

Work, Energy and Power — Assignment 1

Class 11 Physics · Topic-wise question bank covering every concept of the chapter · Narayan Gurukul Academy

Instructions: (1) Attempt all questions. This worksheet walks through every concept of the chapter, topic by topic.
(2) The interactive MCQ version of these questions (with instant answer reveal) is available on the notes page.
(3) Universal values: $g = 10 \text{ m/s}^2$ unless stated. Give answers with correct SI units.

Work

MCQ Questions (choose the correct option)

1. A man squatting on the ground gets straight up and stands. The force of reaction of the ground on the man during the process is —
(A) constant and equal to mg in magnitude.
(B) constant and greater than mg in magnitude.
(C) variable but always greater than mg .
(D) at first greater than mg and later becomes equal to mg .
2. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on to the table? (Take $g = 10 \text{ m/s}^2$.)
(A) 7.2 J
(B) 3.6 J
(C) 120 J
(D) 1200 J
3. 300 J of work is done in sliding a 2 kg block up an inclined plane of height 10 m. The work done against friction is ($g = 10 \text{ m/s}^2$) —
(A) 1000 J
(B) 200 J
(C) 100 J
(D) zero

1 Mark Questions

1. How much work is done by a coolie walking on a horizontal platform with a load on his head?
2. A body is moving along a circular path. How much work is done by the centripetal force?
3. State the two conditions under which a force does no work?
4. A body is moving at constant speed over a frictionless surface. What is the work done by the weight of the body?

2 Mark Questions

1. Mountain roads rarely go straight up the slope but wind up gradually. Why?
2. Is it necessary that work done in the motion of a body over a closed loop is zero for every force in nature? Why?
3. Give an example in which a force does work on a body but fails to change its K.E.

3 Mark Questions

1. A body of mass 0.3 kg is taken up an inclined plane of length 10 m and height 5 m and then allowed to slide down to the bottom again. The coefficient of friction between the body and the plane is 0.15. Calculate (i) the work done by the gravitational force over the round trip, (ii) the work done by the applied force over the upward journey, (iii) the

work done by the frictional force over the round trip, (iv) the kinetic energy of the body at the end of the trip. How is the answer to (iv) related to the first three answers?

Work Done by a Variable Force

MCQ Questions (choose the correct option)

1. A position-dependent force $F = 7 - 2x + 3x^2$ N acts on a small body of mass 2 kg and displaces it from $x = 0$ to $x = 5$ m. The work done in joules is —

- (A) 135
- (B) 270
- (C) 35
- (D) 70

2 Mark Questions

1. Find the work done when a particle moves from position $r_1 = (3\hat{i} + 2\hat{j} - 6\hat{k})$ to $r_2 = (14\hat{i} + 13\hat{j} - 9\hat{k})$ under a constant force $F = (4\hat{i} + \hat{j} + 3\hat{k})$ N.

3 Mark Questions

1. A body is moving along the z-axis of a coordinate system under the effect of a constant force $F = (2\hat{i} + 3\hat{j} + k)$ N. Find the work done by the force in moving the body a distance of 2 m along the z-axis.

Kinetic Energy and the Work–Energy Theorem

MCQ Questions (choose the correct option)

1. A body of mass 0.5 kg travels in a straight line with velocity $V = a \cdot x^{3/2}$, where $a = 5 \text{ m}^{-1/2} \text{ s}^{-1}$. The work done by the net force during its displacement from $x = 0$ to $x = 2$ m is —

- (A) 15 J
- (B) 50 J
- (C) 10 J
- (D) 100 J

2. An athlete in the Olympic games covers a distance of 100 m in 10 s. His kinetic energy can be estimated to be in the range (assume $m = 60$ kg) —

- (A) 200 J – 500 J
- (B) 2×10^5 J – 3×10^5 J
- (C) 20000 J – 50000 J
- (D) 2000 J – 5000 J

3. If the linear momentum of a body is increased by 50%, then its kinetic energy will increase by —

- (A) 50%
- (B) 100%
- (C) 125%
- (D) 25%

4. A body of mass 50 kg is at rest. The work done to accelerate it to 20 m/s in 10 s is —

- (A) 10^3 J
- (B) 10^4 J
- (C) 2×10^3 J
- (D) 4×10^4 J

5. A particle is projected at an angle of 60° to the horizontal with a kinetic energy E . The kinetic energy at the highest point is —

- (A) E
- (B) $E/4$
- (C) $E/2$
- (D) zero

1 Mark Questions

1. A light and heavy body have same linear momentum. Which one has greater kinetic energy?
2. How will the momentum of a body change if its kinetic energy is made double?
3. K.E. of a body is increased by 300 %. Find the % increase in its momentum?
4. A light and a heavy body have same K.E., which of the two have more momentum and why?

