D) $\sqrt{\frac{u^2+v^2}{2}}$

Ans:-(D)

Solution:-(d) 

Let S be the distance between AB and a be constant acceleration of a particle. Then

$v^2 - u^2 = 2aS$

Or $aS = \frac{v^2-u^2}{2}$ ... (i)

Let v_c be velocity of a particle at midpoint C

$\therefore\ v_c^2 - u^2 = 2a\left(\frac{S}{2}\right)$

$v_c^2 = u^2 + aS = u^2 + \frac{v^2-u^2}{2}$ [Using (i)]

$v_c = \sqrt{\frac{u^2+v^2}{2}}$

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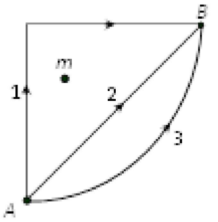
3. If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 respectively (as shown) in the gravitational field of a point mass m, find the correct relation between W_1, W_2 and W_3



(A) $W_1 > W_2 > W_3$ (B) $W_1 = W_2 = W_3$ (C) $W_1 < W_2 < W_3$ (D) $W_2 > W_1 > W_3$

Ans:-(B)

Solution:-(b) Gravitational force is a conservative force and work done against it is a point function $i.e.$ does not depend on the path

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4. A $20\ kg$ block is initially at rest on a rough horizontal surface. A horizontal force of $75\ N$ is required set

the block in motion. After it is in motion, a horizontal force of $60\ N$ is required to keep the block moving with constant speed. The coefficient of static friction is
(A) 0.38 (B) 0.44 (C) 0.52 (D) 0.60
Ans:-(A)
Solution:-(a) Coefficient of friction $\mu_s = \frac{F_1}{R} = \frac{75}{mg} = \frac{75}{20\times 9.8} = 0.38$

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5. A boy of mass $0.25\ kg$ is projected with muzzle velocity $100\ ms^{-1}$ from a tank of mass $100\ kg$. What is the recoil velocity of the tank
(A) $5\ ms^{-1}$ (B) $25\ ms^{-1}$ (C) $0.5\ ms^{-1}$ (D) $0.25\ ms^{-1}$
Ans:-(D)
Solution:-(d) Using law of conservation of momentum, we get
$100\times v = 0.25\times 100 \Rightarrow v = 0.25\ m/s$

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6. The dimensional formula of capacitance in terms of M, L, T and I is
(A) $[\mathrm{ML^2T^2I^2}]$ (B) $[\mathrm{ML^{-2}T^4I^2}]$ (C) $[\mathrm{M^{-1}L^3T^3I}]$ (D) $[\mathrm{M^{-1}L^{-2}T^4I^2}]$
Ans:-(D)
Solution:-(d) Capacitances $C = \frac{Q}{V} = \frac{QQ}{W} = \frac{Q^2}{W} = \frac{I^2t^2}{W}$,
$$[C] = \frac{[\mathrm{I^2T^2}]}{[\mathrm{ML^2T^{-2}}]} = [\mathrm{M^{-1}L^{-2}T^4I^2}]$$

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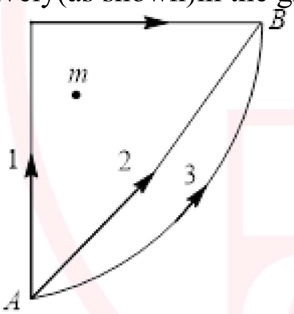
7. If $w_1, w_2\ and\ w_3$ represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 respectively(as shown)in the gravitational field of a point mass m. Find the correct relation between $w_1, w_2 and\ w_3$



(A) $w_1 > w_2 > w_3$ (B) $w_1 = w_2 = w_3$ (C) $w_1 < w_2 < w_3$ (D) $w_2 > w_1 > w_3$
Ans:-(B)
Solution:-(b) Gravitational field is a conservative force field. In a conservative force field work done is path independent.
$\therefore\quad W_1 = W_2 = W_3$

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8. An artillery piece which consistently shoots its shells with the same muzzle speed has a maximum range R. To hit a target which is $\frac{R}{2}$ from the gun and on the same level, the elevation angle of the gun should be
(A) 15° (B) 45° (C) 30° (D) 60°
Ans:-(A)
Solution:-(a) $R_{\max} = R = \frac{u^2}{g}$
$\Rightarrow u^2 = Rg$
Now, as range $= \frac{u^2 \sin 2\theta}{g}$
then $\frac{R}{2} = \frac{Rg\sin 2\theta}{g}$
$\Rightarrow \sin 2\theta = \frac{1}{2} = \sin 30° \Rightarrow \theta = 15°$

