Work, Energy and Power (HA-1)

Total No. of Questions: 40 **Total Marks: 160**

SECTION 1: Physics

Q1 Find the work done by the external force acting at the end A of the chain in slowly pulling the chain completely onto the table (4 Marks)

A. $\frac{mg\ell}{9}$

B. $mg\ell$

C. $\frac{9}{10}\text{mg}\ell$

D. $\frac{10}{9}\text{mg}\ell$

Q2 A rod of mass m and length l is lying on a horizontal table. Work done in making it stand on one end will be (4 Marks)

A. mgl

B. $\frac{mgl}{2}$

C. $\frac{mgl}{4}$

D. $2mgl$

Q3 A particle of mass m at rest is acted upon by a force F for a time t. Its Kinetic energy after an interval t is (4 Marks)

A. $\frac{F^2t^2}{m}$

B. $\frac{F^2t^2}{2m}$

C. $\frac{F^2t^2}{3m}$

D. $\frac{Ft}{2m}$

Q4 A particle of mass moves along the quarter section of the circular path whose centre is at the origin. the radius of the circular path is _a...A force $\overrightarrow{F} = y\hat{i} - x\hat{j}$ newton acts on the particle , where x,y denote the coordinates of position of the particle . Calculate the work done by this force in taking the particle from point A (a,o) to point B(a,0) along the circular path. (4 Marks)

A. $\frac{\pi a^2}{4}J$

B. $\frac{\pi a^2}{2}J$

C. $-\frac{\pi a^2}{2}J$

D. $-\frac{\pi a^2}{4}J$

Q5 The potential energy function for the force between two atoms in a diatomic molecule is approximately given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$, where a and b are constants and x is the distance between the atoms. lf the dissociation energy of the molecule is $D = [U(x = \infty) - U_{at\ equilibrium}]$, then D is equal to (4 Marks)

A. $\frac{b^2}{2a}$
B. $\frac{b^2}{12a}$
C. $\frac{b^2}{4a}$
D. $\frac{b^2}{6a}$

Q6 A point mass m (neglect volume of the point mass) is floating on the surface of water contained by a vertical cylinder. The water is upto height H .Due to leakage at bottom of the cylinder, total water spread out near bottom of cylinder. The total mass of water is M . The work done by gravity is (4 Marks)

A. $Mg\frac{H}{2}$
B. $(m + M)gH$
C. $\left(m + \frac{M}{2}\right) gH$
D. $(m + M)g\frac{H}{2}$

Q7 A particle experiences a position-dependent force given by $F(x) = -6x^2 + 4x + 3/x^2$ where x is in meters and F is in Newtons (units have been abbreviated). At $x = 1m$, what is the potential energy of the particle relative to the potential energy at the origin? (4 Marks)

A. $+5J$
B. $+3J$
C. $-3J$
D. $-5J$
E. Cannot be determined

Q8 A small block of mass m is kept on a rough inclined surface of inclination θ fixed in an elevator. The elevator goes up with a uniform velocity v and the block does not slide on the wedge. The work done by the force of friction on the block in time t will be then (4 Marks)

A. zero
B. mgvt $\cos^2\theta$
C. mgvt $\sin^2\theta$
D. mgvt $\sin 2\theta$

Q9 The kinetic energy K of a particle moving in a straight line depends upon the distance s as $K = as^2$ The force acting on the particle is (4 Marks)

A. $2as$
B. $2mas$
C. $2a$
D. $\sqrt{as^2}$

Q10 A cutting tool under microprocessor control has several forces acting on it. One force is $\vec{F} = -\alpha x y^2 \hat{j}$, a force in the negative y-direction whose magnitude depend on the position of the tool. The constant is $\alpha = 2.50\ N/m^3$. Consider the displacement of the tool from the origin to the point $x = 3.00\,m, y = 3.00\,m$. Calculate the work done on the tool by $\vec{F}$ if the tool is first moved out along the x-axis to the point $x = 3.00m,\ y = 0m$ and then moved parallel to the y-axis to $x = 3.00m, y = 3.00\,m$. (4 Marks)

A. $67.5J$
B. $85J$
C. $102J$
D. $7.5J$

Q11 You lift a suit case from the floor and keep it on a table. The work done by you on the suiitcase does not depend on. (4 Marks)

A. the path taken by the suitcase.
B. the time taken by you in doing work.
C. weight of the suitcase.
D. initial and final position.