2 Mark Questions

1. The momentum of a body is doubled. By what percentage does its kinetic energy change?
2. A truck and a car moving with the same K.E. on a straight road. Their engines are simultaneously switched off which one will stop at a lesser distance?
3. Derive an expression for the kinetic energy of a body of mass m moving with velocity v by the calculus method.
4. How high must a body be lifted to gain an amount of potential energy equal to the kinetic energy it has when moving at a speed of $20 \text{ m}\cdot\text{s}^{-1}$? (Take $g = 9.8 \text{ m}\cdot\text{s}^{-2}$.)
5. State and prove work energy theorem.

3 Mark Questions

1. In lifting a 10 kg weight to a height of 2m, 230 J energy is spent. Calculate the acceleration with which it was raised?
2. A bullet of mass 0.02 kg is moving with a speed of 10 ms^{-1} . It can penetrate 10 cm of a wooden block, and comes to rest. If the thickness of the target would be 6 cm only, find the K.E. of the bullet when it comes out.

The Concept of Potential Energy

1 Mark Questions

1. Define the conservative and non-conservative forces. Give examples of each.
2. What happens to the P.E. of a bubble when it rises in water?

Conservation of Mechanical Energy

MCQ Questions (choose the correct option)

1. A child is sitting on a swing. Its minimum and maximum heights from the ground are 0.75 m and 2 m respectively. Its maximum speed will be ($g = 10 \text{ m/s}^2$) —
 - (A) 10 m/s
 - (B) 5 m/s
 - (C) 8 m/s
 - (D) 15 m/s

2 Mark Questions

1. A bob is pulled sideways so that string becomes parallel to horizontal and released. Length of the pendulum is 2 m. If due to air resistance loss of energy is 10%, what is the speed with which the bob arrived at the lowest point.

2. A ball at rest is dropped from a height of 12 m. It loses 25% of its kinetic energy in striking the ground, find the height to which it bounces. How do you account for the loss in kinetic energy?

3 Mark Questions

1. A ball bounces to 80% of its original height. Calculate the mechanical energy lost in each bounce.

Potential Energy of a Spring

MCQ Questions (choose the correct option)

1. A spring of force constant $800 \text{ N}\cdot\text{m}^{-1}$ has an extension of 5 cm. The work done in extending it from 5 cm to 15 cm is —

- (A) 16 J
- (B) 8 J
- (C) 35 J
- (D) 24 J

1 Mark Questions

1. Which spring has greater value of spring constant – a hard spring or a delicate spring?
2. Does the P.E. of a spring decreases or increases when it is compressed or stretched?
3. Define spring constant of a spring.

2 Mark Questions

1. Two springs A and B are identical except that A is harder than B, so $K_A > K_B$. If both are stretched by the same force, on which spring is more work done?
2. Two springs A and B are identical except that A is harder than B, so $K_A > K_B$. If both are stretched by the same amount, on which spring is more work done?
3. A spring of force constant K is cut into two equal pieces. Calculate force constant of each part.

3 Mark Questions

1. An elastic spring is compressed by an amount x . Show that its potential energy is $\frac{1}{2}kx^2$, where k is the spring constant.
2. 20 J work is required to stretch a spring through 0.1 m. Find the force constant of the spring. If the spring is further stretched through 0.1 m. Calculate work done.
3. To simulate car accidents, auto manufacturers study the collisions of moving cars with mounted springs of different spring constants. Consider a typical simulation with a car of mass 1000 kg moving with a speed of $18.0 \text{ km}\cdot\text{h}^{-1}$ on a smooth road and colliding with a horizontally mounted spring of spring constant $6.25 \times 10^5 \text{ N}\cdot\text{m}^{-1}$. What is the maximum compression of the spring?

Power

MCQ Questions (choose the correct option)

1. How much water can a pump of 2 kW raise in one minute to a height of 10 m? ($g = 10 \text{ m/s}^2$) —
 - (A) 1000 litres
 - (B) 1200 litres
 - (C) 10 litres
 - (D) 2000 litres

