TOPIC WISE MULTIPLE CHOICE QUESTIONS

4.1 WORK DONE BY A CONSTANT FORCE

(1) Work is the dot product of

(a) force and distance **(b)** force and velocity
(c) force and energy **(d)** force and displacement

(2) Work done is maximum when the angle between force and displacement is

(a) 0° **(b)** 30°
(c) 60° **(d)** 90°

(3) Work has dimensions as that of **LHR-2018 (G-I)**

(a) momentum **(b)** power
(c) torque **(d)** force

(4) Work done will be zero when angle between $\vec{F}$ and $\vec{d}$ is: **LHR 2016 (G-II)**

(a) 120° **(b)** 90°
(c) 60° **(d)** 0°

(5) Scalar product of force and velocity is: **FSD 2019 (G-I)**

(a) work **(b)** power
(c) energy **(d)** acceleration

(6) Dimension of work is

(a) [MLT] **(b)** $[ML^2T^{-1}]$
(c) $[MLT^{-2}]$ **(d)** $[ML^2T^{-2}]$

(7) Work can be defined as

(a) $W = Fd\cos\theta$ **(b)** $W = Fd\sin\theta$
(c) $W = \vec{F}\times\vec{d}$ **(d)** $W = \vec{F}.\vec{v}$

(8) Work done is negative if θ is **FSD-2018**

(a) 30° **(b)** 60°
(c) 180° **(d)** 90^0

(9) At which angle between force and displacement work done by force is half than its maximum

(a) 30^o **(b)** 45^o
(c) 60^o **(d)** 90^o

(10) Dimension of work is same that of

(a) momentum **(b)** torque
(c) power **(d)** inertia

(11) The component of force in the direction of the displacement 'd' is

(a) F sinθ **(b)** F cosθ
(c) F tanθ **(d)** F (d sinθ)

(12) **If $\theta < 90^0$ work is said to be**
(a) negative **(b)** positive
(c) zero **(d)** none of these

(13) **When force and displacement are in opposite direction then the work done is taken as**
(a) positive **(b)** Negative
(c) zero **(d)** Infinite

(14) **1 Joule =**
(a) N m **(b)** Ns
(c) N m^{-1} **(d)** N s^{-1}

(15) **Work is a**
(a) scalar quantity **(b)** vector quantity
(c) fixed quantity **(d)** constant quantity

(16) **If $\theta > 90^0$ work is said to be**
(a) negative **(b)** positive
(c) zero **(d)** none of these

(17) **The work done would be zero, if the angle between force and displacement is**
(a) 180° **(b)** 45°
(c) 0° **(d)** 90^o

(18) **The unit of work in CGS system is**
(a) joule **(b)** Newton
(c) dyne **(d)** erg

(19) **When a person holding a pail by the force $\vec{F}$ is moving forward then the work being done on the pail is**
(a) maximum **(b)** negative
(c) minimum **(d)** zero

(20) **1erg =**
(a) 10^{10} J **(b)** 10^{-7} J
(c) 10^{7} J **(d)** 10^{-5} J

(21) **A body of mass 4kg is moving with a velocity of 4m/sec. How much force is required to stop the body with in a distance of one meter**
(a) 16N **(b)** 32N
(c) 8N **(d)** 64N

(22) **The work is said to be 1 J when the force of 1N moves the body in its direction through a distance of**
(a) 1 cm **(b)** 1m
(c) 1mm **(d)** 1km

(23) **Area under force displacement curve gives**
(a) distance covered **(b)** work done
(c) power **(d)** none

(24) **Work done by a person holds a bag of groceries while standing still is**
(a) positive **(b)** negative
(c) zero **(d)** none of these

4.2 WORK DONE BY A VARIABLE FORCE

(25) **When rocket moves away from the Earth, then work is done**
(a) against centripetal force **(b)** against force of gravity
(c) against magnetic force **(d)** against electrostatic force

(26) **Work is a quantity which can be represented by**
(a) numerical value (b) unit
(c) direction (d) both a & b

(27) **Work done by a variable force making angles at different points with displacement in moving the particle from one point to another is equal to the area under the curve of**
(a) F sin θ versus d (b) F cos θ versus d cos θ
(c) F cos θ versus d (d) F versus d cos θ

(28) **When force acting on body is variable then work is determined by dividing**
(a) force into intervals (b) displacement into intervals
(c) both force and displacement into intervals (d) all are correct

(29) **Force of gravity varies as the ____________ square of distance from the Earth's center.**
(a) direct (b) inverse
(c) reverse (d) none of these

(30) **Work done by a variable force for the first interval is**
(a) $F_n \cos\theta_n \Delta d_n$ (b) $F_1 \cos\theta_1 \Delta d_1$
(c) $F_2 \cos\theta_2 \Delta d_2$ (d) $F_3 \cos\theta_3 \Delta d_3$

4.3 WORK DONE BY GRAVITATIONAL FIELD

(31) **Which of the following is non conservative force**
(a) friction (b) air resistance
(c) tension in string (d) all of them

(32) **Which is non conservative force?** **FSD 2016 (G-I)**
(a) electric force (b) magnetic force
(c) gravitational force (d) frictional force

