Work, Energy and Power

Question1

If a position dependent force $(3x^2 - 2x + 7)\mathrm{N}$ acting on a body of mass 2 kg displaces it from $x = 0\ \mathrm{m}$ to $x = 5\ \mathrm{m}$, then the work done by the force is

AP EAPCET 2025 - 26th May Morning Shift

Options:

A.

165 J

B.

115 J

C.

150 J

D.

135 J

Answer: D

Solution:

$$
\begin{aligned}
W &= \int_0^5 F dx \\
&= \int_0^5 \left(3x^2 - 2x + 7\right) dx \\
&= \left[3 \cdot \frac{x^3}{3} - \frac{2x^2}{2} + 7x\right]_0^5 \\
&= \left[x^3 - x^2 + 7x\right]_0^5 \\
&= \left[5^3 - 5^2 + 7 \times 5 - 0 + 0 - 0\right] \\
&= 135 \text{ J}
\end{aligned}
$$

Question2

If a constant force of $(2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 4\hat{\mathbf{k}})\text{N}$ acting on a body of mass 5 kg displaces it from $(3\hat{\mathbf{i}} - 4\hat{\mathbf{k}})\text{m}$ to $(2\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + 3\hat{\mathbf{k}})$ m , then the work done by the force on the body is

AP EAPCET 2025 - 26th May Evening Shift

Options:

A.

32 J

B.

28 J

C.

36 J

D.

44 J

Answer: A

Solution:

$$
\begin{aligned}
W &= F \cdot s \\
&= (2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 4\hat{\mathbf{k}}) \\
&\quad \cdot [(2-3)\hat{\mathbf{i}} + (2-0)\hat{\mathbf{j}} + (3+4)\hat{\mathbf{k}}] \\
&= (2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 4\hat{\mathbf{k}}) \cdot [-\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + 7\hat{\mathbf{k}}] \\
&= -2 + 6 + 28 = 32 \text{ J}
\end{aligned}
$$

Question3

A motor can pump 7560 kg of water per hour from a well of depth 100 m . If the efficiency of the pump is 70%, then power of the pump is

(Acceleration due to gravity $= 10 \text{ ms}^{-2}$)

AP EAPCET 2025 - 26th May Evening Shift

Options:

A.

4 kW

B.

6 kW

C.

3 kW

D.

7 kW

Answer: C

Solution:

$$
\begin{aligned}
\text{Power, } P &= \frac{W}{t} = \frac{mgh}{t} \\
&= \frac{7560 \times 10 \times 100}{60 \times 60} = 2100 \text{ W}
\end{aligned}
$$

Since, $\eta = 0.7$

$$\Rightarrow \frac{P_{\text{out}}}{P_{\text{in}}} = 0.7$$

$$\Rightarrow \quad P_i = \frac{P_{\text{out}}}{0.7} = \frac{2100}{0.7}$$
$$= 3000 \text{ W} = 3 \text{ kW}$$

Question4

If the potential energy of a particle of mass 0.1 kg moving along X-axis is $5x(x-4)$J, then the speed of the particle is maximum at a position of

AP EAPCET 2025 - 26th May Evening Shift

Options:

A.

$x = 2 \text{ m}$

B.

$x = 3 \text{ m}$

C.

$x = 0.5 \text{ m}$

D.

$x = 5 \text{ m}$

Answer: A

Solution:

$$U = 5x(x-4) = 5x^2 - 20x$$
$$\frac{dU}{dx} = 10x - 20$$

U may be maximum or minimum if

$\frac{dU}{dx} = 0$
$10x - 20 = 0$
$x = 2 \text{ m}$
$\frac{d^2u}{dx^2} = 10$

At $x = 2 \text{ m}, \frac{d^2U}{dx^2} = 10(+\text{ve})$

Thus, U is minimum at $x = 2 \text{ m}$.

According to conservation of energy, kinetic energy will be maximum at $x = 2 \text{ m}$.

Thus, speed of particle is maximum at $x = 2 \text{ m}$

Question5

If a force $\mathbf{F} = (3\hat{\mathbf{i}} - 2\hat{\mathbf{j}})\text{N}$ acting on a body displaces it from point $(1 \text{ m}, 2 \text{ m})$ to point $(2 \text{ m}, 0 \text{ m})$, then work done by the force is

AP EAPCET 2025 - 24th May Morning Shift

Options:

A.

5 J

B.

6 J

C.

4 J

D.

7 J

Answer: D

Solution:

Displacement vector of body is

$$\begin{aligned}\mathbf{S} &= (x_2 - x_1)\hat{\mathbf{i}} + (y_2 - y_1)\hat{\mathbf{j}} \\ &= (2-1)\hat{\mathbf{i}} + (0-2)\hat{\mathbf{j}} \\ &= 1\hat{\mathbf{i}} - 2\hat{\mathbf{j}}\ \mathrm{m}\end{aligned}$$

Force on body

$$\mathbf{F} = (3\hat{\mathbf{i}} - 2\hat{\mathbf{j}})\mathrm{N}$$

Work done, $W = \mathbf{F} \cdot \mathbf{S}$

$$\begin{aligned}&= (3\hat{\mathbf{i}} - 2\hat{\mathbf{j}}) \cdot ((\hat{\mathbf{i}} - 2\hat{\mathbf{j}}) \\ &= 3 + 4 = 7\ \mathrm{N} \cdot\ \mathrm{m} \\ &= 7\ \mathrm{J}\end{aligned}$$

Question6

If a force of $\left(6x^2 - 4x\right)\mathrm{N}$ acts on a body of mass 10 kg , then work to be done by the force in displacing the body from $x = 2\ \mathrm{m}$ to $x = 4\ \mathrm{m}$ is

AP EAPCET 2025 - 23rd May Evening Shift

Options:

A.

22 J

B.

44 J

C.

66 J

D.

88 J

Answer: D

Solution:

$$
\begin{aligned}
W &= \int_{x_1}^{x_2} f dx \\
&= \int_2^4 \left(6x^2 - 4x\right) dx \\
&= \left[\frac{6x^3}{3} - \frac{4x^2}{2}\right]_2^4 \\
&= \left[2x^3 - 2x^2\right]_2^4 \\
&= 2 \times 4^3 - 2 \times 4^2 - 2 \times 2^3 + 2 \times 2^2 \\
&= 128 - 32 - 16 + 8 \\
&= 88 \text{ J}
\end{aligned}
$$

Question7

A circular well of diameter 2 m has water upto the ground level. If the bottom of the well is at a depth of 14 m , the time taken in seconds to empty the well using a 1.4 kW motor is

(Acceleration due to gravity $= 10 \text{ ms}^{-2}$ **)**

AP EAPCET 2025 - 23rd May Evening Shift

Options:

A.

1860

B.

2200

C.

2660

D.

3300

Answer: B

Solution:

Step 1: Find the volume of water in the well

The well is a cylinder. Its diameter is 2 m, so its radius $r = 1$ m. Its depth (height) $h = 14$ m. The volume formula for a cylinder is $V = \pi r^2 h$. So, the volume of water is $V = \pi \times 1^2 \times 14 = 14\pi$ cubic meters.

Step 2: Find the mass of the water

The density (ρ) of water is 1000 kg/m³. So, mass (m) = volume × density = $14\pi \times 1000$ kg.

Step 3: Calculate work needed to lift all the water

The work to lift water from the bottom to the ground level is $W = mgh$, where $g = 10$ m/s² and h is the height (14 m). So,$W = (1000 \times 14\pi) \times 10 \times 7$

Step 4: Substitute values and calculate

$W = 1000 \times \frac{22}{7} \times 1^2 \times 14 \times 10 \times 7 = 3.08 \times 10^6$ J

Step 5: Use the power of the motor to find time

Power (P) is 1.4 kW, which is 1.4×10^3 W.

Time (t) = $\frac{W}{P} = \frac{3.08 \times 10^6}{1.4 \times 10^3}$.