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9. A train has to negotiate a curve of radius $400\ \mathrm{m}$. The speed of the train is $72\ \mathrm{km}/$ hour. The horizontal distance is to be raised with respect to the inner radius by h . If distance between rail is $l = 1\ \mathrm{m}$, the value of h will be $(\mathrm{g} = 10\ \mathrm{m/s^2})$

(A) $15\ \mathrm{cm}$ (B) $10\ \mathrm{cm}$ (C) $5\ \mathrm{cm}$ (D) $2.5\ \mathrm{cm}$

Ans:-(B)

Solution:-

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10. A body is falling freely under gravity. The distances covered by the body in first, second and third minute of its motion are in the ratio

(A) 1 : 4 :9 (B) 1 : 2 : 3 (C) 1 : 3 : 5 (D) 1 : 5 : 6

Ans:-(C)

Solution:-(c) Distance covered in a particular time is

$$s_n = u + \frac{1}{2}\mathrm{g}(2\mathrm{n} - 1)$$

$$s_1 = 0 + \frac{1}{\mathrm{g}}(2 \times 1 - 1) = \frac{\mathrm{g}}{2}$$

$$s_2 = 0 + \frac{1}{2}\mathrm{g}(2 \times 2 - 1) = \frac{3}{2}\mathrm{g}$$

And $s_3 = 0 + \frac{1}{2}\ \mathrm{g}(2 \times 3 - 1) = \frac{5}{2}\ \mathrm{g}$

Hence, the required ration is

$$s_1 : s_2 : s_3 = \frac{\mathrm{g}}{2} : \frac{3}{2}\mathrm{g} : \frac{5}{2}\mathrm{g}$$

$$= 1 : 3 : 5$$

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11. A body of mass m is projected at an angle of 45° with the horizontal. If air resistance is negligible, then total change in momentum when it strikes the ground is

(A) $2mv$ (B) $\sqrt{2}\,mv$ (C) mv (D) $mv/\sqrt{2}$

Ans:-(B)

Solution:-(b) Change in momentum $= 2mv \sin\theta = 2mv \sin\frac{\pi}{4} = \sqrt{2}mv$

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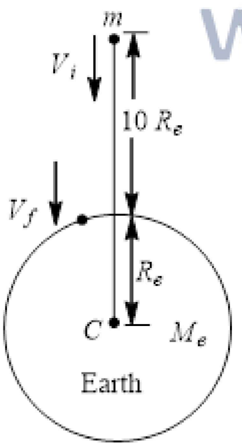
12. An asteroid of mass m is approaching earth, initially at a distance of $10\,R_e$ with speed v_i . It hits the earth with a speed v_f (R_e and M_e are radius and mass of earth), then

(A) $v_f^2 = v_i^2 + \frac{2Gm}{M_eR}\left(1 - \frac{1}{10}\right)$ (B) $v_f^2 = v_i^2 + \frac{2GM_e}{R_e}\left(1 + \frac{1}{10}\right)$ (C) $v_f^2 = v_i^2 + \frac{2GM_e}{R_e}\left(1 - \frac{1}{10}\right)$ (D) $v_f^2 = v_i^2 + \frac{2Gm}{R_e}\left(1 - \frac{1}{10}\right)$

Ans:-(C)

Solution:-(c) Applying law of conservation of energy for asteroid at a distance $10\,R_e$ and at earth s surface.



$$K_i + U_i = K_f + U_f \qquad \text{.... (i)}$$

Now, $K_f = \frac{1}{2}mv_i^2$ and $U_i = -\frac{GM_e m}{10R_e}$

$K_f = \frac{1}{2}mv_f^2$ and $U_f = -\frac{GM_e m}{R_e}$

Substituting these values in Eq. (i), we get

$$\frac{1}{2}mv_i^2 - \frac{GM_e m}{10R_e} = \frac{1}{2}mv_f^2 - \frac{GM_e m}{R_e}$$

$$\Rightarrow \frac{1}{2}mv_f^2 = \frac{1}{2}mv_f^2 + \frac{GM_e m}{R_e} - \frac{GM_e m}{10R_e}$$

$$\Rightarrow v_f^2 = v_i^2 + \frac{2GM_e}{R_e} - \frac{2GM_e}{10R_e}$$

$$\therefore \quad v_f^2 = v_i^2 + \frac{GM_e m}{R_e}\left(1 - \frac{1}{10}\right)$$

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13. Sun is about 330 times heavier and 100 times bigger in radius than earth. The ratio of mean density of the sun to that of earth is

