PRACTICE PAPER 11 (2024-25)

CHAPTER 10 WORK AND ENERGY (ANSWERS)

SUBJECT: SCIENCE **MAX. MARKS : 40**

CLASS : IX **DURATION : 1½ hrs**

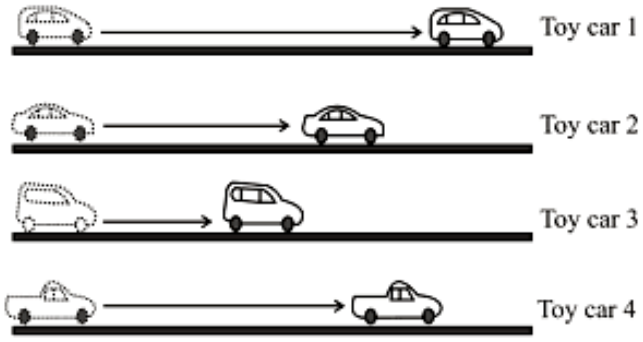
General Instructions:

(i). **All** questions are compulsory.
(ii). This question paper contains 2**0** questions divided into five Sections A, B, C, D and E.
(iii). **Section A** comprises of **10 MCQs** of **1 mark** each. **Section B** comprises of 4 questions of **2 marks** each. **Section C** comprises of 3 questions of **3 marks** each. **Section D** comprises of 1 question of **5 marks** each and **Section E** comprises of 2 Case Study Based Questions of **4 marks** each.
(iv). There is no overall choice.
(v). Use of Calculators is not permitted

SECTION – A

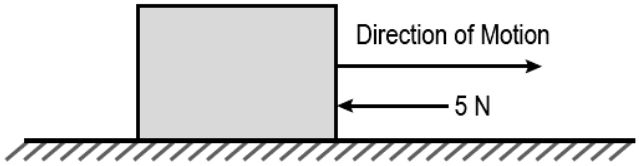
Questions 1 to 10 carry 1 mark each.

1. Rahul pushed four toy cars on a surface. The picture shows the distance each toy car travelled before coming to a stop.



In pushing, on which car was the work done by Rahul was the greatest?
(a) Toy car 1 (b) Toy car 2 (c) Toy car 3 (d) Toy car 4
Ans. (a) Toy car 1
Toy car 1 covered the largest distance as compared to toy cars 2, 3 and 4. We know, W = F × s. As distance travelled by toy car 1 is more, so the work done is more than any of the other toy cars.

2. An object is moving with a uniform velocity along a particular direction. A retarding force of 5N, is applied in the direction as shown.



The object stops after a displacement of 5m. What is the work done by the retarding force?
(a) –5J (b) –25J (c) 5J (d) 25J
Ans. (b) –25J
Force = -5 N (negative because it opposes the motion).
Displacement = 5m.
Work = force x displacement = -5 x 5 = -25J

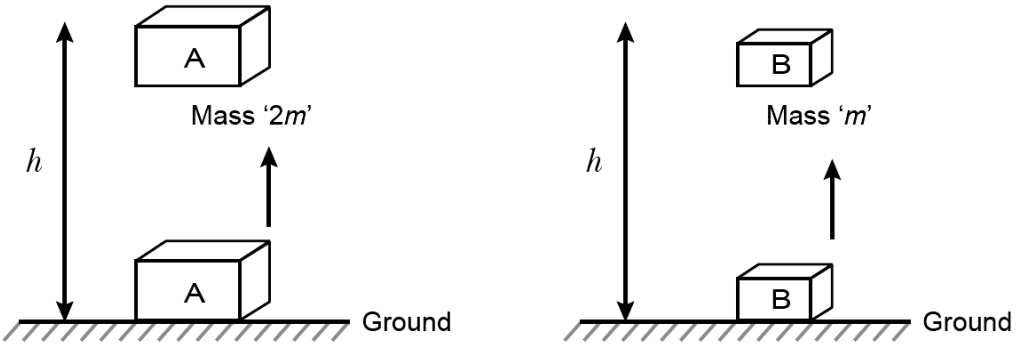
3. In which of these conditions is the work done negative?
(I) Wind force making a boat move forward on water.
(II) Brake force resisting the motion of a moving wheel.
(III) Buoyant force slowing the sinking of an iron nail in water.
Options:

(a) (I) and (II) (b) Only (II) (c) Only (III) (d) (II) and (III)
Ans. (d) (II) and (III)
Brake force resists the motion of a moving wheel and buoyant force shows the sinking of an iron nail in water. Wind force makes a boat move forward on water.