$t = 22 \times 10^2$ s $= 2200$ s

Question8

A car of mass 2000 kg is accelerating from rest. If its engine is supplying constant power of 10 kW , then the velocity of the car at a time of 10 s is

AP EAPCET 2025 - 23rd May Morning Shift

Options:

A.

15 ms^{-1}

B.

20 ms^{-1}

C.

5 ms^{-1}

D.

10 ms^{-1}

Answer: D

Solution:

According to work energy theorem

$$W = \frac{1}{2} m v^2$$

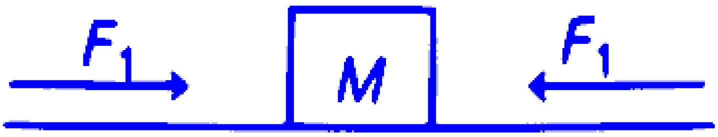
$$\therefore \quad P = \frac{W}{t}$$

$$P = \frac{1}{2} m v^2 / t \Rightarrow v = \sqrt{\frac{2Pt}{m}}$$

$$= \sqrt{\frac{2 \times 10 \times 10^3 \times 10}{2000}} = 10 \text{ m/s}$$

Question9

A body of mass ' M ' is moving with a uniform speed of ' V' on a frictionless horizontal surface under the influence of two forces F_1 and F_2 as shown in the figure. The net power of the system is



AP EAPCET 2025 - 23rd May Morning Shift

Options:

A.

$(F_1 - F_2)v$

B.

$0.5\,(F_1 + F_2)v$

C.

$(F_1 + F_2)v$

D.

zero

Answer: D

Solution:

The body moves at a steady speed, which means its speed does not change. This only happens if the total (net) force on the body is zero.

So, $F_1 - F_2 = 0$
which means $F_1 = F_2$

Work and Energy:

Because the body's speed is not changing, its kinetic energy also stays the same. The work-energy theorem tells us that the total work done on the body is equal to the change in its kinetic energy.

$W = \Delta E_k$
$W = 0$

Net Power:

Power is the work done divided by time. Since the total work (W) is zero, the net power is also zero:

$P = \frac{W}{t} = 0$

Question10

Two bodies A and B of masses 20 kg and 5 kg respectively are at rest. Due to the action of a force of 40 N separately, if the two bodies acquire equal kinetic energies in times t_A and t_B respectively, then $t_A : t_B =$

AP EAPCET 2025 - 22nd May Evening Shift

Options:

A.

1 : 2

B.

2 : 1

C.

2 : 5

D.

5 : 6

Answer: B

Solution:

Let's use the work-energy theorem, which says:

$$\begin{aligned} & K = W \\ \Rightarrow \quad & K = F \times s \quad \ldots (i) \end{aligned}$$

Here, K is kinetic energy, F is force, and s is distance.

When a force acts and the body starts from rest, the distance s covered in time t is:

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

Since acceleration $a = \frac{F}{m}$ (where m is mass), we get:

$s = \frac{1}{2} \times \frac{F}{m} \times t^2 \quad \ldots (ii)$

Now, substitute s from (ii) into our equation (i):

$K = F \times \frac{1}{2} \times \frac{F}{m} \times t^2$

So, $K = \frac{F^2}{2m} t^2$

We are told both bodies A and B get the same kinetic energy ($K_A = K_B$) using the same force $F = 40$ N, but their masses and times are different.

Set up the equation for both bodies and compare:

$\frac{F^2}{2m_A} t_A^2 = \frac{F^2}{2m_B} t_B^2$

You can cancel out F^2 and $\frac{1}{2}$ because they are the same:

$\frac{t_A^2}{m_A} = \frac{t_B^2}{m_B}$

Rearrange to solve for time ratio:

$\frac{t_A^2}{t_B^2} = \frac{m_A}{m_B}$

Take the square root for the ratio $t_A : t_B$:

$\frac{t_A}{t_B} = \sqrt{\frac{m_A}{m_B}}$

Plug in $m_A = 20$ kg and $m_B = 5$ kg:

$\frac{t_A}{t_B} = \sqrt{\frac{20}{5}} = \sqrt{4} = 2$

So, the ratio $t_A : t_B = 2 : 1$.

Question11

A crane of efficiency 80% is used to lift 8000 kg of coal from a mine of depth 108 m . If the time taken by the crane to lift the coal is one hour, then the power of the crane (in kW) is

(Acceleration due to gravity $= 10 \text{ ms}^{-2}$)

AP EAPCET 2025 - 22nd May Evening Shift

Options:

A.

5

B.

4

C.

6

D.

3

Answer: D

Solution:

Potential energy gained by crane,

$$
\begin{aligned}
U &= mgh \\
&= 8000 \times 10 \times 108 \\
&= 8.64 \times 10^6 \text{ J}
\end{aligned}
$$

$\therefore$ Output power of crane

$$
P_0 = \frac{W}{t} = \frac{U}{t} = \frac{8.64 \times 10^6}{60 \times 60}
$$

$$
\Rightarrow \quad P_0 = 2.4 \times 10^3 \text{ W} = 2.4 \text{ kW}
$$

Since, efficiency of crane

$$
\eta = \frac{P_0}{P_i}
$$

$$
\Rightarrow \quad 0.8 = \frac{P_0}{P_i}
$$

$$
\Rightarrow \quad P_i = \frac{P_0}{0.8} = \frac{2.4}{0.8} \text{ kW} = 3 \text{ kW}
$$

Question12

A train of mass 10^6 kg is moving at a constant speed of 108 km/h. If the frictional force acting on it is 0.5 N per 100 kg , then the power of the train is

AP EAPCET 2025 - 22nd May Morning Shift

Options:

A.

300 kW

B.

150 kW

C.

75 kW

D.

225 kW

Answer: B

Solution:

$v = 108 \text{ km/h} = 108 \times \frac{5}{18} = 30 \text{ m/s}$

Total frictional force on the train

$f_s = \frac{10^6 \times 0.5}{100} = 5000 \text{ N}$

$\therefore$ Power of the train

$$P = f_s \cdot v = 5000 \times 30$$
$$= 150000 \text{ W} = 150 \text{ kW}$$

Question13

A body is moving along a straight line under the influence of a constant power source. If the relation between the displacement (s) of the body and time (t) is $s \propto t^x$, then $x =$

AP EAPCET 2025 - 22nd May Morning Shift

Options:

A.

1

B.

2

C.

$\frac{2}{3}$

D.

$\frac{3}{2}$

Answer: D

Solution:

Step 1: Write the equation for power

Power (P) is force (F) multiplied by velocity (v):

$$P = F \cdot v$$

Step 2: Replace force with mass and acceleration

Force is mass (m) times acceleration ($\frac{dv}{dt}$):

$$P = m\frac{dv}{dt} \cdot v$$

Step 3: Rearrange to separate variables

Move terms so you have all v terms on one side and t terms on the other:

$$v\frac{dv}{dt} = \frac{P}{m}$$

Step 4: Integrate both sides

Integrate with respect to v and t:

$$\int v\, dv = \frac{P}{m} \int dt$$

After integrating:

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

Step 5: Solve for velocity (v)

$$v = \sqrt{\frac{2Pt}{m}}$$

Step 6: Find the relationship between displacement and time

Velocity is the rate of change of displacement, so:

$$\frac{ds}{dt} = \sqrt{\frac{2Pt}{m}}$$

Step 7: Integrate to get displacement (s)

Integrate both sides with respect to t:

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

The right side integrates to $t^{3/2}$:

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

Step 8: Answer

The value of x is $\frac{3}{2}$.

Question14

A body is projected at an angle of 60° with the horizontal. If the initial kinetic energy of the body is X, then its kinetic energy at the highest point is

AP EAPCET 2025 - 22nd May Morning Shift

Options:

A.

X

B.

$2X$

C.

$\frac{X}{2}$

D.