(A) 3.3×10^{-6} (B) 3.3×10^{-4} (C) 3.3×10^{-2} (D) 1.3

Ans:-(B)

Solution:-(b) As mass, $M = \frac{4}{3}\pi R^2 \rho$

or $\rho = \frac{3M}{4\pi R^3}$

$$\therefore \frac{\rho_s}{\rho_e} = \frac{M_s}{M_e} \times \frac{R_e^3}{R_s^3} = 330 \times \left(\frac{1}{100}\right)^3 = 3.3 \times 10^{-4}$$

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14. A spring pong ball of mass m is floating in air by a jet of water emerging out of a nozzle. If the water strikes the ping pong ball with a speed v and just after collision water falls dead, the rate of flow of water in the nozzle is equal to

(A) $\frac{2mg}{v}$ (B) $\frac{m}{g}$ (C) $\frac{mg}{v}$ (D) $\frac{2m}{vg}$

Ans:-(C)

Solution:-(c) The impact force $F = \frac{\Delta p}{\Delta t} = v\frac{\Delta m}{\Delta t}$ where $\frac{\Delta m}{\Delta t}$ = rate of flow of water in the nozzle and v the velocity of water jet.

Since the ball is in equilibrium $F = mg$ where m = mass of ping pong ball.

$\Rightarrow v\frac{\Delta m}{\Delta t} = mg$ or rate of flow of water $\frac{\Delta m}{\Delta t} = \frac{mg}{v}$

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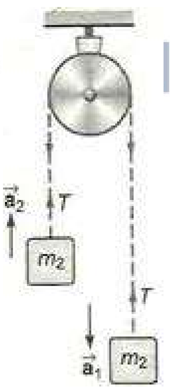
15. The two bodies of mass m_1 and $m_2 (m_1 > m_2)$ respectively are tied to the ends of a massless string, which passes over a light and frictionless pulley. The masses are initially at rest and the released. Then



acceleration of the centre of mass of the system is

(A) $\left[\frac{m_1 - m_2}{m_1 + m_2}\right]^2 \mathbf{g}$ (B) $\left[\frac{m_1 - m_2}{m_1 + m_2}\right]^2$ (C) $\mathbf{g}$ (D) zero

Ans:-(A)

Solution:-(a) In the pulley arrangement $|\vec{a}_1| = |\vec{a}_2| = a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)g$

But $\vec{a}_1$ is in downward direction and in the upward direction ie, $\vec{a}_2 = -\vec{a}_1$

$\therefore$ Acceleration of centre of mass

$$\vec{a}_{CM} = \frac{m_1\vec{a}_1 + m_2\vec{a}_2}{m_1 + m_2} = \frac{m_1\left[\frac{m_1 - m_2}{m_1 + m_2}\right]g - m_2\left[\frac{m_1 - m_2}{m_1 + m_2}\right]g}{(m_1 + m_2)}$$

$$= \left[\frac{m_1 - m_2}{m_1 + m_2}\right]^2 g$$

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16. From the top of tower, a stone is thrown up. It reaches the ground in t_1 second. A second stone thrown down with the same speed reaches the ground in t_2 second. A third stone released from rest reaches the ground in t_3 second. Then

(A) $t_3 = \frac{(t_1 + t_2)}{2}$ (B) $t_3 = \sqrt{t_1 t_2}$ (C) $\frac{1}{t_3} = \frac{1}{t_1} - \frac{1}{t_2}$ (D) $t_3^2 = t_2^2 - t_1^2$

Ans:-(B)

Solution:-

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17. A bullet fired into a fixed wooden block loses half of its velocity after penetration 40 cm. it comes to rest after penetrating a further distance of

(A) $\frac{22}{3}$ cm (B) $\frac{40}{3}$ cm (C) $\frac{20}{3}$ cm (D) $\frac{22}{5}$ cm

Ans:-(B)

Solution:-(b) Let initial velocity of body a point A is v, AB is 40 cm.

From $v^2 = u^2 - 2as$

$$\Rightarrow \quad \left(\frac{v}{2}\right)^2 = v^2 - 2a \times 40$$

$$\text{Or} \quad a = \frac{3v^2}{320}$$

Let on penetrating 40 cm in a wooden block, the body moves x distance from B to C.