2 Mark Questions

1. Which of the two kilowatt hour or electron volt is a bigger unit of energy and by what factor?

3 Mark Questions

1. A car of mass 2000 kg is lifted up a distance of 30 m by a crane in 1 min. A second crane does the same job in 2 min. Do the cranes consume the same or different amounts of fuel? What is the power supplied by each crane? Neglect Power dissipation against friction.
2. A pump on the ground floor of a building can pump up water to fill a tank of volume 30 m^3 in 15 min. If the tank is 40 m above the ground, how much electric power is consumed by the pump. The efficiency of the pump is 30%.
3. Water is pumped out of a well 10 m deep by means of a pump rated 10 KW. Find the efficiency of the motor if 4200 kg of water is pumped out every minute. Take $g = 10 \text{ m/s}^2$
4. A man pulls a lawn roller through a distance of 20 m with a force of 20 kg weight. If he applies the force at an angle of 60° with the ground, calculate the power developed if he takes 1 min in doing so.
5. A truck of mass 1000 kg accelerates uniformly from rest to a velocity of $15 \text{ m}\cdot\text{s}^{-1}$ in 5 s. Calculate (i) its acceleration, (ii) its gain in kinetic energy, (iii) the average power of the engine during this period. Neglect friction.
6. An elevator which can carry a maximum load of 1800 kg (elevator + passengers) is moving up with a constant speed of 2 ms^{-1} . The frictional force opposing the motion is 4000 N. Determine the minimum power delivered by the motor to the elevator in watts as well as in horse power.

Collisions

MCQ Questions (choose the correct option)

1. A block of mass 0.5 kg is moving with a speed of 2 m/s on a smooth surface. It strikes another mass of 1 kg at rest and then they move together as a single body. The energy loss during the collision is —
(A) 0.16 J
(B) 1.00 J
(C) 0.67 J
(D) 0.34 J
2. A bullet fired into a fixed target loses half of its velocity after penetrating a distance of 3 cm. How much further will it penetrate before coming to rest, assuming it faces constant resistance to its motion? —
(A) 3 cm
(B) 2.0 cm
(C) 1.5 cm
(D) 1.0 cm
3. A block of mass m collides with another stationary block of mass $2m$. The lighter block comes to rest after the collision. If the velocity of the first block is V , the value of the coefficient of restitution will be —
(A) 0.5
(B) 0.4
(C) 0.6
(D) 0.8
4. During an inelastic collision between two bodies, which of the following quantities always remains conserved? —
(A) Total kinetic energy
(B) Total mechanical energy
(C) Total linear momentum
(D) Speed of each body
5. Two bodies with kinetic energies in the ratio 4 : 1 are moving with equal linear momentum. The ratio of their masses is —

- (A) 4 : 1
- (B) 1 : 1
- (C) 1 : 2
- (D) 1 : 4

6. A ball is dropped from a height h on to the ground, where the coefficient of restitution is e . After one bounce the maximum height attained is —

- (A) e^2h
- (B) ev/h
- (C) eh
- (D) $\sqrt{eh}$

7. A bomb of mass 30 kg at rest explodes into two pieces of masses 18 kg and 12 kg. The velocity of the 18 kg mass is 6 m/s. The kinetic energy of the other mass is —

- (A) 324 J
- (B) 486 J
- (C) 256 J
- (D) 5245 J

1 Mark Questions

1. Two bodies stick together after collision. What type of collision is in between these two bodies?
2. Name a process in which momentum changes but K.E. does not.

3 Mark Questions

1. Prove that bodies of identical masses exchange their velocities after head-on elastic collision.
2. A bullet of mass 0.012 kg and horizontal speed 70 m/s strikes a block of wood of mass 0.4 kg and instantly comes to rest w.r.t. the block. The block is suspended from the ceiling by wire. Calculate the height to which the block rises. Also, estimate the amount of heat produced in the block.
3. Define elastic and inelastic collision. A lighter body collides with a much more massive body at rest. Prove that the direction of lighter body is reversed and massive body remains at rest.
4. A body of mass M at rest is struck by a moving body of mass m . Prove that fraction of the initial K.E. of the mass m transferred to the struck body is $4mM/(m + M)^2$ in an elastic collision.
5. Show that in an elastic one dimensional collision the relative velocity of approach before collision is equal to the relative velocity of separation after collision.
6. A railway carriage of mass 9000 kg moving with a speed of $36 \text{ km}\cdot\text{h}^{-1}$ collides with a stationary carriage of the same mass. After the collision the carriages get coupled and move together. What is their common speed after the collision? What type of collision is this?
7. Two identical 5 kg blocks are moving with the same speed of $2 \text{ m}\cdot\text{s}^{-1}$ towards each other along a frictionless horizontal surface. The two blocks collide, stick together and come to rest. Considering the two blocks as a system, calculate the work done by (i) external forces and (ii) internal forces.

Motion in a Vertical Circle

MCQ Questions (choose the correct option)

1. A mass of 5 kg is moving along a circular path of radius 1 m. If the mass moves with 300 rev/min, its kinetic energy would be —
 - (A) $250\pi^2 \text{ J}$
 - (B) $100\pi^2 \text{ J}$

(C) $5\pi^2 \text{ J}$

(D) 0 J