	INDIAN SCHOOL AL WADI AL KABIR	
Class: XI	**Department: SCIENCE 2024 – 25** **SUBJECT: PHYSICS**	**Date of submission:** **10-09-2024**
Worksheet No: 05 **WITH ANSWERS**	**CHAPTER / UNIT: WORK, ENERGY AND POWER**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT:	**CLASS & SEC:**	**ROLL NO.:**

OBJECTIVE TYPE OF QUESTIONS (1 MARK):

1) Which of the following unit represent dimensional formula $[ML^2T^{-2}]$?
   a) joule
   b) Horse power
   c) Watt
   d) Pascal

2) A particle is thrown upward with some kinetic energy. What happens to its kinetic energy at the highest point?
   a) Its kinetic energy is lost
   b) Its kinetic energy is absorbed by the air
   c) Its kinetic energy is converted into potential energy
   d) Its kinetic energy remains same.

3) A body is falling freely under the action of gravity alone in vacuum. Which of the following quantities remain constant during the fall?
   a) Kinetic energy
   b) Potential energy
   c) Total mechanical energy
   d) Total linear momentum

4) During inelastic collision between two bodies, which of the following quantities always remain conserved?
   a) Total kinetic energy
   b) Total mechanical energy
   c) Total linear momentum
   d) Speed of each body

5) What is the smallest unit of power?
   a) watt
   b) kilowatt
   c) Horse power
   d) milliwatt

6) If the velocity of the object is increased by 0.1%, then the kinetic energy is increased by
   a) 0.1%
   b) 0.2%
   c) 0.4%
   d) 0.01%

7) A body of mass 1 kg is rotating in a circular path of radius 1m with constant velocity of 5 rev/sec. the work done in one complete revolution is
   a) 5 J
   b) 2.5 J
   c) 12.5 J
   d) 0 J

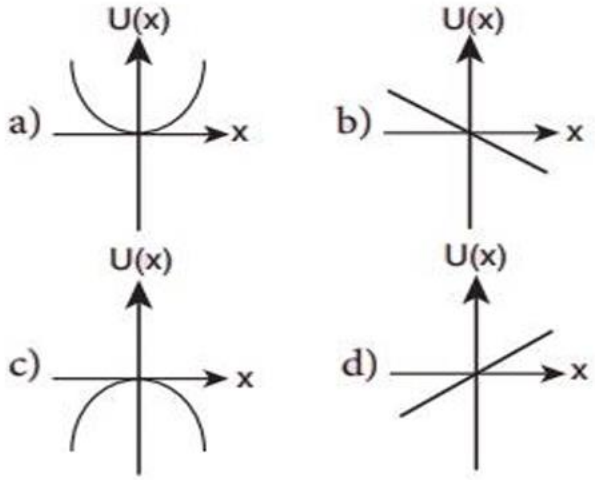
8) Work done by a person against friction force always results in a:
   a) loss of kinetic energy
   b) loss of potential energy
   c) gain in kinetic energy
   d) None of them

9) Consider 2 balls A and B of same mass. The potential energy of ball A is thrice that of ball B. how high is ball A compared to ball B?
   a) Same height as ball B
   b) Twice as high as ball B
   c) Thrice as high as ball B
   d) Four times as high as ball B

10) A spring with an initial stretch of 0.2 m has a force constant 10 N/m. When the stretch is changed to 0.25 m, the increase in potential energy is:
   a) 0.2 J
   b) 0.3 J
   c) 0.1 J
   d) 0.5 J

11) The potential energy of a system increases, if work is done
   a) By the system against a conservative force
   b) By the system against a non-conservative force
   c) Upon the system by a conservative force
   d) Upon the system by a non-conservative force

12) A particle is placed at the origin and a force F=-kx is acting on it (where k is a positive constant). If U(0)=0, the graph of U(x) versus x will be (where U is the potential energy function)



13) In elastic collision, 100% energy transfer takes place when
   a) $m_1 = m_2$
   b) $m_1 > m_2$
   c) $m_1 < m_2$
   d) $m_1 = 2m_2$

14) A ball of mass M moving with a velocity V collides head on elastically with another of same mass but moving with a velocity v in the opposite direction. After collision,
   a) the velocities are exchanged between the two balls.
   b) both the balls come to rest
   c) both of them move at right angle to the original line of motion
   d) one ball comes to rest and another ball travels back with velocity

15) A lift of mass 200 kg moves upwards with a uniform velocity of 4 m/s, if the efficiency of its motor is 70%, the input power of the motor is
   a) 11.2 kW
   b) 7.84 kW
   c) 5.49 kW
   d) 4.63 kW

ASSERTION AND REASONING TYPE OF QUESTIONS (1 MARK):

DIRECTION: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
c) If Assertion is true but Reason is false.
d) If both Assertion and Reason are false.