So, for B to C

$$u = \frac{v}{2}, v = 0$$

$$s = x, a = \frac{3v^2}{320} \text{(deceleration)}$$

$$\therefore \quad (0)^2 = \left(\frac{v}{2}\right)^2 - 2 \times \frac{3v^2}{320} \times x$$

$$\text{Or} \quad x = \frac{40}{3}\text{cm}$$

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18. A car of mass m is driven with an acceleration a along a straight level road against a constant external resistive force R. When the velocity of the car is v, the rate at which engine of the car is doing work, will be

(A) $R \cdot v$ (B) $ma \cdot v$ (C) (R+m (D) $\cdot v$

Ans:-(C)

Solution:-(c) From the diagram

$$F - R = ma$$

$or \quad F = R + ma$

Or Rate of doing work=power

=F $\cdot v$

=(R+ma) $\cdot v$

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19. An object weighs $72\ N$ on earth. Its weight at a height of $R/2$ from earth is
(A) $32\ N$ (B) $56\ N$ (C) $72\ N$ (D) Zero
Ans:-(A)
Solution:-(a) $g' = g\left(\frac{R}{R+h}\right)^2 = g\left(\frac{R}{R+\frac{R}{2}}\right)^2 = \frac{4}{9}g$
$\therefore W' = \frac{4}{9} \times W = \frac{4}{9} \times 72 = 32N$

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20. A stone of mass 2 kg is projected upward with KE of 98 J. The height at which the KE of the body becomes half its original value, is given by (Take $\mathrm{g} = 10\mathrm{ms}^{-2}$)
(A) 5 m (B) 2.5 m (C) 1.5 m (D) 0.5 m
Ans:-(B)
Solution:-(b) $K = \frac{1}{2}mv^2$
$v^2 = \frac{98 \times 2}{2} = 98$
$h = \frac{v^2}{2\mathrm{g}} = \frac{98}{2 \times 9.8} = 5$
$K_1 = \frac{1}{2}mv^2 = \frac{1}{2}m \times 2\mathrm{g}h$
$\therefore \quad \frac{K_2}{K_1} = \frac{h_2}{h_1}$
Given $K_2 = \frac{K_1}{2}$
$\therefore \ = \frac{K_1}{2K_1} = \frac{h_2}{5}$
$\therefore\ h_2 = 2.5\ \mathrm{m}$

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21. A motorcycle is travelling on a curved track of radius $500\ m$. If the coefficient of between road and tyres is 0.5, the speed avoiding skidding will be
(A) $50\ m/s$ (B) $75\ m/s$ (C) $25\ m/s$ (D) $35\ m/s$
Ans:-(A)
Solution:-(a) $v = \sqrt{\mu rg} = \sqrt{0.5 \times 500 \times 10} = 50\ m/s$

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22. A coolie 1.5 m tall raises a load of 80 kg in 2 s from the ground to his head and then walks a distance of 40 m in another 2 s. The power developed by the coolie is $[\mathbf{g = 10\ ms^{-2}}]$
(A) 0.2 kW (B) 0.4 kW (C) 0.6 kW (D) 0.8 kW
Ans:-(C)
Solution:-(c) $P = \frac{mgh}{t} = \frac{80 \times 10 \times 1.5}{2}$
$= 600\ \mathrm{W} = \ 0.6\ \mathrm{kW}$

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23. The value of Planck s constant is
(A) $6.63\ \times 10^{-34}\ J$ - sec (B) $6.63\ \times 10^{34}\ J$ - sec (C) $6.63\ \times 10^{-34}\ kg$ - m^2 (D) $6.63\ \times 10^{34}\ kg$ - sec
Ans:-(A)
Solution:-

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24. A uniform rope of length l lies on a table. If the coefficient of friction is μ , then the maximum length l_1 of the part of this rope which can overhang from the edge of the table without sliding down is
(A) $\frac{1}{\mu}$ (B) $\frac{1}{\mu + l}$ (C) $\frac{\mu l}{1+\mu}$ (D) $\frac{\mu l}{\mu - 1}$
Ans:-(C)

Solution:-(c) For given condition we can apply direct formula
$l_1 = \left(\frac{\mu}{\mu+1}\right) l$

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25. Two bodies A and B have masses M and m respectively, where $M > m$ and they are at a distance d apart. Equal force is applied to them so that they approach each other. The position where they hit each other is
(A) Nearer to B (B) Nearer to A (C) At equal distance from A and B (D) Cannot be decided
Ans:-(B)
Solution:-(b) As net external force on the system is zero therefore position of their centre of mass remains unaffected i. e . they will hit each other at the point of centre of mass.
The centre of mass of the system lies nearer to A because $m_A > m_B$