(33) **Which one is a conservative force:** **BWP-2017 (G-II)**
(a) Elastic spring force (b) Frictional force
(c) Air resistance (d) Tension in the string

(34) **A force of 10N acts on the body and body moves 10m distance perpendicular to it. Work done by the force on the body is**
(a) 10J (b) 100J
(c) zero (d) infinite

(35) **A field in which work done in moving a body in a closed path is zero is called**
(a) gravitational field (b) electric field
(c) conservative field (d) ideal field

(36) **Which one is the bigger unit of work**
(a) 10J (b) kilo joule
(c) mega joule (d) kilo watt hour

(37) **In conservative field the work done is independent of**
(a) path followed by the body (b) direction
(c) force (d) none of these

(38) **The total work done in a closed path in gravitational field is**
(a) maximum (b) constant
(c) zero (d) none of these

(39) **If a body of weight w is lifted through a height 'h' from ground, then the work done by the gravity will be**
(a) wg (b) wh
(c) –wh (d) zero

(40) The field or space around the earth in which the gravitational forces acts on a body is called
(a) gravitational field (b) electric field
(c) magnetic field (d) ideal field

4.4 POWER

(41) Slope of work time graph is equal to
(a) force (b) velocity
(c) power (d) energy

(42) 1 Kilowatt hour is a unit of: RWP 2016 (G-I)
(a) energy (b) power
(c) pressure (d) force

(43) 3 joules of work is done in 3 seconds, then power is: MTN 2015 (G-II)
(a) 6 watt (b) 3 watt
(c) 18 watt (d) 1 watt

(44) Power is written by equation
(a) $\vec{F}.\vec{v}$ (b) $\vec{F}\times\vec{v}$
(c) $\vec{F}.\vec{d}$ (d) $\vec{F}\times\vec{d}$

(45) Kilo watt is unit of
(a) power (b) energy
(c) torque (d) momentum

(46) 1 MWh is equal to __________ joule
(a) 3.6×10^3 (b) 3.6×10^6
(c) 3.6×10^9 (d) 3.6×10^{12}

(47) The dimension of power is
(a) $[MLT^{-2}]$ (b) $[MLT^{-3}]$
(c) $[ML^{-1}T^{-2}]$ (d) $[ML^2T^{-3}]$

(48) If an agent consumes a power of 1kilo-watt in one hour, the work done is
(a) one watt (b) one kilo-watt
(c) one kilowatt-hour (d) zero

(49) The power needed to lift a mass of 5000g to height of 1m in 2sec is
(a) 24.5watt (b) 2.45watt
(c) 0.245watt (d) 245 watt

(50) The average power and instantaneous power becomes equal if the work is done at
(a) variable rate (b) uniform rate
(c) average rate (d) high rate

(51) One kilo watt hour is the amount of work done in
(a) one day (b) one year
(c) one month (d) one hour

(52) Power is one kilowatt if work is done at the rate of
(a) $1000Js^{-1}$ (b) $100Js^{-1}$
(c) 318MJ (d) $3.8\ MJs^{-1}$

4.5 & 4.6 ENERGY, ABSOLUTE P.E, ESCAPE VELOCITY, WORK ENERGY PRINCIPLE & INTERCONVERSION OF P.E AND K.E

(53) The energy possessed by a body due to its motion is called
(a) P.E **(b)** K.E
(c) elastic P.E **(d)** G.P.E

(54) If the velocity of an object is double then its K.E becomes: **MIRPUR (AJK) 2015, GRW-2019 (G-II)**
(a) double **(b)** constant
(c) four times **(d)** sixteen times

(55) ______ is non-conservative force. **GRW-2019 (G-I)**
(a) electric force **(b)** magnetic force
(c) gravitational force **(d)** frictional force

(56) A body of mass 1.0 kg drops form the top of a tower of height 50m, what will be its K.E, 10 m below the top **(LHR 2014)**
(a) 490 J **(b)** 49 J
(c) 98 J **(d)** 980 J

(57) A stone is thrown up from the surface of earth when it reaches at maximum height, its K.E. is equal to **(LHR 2013)**
(a) mgh **(b)** $\frac{1}{2}mv^2$
(c) Zero **(d) 2mgh**

(58) The energy needed to lift a mass of 5000g to height of 1m is **(FSD-2017)**
(a) 50 J **(b)** 25 J
(c) 5 J **(d)** 500 J

(59) The K.E of bullet of mass 500 gm moving at a speed of 200 ms^{-1} is: **(MTN 2015)**
(a) 250J **(b)** 125J
(c) 2500J **(d)** 10,000J

(60) Energy stored in spring is: **MTN-2016 (G-II)**
(a) elastic P.E. **(b)** gravitational P.E.
(c) K.E. **(d)** chemical P.E.

