



CHAPTER 9

WORK, ENERGY AND POWER

SOLUTIONS

TEXTUAL QUESTIONS AND ANSWERS EXERCISES

- Q1.** Calculate the work done by a student in lifting a packet of books of mass 5kg from the ground and keeping it on the shelf 1.5 m high (take $g = 10 \text{ m/s}^2$).

Ans: Mass of the book, $m = 5 \text{ kg}$

The force acting on the book is given by-

$$\begin{aligned} F &= mg \\ &= (5 \times 10) \text{ N} \\ &= 50 \text{ N} \end{aligned}$$

The displacement s created by this force is the height of the shelf

$$s = 1.5 \text{ m}$$

We have,

$$\begin{aligned} \text{Work done } W &= Fs \\ &= (50 \times 1.5) \text{ J} \\ &= 75 \text{ J} \end{aligned}$$

Therefore, the work done by the student in lifting the packet of book is 75 J.

- Q2.** A player kicks a ball of mass 500 g placed at the centre of a football ground. The ball leaves his feet with a speed of 4 ms^{-1} . Find the work done by the player on the ball. Does it equal to the kinetic energy of the ball as it leaves?

Ans: Here,

$$\begin{aligned} \text{Mass of the ball, } m &= 500 \text{ g} \\ &= 0.5 \text{ kg} \end{aligned}$$

$$\begin{aligned} \text{Force applied to the ball, } F &= mg \\ &= (0.5 \times 10) \text{ N} \\ &= 5 \text{ N} \end{aligned}$$

$$\text{Initial velocity, } u = 0$$

$$\text{Final velocity, } v = 4 \text{ ms}^{-1}$$



We have,

$$v^2 - u^2 = 2 g s$$

where, s is the displacement

Then,

$$s = \frac{v^2 - u^2}{2g}$$
$$= 4^2 / 20 \text{ m}$$

Therefore, work done W by the player on the ball is

$$W = Fs$$
$$= 5 \times (4^2 / 20) \text{ J}$$
$$= 4 \text{ J}$$

The kinetic energy E_k of the ball as it leaves is

$$E_k = \frac{1}{2} m v^2$$
$$= \frac{1}{2} (0.5)(4^2) \text{ J}$$
$$= 4 \text{ J}$$

Hence, the work done is equal to the kinetic energy of the ball.

- Q3. A ball of mass 2kg is thrown upwards vertically with a speed of 4.9 ms^{-1} . (a) Find the potential energy when it reaches the highest point. (b) Calculate the maximum height it reaches.**

Ans: Mass of the ball, $m = 2 \text{ kg}$

Velocity of the ball, $v = 4.9 \text{ ms}^{-1}$

When the ball reaches the highest point, the potential energy is equal to the kinetic energy

$$E_k = E_p$$
$$\Rightarrow mgh = \frac{1}{2} m v^2$$
$$\Rightarrow h = \frac{1}{2} (v^2 / g)$$
$$= \frac{1}{2} (24.01 / 9.8) \text{ m}$$
$$= 24.01 / 19.6 \text{ m}$$
$$= 1.225 \text{ m}$$



মণিপুরৰ শ্বৰে নক্সাৰাল (সংল)

DEPARTMENT OF EDUCATION (S)

Government of Manipur

a) The potential energy E_p is given by

$$E_p = mgh$$

$$= (2 \times 9.8 \times 1.225) \text{ J}$$

$$= 24.01 \text{ J}$$

b) The maximum height is 1.225m.

Q4. A ball is thrown at a certain angle to the ground. It moves along a curve path and falls back on the ground. The initial and final positions of the path lie on the same horizontal line. What is the work done by the force of gravity on the ball?

Ans: Since the initial and final positions of the path lie on the same horizontal line, displacement is zero.

Since, work done = force x displacement

Hence, the work done is zero.

Q5. How much time an agent will take to perform 400 J of work at the rate of 20 W?

Ans: Here,

$$\text{Work done, } W = 400 \text{ J}$$

$$\text{Power, } P = 20 \text{ W}$$

$$\text{Since, } P = W/t$$

$$\Rightarrow t = W/P$$

$$= 400/20 \text{ s}$$

$$= 20 \text{ s}$$

Therefore, the agent will take 20 seconds to perform the work.

Q6. Tomba does 200 J of work in 10 seconds and his brother Pishak does 100 J of work in 4 seconds. (a) Who is delivering more power? (b) Find the ratio of the powers of Tomba to that of Pishak.

Ans: Work done by Tomba, $W_T = 200 \text{ J}$

Time taken by Tomba, $t_T = 10 \text{ s}$

Power delivered by Tomba, $P_T = W_T/t_T$

$$= 200/10 \text{ W}$$

$$= 20 \text{ W}$$



মণিপুরৰ শ্বৰে নক্সাৰ (ৱ'ল)

DEPARTMENT OF EDUCATION (S)

Government of Manipur

Work done by Pishak, $W_P = 100 \text{ J}$

Time taken by Pishak, $t_P = 4 \text{ s}$

Power delivered by Pishak, $P_P = W_P/t_P$

$$= 100/4 \text{ W}$$

$$= 25 \text{ W}$$

Therefore, Pishak delivers more power than Tomba.

b) The ratio of their powers delivered are $P_T : P_P = 20 : 25 = 4 : 5$

Q7. In a certain household 500 units of energy is consumed during one month. Express it in terms of Joules.