16) **Assertion:** When a body moves along a circular path no work is done by the centripetal force.
Reason: The centripetal force is used in moving the body along a circular path and hence no work is done.

17) **Assertion:** If linear momentum of a body increases by 50% its kinetic energy will increase by 125%
Reason: kinetic energy is proportional to square of velocity if mass is constant.

18) **Assertion:** Both linear momentum and kinetic energy for a system are conserved in all collisions.
Reason: Conservation of Linear momentum and kinetic energy for a system depends on conservative and non-conservative forces acting on the system.

19) **Assertion:** Graph between potential energy of a spring v/s the extension / compression (x) of the spring is a straight line
Reason: Potential energy is directly proportional to x.

VERY SHORT ANSWER TYPE OF QUESTIONS: (2 MARK)

20) State and prove work energy theorem.
21) A lorry and a car with the same kinetic energy are brought to rest by the application of brakes which provide equal retarding force. Which of them will come to rest in a shorter distance?
22) In lifting a 10 kg weight to a height of 2m, 250 joule of energy is spent. Calculate acceleration with which it was raised? ($g=10\ m/s^2$)
23) How high must a body be lifted to gain an amount of P.E. equal to the K.E. when moving at a speed 20 m s^{-1}. (The value of acceleration due to gravity at a place is 9.8 m s^{-2}).
24) 20 J work is required to stretch a spring through 0.1 m. Find the force constant of the spring. If the spring is stretched further through 0.1m calculate work done?
25) Derive an expression for K.E. of a body of mass 'm' moving with velocity 'v'
26) 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%.
27) Two springs A and B with constants k_A and k_B ($k_A > k_B$) are given. In which of the springs more work is to be done if
    (i) They are stretched by the same amount
    (ii) They are stretched by same force.

SHORT ANSWER TYPE OF QUESTIONS (3 MARKS):

28) An elastic spring is compressed by an amount x. Show that its P.E. is $1/2\ kx^2$ where k is the spring constant.

29) 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.

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

31) Find % change in K.E of body when its momentum is increased by 50%.

32) 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.

33) Draw a plot of spring force versus displacement. Hence find an expression for the potential energy of an elastic stretched spring.

CASE STUDY TYPE OF QUESTIONS (4 MARKS):

34) The term collision does not necessarily mean that a particle or a body must actually strike another. In fact, two particles may not even touch each other and yet they are said to collide if one particle influences the motion of the other. When two bodies collide, each body exerts an equal and opposite force on the other. The fundamental conservation law of physics is used to determine the velocities of the bodies after the collision. Collision may be elastic or inelastic. Thus a collision may be defined as an event in which two or more bodies exert relatively strong forces on each other for a relatively short time. The forces that the bodies exert on each other are internal to the system. Almost all the knowledge about the sub-atomic particles such as electrons, protons, neutrons, muons, quarks, etc. is obtained from the experiments involving collisions. There are certain collisions called nuclear reactions in which new particles are formed. For example, when a slow neutron collides with a U235 nucleus, new nuclei Ba141 and Kr92 are formed. This collision is called nuclear fission. In nuclear fusion, two nuclei deuterium and tritium collide (or fuse) to form a helium nucleus with the emission of a neutron.

i. Which one of the following collisions is not elastic?

a) A hard steel ball dropped on a hard-concrete floor and rebounding to its original height.
b) Two balls moving in the same direction collide and stick to each other.
c) Collision between molecules of an ideal gas.
d) Collisions of fast neutrons with hydrogen atoms in a fission reactor.

ii. Which one of the following statements is true about inelastic collision?

a) The total kinetic energy of the particles after collision is equal to that before collision.
b) The total kinetic energy of the particle after collision is less than that before collision.

c) The total momentum of the particles after collision is less than that before collision.

