JEE Main 2021 | Work, Energy, Power

Question 1

(Only one correct answer) 2021

Given below is the plot of a potential energy function $U(x)$ for a system, in which a particle is in one dimensional motion, while a conservative force $F(x)$ acts on it. Suppose that

where $K.E.=$ kinetic energy

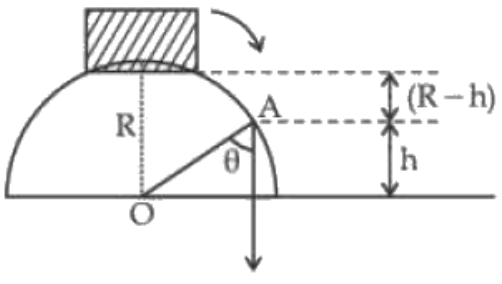
- (a) at $x = x_3,\ K.E. = 4$
- (b) at $x > x_4,\ K.E.$ is constant throughout the region.
- (c) at $x < x_1,\ K.E.$ is smallest and the particle is moving at the slowest speed.
- (d) at $x = x_2,\ K.E.$ is greatest and the particle is moving at the fastest speed.

Question 2

(Integer type question) 2021

A small block slides down from the top of hemisphere of radius $R = 3\ m$ as shown in the figure. The height $'h'$ at which the block will lose contact with the surface of the sphere is .....

Assume there is no friction between the block and the hemisphere



Question 3

(Integer type question) 2021

A uniform chain of length 3 meter and mass $3\ kg$ overhangs a smooth table with 2 meter laying on the table. If k is the kinetic energy of the chain in joule as it completely slips off the table, then the value of k is .....

Question 4

(Integer type question)

2021

Two persons A and B perform same amount of work in moving a body through a certain distance d with application of forces acting at angles 45° and 60° with the direction of displacement respectively. The ratio of force applied by person A to the force applied by person B is $\frac{1}{\sqrt{x}}$. The value of x is .....

Question 5

(Only one correct answer)

2021

A boy is rolling a $0.5\ kg$ ball on the frictionless floor with the speed of $20\ ms^{-1}$. The ball gets deflected by an obstacle on the way. After deflection it moves with 5 % of its initial kinetic energy. What is the speed of the ball now ?

- (a) $4.47\ ms^{-1}$
- (b) $19.0\ ms^{-1}$
- (c) $1.00\ ms^{-1}$
- (d) $14.41\ ms^{-1}$

Question 6

(Integer type question)

2021

A ball of mass $4\ kg$, moving with a velocity of $10\ ms^{-1}$, collides with a spring of length $8\ m$ and force constant $10\ Nm^{-1}$. The length of the compressed spring is $x\ m$. The value of x, to the nearest integer, is .....

Question 7

(Integer type question)

2021

A pendulum bob has a speed of $3\ m/s$ at its lowest position. The pendulum is $50\ cm$ long. The speed of bob, when the length makes an angle of 60° to the vertical will be $(g = 10\ m/s^2)$ ..... m/s.

Question 8

(Integer type question)

2021

A force of $F = (5y + 20)\ \hat{j}\ N$ acts on a particle. The work done by this force when the particle is moved from $y = 0\ m$ to $y = 10\ m$ is .....

Question 9

(Only one correct answer)

2021

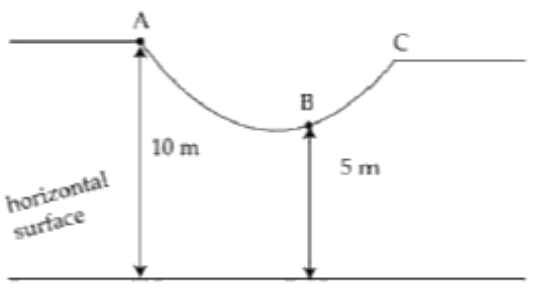
An automobile of mass $'m'$ accelerates starting from origin and initially at rest, while the engine supplies constant power P. The position is given as a function of time by :

- (a) $\left(\frac{8P}{9m}\right)^{1/2} t^{3/2}$
- (b) $\left(\frac{9P}{8m}\right)^{1/2} t^{3/2}$
- (c) $\left(\frac{9m}{8P}\right)^{1/2} t^{3/2}$
- (d) $\left(\frac{8P}{9m}\right)^{1/2} t^{2/3}$

Question 10

(Integer type question) 2021

As shown in the figure, a particle of mass $10\ kg$ is placed at a point A. When the particle is slightly displaced to its right, it starts moving and reaches the point B. The speed of the particle at B is $x\ m/s$. (Take $g = 10\ m/s^2$). The value of $'x'$ to the nearest integer is ..... .



Question 11

(Only one correct answer) 2021

A body at rest is moved along a horizontal straight line by a machine delivering a constant power. The distance moved by the body in time $'t'$ is proportional to :

- (a) $t^{\frac{1}{2}}$
- (b) $t^{\frac{1}{4}}$
- (c) $t^{\frac{3}{2}}$
- (d) $t^{\frac{3}{4}}$

Question 12

(Only one correct answer) 2021

A constant power delivering machine has towed a box, which was initially at rest, along a horizontal straight line. The distance moved by the box in time $'t'$ is proportional to :

- (a) t

- (b) $t^{2/3}$
- (c) $t^{3/2}$
- (d) $t^{1/2}$

Answer 1

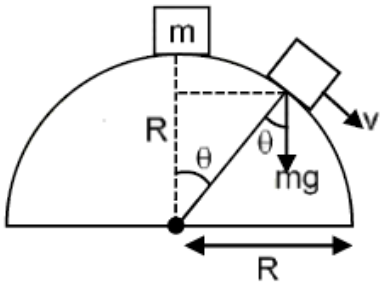
Correct answers is C

Solution:

