PQ 12

Questions and Answers

Q1

- What is the potential energy of a 10kg mass:
- a) 100m above the surface of the earth

$$\begin{aligned}\text{potential energy} &= mgh \\ &= 10 \times 9.81 \times 100 \\ &= 9810\,J \\ &= 9.81\,kJ\end{aligned}$$

- b) at the bottom of a vertical mine shaft 1000m deep.

$$\begin{aligned}\text{potential energy} &= mgh \\ &= 10 \times 9.81 \times (-1000) \\ &= -98100\,J \\ &= -98.1\,kJ\end{aligned}$$

Q2

- A car of mass 1000 kg travelling at 30m/s has its speed reduced to 10m/s by a constant breaking force over a distance of 75m.
- Find:
- The cars initial kinetic energy
- The final kinetic energy
- The breaking force

$$\text{Initial kinetic energy} = \frac{1}{2}mv^2$$
$$= 500 \times 30^2$$
$$= 450000\,J$$
$$= 450\,kJ$$

$$\text{Final kinetic energy} = \frac{1}{2}mv^2$$
$$= 500 \times 10^2$$
$$= 50000\,J$$
$$= 50\,kJ$$

$$\text{Change in kinetic energy} = 400\ kJ$$

work done = change in kinetic energy so

$$Fs = \text{change in kinetic energy}$$
$$\text{Breaking force} \times 75 = 400\,000$$
$$\text{Breaking force} = 5333\,N$$

Q3

- A constant force of 2kN pulls a crate along a level floor a distance of 10 m in 50s.
- What is the power used?

$$\begin{aligned}\text{Work done} &= \text{force} \times \text{distance} \\ &= 2000 \times 10 \\ &= 20000\,J\end{aligned}$$

$$\begin{aligned}\text{Power} &= \frac{\text{work done}}{\text{time taken}} \\ &= \frac{20000}{50} \\ &= 400\,W\end{aligned}$$

Q3 alternative

- Alternatively we could have calculated the speed first and then calculated power

$$v = \frac{\text{distance}}{\text{time}}$$
$$= \frac{10}{50} = 0.2 m/s$$

$$\text{Power} = \text{Force} \times \text{Speed}$$
$$= Fv$$
$$= 2000 \times 0.2$$
$$= 400 W$$

Q4

- A hoist operated by an electric motor has a mass of 500 kg. It raises a load of 300 kg vertically at a steady speed of 0.2 m/s. Frictional resistance can be taken to be constant at 1200 N.
- What is the power required?

$$\text{Total mass} = m = 800kg$$
$$\text{Weight} = 800 \times 9.81$$
$$= 7848N$$

$$\text{Total force} = 7848 + 1200$$
$$= 9048N$$

If work is being done by a machine moving at speed *v* against a constant force, or resistance, *F*, then since work done is force times distance, work done per second is *Fv*, which is the same as power.

$$\text{Power} = \text{force} \times \text{speed}$$
$$= 9048 \times 0.2$$
$$= 1810W$$
$$= 1.81kW$$

Q5

- Find the work done in raising a lift of people through 20 m if the total mass is 2000kg.

- Work done = force × distance
- Work done = ma × 20 = 392 400 J

Q6

- What is the kinetic energy of a mass of 0.08 kg travelling at 16 m/s?

$$\mathrm{Ke} = \mathrm{mv}^2/2 = 0.08 \times 16^2 /2 = 10.24\ \mathrm{J}$$

Q7

- Find the kinetic energy of a body if mass 2 kg when it falls under gravity a distance of 2m from rest.

$$v^2 = u^2 + 2as$$

$$v^2 = 0 + 2 \times 9.81 \times 2$$

$$v = 6.26 \text{ m/s}$$

$$Ke = 2 \times 6.26^2 / 2 = 39.24 \text{ J}$$

Q8

- A man of mass 70 kg runs up a flight of 50 steps each 0.25 m high in 25 s. What is his rate of working?

$$m = 70\ \text{kg}$$
$$t = 25\ \text{s}$$
$$s = 50 \times 0.25 = 12.5\ \text{m}$$

$$\text{Work} = Fs = (70 \times g)12.5 = 8583.75\ \text{J}$$
$$\text{Power} = \text{work/time} = 343.35\ \text{W}$$

Q9

- A car engine has an output of 8 kW. Find the resistance to motion when the car travels at a steady speed of 15 m/s along a level road.

$$\text{Power} = 8000 \text{ w}$$
$$\text{Power} = Fv$$
$$8000 = F\ 15$$
$$F = 533 \text{ N}$$

Q 10

- The engine of a car has a maximum power output of 50 kW and the car's transmission has an efficiency of 70%. If the mass of the car is 1 tonne and the total resistance to motion is a constant 600 N, find the maximum speed which the car can achieve a) along a horizontal track.

$$\text{Power} = 50\,000 \text{ W}$$

$$\text{effective power} = 0.7 \times 50\,000 = 35\,000 \text{ W}$$

$$m = 1000 \text{ kg}$$
$$Fr = 600 \text{ N}$$

$$\text{Power} = Fv$$
$$35000 = 600\ v$$
$$v = 58.3 \text{ m/s}$$