d) Kinetic energy and momentum are both conserved in the collision.

iii. In Perfect elastic collision, For a system of particles,

a) Only energy is conserved.

b) Only momentum is conserved.

c) Neither energy nor momentum is conserved.

d) Both energy and momentum are conserved.

iv. A lead ball strikes a wall and falls down, a tennis ball having the same mass and velocity strikes the wall and bounces back. Check the correct statement.

a) The lead ball suffers a greater change in momentum compared with the tennis ball

b) The tennis ball suffers a greater change in momentum as compared with the lead ball

c) The momentum of the lead ball is greater than that of the tennis ball

d) Both suffer an equal change in momentum

OR

A shell initially at rest explodes into two pieces of equal mass, then the two pieces' will

a) Move with different velocities in different directions

b) Be at rest

c) Move with the same velocity in the same direction.

d) Move with the same velocity in opposite directions.

35) When a force is applied on a body and the body is displaced in the direction of force, then the kinetic energy of the body changes. This change in the kinetic energy of the body is measured in terms of work, i.e. the change in kinetic energy of the body must be equal to work done. It is also known as work energy theorem. If m is the mass of body, u is initial velocity of body, v is final velocity of body then Work done = Change in kinetic energy, $W= ½ mv^2 - ½ mu^2$.

(i) The kinetic energy of a body of mass 2kg and momentum 2kgm/s

(a) 1J (b) 2J (c) 3J (d) 4 J

(ii) Two bodies of mass m and 4m have equal kinetic energies. Ratio of their linear momenta is:

(a) 1:4 (b)1:2 (c) 1:1 (d) 2:1

(iii) If the momentum is increase by 20% , then the KE is increases by: 25

(a) 48% (b) 40 % (c) 44 % (d) 35 %

(iv) Which of the following must be known in order to determine the power output of an automobile?

(a) Final velocity and height

(b) Mass and amount of work performed

(c) Force exerted and distance of motion

(d) Work performed and elapsed time of work

(v) When a force is applied on a body of mass 20kg, it changes its velocity from 5m/s to 10 m/s. The work done by the force is:

(a) 550J (b) 650J (c) 750J (d) 850J

Ans. (i) a (ii) b (iii) c (iv) d (v) c

LONG ANSWER TYPE OF QUESTIONS (5 MARK):

36) Show that at any instant of time during the motion total mechanical energy of a freely falling body remains constant. Show graphically the variation of K.E. and P.E. during the motion.

37) How does a perfectly inelastic collision differ from perfectly elastic collision? Two particles of mass m_1 and m_2 having velocities U_1 and U_2 respectively make a head on collision. Derive the relation for their final velocities. Discuss the following special cases.

(i) $m_1 = m_2$

(ii) $m_1 >> m_2$ and $U_2 = 0$

(iii) $m_1 << m_2$ and $U_1 = 0$

38) A body of mass 0.3 kg is taken up an inclined plane to 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. What is the

(i) work done by the gravitational force over the round trip.

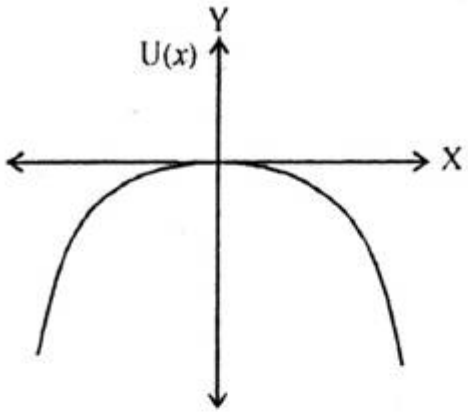
(ii) work done by the applied force over the upward journey.

(iii) work done by frictional force over the round trip.

(iv) kinetic energy of the body at the end of the trip.

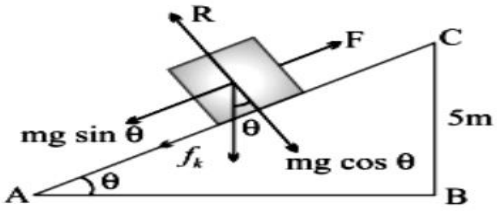
(v) How is the answer (iv) related to the first three answers?

