Question1

A body of mass 0.25 kg travels along a straight line from $x = 0$ to $x = 2$ m with a speed $v = kx^{3/2}$ where $k = 2$ SI units. The work done by the net during this displacement is

KCET 2025

Options:

A. 8 J

B. 16 J

C. 32 J

D. 4 J

Answer: D

Solution:

To determine the work done by the net force during the displacement of the body, we need to evaluate the change in kinetic energy (ΔKE) as the object moves from $x = 0$ to $x = 2$ m.

The initial velocity u when $x = 0$ is zero because $v = kx^{3/2}$ and substituting $x = 0$ gives $v = 0$.

The final kinetic energy at $x = 2$ m can be found by calculating the velocity at this point:

$v = k \cdot (2)^{3/2}$

Given $k = 2$ SI units, the velocity at $x = 2$ is:

$v = 2 \cdot 2^{3/2}$

The change in kinetic energy is:

$\Delta\text{KE} = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

Substituting $m = 0.25\,\text{kg}$ and $u = 0$:

$\Delta\text{KE} = \frac{1}{2} \times 0.25 \times (2 \times 2^{3/2})^2 - 0$

Calculate $(2 \times 2^{3/2})^2$:

$= (2^1 \times (2^{3/2}))^2 = 2^2 \times (2^3) = 2^5 = 32$

So the change in kinetic energy is:

$\Delta\text{KE} = \frac{1}{2} \times 0.25 \times 32$
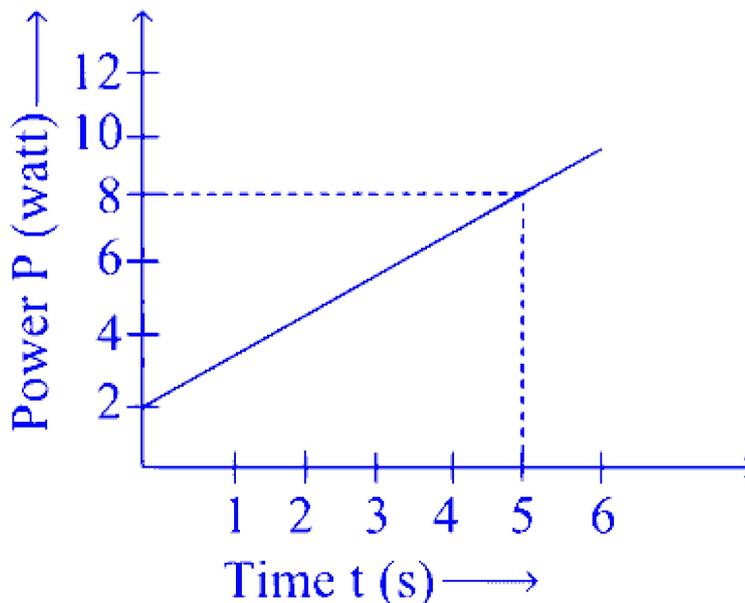
Finally, solving gives:

$= 4\,\text{J}$

Hence, the work done by the net force during the displacement is 4 Joules.

Question2

A particle of mass 500 g is at rest. It is free to move along a straight line. The power delivered to the particle varies with time according to the following graph

The momentum of the particle at $t = 5$ s is
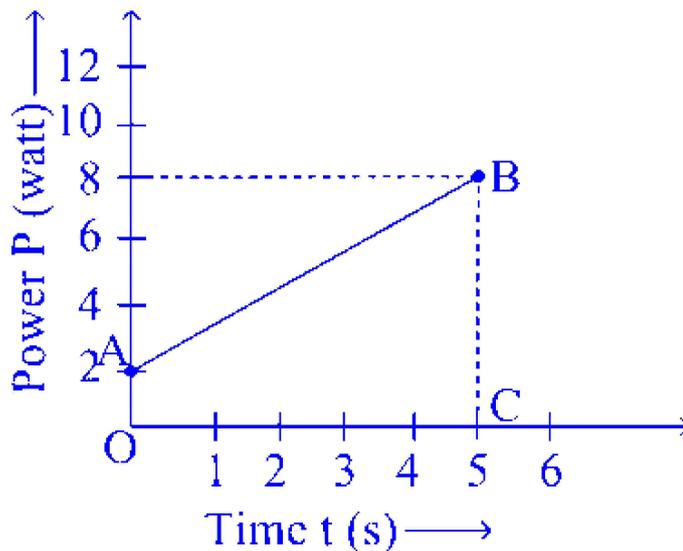
KCET 2024

Options:

A. $2\sqrt{5}$ N – s

B. $5\sqrt{2}$ N – s

C. 5 N – s

D. 5.5 N – s

Answer: C

Solution:

Area under P - t graph is equal to work done (or change in kinetic energy)

$\therefore \quad \Delta k = \frac{P^2}{2m} =$ area of region $OABC$

$\Rightarrow \quad \frac{P^2}{2m} = \frac{(2+8)5}{2}$

$\Rightarrow \quad \frac{P^2}{2\times 0.5} = 25 \quad [\because m = 500 \text{ g} = 0.5 \text{ kg}]$

$\Rightarrow \quad P^2 = 25 \Rightarrow P = 5 \text{ kg ms}^{-1}$

Question3

A ball of mass 0.2 kg is thrown vertically down from a height of 10 m. It collides with the floor and loses 50% of its energy and then rises back to the same height. The value of its initial velocity is

KCET 2023

Options:

A. Zero

B. 14 ms^{-1}

C. 196 ms^{-1}

D. 20 ms^{-1}

Answer: B

Solution:

Given, mass of the ball, $m = 0.2$ kg

Height from the surface of floor, $h = 10$ m

Let initial velocity be u.