4. A force of 20 N acts on a body. The body moves 2 m in the direction of the force. What is the work done by the force?
(a) 10 J (b) 40 J (c) 10 W (d) 40 W
Ans. (b) 40 J
Here, F = 20 N, s = 2 m
Work done (W) = Force (F) × displacement (s) = 20 × 2 = 40 J

5. Which type of energy conversion is found in a microphone?
(a) Mechanical energy into sound energy
(b) Electrical energy into sound energy
(c) Sound energy into electrical energy
(d) Mechanical energy to electrical energy and then sound energy
Ans. (c) Sound energy into electrical energy

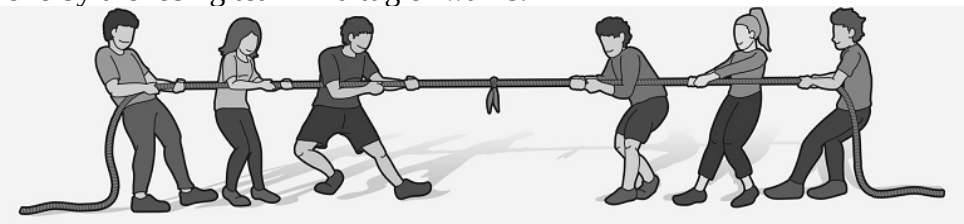
6. Compare the energy possessed by the virtue of position for the 2 bodies shown below.



(a) By virtue of their positions, the energy possessed by body A is half the energy possessed by body B.
(b) By virtue of their positions, the energy possessed by body A is twice the energy possessed by body B.
(c) By virtue of their positions, the energy possessed by body A is 4 times the energy possessed by body B.
(d) By virtue of their positions, the energy possessed by both Body A and Body B is the same.
Ans. (b) By virtue of their positions, the energy possessed by body A is twice the energy possessed by body B.
The potential energy (U) of a body is given by:
where: m = mass of the body,
g = acceleration due to gravity,
h = height above the ground.
For Body A: $U_A = 2mgh = 2\ (mgh)$
For Body B: $U_B = mgh$
Comparing the two: $U_A = 2U_B$
This means the potential energy of Body A is twice the potential energy of Body B.

7. A person A does 500 J of work in 10 minutes and another person B does 600 J of work in 20 minutes. Let the power delivered by A and B be P_A and P_B respectively. Then,
(a) $P_A = P_B$ (b) $P_A > P_B$ (c) $P_A < P_B$ (d) P_A and P_B are undefined
Ans. (b) $P_A > P_B$
$P_A = 500/600 = 0.833$ W and $P_B = 600/1200 = 0.5$ W

8. The work done by the losing team in a tug of war is:



(a) zero (b) positive (c) negative (d) none of these

Ans. (c) negative

When force and displacement are in opposite directions, the work done is said to be negative. Since the losing team's displacement is towards the winning team and the ground's friction force is in the opposite direction of their displacement. Hence, negative work will be done by the losing team and positive work will be done by the winning team.

In the following questions 9 and 10, a statement of assertion (A) is followed by a statement of Reason (R). Choose the correct answer out of the following choices.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true and R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

9. Assertion (A): A falling coconut, a speeding car, a rolling stone, a flying aircraft, flowing water, blowing wind and a running athlete, all possess kinetic energy.
Reason (R): Objects in motion possess kinetic energy.
Ans. (a) Both A and R are true and R is the correct explanation of A.

10. Assertion (A): When a light and a heavy body have the same momentum, the lighter body has more kinetic energy.
Reason (R): The square of a body's velocity determines its kinetic energy.
Ans. (b) Both A and R are true and R is not the correct explanation of A.