39) A truck of mass 1000 kg accelerates uniformly from rest to a velocity of 15 m s^{-1} in 5 second. Calculate (i) its acceleration, (ii) its gain in K.E., (iii) average power of the engine during this period, neglect friction.

ANSWER KEY	
1	a)joule
2	c)Its kinetic energy is converted into potential energy
3	c)Total mechanical energy
4	c)Total linear momentum
5	d)milliwatt
6	b)0.2%
7	d)0 J
8	a)loss of kinetic energy
9	c)Thrice as high as ball B
10	c)0.1 J
11	a) By the system against a conservative force
12	 Given F = kx PE = U(x) as F = [{– dU(x)} / {dx}] hence [{– dU(x)} / {dx}] = kx $\int$ – dU(x) = $\int$ k.x dx hence – U(x) = k(x^2 / 2) U(x) = (– 1 / 2)kx^2 if we plot graph of U(x) Vs x then we will get
13	a)$m_1 = m_2$
14	a)the velocities are exchanged between the two balls.
15	a)11.2 kW
16	c) If Assertion is true but Reason is false.
17	a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
18	d) If both Assertion and Reason are false.

19	d) If both Assertion and Reason are false.
20	As per notes
21	If lorry and car both possess same kinetic energy and same retarding force should apply to stop them. Work done = F_{ret} × d = Kinetic energy; $d = \frac{K.E}{F_{ret}}$; and therefore both stop at same distance
22	$$work\ done = mah + mgh = mh(a + g)$$ $$a = \frac{work\ done}{mh} - g = \frac{250}{10 \times 2} - 10 = 2.5\ m/s^2$$
23	Given, K.E = P.E and also v = 20 m/s, g = 9.8 m/s^2, $$mgh = \frac{1}{2}mv^2$$ $$h = \frac{v^2}{2g} = \frac{20^2}{2 \times 9.8} = 20.4\ m$$
24	Given, Work done = 20 joule, x = 0.1 m $Work\ done = Potential\ energy\ (U) = \frac{1}{2}kx^2$ $$20 = \frac{1}{2}k \times 0.1^2; therefore, k = 4000\ N/m$$ When it stretched further 0.1 m then x = 0.2 m, then P.E (U') = $\frac{1}{2} \times 4000 \times 0.2^2 = 80\ J$ Change in P.E = 80 – 20 = 60 J
25	Refer notes
26	Given, Volume of the tank, V = 30 m^3, t = 15 min = 15 × 60 = 900 s, h = 40 m Efficiency (η) = 30%, Density of water, ρ = 1000 kg/m^3, then Mass of water, m = ρV = 30 × 10^3 kg Output power can be obtained as: $$Output\ power = \frac{Work\ done}{Time} = \frac{mgh}{t} = \frac{30 \times 10^3 \times 9.8 \times 40}{900} = \frac{11760 \times 10^3}{900}$$ $$= 13.06 \times 10^3 W = 13.06\ kW$$ $$\text{Efficiency } (\eta)\ \frac{input\ power}{output\ power} = \frac{P_o}{P_i} = 30\%$$ $$P_i = \frac{P_o}{\eta} = \frac{13.06 \times 10^3 \times 100}{30} = 0.435 \times 10^5\ W = 43.5 \times 10^3\ kW$$

27	Given $k_A > k_B$ Case (a) Stretched through same distance x. Work done by spring A , $W_A = \frac{1}{2}k_A x^2$ Work done by spring B , $W_B = \frac{1}{2}k_B x^2$ $\therefore W_A > W_B$ Case (b) Stretched by same force F Let spring A is stretched by x_A and spring B is stretched by x_B. Force $F = k_A x_A = k_B x_B \Rightarrow x_A < x_B$ Work done by spring A , $W_A = Fx_A$ Work done by spring B , $W_B = Fx_B$ $\therefore W_A < W_B$
28	Refer Notes
29	Refer Notes
30	Suppose the ball is dropped from a height h. Initial K.E.=mgh. $P.E. after\ the\ bounce\ = mg \times (80\%)h\ = \left(\frac{4}{5}\right)mgh$ $P.E. lost\ in\ each\ bounce = mgh\ - \left(\frac{4}{5}\right)mgh = \left(\frac{1}{5}\right)mgh$ $$Fraction\ of\ P.E. lost\ in\ each\ bounce = \frac{\left(\frac{1}{5}\right)mgh}{mgh} = 0.20 = 20\%$$
31	*Let initial momentum be p and kinetic energy be K* *From definition of momentum we can say, p=mv* *If p increases by 50%, the new momentum* $p' = p + \left(\frac{1}{2}\right)p = \left(\frac{3}{2}\right)p$ *Relation between kinetic energy and momentum is given by;* *We know that* $K = \left(\frac{p^2}{2m}\right)$ *Let K' is new kinetic energy, Ratio of Kinetic energy,* $$\frac{K'}{K} = \frac{\left(\frac{p'^2}{2m}\right)}{\left(\frac{p^2}{2m}\right)} = \frac{(p'^2)}{(p^2)} = \frac{\left(\left(\frac{3}{2}\right)p\right)^2}{(p^2)} = \frac{9}{4}$$ $$K' = \frac{9}{4}K$$