Q12 A body of mass $6kg$ is under a force which causes displacement in it given by $S = \frac{t^2}{4}$ metres where r is time. The work done by the force in 2 seconds is (4 Marks)

A. $12J$
B. $9J$
C. $6J$
D. $3J$

Q13 At two positions kinetic energy and potential energy of a particle are $K_1 = 10J : U_1 = -20J, K_2 = 20J, U_2 = -10J$ (4 Marks)

In moving from 1 to 2,

A. work done by conservative force is positive
B. work done by conservative force is negative
C. work done by all forces is positive
D. work done by all forces is negative

Q14 A particle of mass m is initially at rest at the origin. It is subjected to a force and starts moving along the x-axis. Its kinetic energy K changes with time as dK/dt = γt, where γ is a positive constant of appropriate dimensions. Which of the following statements is (are) true? (4 Marks)

A. The force applied on the particle is constant
B. The speed of the particle is proportional to time
C. The distance of the particle from the origin increases linearly with time
D. The force is conservative

Q15 Which of the following statements is/are correct about work? (4 Marks)

A. In a certain reference frame, $W_{pseudo\ force} + W_{conservattive\ force} + W_{non-conservattive\ force} + W_{other\ forces} = \Delta K$
B. Work done by friction is always negative.
C. Work done by a force is defined as the dot product of the force and the displacement of the point of application of force.
D. Work done by conservative force in moving a body from A to B = potential energy of the body at A - potential energy of the body at B

Q16 A man is climbing a staircase. The energy he uses depends on : (4 Marks)

A. The height of the staircase.
B. The weight of his body.
C. The time taken to reach the top.
D. The mass of his body.

Q17 A particle of mass m is attached to a light string of length l, the other end of which is fixed. Initially the string is kept horizontal and the particle is given an upward velocity v. The particle is just able to complete a circle. Then (4 Marks)

A. The string becomes slack when the particle reaches its highest point
B. The velocity of the particle becomes zero at the highest point
C. The kinetic energy of the ball in initial position was $\frac{1}{2}mv^2 = mgl$
D. The particle again passes through the initial position

Q18 A man of mass m speeds up while running from rest to a speed v in a straight track along an inclined plane, after rising through a height h. (4 Marks)

$W_{gravity}$ = work done by gravity on the man.
$W_{friction}$ = work done by gravity on the man.
W_{man} = work done by man.
Which of the following options is correct regarding the various work done?

A. $W_{gravity}$ = -mgh
B. $W_{friction} > 0$
C. $W_{man} = mgh + \frac{1}{2}mv^2$
D. $W_{friction} = 0$

Q19 Two cars A and B of equal masses $100\ kg$ are moving on a straight horizontal road with same velocity $3\ m/s$. At t= 0 car A starts accelerating with constant acceleration of $2\ m/s^2$ (initial separation between cars is $25m$. Choose correct options (neglect length of cars) (4 Marks)

A. car A catches car B at t = 6 sec.
B. total work done of all forces on car B w.r.t. car A is zero in first 2 sec.
C. car A catch car B at t= 5 sec.
D. total work done by all forces on car A w.r.t. car B is nonzero in first 2 sec.

Q20 The potential energy of a particle of mass 5 kg moving in $x - y$ plane is given as $U = 7x + 24y$ J, and x and y being in metre. Initially at $t = 0$, the particle is at origin $(0, 0)$ moving with a velocity of $(8.6\hat{i} + 23.2\hat{j})\ ms^{-1}$.Then, (4 Marks)

A. The velocity of the particle at $t = 4\ \ s$, is $5\ ms^{-1}$
B. The acceleration of the particle is $5\ ms^{-2}$
C. The direction of motion of the particle initially (at $t = 0$) is at right angles to the direction of acceleration
D. The path of the particle is circle

Q21 Imagine that an object is falling through a long straight glass tube held vertical, the air has been removed completely from the tube. The object does not touch the walls of the tube. Will the object experience any force of friction? (Yes/No) (4 Marks)

Q22 Can a body possess K.E without having momentum? (Yes/ No) (4 Marks)

Q23 The potential energy of a particle is determined by the expression $U = \alpha(x^2 + y^2)$, where α is a positive constant. The particle begins to move from a point with the coordinates $(3, 3)(m)$, only under the action of potential field force. Then its kinetic energy T at the instant when the particle is at a point with the coordinates $(1, 1)(m)$ is $\alpha k/2$. Find the value of k (4 Marks)