Kinetic energy is mathematically expressed as: K.E.= $\frac{1}{2}$ mv²

Therefore, Kinetic energy can be determined by the square of its velocity.
Momentum of a body is the product of mass and velocity.
$p = mv \Rightarrow v = p/m$
Hence, K.E. = $p^2/2m$
Kinetic energy is proportional to mass 'm' even though the two bodies have the same momentum.

SECTION – B

Questions 11 to 14 carry 2 marks each.

11. The kinetic energy of an object of mass, m moving with a velocity of 5 ms^{-1} is 25 J. What will be its kinetic energy when its velocity is doubled? What will be its kinetic energy when its velocity is increased three times?

Ans. Expression for kinetic energy is $E_k = \frac{1}{2}mv^2$

m = Mass of the object
v = Velocity of the object = 5 m/s
Given that kinetic energy, E_k = 25 J
(i) If the velocity of an object is doubled, then $v = 5 \times 2 = 10$ m/s.
Therefore, its kinetic energy becomes 4 times its original value, because it is proportional to the square of the velocity. Hence, kinetic energy = $25 \times 4 = 100$ J.

(ii) If velocity is increased three times, then its kinetic energy becomes 9 times its original value, because it is proportional to the square of the velocity. Hence, kinetic energy = 25 × 9 = 225 J.

12. A man carrying a bag of mass 25 kg climbs up to a height of 10m in 50 seconds. Calculate the power delivered by him to the bag.

Ans. The force exerted by the man on the bag is equal to the weight of the bag, which is
mg = 25 × 9.8 = 245 N
The work done by this force in taking the bag up by 10m is
W = 245 × 10 = 2450 J

This work is done in 50s. The power delivered is $P = \frac{W}{t} = \frac{2450}{50} = 49W$

OR

Calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 km/h?

Ans. Kinetic energy, $E_k = \frac{1}{2}mv^2$

Where, Mass of car, m = 1500 kg

Velocity of car, v = 60 km/h $= 60 \times \frac{5}{18} ms^{-1}$

$\therefore E_k = \frac{1}{2} \times 1500 \times \left(60 \times \frac{5}{18}\right)^2 = 20.8 \times 10^4 J$

Hence, 20.8 × 104 J of work is required to stop the car.

13. A person holds a bundle of hay over his head for 30 minutes and gets tired. Has he done some work or not? Justify your answer.

Ans. Work is done whenever the given two conditions are satisfied:
(i) A force acts on the body.
(ii) There is a displacement of the body by the application of force in or opposite to the direction of force.
When a person holds a bundle of hay over his head, then there is no displacement in the bundle of hay. Although, force of gravity is acting on the bundle, the person is not applying any force on it. Hence, in the absence of force, work done by the person on the bundle is zero.

OR

Avinash can run with a speed of 8 m/s against the frictional force of 10 N and Kapil can move with a speed 3 m/s against the frictional force of 25 N. Who is more powerful and why?

Ans. Force applied by Avinash = 10 N
Speed of Avinash = 8 m/s
Force applied by Kapil = 25 N
Speed of Kapil = 3 m/s
Use the formula of power to find power of Avinash and Kapil
Power = Force × velocity
Therefore, Power of Avinash, P_A = 10 × 8 = 80 Watt
Power of Kapil, P_K = 25 × 3 = 75 Watt
Hence, Avinash is more powerful than Kapil.

14. (a) Define 1 J of work.

(b) A pair of bullocks exerts a force of 140 N on a plough. The field being ploughed is 15 m long. How much work is done in ploughing the length of the field?

Ans: (a) 1 J is the amount of work done by a force of 1 N on an object that displaces it through a distance of 1 m in the direction of the applied force.

(b) Work done by the bullocks is given by the expression:
Work done = Force × Displacement
W = F × d
W = 140 × 15 = 2100 J

Hence, 2100 J of work is done in ploughing the length of the field.

SECTION – C

Questions 15 to 17 carry 3 marks each.

15. A 10 kg ball is thrown upwards with a speed of 5 m/s. (*i*) Find its potential energy when it, reaches the highest point. (*ii*) Calculate the maximum height it reaches.