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26. Four particles given, have same momentum. Which has maximum kinetic energy
(A) Proton (B) Electron (C) Deutron (D) α - particles
Ans:-(B)
Solution:-(b) $E = \frac{p^2}{2m}$ $\therefore E \propto \frac{1}{m}$ [If $P =$ constant]
$i.e$., the lightest particle will possess maximum kinetic energy and in the given option mass of electron is minimum

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27. The work done in pulling up a block of wood weighing $2\ kN$ for a length of $10\ m$ on a smooth plane inclined at an angle of $15°$ with the horizontal is $[\sin 15° = 0.2588]$
(A) $4.36\ kJ$ (B) $5.17\ kJ$ (C) $8.91\ kJ$ (D) $9.82\ kJ$
Ans:-(B)
Solution:-(b) $W = mg \sin\theta \times s$
$= 2 \times 10^3 \times \sin 15° \times 10$
$= 5.17\ kJ$

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28. A body weighs $700\ g\ wt$ on the surface of the earth. How much will it weigh on the surface of a planet whose mass is $\frac{1}{7}$ and radius is half that of the earth
(A) $200\ g\ wt$ (B) $400\ g\ wt$ (C) $50\ g\ wt$ (D) $300\ g\ wt$
Ans:-(B)
Solution:-(b) We know that $g = \frac{GM}{R^2}$
On the planet $g_p = \frac{GM/7}{R^2/4} = \frac{4}{7} g$
Hence weight on the planet $= 700 \times \frac{4}{7} = 400\ gm\ wt$

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29. The engine of a car produces an acceleration of $6\ \mathrm{ms}^{-2}$ in the car. If this car pulls another car of the same mass, then the acceleration would be
(A) 6 ms^{-2} (B) 12 ms^{-2} (C) 3 ms^{-2} (D) 1.5 ms^{-2}
Ans:-(C)
Solution:-(c) Force applied by engine= 6 m
When two cars are pulled,
$(m+m)a = 6\ m$
or $2ma = 6m$ or $a = 3\ \mathrm{ms}^{-2}$

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30. Spot the $wrong$ statement: The acceleration due to gravity $'g'$ decreases if
(A) We go down from the surface of the earth towards its centre (B) We go up from the surface of the earth (C) We go from the equator towards the poles on the surface of the earth (D) The rotational velocity of the earth is increased

Ans:-(C)
Solution:-(c) Value of g decreases when we go from poles to equator

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31. A steel ball of mass 5 g is thrown downward with velocity $10\ \text{ms}^{-1}$ from height 19.5 m. It penetrates sand by 50 cm. The change in mechanical energy will be $(g = 10\text{ms}^{-2})$
(A) 1 J (B) 1.25 J (C) 1.5 J (D) 1.75 J
Ans:-(B)
Solution:-(b) Given m= 5g = 0.005kg, h=19.5m,
$x = 50cm = 0.5m,\ \ v = 10ms^{-1}, g = 10ms^{-2}$
The change in mechanical energy
$\Delta U = mg(h+x) + \frac{1}{2}mv^2$
$= 0.005 \times 10(19.5 + 0.5) + \frac{1}{2} \times 0.005 \times (10)^2$
$= 0.005 \times 10 \times 20 + \frac{1}{2} \times 0.005 \times 100$
$= 1 + 0.25 = 1.25j$

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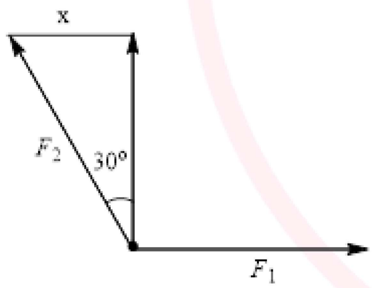
32. The resultant of two forces acting at an angle of $120°$ is 10 kg-wt and is perpendicular to one of the forces. That force is
(A) $\frac{10}{\sqrt{3}}$ kg- wt (B) 10 kg-wt (C) $20\sqrt{3}$ kg-wt (D) $10\sqrt{3}$ kg-wt
Ans:-(A)
Solution:-(a) $\tan 30° = \frac{1}{\sqrt{3}} = \frac{x}{10}$

$x = \frac{10}{\sqrt{3}}$



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33. Moment of inertia of a disc about a diameter is I . Find the moment of inertia of disc about an axis perpendicular to its plane and passing through its rim?
(A) $6I$ (B) $4I$ (C) $2I$ (D) $8I$
Ans:-(A)
Solution:-(a) Moment of inertia of a disc about a diameter is
$\frac{1}{4}MR^2 = I$ (given)
$\therefore MR^2 = 4I$
Now, required moment of inertia $= \frac{3}{2}MR^2$
$= \frac{3}{2}(4I) = 6I$