$\frac{X}{4}$

Answer: D

Solution:

Initial kinetic energy

$$E_{k_1} = \frac{1}{2}mv^2$$
$$\Rightarrow \quad X = \frac{1}{2}mv^2$$

Kinetic energy at highest point

$$\begin{aligned} E_{k_2} &= \frac{1}{2}m(v\cos 60^{\circ})^2 \\ &= \frac{1}{2}mv^2\left(\frac{1}{2}\right)^2 = \frac{1}{4}\left(\frac{1}{2}mv^2\right) \\ &= \frac{1}{4}(X) \\ &= \frac{X}{4} \end{aligned}$$

Question15

The bob of a simple pendulum of length 200 cm is released from horizontal position. If 10% of its initial energy is lost due to air resistance, then the speed of bob at the mean position is

(Acceleration due to gravity $= 10 \text{ ms}^{-2}$)

AP EAPCET 2025 - 21st May Evening Shift

Options:

A.

6 ms^{-1}

B.

3 ms^{-1}

C.

12 ms^{-1}

D.

2 ms^{-1}

Answer: A

Solution:

Given Data

- Length of pendulum, $l = 200 \text{ cm} = 2 \text{ m}$
- Released from horizontal position → Initial height (relative to mean position) = $l = 2 \text{ m}$
- Acceleration due to gravity, $g = 10 \text{ m/s}^2$
- 10% of energy lost due to air resistance

Step 1: Initial Potential Energy

At horizontal position (bob just released):

$E_{\text{initial}} = mgh = mgl = m(10)(2) = 20m$ J

Step 2: Energy Lost in Air Resistance

10% of energy is lost → only 90% remains.

$E_{\text{mean}} = 0.9 \times E_{\text{initial}} = 0.9 \times 20m = 18m$ J

Step 3: Energy at Mean Position

At mean position, the bob has only kinetic energy (potential energy = 0):

$\frac{1}{2}mv^2 = 18m$

$v^2 = 36 \quad \Rightarrow \quad v = 6$ m/s

✅ **Final Answer:**

$\boxed{v = 6 \text{ m/s}}$

Correct Option: A) 6 m/s

Question16

The power required for an engine to maintain a constant speed of $50\ \text{ms}^{-1}$ for a train of mass 3×10^6 kg on rough rails is

(The coefficient of kinetic friction between the rails and wheels of the train is 0.05 and acceleration due to gravity $= 10\ \text{ms}^{-2}$)

AP EAPCET 2025 - 21st May Morning Shift

Options:

A.

75 MW

B.

40 MW

C.

75 kW

D.

65 MW

Answer: A

Solution:

Frictional force

$$\begin{aligned} f_s &= \mu m g \\ &= 0.05 \times 3 \times 10^6 \times 10 \\ &= 1.5 \times 10^6 \mathrm{~N} \end{aligned}$$

$\therefore$ Power, $P = f_s v$

$$\begin{aligned} &= 1.5 \times 10^6 \times 50 \\ &= 75 \times 10^6 \mathrm{~W} \\ &= 75 \mathrm{WM} \end{aligned}$$

Question17

The linear momentum of a body of mass 8 kg is $24 \mathrm{~kg} \mathrm{~ms}^{-1}$. If a constant force of 24 N acts on the body in the direction of motion of the body for a time of 3 s , then the increase in the kinetic energy of the body is

AP EAPCET 2025 - 21st May Morning Shift

Options:

A.

480 J

B.

540 J

C.

270 J

D.

240 J

Answer: B

Solution:

$p = mv = 24 \text{ kg m/s}$

$\therefore u = \frac{24}{m} = \frac{24}{8} = 3 \text{ m/s}$

Impulse, $J = F \cdot \Delta t$

$$= 24 \times 3 = 72 \text{Ns}$$
$$\therefore \quad J = \Delta p = 72 \text{Ns}$$

$\therefore$ Final momentum

$$\begin{aligned} p_f &= p_i + \Delta p = 24 + 72 \\ &= 96 \text{ kg m/s} \\ \therefore \quad v_f &= \frac{p_f}{m} = \frac{96}{8} = 12 \text{ m/s} \end{aligned}$$

Thus, increase in kinetic energy,

$$\begin{aligned} \Delta K &= K_f - K_i \\ &= \frac{1}{2} m v_f^2 - \frac{1}{2} m u^2 \\ &= \frac{1}{2} m \left(v_f^2 - u^2\right) \\ &= \frac{1}{2} \times 8 \left(12^2 - 3^2\right) \\ &= 4(135) = 540 \text{ J} \end{aligned}$$

Question18

A person holds a ball of mass 0.25 kg in his hand and throws it, so that it leaves his hand with a speed of 12 ms^{-1}. In this process, if his hand moved through a distance of 0.9 m , then the net force acted on the ball is

AP EAPCET 2025 - 21st May Morning Shift

Options:

A.

40 N

B.

20 N

C.

25 N

D.

10 N

Answer: B

Solution:

According to work energy theorem,

Work done, $W = \Delta K$

$$= K_f - K_i$$
$$= \frac{1}{2} \times 0.25 \times 12^2 - \frac{1}{2} \times 0.25 \times 0$$
$$= 18 \text{ J}$$

If F be the net force acted on the ball, then

$$W = F \cdot s$$
$$\Rightarrow \quad F = \frac{W}{s} = \frac{18}{0.9} = 20 \text{ N}$$

Question19

A particle of mass m at rest on a rough horizontal surface with a coefficient of friction μ is given a

velocity u. The average power imparted by friction before it stops

AP EAPCET 2024 - 23th May Morning Shift

Options:

A.

zero

B.

$\frac{1}{2}\mu mgu$

C.

μmgu

D.

2μMgv

Answer: B

Solution:

To determine the average power imparted by friction before the particle stops, consider the following:

Mass and Initial Conditions:

The particle has a mass m and is initially at rest before being given a velocity u.

The surface has a coefficient of friction μ.

Work Done by Friction:

The work done by friction W_f is accounted by the change in kinetic energy as the particle stops. This can be equated to the initial kinetic energy:

$W_f = \frac{1}{2}mu^2$

Acceleration Due to Friction:

The deceleration a due to friction is given by the frictional force divided by the mass:

$a = \frac{\mu mg}{m} = \mu g$

Time to Stop:

The time t taken for the particle to come to a rest can be calculated from the equation of motion $v = u + at$, setting final velocity $v = 0$:

$0 = u - at \quad \Rightarrow \quad t = \frac{u}{a} = \frac{u}{\mu g}$

Average Power:

The average power P imparted by the friction is the total work done over the time taken to stop:

$P = \frac{W_f}{t} = \frac{\frac{1}{2}mu^2}{\frac{u}{\mu g}} = \frac{1}{2}mu\mu g$

Thus, the average power imparted by friction before the particle stops is $\frac{1}{2}\mu mgu$.

Question20

A force of $(4\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + \hat{\mathbf{k}})\mathrm{N}$ is action on a particle of mass 2 kg displaces the particle from a position of $(2\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + \hat{\mathbf{k}})\ m$ to a position of $(4\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 2\hat{\mathbf{k}})\mathrm{m}$. The work done by the force on the particle in joules is

AP EAPCET 2024 - 22th May Evening Shift

Options:

A. 21 J

B. 11 J

C. 14 J

D. 18 J

Answer: B

Solution:

Given:

Force: $\mathbf{F} = (4\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + \hat{\mathbf{k}})\,\mathrm{N}$

Initial position: $\mathbf{r}_1 = (2\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + \hat{\mathbf{k}})\,\mathrm{m}$

Final position: $\mathbf{r}_2 = (4\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 2\hat{\mathbf{k}})\,\mathrm{m}$

Calculating Total Displacement:

The displacement $\mathbf{s}$ is given by the difference between the final and initial positions:

$$\begin{aligned} \mathbf{s} &= \mathbf{r}_2 - \mathbf{r}_1 \\ &= (4\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 2\hat{\mathbf{k}}) - (2\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + \hat{\mathbf{k}}) \\ &= (2\hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}}) \end{aligned}$$

Calculating Work Done:

The work done by the force is calculated using the dot product of the force vector and the displacement vector:

$$
\begin{aligned}
W &= \mathbf{F} \cdot \mathbf{s} \\
&= (4\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + \hat{\mathbf{k}}) \cdot (2\hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}}) \\
&= (4 \times 2) + (2 \times 1) + (1 \times 1) \\
&= 8 + 2 + 1 \\
&= 11 \mathrm{~J}
\end{aligned}
$$

Thus, the work done by the force on the particle is 11 Joules.