$K.E. + U =$ Total energy $=$ constant

Answer 2

Solution:



From work energy theorem $W = \Delta K$

$Mg(R - R\cos\theta) = 1/2mv^2$

$v = \sqrt{2gR(1-\cos\theta)}$

To loose contact $\dfrac{mv^2}{R} = mg\cos\theta$

$2mg(1-\cos\theta) = mg\cos\theta$

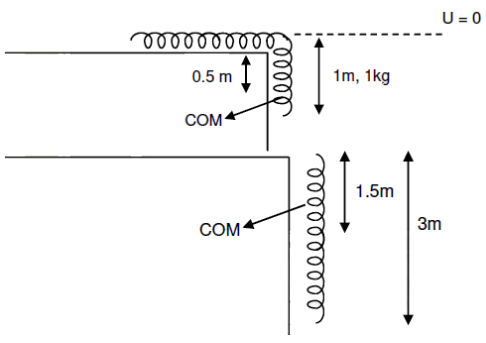
$2 - 2\cos\theta = \cos\theta$

$\cos\theta = \dfrac{2}{3} = \dfrac{h}{R} = \dfrac{h}{3}$

$\implies h = 2m$

Answer 3

Solution:



Apply conservation of energy $U_i + K_i = U_f + K_f$

$-1 \times 10 \times \left(\dfrac{1}{2}\right) + 0 = -3 \times 10 \times 1.5 + K.E.$

$K.E. = 45 - 5 = 40\ J$

Answer 4

Solution:

$w_1 = w_2$

$F_1 s\cos 45^\circ = F_2 s\cos 60^\circ$

$$\frac{F_1}{F_2} = \frac{1}{\sqrt{2}}$$
$$x = 2$$

Answer 5

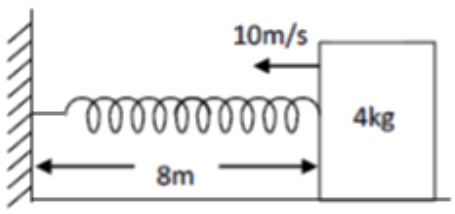
Correct answers is A

Solution:

$$kE_{\text{final}} = \eta\frac{1}{2}mv^2 = \frac{5}{100} \times \frac{1}{2}m(20)^2$$
$$\frac{1}{2}mv_{\text{final}}^2 = \frac{5}{100} \times \frac{1}{2}m(20)^2$$
$$v_{\text{final}} = \sqrt{20} = 2\sqrt{5} = 4.47\ m/s$$

Answer 6

Solution:



$$\frac{1}{2}kx^2 = \frac{1}{2}mv^2$$
$$100 \times x^2 = 4 \times 10^2$$
$$x = 2\ m \quad \text{compression in spring}$$

Length of spring will be $6\ m$

Answer 7

Solution:

$$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mgl(1 - \cos 60^\circ)$$
$$u^2 = v^2 + 2gl(1 - \cos 60^\circ)$$
$$9 = v^2 + 20 \times 1/2 \times 1/2$$
$$9 = v^2 + 5$$
$$v = 2\ m/s$$

Answer 8

Solution:

$$W = \int F.dy$$
$$W = \int_0^{10}(5y + 20)dy = \left[\frac{5y^2}{2} + 20y\right]_0^{10}$$
$$\implies = \frac{5 \times 100}{2} + 200 = 450\ J$$

Answer 9

Correct answers is A

Solution:

Energy supply $= Pt$ in $t\ sec$

$$Pt = \frac{1}{2}mV^2$$

$$V = \sqrt{\frac{2pt}{m}}$$

$$\frac{dS}{dt} = \sqrt{\frac{2P}{m}}\sqrt{t}$$

$$\int_0^S dS = \sqrt{\frac{2P}{m}}\int_0^t t^{1/2}dr$$

$$S = \frac{2\sqrt{\frac{2P}{m}}t^{3/2}}{3}$$

$$t^{3/2} = \frac{3S}{2\sqrt{\frac{2P}{m}}}$$

$$S = \left(\frac{8P}{9m}\right)^{1/2}t^{3/2}$$

Answer 10

Solution:

Apply conservation of energy

$$(K.E.)_A + (P.E.)_A = (K.E.)_B + (P.E.)_B$$

$$0 + mg(10) = \frac{1}{2}mV^2 + mg(5)$$

$$V^2 = 2 \times 10 \times 5$$

$$V = 10\ m/s$$

Answer 11

Correct answers is C

Solution:

Energy supply $= Pt$

in $t\ sec$

$$Pt = \frac{1}{2}mV^2;$$

$$V \propto \sqrt{t};$$

$$\frac{dS}{dt} = C\sqrt{t}$$

$$\int_0^S dS = C\int_0^t t^{1/2}dt$$

$$\implies S = \frac{2Ct^{3/2}}{3}$$

$$S \propto t^{3/2}$$

Answer 12

Correct answers is C

Solution:

$$P = (ma)V = mV\frac{dV}{dx} \times \frac{dx}{dt}$$

$$\int \frac{P}{m}dt = \int VdV$$

$$\frac{V^2}{2} = \frac{P}{m}t$$

$$\left(\frac{dx}{dt}\right) = \sqrt{\frac{2P}{m}t}$$

$$\int dx = \int \sqrt{\frac{2P}{m}}t^{1/2}dt$$

$$x = \frac{2}{3}\sqrt{\frac{2P}{m}}t^{3/2}\ ; \quad x \propto t^{3/2}$$