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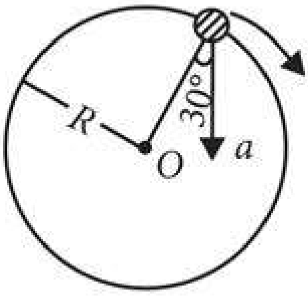
34. In the given figure, $a = 15\ \text{m s}^{-2}$ represents the total acceleration of a particle moving in the clockwise direction in a circle of radius $R = 2.5\ \text{m}$ at a given instant of time. The speed of the particle is (NEET-II

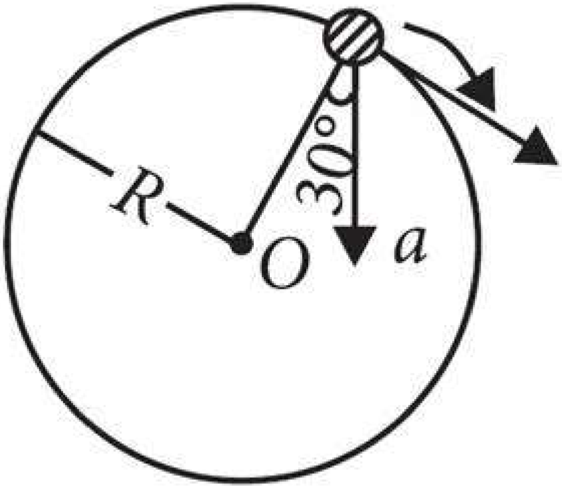
2016) 

(A) 4.5 m s^{-1} (B) 5.0 m s^{-1} (C) 5.7 m s^{-1} (D) 6.2 m s^{-1}

Ans:-(C)

Solution:-(c) : Here, $a = 15 \text{ m s}^{-2}$, $R = 2.5 \text{ m}$

From figure,



$a_c = a\cos 30° = 15 \times \frac{\sqrt{3}}{2} \text{ m s}^{-2}$

As we know, $a_c = \frac{v^2}{R} \Rightarrow v = \sqrt{a_c R}$

$\therefore\ v = \sqrt{15 \times \frac{\sqrt{3}}{2} \times 2.5} = 5.69 \simeq 5.7 \text{ m s}^{-1}$

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35. If g is the acceleration due to gravity on the surface of earth, its value at a height equal to double the radius of earth is

(A) g (B) $\frac{g}{2}$ (C) $\frac{g}{3}$ (D) $\frac{g}{9}$

Ans:-(D)

Solution:-(d) Acceleration due to gravity at a height h form the surface of the earth

$$g' = g\frac{1}{\left(1+\frac{h}{R}\right)^2}$$

Given, $h = 2R$

$\therefore\quad g' = g\frac{1}{(1+2)^2}$

or $\quad g' = \frac{g}{9}$

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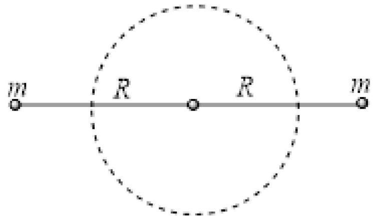
36. Two particles of equal mass m go around a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle with respect to their center of mass is

(A) $\sqrt{\frac{Gm}{R}}$ (B) $\sqrt{\frac{Gm}{4R}}$ (C) $\sqrt{\frac{Gm}{3R}}$ (D) $\sqrt{\frac{Gm}{2R}}$

Ans:-(B)

Solution:-(b) Gravitational force provides necessary centripetal force



$$\frac{Gm^2}{(2R)^2} = \frac{mv^2}{R}$$
$$\Rightarrow \ v = \sqrt{\frac{Gm}{4R}}$$

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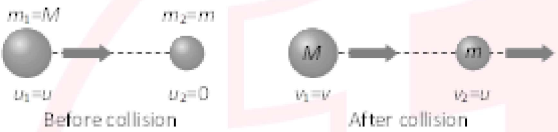
37. A big ball of mass M , moving with velocity u strikes a small ball of mass m , which is at rest. Finally small ball obtains velocity u and big ball v . Then what is the value of v

(A) $\frac{M-m}{M+m}u$ (B) $\frac{m}{M+m}u$ (C) $\frac{2m}{M+m}u$ (D) $\frac{M}{M+m}u$

Ans:-(A)

Solution:-(a)