Question21

A body thrown vertically upwards from the ground reaches a maximum height H. The ratio of the velocities of the body at heights $\frac{3H}{4}$ and $\frac{8H}{9}$ from the ground is

AP EAPCET 2024 - 22th May Morning Shift

Options:

A. 4 : 9

B. 27 : 32

C. 3 : 2

D. 3 : 8

Answer: C

Solution:

When a body is thrown vertically upwards and reaches a maximum height H, we can analyze the situation using conservation of energy. The ratio of velocities at specified heights involves comparing kinetic and potential energies at those points:

Maximum Height H:

Potential Energy (PE) at the maximum height is given by:

$\mathrm{PE}_{\max} = mgH$

Height $\frac{3H}{4}$:

Potential Energy at this height:

$\mathrm{PE}_1 = mg\left(\frac{3H}{4}\right)$

Kinetic Energy (KE) at this height using energy conservation:

$$\mathrm{KE}_1 = \mathrm{PE}_{\max} - \mathrm{PE}_1 = mgH - mg\left(\frac{3H}{4}\right) = mg\left(\frac{H}{4}\right)$$

Height $\frac{8H}{9}$:

Potential Energy at this height:

$$\mathrm{PE}_2 = mg\left(\frac{8H}{9}\right)$$

Kinetic Energy at this height:

$$\mathrm{KE}_2 = \mathrm{PE}_{\max} - \mathrm{PE}_2 = mgH - mg\left(\frac{8H}{9}\right) = mg\left(\frac{H}{9}\right)$$

Velocities v_1 and v_2:

Velocity at $\frac{3H}{4}$:

$$v_1 = \sqrt{\frac{2\mathrm{KE}_1}{m}} = \sqrt{2g\left(\frac{H}{4}\right)}$$

Velocity at $\frac{8H}{9}$:

$$v_2 = \sqrt{\frac{2\mathrm{KE}_2}{m}} = \sqrt{2g\left(\frac{H}{9}\right)}$$

Ratio of Velocities:

The ratio of the velocities is:

$$\frac{v_1}{v_2} = \frac{\sqrt{2gH/4}}{\sqrt{2gH/9}} = \sqrt{\frac{9}{4}} = \frac{3}{2}$$

Thus, the ratio of the velocities of the body at the heights $\frac{3H}{4}$ and $\frac{8H}{9}$ is 3 : 2.

Question22

The average power generated by a 90 kg mountain climber who climbs a summit of height 600 m in 90 min is (Acceleration due to gravity $= 10\ \mathrm{ms}^{-2}$)

AP EAPCET 2024 - 22th May Morning Shift

Options:

A. 100 W

B. 25 W

C. 200 W

D. 50 Wv

Answer: A

Solution:

Given:

Mass (m): 90 kg

Acceleration due to gravity (g): 10 m/s²

Height climbed (h): 600 m

Time (t): 90 minutes = 90 × 60 = 5400 seconds

To find the average power generated by the climber, we first calculate the work done using the formula for work:

$$W = m \times g \times h$$

Substituting the given values:

$$W = 90 \times 10 \times 600 = 540,000 \text{ Joules (J)}$$

Next, the average power (P_{av}) can be calculated using the formula:

$$P_{\text{av}} = \frac{W}{t}$$

Substitute the known values:

$$P_{\text{av}} = \frac{540,000}{5400}$$

$$P_{\text{av}} = 100 \text{ Watts (W)}$$

Thus, the average power generated by the climber is 100 Watts.

Question23

A light body of momentum p_L and a heavy body of momentum p_H both have the same kinetic energy, then

AP EAPCET 2024 - 21th May Evening Shift

Options:

A. $p_L > p_H$

B. $p_H > p_L$

C. $p_L = p_H$

D. always $p_H = 2p_L$

Answer: B

Solution:

Given:

Light body momentum: p_L

Heavy body momentum: p_H

The kinetic energy for an object is given by:

$K = \frac{p^2}{2m}$

For the lighter body:

The kinetic energy K_L is:

$K_L = \frac{p_L^2}{2m_L}$

For the heavier body:

The kinetic energy K_H is:

$K_H = \frac{p_H^2}{2m_H}$

Since both bodies have the same kinetic energy:

$\frac{p_L^2}{2m_L} = \frac{p_H^2}{2m_H}$

From this equation, we can derive:

$p_H^2 = \frac{m_H}{m_L} p_L^2$

Given that the mass of the heavy body (m_H) is greater than that of the light body (m_L), the ratio $\frac{m_H}{m_L}$ is greater than one. Therefore, it follows that:

$p_H > p_L$

Question24

A machine with efficiency $\frac{2}{3}$ used 12 J of energy in lifting 2 kg block through certain height and it is allowed to fall through the same. The velocity while it reach the ground is

AP EAPCET 2024 - 21th May Evening Shift

Options:

A. $\sqrt{2}\ \mathrm{ms}^{-1}$

B. $2\ \mathrm{ms}^{-1}$

C. $2\sqrt{2}\ \mathrm{ms}^{-1}$

D. $0.2\ \mathrm{ms}^{-1}$

Answer: C

Solution:

To determine the velocity of a block when it reaches the ground, given a machine with an efficiency of $\frac{2}{3}$:

Calculate the Work Done:

Energy Used: 12 J

Efficiency: $\frac{2}{3}$

$\text{Work done} = \text{Efficiency} \times \text{Energy}$

$\text{Work done} = \frac{2}{3} \times 12 = 8\ \mathrm{J}$

Apply the Work-Energy Theorem:

Work Done: Equals the change in potential energy.

$W = mgh$

Given:

Mass $m = 2\,\mathrm{kg}$

Gravitational acceleration $g = 10\,\mathrm{m/s}^2$

$8 = 2 \times 10 \times h$

$h = \frac{8}{20}\ \mathrm{m} = 0.4\,\mathrm{m}$

Use Conservation of Energy:

The potential energy when the block is lifted is converted to kinetic energy when it falls.

$\frac{1}{2}mv^2 = mgh$

Solve for v :

$v = \sqrt{2gh}$

Substitute the values:

$v = \sqrt{2 \times 10 \times \frac{8}{20}}$

$v = \sqrt{2 \times 10 \times 0.4}$

$v = \sqrt{8}$

$v = 2\sqrt{2}\,\text{m/s}$

Thus, the velocity of the block when it reaches the ground is $2\sqrt{2}\,\text{m/s}$.

Question25

The upper $\left(\frac{1}{n}\right)$ th of an inclined plane is smooth and the remaining lower part is rough with coefficient of friction μ_k. If a body starting from rest at the top of the inclined plane will again come to rest at the bottom of the plane, then the angle of inclination of the inclined plane is

AP EAPCET 2024 - 21th May Morning Shift

Options:

A. $\sin^{-1}\left[\left(\frac{n}{n-1}\right)\mu_k\right]$

B. $\sin^{-1}\left[\left(\frac{n-1}{n}\right)\mu_k\right]$

C. $\tan^{-1}\left[\left(\frac{n}{n-1}\right)\mu_k\right]$

D. $\tan^{-1}\left[\frac{(n-1)\mu_k}{n}\right]$

Answer: D

Solution:

Let's consider an inclined plane with a total length of L, where the top $\frac{1}{n}$ of the plane is smooth, and the remaining lower part is rough with a coefficient of friction μ_k. A body starts from rest at the top and returns to rest at the bottom.