Ans: 1 unit of energy is 1 kWh.

$$1 \text{ kW} = 3.6 \times 10^6 \text{ J}$$

Therefore, $500 \text{ kWh} = 500 \times 3.6 \times 10^6 \text{ J}$

$$= 1.8 \times 10^9 \text{ J}$$

Q8. Read the situations given below carefully and reason out whether work is done or not in the light of scientific term of work.

(a) Kamala is swimming in a pond along a straight path.

(b) Tomba is standing with a load having the same weight as his weight on his head.

(c) Chaoba pushes a huge stone with all his strength but the rock does not move.

(d) A horse carrying a load on its back and moves on a horizontal surface.

Ans:

(a) Work is said to be done since the force pushes the water in the backward direction and there is displacement in the opposite direction. This is a negative work done.

(b) The work done is zero since the displacement is zero.

(c) The work done is zero since the displacement is zero.

(d) We have work done $W = F_s \cos \theta$ (θ is the angle between the force exerted and the displacement). Since $\theta = 90^\circ$ and $\cos 90^\circ = 0$, Work done $W = F_s \times 0$. Therefore, work done is zero.



মণিপুর সরকারের শিক্ষা বিভাগ (সংসদ)

DEPARTMENT OF EDUCATION (S)

Government of Manipur

Q9. The work done by the weight of 1kg mass while it is raised through a height of 1m is

- (A) 9.8 J (B) -9.8 J
(C) zero (D) 1/9.8 J

Ans: (B) - 9.8 J (since, the displacement is in the opposite direction of the force applied work done is negative.

$$\begin{aligned}\text{work done} &= - mgh \\ &= - 9.8 \text{ J})\end{aligned}$$

Q10. When a body slides down an inclined plane, it has

- (A) Only kinetic energy
(B) Only potential energy
(C) Neither kinetic nor potential energy
(D) Both kinetic and potential energies

Ans: (D) Both kinetic and potential energies. (since, the body is at a particular height it will have potential energy. At the same time since it is sliding it will have kinetic energy)

Q11. A stone of mass 2 kg falls from a height of 1 m. Its kinetic energy when it reaches the ground is

- (A) 19.6 J (B) 10 J
(C) 9.8 J (D) zero

Ans: (A) 19.6 J (kinetic energy when it reaches the ground is equal to the potential energy at the highest point.)

$$\begin{aligned}E_k &= E_p \\ &= mgh \\ &= 2 \times 9.8 \times 1 \text{ J} \\ &= 19.6 \text{ J}\end{aligned}$$



মণিপুর সরকারের শিক্ষা বিভাগ (সংসদ)
DEPARTMENT OF EDUCATION (S)
Government of Manipur



মহাশিক্ষা বিভাগ (মাণিক্য)

DEPARTMENT OF EDUCATION (S)

Government of Manipur

Q12. Two bodies of unequal masses are dropped from a certain height above the ground. At any point of their path they have equal

(A) Momentum

(B) potential energy

(C) Acceleration

(D) kinetic energy

Ans: (C) Acceleration. (since the two bodies have different mass it is not possible to have equal momentum, potential energy and kinetic energy)

They will have equal acceleration which is $g = 9.8 \text{ ms}^{-1}$

TRY TO ANSWER

Q1. When do we say work is done by a force?

Ans: When an object moves under an applied force, we say that the force has done work on the object.

Q2. What is the expression for work done when a force is acting on an object in the direction of displacement?

Ans: The expression of work done W when a force F is acting on an object in the direction of displacement s is as follows -

$$W = Fs$$

Q3. What is 1J of work?

Ans: 1J of work is the amount of work done when a force of 1N applied to an object displaces it by a distance of 1m.



মণিপুর সরকারের শিক্ষা বিভাগ (সংসদ)

DEPARTMENT OF EDUCATION (S)
Government of Manipur

Q4. In ploughing a paddy field, a pair of bullocks exerts a force of 200 N together. If the length of the field is 50m, how much work is done in the process?

Ans: Let F be the force exerted by the bullocks and

s be the displacement of the plough made by the force F .

Then,

$$F = 200 \text{ N}$$

$$s = 50 \text{ m}$$

Since, Work done = Force \times displacement

$$W = Fs$$

$$= (200 \times 50) \text{ Nm}$$

$$= 10,000 \text{ J}$$

Therefore, the work done in the process is 10,000 J.



মণিপুর সরকারের শিক্ষা বিভাগ (সংসদ)
DEPARTMENT OF EDUCATION (S)
Government of Manipur