Q24 The work done in pushing a block of mass 10 kg from bottom to the top of a frictionless inclined plane 5 m long and 3 m high is : $\left(g = 9.8 m/sec^2\right)$ (4 Marks)

Q25 Under a force $10\hat{i} - 3\hat{j} + 8\hat{k}$ newton a body of mass $5kg$ moves from position $(6\hat{i} + 5\hat{j} - 3\hat{k})\, m$ to $(10\hat{i} - 2\hat{j} + 7\hat{k})\, m$. The work done by the force is: (4 Marks)

Q26 A locomotive of mass m starts moving so that its velocity varies according to the law $v = a\sqrt{s}$, where a is a constant, and s is the distance covered. The total work performed by all the forces which are acting on the locomotive during the first t seconds after the beginning of motion is $W = \frac{ma^4t^2}{x}$. Find x. (4 Marks)

Q27 The potential energy (in SI units) of a particle of mass 2 kg in a conservative field is U = 6x - 8y. If the initial velocity of the particles is $\vec{u} = -1.5\hat{i} + 2\hat{j}$, then find the total distance travelled by the particle in the first two seconds. (4 Marks)

Q28 A particle of mass m_1 is projected to the right with a speed v_1 onto a smooth wedge of mass m_2 which is simultaneously projected due to the left with a speed v_2. Highest point on the wedge attained by the particle is $\frac{m_2(v_1 + v_2)^2}{xg(m_1 + m_2)}$. Find x. (4 Marks)

Q29 A $24kg$ projectile is fired at an angle of 53° above the horizontal with an initial speed of $50m/s$. At the highest point in its trajectory, the projectile explodes into two fragments of equal mass, the first of which fall vertically with zero initial speed. How far (in m) from the point of firing does the second fragment strike the ground? (Assume the ground is level) (4 Marks)

Q30 A particle of mass m moves along a circle of radius R with a normal acceleration varying with time as $w_n = at^2$, where a is a constant. If P denotes the time dependence of the power developed by all the forces acting on the particle, and P_{avg} denotes the mean value of this power averaged over the first t seconds after the beginning of motion. Find $\frac{P}{P_{avg}}$ (4 Marks)

Q31 A man having a box on his head, climbs up a slope and another man having an identical box walks the same distance on a levelled road. Who does more work against the force of gravity and why? (4 Marks)

Q32 An object of mass 15 kg moving with a uniform velocity 4m/s. What is the kinetic energy possessed by the obejct? (4 Marks)

Q33 To what height should a body of mass 5 kg be raised so that its potential energy is 490 J? Take, $g = 9.8\, m/s^2$ (4 Marks)

Q34 What are conservative forces? (4 Marks)

Q35 A frightened child is restrained by her mother as the child slides down a frictionless playground slide. If the force on the child from the mother is 100 N up the slide, the child's kinetic energy increases by 30 J as she moves down the slide a distance of 1.8 m. (a) How much work is done on the child by the gravitational force during the 1.8 m descent?
(b) If the child is not restrained by her mother, how much will the child's kinetic energy increase as she comes down the slide that same distance of 1.8 m? (4 Marks)

Q36 If a man of mass 50 kg takes 60 s to climb up 20 steps, each 15 cm high, calculate his power. (4 Marks)

Q37 $40kg$ of water flows out of a tap at uniform speed of $5ms^{-1}$. Calculate the amount of energy possessed by water. (4 Marks)

Q38 A water pump raises 50 litres of water through a height of $25\,m$ in $5\,s$. Calculate the power which the pump supplies.
(Take $g = 10\,N\,kg^{-1}$ and density of water = $1000\,kg\,m^{3}$) (4 Marks)

Q39 Force acting on a particle in a conservative force field is:
(i) $F = (2\hat{i} + 3\hat{j})$
(ii) $F = (2x\hat{i} + 2y\hat{j})$
(iii) $F = (y\hat{i} + x\hat{j})$
Find the potential energy function, if it is zero at origin. (4 Marks)

Q40 A stone falls down without initial velocity from a height h onto the Earth's surface. The air drag assumed to be negligible, the stone hits the ground with velocity $v_0 = \sqrt{2gh}$ relative to the Earth. Obtain the same formula in terms of the reference frame "falling" to the Earth with a constant velocity v_0. (4 Marks)

SECTION 2: Chemistry

SECTION 3: Maths