Ans. (*i*) The kinetic energy of the ball is $K = \frac{1}{2}mv^2 = \frac{1}{2} \times 10 \times 5^2 = 125$

At the highest point, the kinetic energy become zero, and hence, the entire kinetic energy of 125J is converted into potential energy. So, the potential energy at the highest point is 125J.

(*ii*) Suppose the ball reaches a maximum height *h*. Its potential energy will be *mgh*.

mgh = 125J

$$\Rightarrow h = \frac{125}{mg} = \frac{125}{10 \times 9.8} = 1.28m$$

16. (i) A body thrown at a certain angle to the ground moves in a curved path and falls back to the ground. The initial and final points of the path of the object lie on the same horizontal line. What is the work done by the force of gravity on the object?

(ii) You lift a heavily packed carton of mass m in vertically upward direction through a height h. What is the work done (a) by you on the carton, (b) by force of gravity on the carton?

(iii) Anil is doing work at a rapid rate but works for only one hour. Ashok does work at a somewhat slower rate but continues to work for six hours. Who has greater power? Who has more energy?

Ans. (i) Work done is zero. This is because equal and opposite work is done in the two paths.

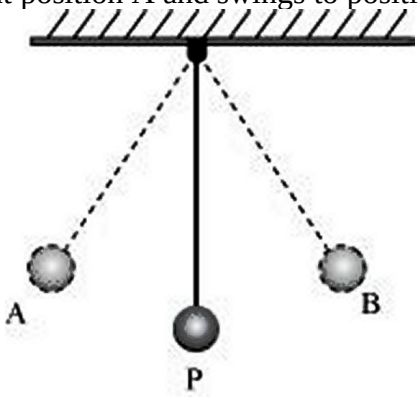
(ii) (a) Work done by me is positive and having a value = *mgh*. This is because I am applying force in vertically upward direction on the carton to hold it and displacement is also in the same direction.

(b) Work done by the force of gravity on the carton= – *mgh*. This is because force is vertically downward but motion is vertically upward.

(iii) Anil has greater power because his rate of doing work is more. Ashok has more energy as he worked for a longer time and the total work done by him is definitely more.

OR

A simple pendulum is released at position A and swings to position B as shown in Figure.



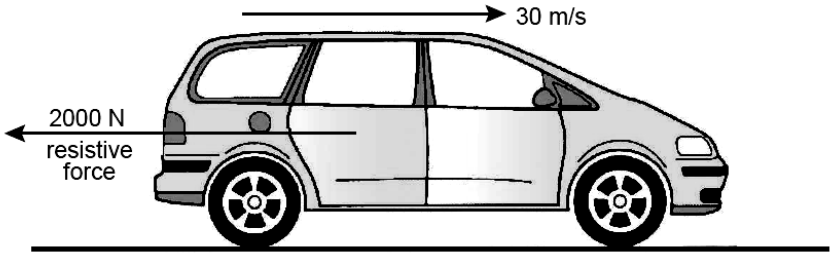
One complete oscillation is when the pendulum swings from A to B and then returns to A.

Why does the bob eventually come to rest? What happens to its energy eventually?

Ans. When a pendulum moves from its mean position P to either of its extreme positions A or B, it rises through a height h above the mean level P. At this point, the kinetic energy of the bob changes completely into potential energy. The kinetic energy becomes zero, and the bob possesses only potential energy. As it moves towards point P, its potential energy decreases progressively. Accordingly, the kinetic energy increases. As the bob reaches point P, its potential

energy becomes zero and the bob possesses only kinetic energy. This process is repeated as long as the pendulum oscillates.
The bob does not oscillate forever. It comes to rest because air resistance resists its motion. The pendulum loses its kinetic energy to overcome this friction and stops after some time.

17. A car of mass 900 kg is travelling at a steady speed of 30 m/s against a resistive force of 2000 N, as illustrated in figure.



(i) Calculate the kinetic energy of the car.
(ii) Calculate the energy used in 1.0 s against the resistive force.
(iii) What is the minimum power that the car engine has to deliver to the wheels?