Length of the smooth part: $\frac{L}{n}$

Length of the rough part: $\frac{n-1}{n} \cdot L$

Angle of inclination: θ

Coefficient of friction: μ_k

Motion on the Smooth Part

The acceleration down the inclined plane due to gravity is $a = g\sin\theta$.

The distance traveled on this smooth part is:

$s_1 = \frac{L}{n}$

Using the kinematic equation for motion:

$v_1^2 = u^2 + 2as_1$

$v_1^2 = 0 + 2(g\sin\theta)\frac{L}{n} = \frac{2gL\sin\theta}{n}$

Motion on the Rough Part

The acceleration on this part is:

$a' = g\sin\theta - \mu_k g\cos\theta$

The distance traveled here is:

$s_2 = \frac{n-1}{n} \cdot L$

Final velocity at the end of this segment (v_2) is 0, and the initial velocity (u_2) is v_1.

Using the equation for this motion:

$v_2^2 = u_2^2 + 2a's_2$

$0 = v_1^2 + 2a's_2$

Substitute the expression for a':

$0 = \frac{2gL\sin\theta}{n} + 2(g\sin\theta - \mu_k g\cos\theta) \cdot \frac{n-1}{n} \cdot L$

Simplify to solve for θ:

$0 = 2gL\sin\theta + 2gL(n-1)(\sin\theta - \mu_k\cos\theta)$

$0 = \sin\theta + (n-1)(\sin\theta - \mu_k\cos\theta)$

$0 = n\sin\theta - (n-1)\mu_k\cos\theta$

$\Rightarrow n\sin\theta = (n-1)\mu_k\cos\theta$

$\Rightarrow \tan\theta = \frac{(n-1)\mu_k}{n}$

Thus, the angle of inclination θ is:

$\theta = \tan^{-1}\left[\frac{(n-1)\mu_k}{n}\right]$

Question26

A spring of spring constant $200 \mathrm{~N}-\mathrm{m}^{-1}$ is initially stretched by 10 cm from the unstretched position. The work to be done to stretch the spring further by another 10 cm is

AP EAPCET 2024 - 21th May Morning Shift

Options:

A. 3 J

B. 6 J

C. 9 J

D. 12 J

Answer: A

Solution:

Given the spring constant $k=200 \mathrm{~N} / \mathrm{m}$.

Initial stretch $x_1=10 \mathrm{~cm}=0.1 \mathrm{~m}$

Total (final) stretch $x_2=20 \mathrm{~cm}=0.2 \mathrm{~m}$

To find the work done to further stretch the spring by 10 cm, we use the formula for work done on a spring:

$W=U_2-U_1$

Where:

U_2 is the elastic potential energy at the final stretch

U_1 is the elastic potential energy at the initial stretch

The formula for elastic potential energy U stored in a spring is:

$U=\frac{1}{2} k x^2$

Substituting for W:

$W=\frac{1}{2} k x_2^2-\frac{1}{2} k x_1^2$

Plug in the values:

$W=\frac{1}{2} \times 200 \mathrm{~N} / \mathrm{m} \times\left[(0.2 \mathrm{~m})^2-(0.1 \mathrm{~m})^2\right]$

$W=100 \times(0.04-0.01)$

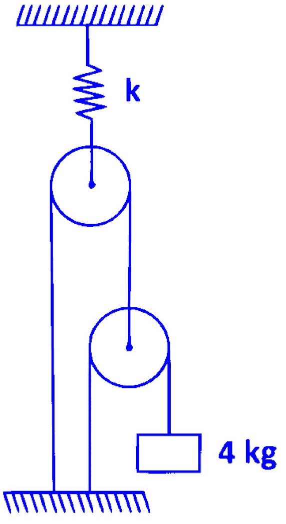
$W = 100 \times 0.03$

$W = 3 \text{ J}$

Therefore, the work done to stretch the spring an additional 10 cm is 3 J.

Question27

A 4 kg mass is suspended as shown in figure. All pulleys are frictionless and spring constant k is $8 \times 10^3 \text{Nm}^{-1}$. The extension in spring is $\left(g = 10 \text{ ms}^{-2}\right)$



AP EAPCET 2024 - 20th May Morning Shift

Options:

A. 2 mm

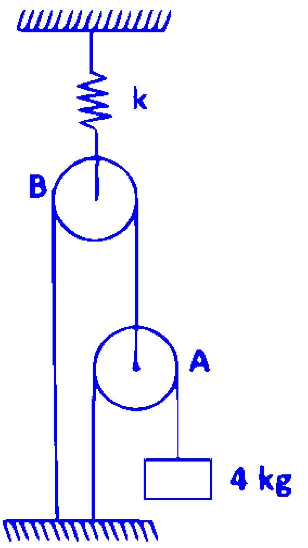
B. 2 cm

C. 4 cm

D. 4 mm

Answer: B

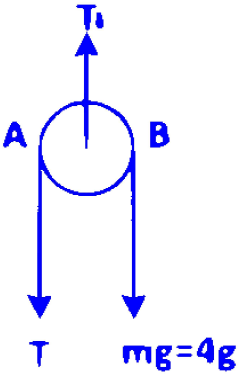
Solution:



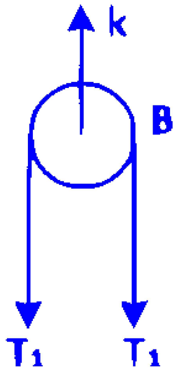
FBD of pulley A

So, $T = mg \Rightarrow T_1 = T + mg$

$T_1 = T + mg = 2mg$



FBD of pulley B



We get, $2T_1 = kx$

$2(2mg) = kx \Rightarrow x = \frac{4mg}{k}$

where x is the extension in the spring,

$$x = \frac{4 \times 4 \times 10}{8 \times 10^3}$$
$$= 2 \times 10^{-2} \text{ m} = 2 \text{ cm}$$

Question28

Two bodies A and B of masses $2m$ and m are projected vertically upwards from the ground with velocities u and $2u$ respectively. The ratio of the kinetic energy of body A and the potential energy of body B at height equal to half of the maximum height reached by body A is

AP EAPCET 2024 - 20th May Morning Shift

Options:

A. 8 : 1

B. 1 : 1

C. 4 : 1

D. 2 : 1

Answer: D

Solution:

Given two bodies, A and B, with masses and initial velocities as follows:

Mass of body A, $M_A = 2m$

Mass of body B, $M_B = m$

Initial velocity of A, $u_A = u$

Initial velocity of B, $u_B = 2u$

The maximum height H_A reached by body A can be calculated using the formula for maximum height in vertical motion:

$H_A = \frac{u_A^2}{2g} = \frac{u^2}{2g}$

The height h, which is half of the maximum height H_A reached by body A, is given by:

$h = \frac{H_A}{2} = \frac{\frac{u^2}{2g}}{2} = \frac{u^2}{4g}$

Using the conservation of energy principle, the velocity v_A of body A at height h is determined as follows:

$$\frac{1}{2}M_A u_A^2 = \frac{1}{2}M_A v_A^2 + M_A gh$$
$$\Rightarrow \frac{1}{2}(2m)u^2 = \frac{1}{2}(2m)v_A^2 + (2m)g\left(\frac{u^2}{4g}\right)$$
$$\Rightarrow u^2 = v_A^2 + \frac{u^2}{2}$$
$$\Rightarrow v_A = \frac{u}{\sqrt{2}}$$

The kinetic energy K_A of body A at height h is:

$$K_A = \frac{1}{2}M_A v_A^2$$
$$= \frac{1}{2}(2m)\left(\frac{u}{\sqrt{2}}\right)^2$$
$$= \frac{1}{2}(2m)\left(\frac{u^2}{2}\right)$$
$$= \frac{mu^2}{2}$$