From the formulae $v_1 = \left(\frac{m_1-m_2}{m_1+m_2}\right)u_1$

We get $v = \left(\frac{M-m}{M+m}\right)u$

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38. A circular disc of radius R and thickness $\frac{R}{6}$ has moment of inertia I about an axis passing through its centre and perpendicular to its plane. It is melted and recasted into a solid sphere. The moment of inertia of the sphere about its diameter as axis of rotation is

(A) I (B) $\frac{2I}{8}$ (C) $\frac{I}{5}$ (D) $\frac{I}{10}$

Ans:-(C)

Solution:-(c) According to problem disc is melted and recasted into a solid sphere so their volume will be same

$V_{\text{Disc}} = V_{\text{Sphere}} \Rightarrow \pi R_{\text{Disc}}^2 t = \frac{4}{3}\pi R_{\text{Sphere}}^3$

$\Rightarrow \pi R_{\text{Disc}}^2\left(\frac{R_{\text{Disc}}}{6}\right) = \frac{4}{3}\pi R_{\text{Sphere}}^3 \quad \left[t = \frac{R_{\text{Disc}}}{6}, \text{given}\right]$

$\Rightarrow R_{\text{Disc}}^3 = 8R_{\text{Sphere}}^3 \Rightarrow R_{\text{Sphere}} = \frac{R_{\text{Disc}}}{2}$

Moment of inertia of disc $I_{\text{Disc}} = \frac{1}{2}MR_{\text{Disc}}^2 = I$ [Given]

$\therefore M(R_{\text{Disc}})^2 = 2I$

Moment of inertia of sphere $I_{\text{Sphere}} = \frac{2}{5}MR_{\text{Sphere}}^2$

$= \frac{2}{5}M\left(\frac{R_{\text{Disc}}}{2}\right)^2 = \frac{M}{10}(R_{\text{Disc}})^2 = \frac{2I}{10} = \frac{I}{5}$

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39. The radius of the earth is about 6400 km and that of the mars is 3200 km. The mass of the earth is about 10 times the mass of the mars. An object weighs 200 N on the surface of earth, its weight on the surface of mars will be

(A) 8 N (B) 20 N (C) 40 N (D) 80 N

Ans:-(D)

Solution:-(d) Weight on mars $= mg' = \frac{mG(m/10)}{(R/2)^2}$

$= m \times \frac{4}{10}mg = \frac{4}{10} \times 200 = 80$ N

40. The value of g on the earth s surface is 980 cms^{-2} . Its value at a height of 64 km from the earth s surface is
(A) 960.40 cms^{-2} (B) 984.90 cms^{-2} (C) 982.45 cms^{-2} (D) 977.55 cms^{-2}
Ans:-(A)
Solution:-(a) $g' = \frac{gR^2}{(R+h)^2}$
$= 980 \times \left(\frac{6400}{6400+64}\right)^2 = 960 \text{cms}^{-2}$

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41. If a long spring is stretched by $0.02\, m$, its potential energy is U . If the spring is stretched by $0.1\, m$, then its potential energy will be
(A) $\frac{U}{5}$ (B) U (C) $5\, U$ (D) $25\, U$
Ans:-(D)
Solution:-(d) $U \propto x^2 \Rightarrow \frac{U_2}{U_1} = \left(\frac{x_2}{x_1}\right)^2 = \left(\frac{0.1}{0.02}\right)^2 = 25 \therefore U_2 = 25\, U$

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42. A body is acted upon by a force towards a point. The magnitude of the force is inversely proportional to the square of the distance. The path of body will be
(A) Ellipse (B) Hyperbola (C) Circle (D) Parabola
Ans:-(A)
Solution:-(a) When a body is acted on by the force towards a point and the magnitude of force is inversely proportional to the square of distance. It means it obeys inverse square law and represents ellipse, for example path of the planet around the sun and the force acts between sun and planet proportional to $\frac{1}{r^2}$

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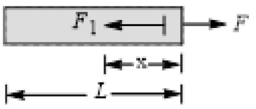
43. A rope of length L is pulled by a constant force F . What is the tension in the rope at distance x from the end when the force is applied?
(A) $\frac{F(L-x)}{L}$ (B) $\frac{FL}{L-x}$ (C) $\frac{FL}{x}$ (D) $\frac{Fx}{L-x}$
Ans:-(A)
Solution:-(a) $F - F_1 = (dm)a$



Acceleration of rope $a = \frac{F}{m}$
$dm = \frac{m}{L}x$
$F - F_1 = \frac{mx}{L} \times \frac{F}{m}$
$F - F_1 = \frac{Fx}{L}$ or $F_1 = \frac{F(L-x)}{L}$