Ans. (i) Kinetic energy = $\frac{1}{2}mv^2$

= $\frac{1}{2} \times 900 \times (30)^2$ = 4,05,000 J

(ii) Energy used = Work done against resistive force
= Force × Distance = 2,000 × 30 = 60,000 J = 60 kJ
(iii) Minimum power = Energy used/Time taken
= 60 000 J/1s = 60,000 W = 60 kW

OR

(a) What is the work done by the force of gravity on a satellite moving round the earth? Justify your answer.
(b) Can there be displacement of an object in the absence of any force acting on it? Justify your answer.
Ans: (a) If the direction of force is perpendicular to displacement, then the work done is zero. When a satellite moves around the Earth, then the direction of force of gravity on the satellite is perpendicular to its displacement. Hence, the work done on the satellite by the Earth is zero.
(b) Yes. For a uniformly moving object
Suppose an object is moving with constant velocity. The net force acting on it is zero. But, there is a displacement along the motion of the object. Hence, there can be a displacement without a force.

SECTION – D

Questions 18 carry 5 marks each.

18. (a) Derive an expression for kinetic energy of an object.
(b) If the velocity of an object is doubled. What will be change in its kinetic energy?
Ans. (a) Let a body (ball) of mass m is moving with an initial velocity v. If it is brought to rest by applying a retarding (opposing) force F, then it comes to rest by a displacement S. Let, E_k = work done against the force used to stop it.

$E_k = F \cdot S$ ----- (1)

But retarding force F = ma ----- (2)

Let initial velocity u = v, final velocity v = 0
From III equation of motion, $v^2 = u^2 + 2as$ applying,

$0 = v^2 - 2as$ (a is retardation)

$\Rightarrow 2as = v^2$

Displacement, $s = \frac{v^2}{2a}$ ----------->(3)

substituting (2) and (3) in (1), we get

$$E_k = ma.\frac{v^2}{2a}$$

$$\Rightarrow E_k = \frac{1}{2}mv^2$$

Kinetic Energy of a moving object is defined as half the product of the mass of the object square of the speed of the object.

(b) When velocity of an object is doubled *i.e.*, $v' = 2v$

$$\Rightarrow K.E.' = \frac{1}{2}m(2v)^2 = \frac{1}{2}m4v^2 = 4\left(\frac{1}{2}mv^2\right) \Rightarrow K.E.' = 4K.E.$$

$\therefore$ If the velocity of an object is doubled its kinetic energy increases four times.

OR

In a small house, there are six bulbs of 100 W and two fans of 60 watt. Two ACs of 2 kW are operated for 4 hours every day.

Calculate the following:

(a) Total power consumed every day.

(b) Total power utilised in 30 days.

(c) Total electrical energy consumed in 30 days.

(d) Cost of electricity at the rate of Rs. 4 per unit.

Ans. (a) Power Consumed by 6 bulbs = 6 × 100 = 600 W

Power Consumed by 2 fans = 2 × 60 = 120 W

Power Consumed by 2 A.Cs = 2 × 2 = 4 kW = 4000 W

Total power consumed in house = 600 + 120 + 4000 = 4720 W

(b) Total power consumed in 30 days = 4720 × 30 = 141600 W = 141.6 kW

(c) Electrical energy consumed in 30 days = Power × time = 141.6 × 4 = 566.4 kW

(d) Cost of electricity = 566.4 × Rs. 4 = Rs. 4672.8

SECTION – E (Case Study Based Questions)

Questions 19 to 20 carry 4 marks each.

19. Read the given passage and answer the questions that follow based on the passage and related studied concepts.

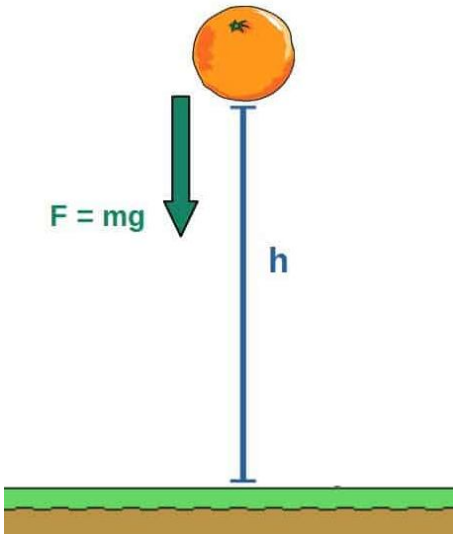
When an object is allowed to fall from higher level to a lower level, it gains speed due to gravitational pull, *i.e.*, it gains kinetic energy. Therefore, in possessing height, a body has the ability to convert its height into kinetic energy, *i.e.*, it possesses potential energy.