The potential energy P_B of body B at height h is:

$$P_B = M_B gh = mg\left(\frac{u^2}{4g}\right) = \frac{mu^2}{4}$$

Finally, the ratio of the kinetic energy of body A to the potential energy of body B is calculated as follows:

$$\text{Ratio} = \frac{K_A}{P_B}$$
$$= \frac{\frac{mu^2}{2}}{\frac{mu^2}{4}}$$
$$= \frac{2}{1}$$
$$K_A : P_B = 2 : 1$$

Question29

A force of $(6x^2 - 4x + 3)$N acts on a body of mass 0.75 kg and displaces it from $x = 2$ m to $x = 5$ m. The work done by the force is

AP EAPCET 2024 - 19th May Evening Shift

Options:

A. 201 J

B. 215 J

C. 229 J

D. 307 J

Answer: A

Solution:

To calculate the work done by the force, we use the formula for work done by a variable force:

$W = \int_{x_1}^{x_2} F \, dx$

Given that the force $F(x) = 6x^2 - 4x + 3$ and the displacement is from $x = 2 \, \text{m}$ to $x = 5 \, \text{m}$, the work done is:

$$\begin{aligned} W &= \int_2^5 (6x^2 - 4x + 3) \, dx \\ &= \left[\frac{6x^3}{3} - \frac{4x^2}{2} + 3x\right]_2^5 \\ &= \left[2x^3 - 2x^2 + 3x\right]_2^5 \\ &= \left[2 \times 5^3 - 2 \times 5^2 + 3 \times 5\right] - \left[2 \times 2^3 - 2 \times 2^2 + 3 \times 2\right] \\ &= (250 - 50 + 15) - (16 - 8 + 6) \\ &= 215 - 14 \\ &= 201 \text{ J} \end{aligned}$$

Thus, the work done by the force is 201 J.

Question30

A spring of $5 \times 10^3 \text{Nm}^{-1}$ spring constant is stretched initially by 10 cm from unstretched position. The work required to stretch it further by another 10 cm is

AP EAPCET 2024 - 18th May Morning Shift

Options:

A. $75 \text{ N} - \text{m}$

B. $50 \text{ N} - \text{m}$

C. $76 \text{ N} \cdot \text{ m}$

D. $82 \text{ N} - \text{m}$

Answer: A

Solution:

Given:

Spring constant, $k = 5 \times 10^3 \, \mathrm{N/m}$

Initially stretched position, $x_1 = 10 \, \mathrm{cm} = 0.1 \, \mathrm{m}$

Further stretched position, $x_2 = 20 \, \mathrm{cm} = 0.2 \, \mathrm{m}$

Work Done:

The work done to further stretch the spring from x_1 to x_2 is equal to the change in potential energy of the spring. This can be calculated using the formula:

Work done $= \frac{1}{2} k \left[(x_2)^2 - (x_1)^2\right]$

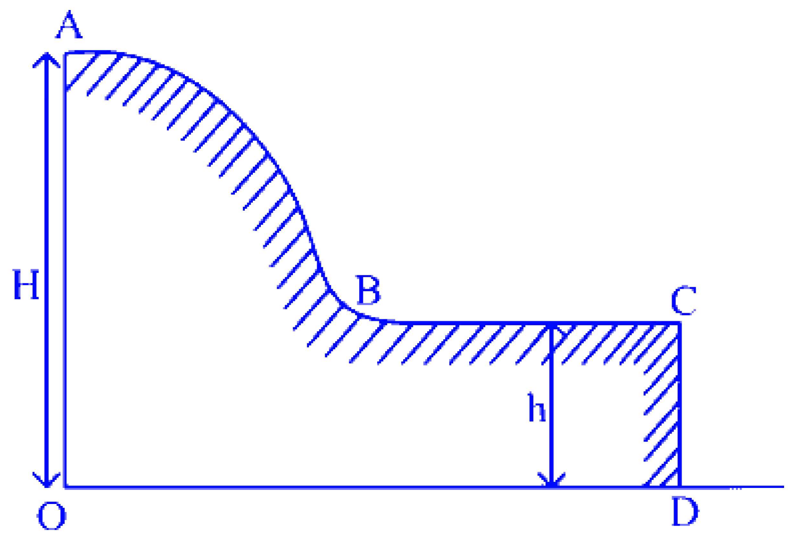
Substitute the given values:

$$
\begin{aligned}
& = \frac{1}{2} \times 5 \times 10^3 \left[(0.2)^2 - (0.1)^2\right] \\
& = \frac{1}{2} \times 5 \times 10^3 \times (0.04 - 0.01) \\
& = \frac{1}{2} \times 5 \times 10^3 \times 0.03 \\
& = 2.5 \times 10^3 \times 0.03 \\
& = 75 \, \mathrm{N} \cdot \mathrm{m}
\end{aligned}
$$

Therefore, the work required to stretch the spring further by another 10 cm is $75 \, \mathrm{N} \cdot \mathrm{m}$.

Question31

A small disc of mass m slides down with initial velocity zero from the top (A) of a smooth hill of height H having a horizontal portion (BC) as shown in the figure. If the height of the horizontal portion of the hill is h, then the maximum horizontal distance covered by the disc from the point D is



AP EAPCET 2022 - 5th July Morning Shift

Options:

A. $\frac{H}{2}$

B. $2H$

C. H

D. $3H$

Answer: C

Solution:

According to law of conservation of energy at point B shown in the figure given in question part, Loss in PE = Gain in KE

$\Rightarrow \quad mg(H-h)=\frac{1}{2}mv^2$

$\Rightarrow \quad v=\sqrt{2g(H-h)}$

Now, $\quad h=\frac{1}{2}gt^2 \Rightarrow t=\sqrt{\frac{2h}{g}}$

$\therefore$ Distance covered in horizontal portion,

$$s=v\times t$$

$$=\sqrt{2g(H-h)}\times\sqrt{\frac{2h}{g}}$$

$\Rightarrow \quad s=\sqrt{4h(H-h)} \quad$ ... (i)

For maximum value of s

$$\frac{ds}{dh} = 0$$

$$\Rightarrow \frac{1}{2\sqrt{4h(H-h)}} \times 4[(H-h)1 + h(-1)] = 0$$

$$\Rightarrow 2(H-2h) = 0 \Rightarrow H = 2h$$

$$\Rightarrow h = \frac{H}{2}$$

Substituting the value of h in Eq. (i), we get,

$$s = \sqrt{4\frac{H}{2}\left(H - \frac{H}{2}\right)}$$

$$= \sqrt{2H \cdot \frac{H}{2}} = H$$

Question32

A block of mass 50 kg is pulled with a constant speed of 4 ms^{-1} across a horizontal floor by an applied force of 500 N directed 30° above the horizontal. The rate at which the force does work on the block in watt is

AP EAPCET 2022 - 5th July Morning Shift

Options:

A. $\frac{2000}{\sqrt{3}}$

B. $500\sqrt{3}$

C. 1732

D. 1864

Answer: C

Solution:

Mass of block, $m = 50$ kg,

speed of block, $v = 4 \text{ ms}^{-1}$,

$F = 500$ N and $\theta = 30^\circ$,

The rate at which the force does work on the block is equal to power which is given as

$$\begin{aligned} P &= \text{ Force in the horizontal direction } \times \text{ velocity} \\ &= 500 \times \cos 30^\circ \times V \\ &= 500 \times \frac{\sqrt{3}}{2} \times 4 = 100\sqrt{3} \\ &= 100 \times 1.732 = 1732 \text{ W} \end{aligned}$$

Question33

A ball of mass 300 g is dropped from a height 10 m above a sandy ground. On reaching the ground, it penetrates through a distance 1.5 m in sand and finally stops. The average resistance offered by the sand to oppose the motion is (acceleration due to gravity $= 10 \text{ ms}^{-2}$)

AP EAPCET 2022 - 4th July Evening Shift

Options:

A. 35 N

B. 23 N

C. 34 N

D. 28 N

Answer: B

Solution:

Use **work–energy** during the whole motion (fall + penetration).