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44. A bullet comes out of the barrel of gun of length 2m with a speed 80 ms^{-1}. The average acceleration of the bullet is
(A) 1.6 ms^{-2} (B) 160 ms^{-2} (C) 1600 ms^{-2} (D) 16 ms^{-2}
Ans:-(C)
Solution:-(c) Given, $s = 2 \text{ m}, u = 80 \text{ ms}^{-1}, v = 0$
From $v^2 = u^2 - 2as$
$\therefore$ $(0)^2 = (80)^2 - 2 \times a \times 2$
Or $a = \frac{80 \times 80}{4} = 1600 \text{ ms}^{-2}$

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45. A particle of mass M is moving in a horizontal circle of radius R with uniform speed v. When it moves from one point to a diametrically opposite point, its (1992)
(A) kinetic energy change by $Mv^2/4$ (B) momentum does not change (C) momentum change by $2Mv$ (D) kinetic energy changes by Mv^2
Ans:-(C)
Solution:-(c): On the diametrically opposite points, the velocities have same magnitude but opposite directions. Therefore change in momentum is
$Mv-(-Mv)=2Mv$

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46. The only mechanical quantity which has negative dimension of mass is
(A) Angular momentum (B) Torque (C) Coefficient of thermal conductivity (D) Gravitational constant
Ans:-(D)
Solution:-(d) Dimensional formula of angular momentum $(L)=[\mathrm{ML^2T^{-1}}]$
Torque $(\tau)=[\mathrm{ML^2T^{-2}}]$
Coefficient of thermal conductivity
$(K)=[\mathrm{MLT^{-3}K^{-1}}]$
Gravitational constant $(G)=[\mathrm{M^{-1}L^3T^{-2}}]$
Thus, gravitational constant has negative dimension of mass.

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47. A constant force acts on a body of mass $0.9\ kg$ at rest for $10s$. If the body moves a distance of $250\ m$, the magnitude of the force is
(A) $3N$ (B) $3.5N$ (C) $4.0N$ (D) $4.5N$
Ans:-(D)
Solution:-(d) $u=0, S=250m, t=10\text{sec}$
$S=ut+\frac{1}{2}at^2 \Rightarrow 250=\frac{1}{2}a[10]^2 \Rightarrow a=5m/s^2$
So, $F=ma=0.9\times 5=4.5N$

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48. If a body of mass m is carried by a lift moving with an upward acceleration a, then the forces acting on the body are (i) the reaction R on the floor of the lift upwards (ii) the weight mg of the body acting vertically downwards. The equation of motion will be given by
(A) $R=mg-ma$ (B) $R=mg+ma$ (C) $R=ma-mg$ (D) $R=mg\times ma$
Ans:-(B)
Solution:-

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49. A ball of mass m_1 is a moving with velocity v. It collides head on elastically with a stationary ball of mass m_2. The velocity of ball becomes $v/3$ after collision. Then the value of the ratio $\frac{m_2}{m_1}$ is
(A) 1 (B) 2 (C) 3 (D) 4
Ans:-(B)

Solution:-(b) $m_1v=(m_1+m_2)v/3$
$3m_1v=m_1v+m_2v$
$3m_1v-m_1v=m_2v$
$2m_1v=m_2v$
$\therefore \frac{m_2}{m_1}=2$

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50. A cannon of a level plane is aimed at an angle θ above the horizontal and a shell is fired muzzle velocity v_0 towards a cliff D distance away. The height at which the canon strikes the cliff is given by
(A) $D\sin\theta-\frac{1}{2}\frac{gD^2}{v_0^2\sin^2\theta}$ (B) $D\cos\theta-\frac{1}{2}\frac{gD^2}{v_0^2\sin^2\theta}$ (C) $D\tan\theta-\frac{1}{2}\frac{gD^2}{v_0^2\cos^2\theta}$ (D) $D\tan\theta-\frac{1}{2}\frac{gD^2}{v_0^2\sin^2\theta}$
Ans:-(C)

Solution:-(c) Time taken to cover horizontal distance D with constant horizontal velocity, $t = D/v_0 \cos\theta$. Taking vertical motion for time t, we have

$$h = v_0 \sin\theta \times t - \frac{1}{2} g t^2$$

$$= v_0 \sin\theta \times \frac{D}{v_0 \cos\theta} - \frac{1}{2} g \left(\frac{D}{v_0 \cos\theta}\right)^2$$

$$= D \tan\theta - \frac{1}{2} \frac{g D^2}{v_0^2 \cos^2\theta}$$