The magnitude of its gravitational potential energy is equivalent to the amount of work done by the weight of the body in causing the descent.

If a mass *m* is at a height *h* above a lower level, the P.E. possessed by the mass is *mgh*.

The chosen level from which height is measured has no absolute position. It is, therefore, important to indicate clearly the zero P.E. level in any problem in which P.E. is to be calculated.

The potential energy of a body may be positive or negative.

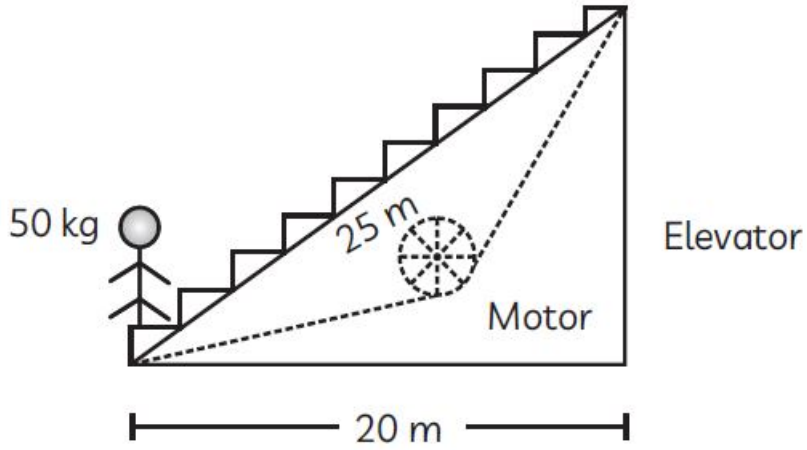


Based on the above information, Answer the following questions:

(a) A cement bag of weight 50 kg has potential energy of 490 J. To what height should it be raised? (1)

(b) When an arrow is shot from its bow, it has kinetic energy. From where does it get this kinetic energy? (1)
(c) Define potential energy. What is the potential energy of a stone of mass 5 kg placed at a height of 2 m above the ground? ($g = 9.8\ m/s^2$). (2)
Ans. (*i*) Potential energy, $U = mgh$.
$\therefore 490 = 50 \times 9.8 \times h \Rightarrow h = \frac{490}{50 \times 9.8} = 1m$
(*ii*) When the arrow is shot, the potential energy of the bow gets converted into the kinetic energy of the arrow.
(*iii*) The energy possessed by a body due to its position or configuration is called potential energy.
Potential energy, $U = mgh = 5 \times 9.8 \times 2\ J = 98\ J$

20. Read the following information and answer the questions based on information and related studied concepts.
A girl weighing 50 kg is travelling in an elevator moving at a speed of 2 m/s. Horizontal distance covered is 25 m while displacement is 20 m.



(a) Calculate K.E. of the girl. (1)
(b) Calculate the gravitational potential energy when the girl reaches the top. (2)
(c) What is the work done by motor to raise the girl to a vertical height? (1)
Ans. (a) $K.E. = \frac{1}{2}mv^2 = \frac{1}{2} \times 50 \times 2 \times 2 = 100J$
(b) According to Pythagoras' theorem
$h = (25)^2 - (24)^2 = 625 - 576 = 49$ or $(7)^2$
$\therefore h = 7$ cm
P.E. = mgh
$\therefore$ P.E. = 50 kg × 10 m/s² × 7 m = 3500 J = 3.5 kJ
(c) Work done to raise the girl to a vertical height of 7 m/s.
$\therefore$ Work done = P.E. change = mgh = 50 × 10 × 7 = 3500 J = 3.5 kJ