- Mass $m = 0.3 \text{ kg}, g = 10 \text{ m s}^{-2}$
- Total downward drop until it stops $= 10 + 1.5 = 11.5 \text{ m}$

Loss of gravitational PE $= mg(11.5) = 0.3 \times 10 \times 11.5 = 34.5 \text{ J}$

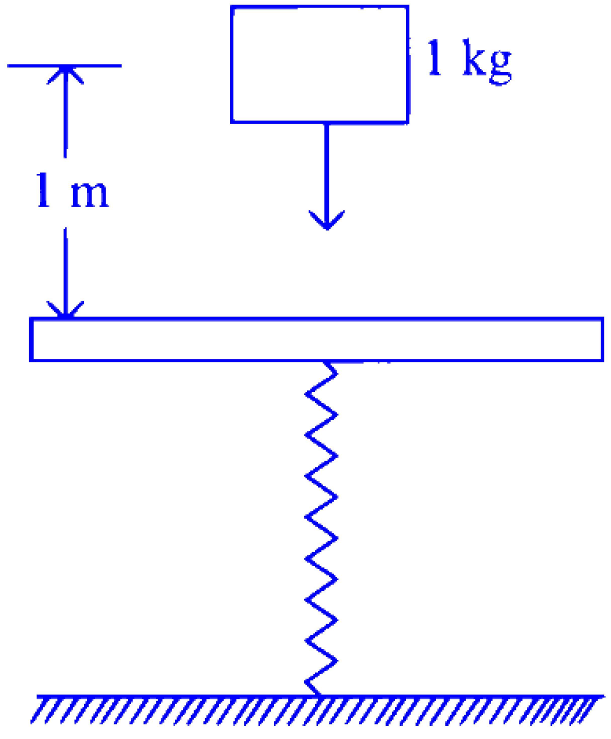
This energy is spent in doing work against the **average resistive force** R over 1.5 m:

$$R(1.5) = 34.5 \quad \Rightarrow \quad R = \frac{34.5}{1.5} = 23 \text{ N}$$

✅ Average resistance = 23 N (Option B)

Question34

A mass of 1 kg falls from a height of 1 m and lands on a massless platform supported by a spring having spring constant $15 \mathrm{~Nm}^{-1}$ as shown in the figure. The maximum compression of the spring is (acceleration due to gravity $= 10 \mathrm{~ms}^{-2}$)



AP EAPCET 2022 - 4th July Morning Shift

Options:

A. 2 m

B. $\sqrt{2}$ m

C. $\left(\frac{2}{\sqrt{3}}\right)$m

D. $\sqrt{3}$ m

Answer: A

Solution:

Given, height, $h = 1$ m

mass, $m = 1$ kg

spring constant, $k = 15\ \mathrm{Nm}^{-1}$

The kinetic energy of mass after falling on the platform will be converted into potential energy of the spring.

Thus, $mg(h + x) = \frac{1}{2}\mathrm{k}x^2$,

$$1 \times 10(1 + x) = \frac{1}{2} \times 15 \times x^2$$

$$\begin{aligned}
\Rightarrow \quad & 10 \times \frac{2}{15}(1 + x) = x^2 \\
\Rightarrow \quad & \frac{4}{3}(1 + x) = x^2 \\
\Rightarrow \quad & 4 + 4x = 3x^2 \\
\Rightarrow \quad & 3x^2 - 4x - 4 = 0 \\
\Rightarrow \quad & 3x^2 - 6x + 2x - 4 = 0 \\
\Rightarrow \quad & 3x(x - 2) + 2(x - 2) = 0 \\
\Rightarrow \quad & (x - 2) = 0 \\
\text{or} \quad & (3x + 2) = 0
\end{aligned}$$

$x = 2$ m or $x = \frac{-2}{3}$ m

Since, x is the compression, which cannot be negative, thus $x = 2$ m.

Question35

A bead of mass 400 g is moving along a straight line under a force that delivers a constant power 1.2 W to the bead. If the bead is initially at rest, the speed it attains after 6 s in ms^{-1}

AP EAPCET 2022 - 4th July Morning Shift

Options:

A. 5

B. 4

C. 6

D. 3

Answer: C

Solution:

Given, mass of bead, $m = 400 \text{ g} = 0.4 \text{ kg}$

Power delivered, $P = 1.2 \text{ W}$

Time, $t = 6 \text{ s}$

when the force is applied, it gives energy to the body. So from work energy theorem,

$$\begin{aligned} W &= \frac{1}{2}mv^2 - \frac{1}{2}mu^2 \\ &= \frac{1}{2}mv^2 \end{aligned}$$

Now, Power = Work/Time

$$\begin{aligned} & P = W/t \\ \Rightarrow \quad & P \times t = W \\ \Rightarrow \quad & 1.2 \times 6 = \frac{1}{2} \times mv^2 \\ \Rightarrow \quad & 7.2 = \frac{0.4}{2} \times v^2 \end{aligned}$$

$$\begin{aligned} \Rightarrow \quad & v^2 = 36 \\ \Rightarrow \quad & v = 6 \text{ ms}^{-1} \end{aligned}$$

Question36

An engine develops 20 kW of power. Howmuch time will it take to lift a mass of 200 kgto a height of 40 m? (g = 10 ms^{-2})

AP EAPCET 2021 - 20th August Evening Shift

Options:

A. 4 s

B. 5 s

C. 8 s

D. 10 s

Answer: A

Solution:

Given, power developed by engine, $P = 20$ kW

Mass, $m = 200$ kg

Height, $H = 40$ m

Acceleration due to gravity, $g = 10 \text{ ms}^{-1}$

$$\text{Since, } \begin{aligned} P &= \frac{\text{energy}}{\text{time}} = \frac{mgh}{t} \\ t &= \frac{mgh}{P} = \frac{200 \times 10 \times 40}{20000} = 4 \text{ s} \end{aligned}$$

Question37

Two bodies having kinetic energy in the ratio4 : 1, are moving with same linear velocity.The ratio of their masses is

AP EAPCET 2021 - 20th August Evening Shift

Options:

A. 1 : 2

B. 1 : 1

C. 4 : 1

D. 1 : 4

Answer: C

Solution:

Given, ratio of kinetic energies $E_1 : E_2 = 4 : 1$

Ratio of linear velocity, $v_1 : v_2 = 1 : 1$

Let ratio of masses be $m_1 : m_2$

As we know that,

$$E = \frac{p^2}{2m}$$
$$\therefore \quad \frac{E_1}{E_2} = \left(\frac{p_1}{p_2}\right)^2 \left(\frac{2m_2}{2m_1}\right) = \left(\frac{m_1 v_1}{m_2 v_2}\right)^2 \left(\frac{m_2}{m_1}\right)$$
$$= \frac{m_1^2}{m_2^2} \times \frac{m_2}{m_1} = \frac{m_1}{m_2} = \frac{4}{1}$$
$$\Rightarrow m_1 : m_2 = 4 : 1$$

Question38

Water is falling on the blades of a turbine from a height of $25 \mathrm{~m}$ and $3 \times 10^3 \mathrm{~kg}$ of water pours on the blade per minute. If the whole of energy is transferred to the turbine, then power delivered is

AP EAPCET 2021 - 20th August Evening Shift

Options:

A. 12500 W

B. 16250 W

C. 8250 W

D. 20250 W

Answer: A

Solution:

Given, height through which water falls $H = 25 \mathrm{~m}$

Mass of water, $m = 3 \times 10^3 \mathrm{~kg}$

Time, $t = 60 \mathrm{~s}$

Let power be P.