Total energy as initial point TE $= \frac{1}{2}mv^2 + mgh$

After collision, remaining energy

$$= \frac{\frac{1}{2}mu^2 + mgh}{2}$$

With this remaining energy the ball bounces upto height h

Therefore, $\frac{\frac{1}{2}mu^2 + mgh}{2} = mgh$

$$\Rightarrow \frac{1}{2}mu^2 + mgh = 2mgh$$
$$\Rightarrow u^2 = \sqrt{2gh}$$
$$= \sqrt{2 \times 10 \times 10} = 14 \text{ m/s}$$

Question4

A smooth chain of length 2 m is kept on a table such that its length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. The work done in pulling the entire chain on the table is (Take, $g = 10 \text{ m/s}^2$)

KCET 2022

Options:

A. 6.3 J

B. 3.6 J

C. 2.0 J

D. 12.9 J

Answer: B

Solution:

Mass per unit length of chain,

$\frac{M}{L} = \frac{4}{2} = 2 \text{ kg/m}$

Work done in pulling the chain of small length dx,

$dW = $ mass of length $dx \times g \times x$

$= \frac{M}{L} \times dx \times g \times x$

$= 2 \times dx \times 10 \times x = 20x \, dx$

Work done, $W = \int_0^{0.6} dW \, dx = \int_0^{0.6} 20x \, dx$

$= \left[20 \frac{x^2}{2} \right]_0^{0.6} = \left[10x^2 \right]_0^{0.6} = 10 \times (0.6)^2 = 3.6 \text{ J}$

Question5

A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to

KCET 2020

Options:

A. $t^{1/2}$

B. t

C. $t^{3/2}$

D. t^2

Answer: B

Solution:

Let in time t, the body will acquire a velocity of v from rest.

As, power (P) = rate of doing work = $\frac{dW}{dt}$

$= \mathbf{F} \cdot \frac{d\mathbf{x}}{dt} = \mathbf{F} \cdot \mathbf{v}$

For motion in one dimension,

$P = Fv \cos 0° = Fv \quad .... (i)$

From first equation of motion,

$v = u + at$
$v = at \quad .... (ii) \quad (\because u = 0)$

From Eqs. (i) and (ii), we get

$P = F \times at = ma \times at \quad (\because F = ma)$
$\quad = ma^2 t$

As ma^2 is constant.

So, $\quad P \propto t$

Question6

Two particles of masses m_1 and m_2 have equal kinetic energies. The ratio of their momentum is

KCET 2018

Options:

A. $m_1 : m_2$

B. $m_2 : m_1$

C. $\sqrt{m_1} : \sqrt{m_2}$

D. $m_1^2 : m_2^2$

Answer: C

Solution:

Let's break down the problem step by step:

The kinetic energy for a particle is given by:

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

Since both particles have equal kinetic energies:

$\frac{p_1^2}{2m_1} = \frac{p_2^2}{2m_2}$

Eliminating the common factor of 2, we have:

$\frac{p_1^2}{m_1} = \frac{p_2^2}{m_2}$

Rearranging the equation to solve for the ratio of the momenta:

$\frac{p_1^2}{p_2^2} = \frac{m_1}{m_2}$

Taking the square root of both sides gives:

$\frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}}$

This means the ratio of the momentum of particle 1 to that of particle 2 is:

$p_1 : p_2 = \sqrt{m_1} : \sqrt{m_2}$

Thus, the correct option is:

Option C

$\sqrt{m_1} : \sqrt{m_2}$

Question7

A motor pump lifts 6 tonnes of water from a well of depth 25 m to the first floor of height 35 m from the ground floor in 20 minutes. The power of the pump (in kW) is $\left[g = 10 \text{ ms}^{-2} \right]$

KCET 2017

Options:

A. 3

B. 12

C. 1.5

D. 6

Answer: A

Solution:

Given:

Water lifted: 6 tonnes (6000 kg)

Depth of well: 25 m

Height of first floor: 35 m

Time taken: 20 minutes (or 1200 seconds)

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

To find the power of the pump:

Calculate the work done:

The work done in lifting the water is given by the formula:

Work $= m \times g \times h$

Here, h is the height difference from the well to the first floor, which is $35 \, \text{m} - 25 \, \text{m} = 10 \, \text{m}$.

Substitute the values:

Work $= 6000 \times 10 \times 10 = 600,000 \, \text{Joules}$

Calculate the power:

Power is the rate at which work is done and is given by the formula:

$P = \frac{\text{Work}}{\text{Time}}$

Substituting the work and time:

$P = \frac{600,000}{1200} = 500 \, \text{W}$

$P = 3,000 \, \text{W} = 3 \, \text{kW}$

Therefore, the power of the pump is $3 \, \text{kW}$.