Work, Energy, And Power JEE Main PYQ - 1

Total Time: 25 Minute **Total Marks:** 40

Instructions

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1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

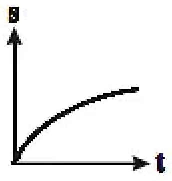
Navigating & Answering a Question

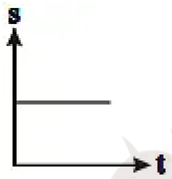
1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

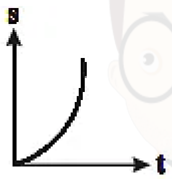
Work, Energy, And Power

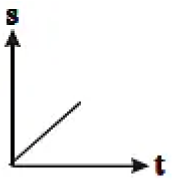
1. A particle is moving unidirectionally on a horizontal plane under the action of a constant power supplying energy source. The displacement (s) - time (t) graph that describes the motion of the particle is (graphs are drawn schematically and are not to scale) : **(+4, -1)**

[3 Sep2020 (II)]

a. 

b. 

c. 

d. 

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2. A 60 HP electric motor lifts an elevator having a maximum total load capacity of 2000 kg. If the frictional force on the elevator is 4000 N, the speed of the elevator at full load is close to : $(1\, HP = 746\, W,\ g = 10\, ms^{-2})$ **(+4, -1)**

[7 Jan. 2020 Shift I]

a. $1.5\, ms^{-1}$

b. $1.7\, ms^{-1}$

c. $2.0\,ms^{-1}$

d. $1.9\,ms^{-1}$

---

3. Two particles of equal mass m have respective initial velocities $u\hat{i}$ and $u\left(\frac{\hat{i}+\hat{j}}{2}\right)$. They collide completely inelastically. The energy lost in the process is : **(+4, -1)**

[9 Jan. 2020 Shift I]

a. $\frac{3}{4}mu^2$

b. $\sqrt{\frac{2}{3}}mu^2$

c. $\frac{1}{3}mu^2$

d. $\frac{1}{8}mu^2$

---

4. A block of mass m, lying on a smooth horizontal surface, is attached to a spring (of negligible mass) of spring constant k. The other end of the spring is fixed, as shown in the figure. The block is initally at rest in its equilibrium position. If now the block is pulled with a constant force F, the maximum speed of the block is : **(+4, -1)**

[9 Jan. 2019 I]

a. $\frac{\pi F}{\sqrt{mk}}$

b. $\frac{2F}{\sqrt{mk}}$

c. $\frac{F}{\sqrt{mk}}$

d. $\frac{F}{\pi\sqrt{mk}}$

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5. A proton of mass m collides elastically with a particle of unknown mass at rest. After the collision, the proton and the unknown particle are seen moving at an angle of 90° with respect to each other. The mass of unknown particle is : **(+4, -1)**

[Online April 15, 2018]

a. $\frac{m}{2}$

b. m

c. $\frac{m}{\sqrt{3}}$

d. $2m$

6. A thin rod MN, free to rotate in the vertical plane about the fixed end N, is held horizontal. When the end M is released the speed of this end, when the rod makes an angle α with the horizontal, will be proportional to : (see figure) **(+4, -1)**

a. $\sqrt{\sin \alpha}$

b. $\sin \alpha$

c. $\sqrt{\cos \alpha}$

d. $\cos \alpha$

7. A body of mass m starts moving from rest along x-axis so that its velocity varies as $v = a\sqrt{s}$ where a is a constant and s is the distance covered by the body. The total work done by all the forces acting on the body in the first t seconds after the start of the motion is : **(+4, -1)**

[Online April 16, 2018]

a. $\frac{1}{8} m a^4 t^2$

b. $8 m a^4 t^2$

c. $4 m a^4 t^2$

d. $\frac{1}{4} m a^4 t^2$

8. A particle of mass M is moving in a circle of fixed radius R in such a way that its centripetal acceleration at time t is given by $n^2 R t^2$ where n is a constant. The power delivered to the particle by the force acting on it, is : **(+4, -1)**

[Online April 10, 2016]

a. $M n^2 R^2 t$

b. $M n R^2 t$

c. $M n R^2 t^2$

d. $\frac{1}{2}M\,n^2R^2t^2$

9. A small particle moves to position $5\hat{i}-2\hat{j}+\hat{k}$ from its initial position $2\hat{i}+3\hat{j}-4\hat{k}$ under the action of force $5\hat{i}+2\hat{j}+7\hat{k}N$. The value of work done will be _________ J (+4, -1)

[1-Feb-2023 Shift 1]

10. A ball is dropped from a height of $20m$ If the coefficient of restitution for the collision between ball and floor is 0.5, after hitting the floor, the ball rebounds to a height of ___ m (+4, -1)

[31-Jan-2023 Shift 2]

Answers

1. **Answer: c**

Explanation:

$$\frac{dK}{dE} = P = \cos\, t$$
$$\Rightarrow K = Pt = \frac{1}{2}mV^2$$
$$\therefore V = \sqrt{\frac{2Pt}{m}} = \frac{ds}{dt}$$
$$\therefore S = \sqrt{\frac{2P}{m}}\frac{2}{3}t^{\frac{3}{2}}$$

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1. Work, Energy and Power:

Work:

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Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

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2. **Answer: d**

Explanation:

$4000?V + mg?V = P$

$\frac{60\times746}{4000+20000} = V$

$V = 1.86\, m/s. \approx 1.9\, m/s.$

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3. **Answer: d**

Explanation:

From momentum conservation

$mu\hat{i} + mu\left(\frac{\hat{i}+\hat{j}}{2}\right) = (m+m)\bar{v}$

$\Rightarrow \bar{v} = \frac{3}{4}u\hat{i} + \frac{u}{4}\hat{j}$

$\Rightarrow |v| = \frac{u}{4}\sqrt{10}$

Final kinetic energy $= \frac{1}{2}2m\left(\frac{u}{4}\sqrt{10}\right)^2 = \frac{5}{8}mu^2$ Initial kinetic energy

$= \frac{1}{2}mu^2 + \frac{1}{2}m\left(\frac{u}{\sqrt{2}}\right)^2 = \frac{6}{8}mu^2$

Loss in $K.E. = k_i - k_f = \frac{1}{8}mu^2$

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4. Answer: c

Explanation:

Maximum speed is at mean position (equilibrium). $F = kx$

$x = \frac{F}{k}$

$W_F + W_{sp} = \Delta KE$

$F\left(x\right) - \frac{1}{2}kx^2 = \frac{1}{2}mv^2 - 0$

$F\left(\frac{F}{k}\right) - \frac{1}{2}k\left(\frac{F}{k}\right)^2 = \frac{1}{2}mv^2$

$\Rightarrow v_{max} = \frac{F}{\sqrt{mk}}$

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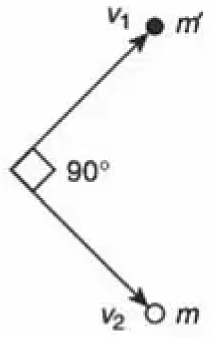
5. **Answer: b**

Explanation:

In figure (i) before collision, m' is mass of unknown particle; m is mass of proton; v_i is initial velocity.

(i) Before collision

Now, in figure (ii), v_1 is final velocity of unknown particle and v_2 is final velocity of proton.



(ii) After collision

By conservation of momentum, we have

Momentum before collision = Momentum after collision

Consider x -component, we have

$mv_1 + m'.0 = m'v_1 \cos 45^\circ + mv_2 \cos 45^\circ$

$mv_i = \frac{1}{\sqrt{2}}(m'v_1 + mv_2)$

Consider y -component, we have

$0 = m'v_1 \sin 45^\circ - mv_2 \sin 45^\circ$

$\frac{1}{\sqrt{2}}(m'v_i - mv_2) = 0$

$\Rightarrow m'v_1 = mv_2$

Substitute E (2) in E (1), we get

$mv_i = \frac{1}{\sqrt{2}}(mv_2 + mv_2) = \sqrt{2}mv_2$

$\Rightarrow v_i = \sqrt{2}v_2$

Using Eqs. (2) and (3) in (1), we get

$mv_i = \frac{1}{\sqrt{2}}(mv_2 + mv_2) = \sqrt{2}mv_2$

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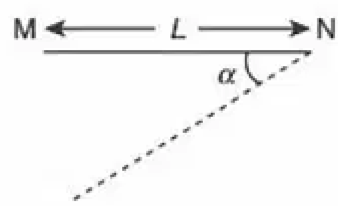
6. Answer: a

Explanation:

When the end M is released and rod makes angle α with horizontal, the displacement of centre of mass is $\frac{L}{2}\sin\alpha$. Now,
we know $mg\frac{L}{2}\sin\alpha = \frac{1}{2}I\omega^2$
Here, $I = \frac{mL^2}{3}$; therefore,
$mg\frac{L}{2}\sin\alpha = \frac{1}{2}\frac{mL^2}{3}\omega^2$
$\Rightarrow \omega^2 = \frac{3g\sin\alpha}{L}$
$\Rightarrow \omega = \sqrt{\frac{3g\sin\alpha}{L}}$
$\Rightarrow \omega \propto \sqrt{\sin\alpha}$



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7. **Answer: a**

Explanation:

Velocity of the body is given by

$v = a\sqrt{s}$

Differentiating w.r.t. t, we get

Acceleration, $a' = \frac{dv}{dt} = a\frac{1}{2}s^{-1/2} \cdot \frac{ds}{dt} = a\frac{1}{2\sqrt{s}} \cdot v \Rightarrow a' = \frac{a}{2\sqrt{s}} \cdot a\sqrt{s} = \frac{a^2}{2}$

Force on the body is $F = ma' = \frac{ma^2}{2}$

Distance covered by the body is given by

$s = ut + \frac{1}{2}a't^2$

$\Rightarrow s = \frac{1}{2} \cdot \frac{a^2}{2}t^2$

Work done =Force $\times$ Distance $= \frac{ma^2}{2} \cdot \frac{1}{2}\frac{a^2}{2}t^2 = \frac{1}{8}ma^4t^2$

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8. **Answer: a**

Explanation:

The correct option is(A): $M\,n^2R^2t$

$\frac{V^2}{R} = n^2\,Rt^2$
$\Rightarrow V^2 = n^2\,R^2\,t^2$
$\Rightarrow V = nRt$
$\Rightarrow \frac{dV}{dt} = nR$
$P = F_tV$
$= \frac{mdV}{dt}V$
$= mnR.nRt$
$P = n^2\,R^2\,t\,m$

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9. **Answer: 40 - 40**

Explanation:

$W = \vec{F}.(\vec{r_f} - \vec{r_i})$

$= (5\hat{i} + 2\hat{j} + 7\hat{k}).((5\hat{i} - 2\hat{j} + \hat{k}) - (2\hat{i} + 2\hat{j} - 4\hat{k}))$

$W = 40J$

So, The correct answer is 40.

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10. Answer: 5 - 5

Explanation:

The correct answer is 5.

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