As we know that,

$$
\begin{aligned}
& P=\frac{\text{Energy }(E)}{\text{Time}(t)} \\
\Rightarrow \quad & P=\frac{m g H}{t} \\
& =\frac{3 \times 10^3 \times 10 \times 25}{60}=12500 \text{ W}
\end{aligned}
$$

Question39

The range of a projectile is 100 m. Its kineticenergy will be maximum after covering adistance of

AP EAPCET 2021 - 20th August Morning Shift

Options:

A. 25 m

B. 50 m

C. 75 m

D. 100 m

Answer: D

Solution:

Given, range of projectile, $R=100$ m

Let initial and final velocities be u and v and angle of projection be θ.

As we know that,

In case of projectile motion, the final velocity of body always less than that of initial velocity of projection $(v<u)$ and kinetic energy $(\mathrm{KE})=\frac{1}{2} m v^2$ where, m is mass and v is velocity.

$\therefore$ Kinetic energy will be again maximum, when it will be again on ground at 100 m from point of projection.

Question40

When a force $F = 17 - 2x + 6x^2$ N acts on a body of mass 2 kg and displaces it from x = 0 m to x = 8 m, the work done is

AP EAPCET 2021 - 20th August Morning Shift

Options:

A. 1096 J

B. 270 J

C. 35 J

D. 135 J

Answer: A

Solution:

Given,

Force on body, $\mathbf{F} = 17 - 2x + 6x^2$

Mass of body, $m = 2$ kg

Initial position, $x_i = 0$ m

Final position, $x_f = 8$ m

Since,

$$\text{work, } \int dW = \int \mathbf{F} \cdot \mathbf{dx}$$
$$= \int (17 - 2x + 6x^2) dx$$
$$\Rightarrow \quad W = 17x - \frac{2x^2}{2} + \frac{6x^3}{3} \Big|_0^8$$
$$= 17x - x^2 + 2x^3 \Big|_0^8$$
$$= 17 \times 8 - 8^2 + 2 \times 8^3$$
$$= 1096 \text{ J}$$

Question41

A rifle bullet loses $\left(\frac{1}{25}\right)$th of its velocity in passing through a plank. The least number of such planks required just to stop the bullet is

AP EAPCET 2021 - 20th August Morning Shift

Options:

A. 5

B. 10

C. 11

D. 13

Answer: D

Solution:

Let initial velocity $= u$

$$\text{Final velocity after passing one plank } = u - \frac{u}{25} = \frac{24}{25}u$$

Number of planks $= N$

Final velocity of bullet, $v = 0 \text{ ms}^{-1}$

Acceleration of bullet $= a$

As we know that,

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

$$\therefore \quad a = \frac{v^2 - u^2}{2s} = \frac{\left(\frac{24}{25}u\right)^2 - u^2}{2s} = -\frac{49u^2}{625 \times 2s}$$

Again for 'N' number of planks,

$$0^2 - u^2 = 2\left(\frac{49u^2}{625 \times 2s}\right) \cdot Ns$$

$$\Rightarrow \quad N = \frac{625}{49} = 12.7 \approx 13$$

Question42

A uniform chain has a mass m and length l.It is held on a frictionless table withone-sixth of its length hanging over the edge.The work done in just pulling the hangingpart back on the table is

AP EAPCET 2021 - 20th August Morning Shift

Options:

A. $\frac{mgl}{72}$

B. $\frac{mgl}{36}$

C. $\frac{mgl}{12}$

D. $\frac{mgl}{6}$

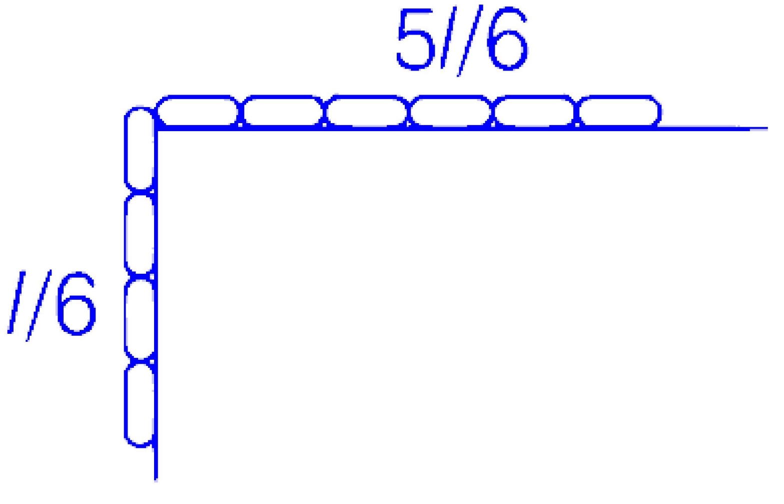
Answer: A

Solution:

Given,

Mass of chain = m

Length of chain = l



According to question,

Mass of chain hanging $= \frac{m}{6}$

Centre of mass of hanged part of chain,

$h=\frac{1}{2}\times\frac{l}{6}=\frac{l}{12}$

As we know that,

Work = mgh

where, g is acceleration due to gravity and h is height moved by chain.

$\therefore \quad W=\frac{m}{6}g\times\frac{l}{12}=\frac{mgl}{72}$

Question43

What is the shape of the graph betweenspeed and kinetic energy of a body?

AP EAPCET 2021 - 19th August Evening Shift

Options:

A. A straight line

B. A hyperbola

C. A parabola

D. Exponential

Answer: C

Solution:

As we know that,

$$\text{Kinetic energy (KE)}=\frac{1}{2}\times\text{mass}(M)\times[\text{ velocity }(v)]^2$$
$$\Rightarrow \quad \text{KE}\propto v^2$$

As, by equation of parabola, $y=mx^2+c$

Equation is $\text{KE}=\frac{1}{2}Mv^2+0$

$\therefore$ Graph will be a parabola.

Question44

A quarter horse power motor runs at a speedof 600 rpm. Assuming 60% efficiency, thework done by the motor in one rotation is

AP EAPCET 2021 - 19th August Evening Shift

Options:

A. 7.46 J

B. 74.6 J

C. 111.9 J

D. 11.19 J

Answer: D

Solution:

Given, power of motor,

$$\begin{aligned} P &= \frac{1}{4}\text{hp} \\ &= \frac{1}{4} \times 746 \text{ W} \end{aligned}$$

Angular speed of motor

$$\begin{aligned} \omega &= 600\text{rpm} \\ &= 600 \times \frac{2\pi}{60} = 20\pi \text{ rad s}^{-1} \end{aligned}$$

$\therefore$ Time for one rev $= \frac{60}{600} = 0.1$ s

Efficiency, $\eta = \frac{60}{100}$

$$\begin{aligned} \because \quad P &= \frac{W}{t} \\ \therefore W(\text{ in 1 rotation}) &= P \times t \\ &= \frac{746}{4} \times \frac{1}{10} = 18.65 \text{ J} \end{aligned}$$

Hence, work done by motor

$= \eta \times W = \frac{60}{100} \times 18.65$

$= 11.19$ J

Question45

A body of mass 8 kg, under the action of aforce, is displaced according to the equation, $s = \frac{t^2}{4}$ m, where t is the time. Find the work done by the force in the first 4 s.

AP EAPCET 2021 - 19th August Morning Shift

Options:

A. 9 J

B. 16 J

C. 6 J

D. 3 J

Answer: B

Solution:

Given, mass of body, $m = 8$ kg

Equation of displacement, $s = t^2/4$

Time, $t = 4$ s

As we know that,

$W = \mathbf{F} \cdot \mathbf{s}$

$= m\mathbf{a} \cdot \mathbf{s}$ ...... (i)

where, W is work, F is force, **a** is acceleration and **s** is displacement.

Now, $a = \frac{d^2s}{dt^2} = \frac{d}{dt}\left(\frac{2t}{4}\right) = \frac{2}{4} = \frac{1}{2}\ \mathrm{ms}^{-2}$

and $s = \frac{4^2}{4} = \frac{16}{4} = 4$ m

Now, put the value of m, a and S in Eq. (i), we get

$W = 8 \times \frac{1}{2} \times 4 = 16 \text{ J}$