	If K′ is the increased kinetic energy, then, $$\%\ of\ change\ in\ K.E = \frac{K' - K}{K} \times 100 = \frac{\left(\frac{9}{4}K\right) - K}{K} \times 100 = 125\%$$
32	Given, mass = 2000 kg distance = 30 m Time t = 1 min =60 s; $$Work\ done\ = mgh = 2000 \times 9.8 \times 30 = 588\ kJ$$ As both cranes do same amount of work so both consume same amount of fuel. Power supplied by first crane $$Power\ = \frac{work\ done}{time} = \frac{588\ \times 10^3}{60} = 9.8\ kW$$ Power supplied by Second crane, here t = 2 min = 120 s $$Power\ = \frac{work\ done}{time} = \frac{588\ \times 10^3}{120} = 4.9\ kW$$
33	Refer Notes
34	b. Two balls moving in the same direction collide and stick to each other b. The total kinetic energy of the particle after collision is less than that before collision. d. Both energy and momentum are conserved. b. The tennis ball suffers a greater change in momentum compared with the lead ball Or d. Move with the same velocity in opposite directions.
35	(i) a (ii) b (iii) c (iv) d (v) c
36	Refer Notes
37	Refer Notes
38	 $\sin\theta = \frac{CB}{CA} = 0{\cdot}5$ $\therefore\ \theta = 30°.$ (i) work done by the gravitational force over the round trip. $W = F \times S = -\ mg\ sin\ \theta \times l = -\ 14 \cdot 7\ J$ is the W.D. by gravitational force in moving the body up the inclined plane. $W' = FS = +\ mg\ sin\ \theta \times l = 14 \cdot 7\ J$ is the W.D. by gravitational force in moving the body down the inclined plane. ∴ Total W.D. round the trip, W1 = W + W′ = 0.

	(ii) Force needed to move the body up the inclined plane, $F = mg\ sin\ \theta\ +\ f_k = mg\ sin\ \theta\ +\ R\ \mu_k = mg\ (sin\ \theta\ +\ \mu_k\ cos\ \theta)$ ∴ W.D. by force over the upward journey is $W2\ =\ F\ \times\ l\ =\ mg\ (sin\ \theta\ +\ \mu_k\ cos\ \theta)\ l\ =\ 18\cdot 5\ J$ $W2\ =\ F\ \times\ l\ =\ 0.3\ \times 9.8 \times \left(\frac{1}{2} + 0.15\left(\frac{\sqrt{3}}{2}\right)\right) \times 10 = 18.5\ J$ (iii) W.D. by frictional force over the round trip, $W3\ =\ -f_k\ (l\ +\ l) = -\ 2f_k\ l\ = -\ 2\mu_k\ mgcos\ \theta l\ = -\ 7\cdot 6\ J$ (iv)K.E. of the body at the end of round trip K.E. of the body at the end of round trip = W.D. by net force in moving the body down the inclined plane $K.E\ =\ mg\ (\sin\theta\ -\ \mu_k \cos\theta) l\ =\ 10\cdot 9\ J$ (v) $K.E.of\ body\ =\ net\ W.D.on\ the\ body.$
39	$a = \frac{v-u}{t} = 3\ \text{m/s}^2$ (ii) Gain in K.E. $= \frac{1}{2}m(v^2-u^2)$ $= 1{\cdot}125\times10^5$ J (iii) P = W/t = 22500 W

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