(61) One kilo watt hour is equal to: **BWP-2019 (G-I)**
(a) 3.6 MJ **(b)** 3.6 KJ
(c) 36 KJ **(d)** 36 MJ

(62) Consumption of Energy by a 60 Watt Electric Bulb in 2 seconds is: **BWP-2019 (G-II)**
(a) 120 J **(b)** 60 J
(c) 30 J **(d)** 0.5 J

(63) The work energy principle is valid for
(a) change in K.E **(b)** Change in P.E
(c) change in E.P.E **(d)** All type of energies

(64) If velocity of a body is doubled and its mass is also doubled then K.E of the body becomes
(a) doubles **(b)** four times
(c) eight times **(d)** one half

(65) Basic forms of mechanical energy are
(a) 3 (b) 2
(c) 5 (d) 4

(66) A body of mass five kg has P.E 98J. Its height from the ground is
(a) 10m (b) 5m
(c) 2m (d) 3m

(67) When we raise the body above the surface of the earth its P.E within the gravitational field
(a) increases (b) decreases
(c) become zero (d) remain same

(68) If a spring is compressed, the work done on it equals the
(a) decrease in P.E (b) increase in elastic P.E
(c) decrease in elastic P.E (d) none of these

(69) P.E of a body increases this means work done by gravity is
(a) positive (b) negative
(c) zero (d) infinite

(70) If a body raised up from the earth's surface, the work done changes the
(a) gravitational P.E (b) K.E
(c) Air resistance (d) elastic P.E

(71) Particles of different masses have same momentum. Which of them has the highest K.E which has
(a) least mass (b) least speed
(c) highest speed (d) highest mass

(72) The energy stored in the spring of watch is
(a) P.E (b) K.E
(c) elastic P.E (d) nuclear energy

(73) In a resistive medium, the loss of P.E of any body is
(a) equal to gain in K.E plus the work done against friction
(b) equal to loss in K.E plus the work done against friction
(c) equal to gain in K.E minus the work done against friction
(d) only equal to gain in K.E

(74) A body at rest may has
(a) momentum (b) velocity
(c) speed (d) potential energy

(75) When two protons are brought close to each other then their
(a) K.E increases (b) K.E and P.E both increases
(c) P.E increases (d) P.E and K.E remain same

(76) A brick of mass 2kg falls from height 10m. it velocity when its height is 5m
(a) $10ms^{-1}$ (b) $5ms^{-1}$
(c) $2ms^{-1}$ (d) $15ms^{-1}$

(77) In explosion which energy is changed into sound energy
(a) heat energy (b) nuclear energy
(c) molecular energy (d) chemical energy

(78) The energy stored in a dam is
(a) elastic P.E (b) gravitational P.E
(c) K.E (d) electric energy

(79) The velocity which is given to a body to enable it to reach at infinite distance from earth is called

(a) terminal velocity **(b)** orbital velocity
(c) final velocity **(d)** escape velocity

(80) If the speed of body increased by 3 times, then its K.E is increased by

(a) 3 times **(b)** 5 times
(c) 7 times **(d)** 9 times

(81) All the food a person eat in one day has about the same energy as

(a) 3 liter of petrol **(b)** 1.3 liter of petrol
(c) 1/3 liter of petrol **(d)** 2/3 liter petrol

(82) The energy stored in the catapult when it pulls is

(a) elastic P.E **(b)** P.E
(c) K.E **(d)** all of these

(83) Mathematical form of work energy principle is

(a) $Fd = \frac{1}{2}mv_i^2 - \frac{1}{2}mv_f^2$ **(b)** $Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
(c) $Fd = \frac{1}{2}mv_f - \frac{1}{2}mv_i$ **(d)** $Fd = \frac{1}{2}mv_f^2 + \frac{1}{2}mv_i^2$

(84) The relation P.E=mgh is the work done by the gravitational force is true only

(a) above the surface of earth **(b)** near the surface of earth
(c) below the surface of earth **(d)** at the infinity

(85) The relation P.E=mgh is true only near the surface of earth where the gravitational field is

(a) zero **(b)** constant
(c) maximum **(d)** minimum

(86) By neglecting the air friction, then relation for free falling body is

MTN-2018 (G-I)

(a) loss in P.E = gain in K.E **(b)** loss in P.E < gain in K.E
(c) gain in P.E > loss in K.E **(d)** none of these

(87) In the presence of air friction, the relation for free falling body is

(a) $mgh = \frac{1}{2}mv^2 - fh$ **(b)** $mgh = \frac{1}{2}mv^2 + fh$
(c) $mgh = fh - \frac{1}{2}mv^2$ **(d)** $mgh = fq + \frac{1}{2}mv^2$

(88) Which of the following is mechanical energy?

(a) P.E **(b)** K.E
(c) both a and b **(d)** none of these

(89) The total amount of energy at any point

(a) decreases **(b)** increases
(c) remain constant **(d)** zero

(90) A body of mass 5kg has P.E 100J. Its height from the ground is

(a) 10m **(b)** 8m
(c) 5m **(d)** 2m

(91) The absolute P.E of the body at the earth's surface

(a) $U_g = -\frac{GM}{2gR}$ **(b)** $U_g = -\frac{GMm}{R}$

(c) $U_g = -\frac{GMm}{gR}$ **(d)** $U_g = -\frac{GM}{2gR}$

(92) In the expression $U_g = -\frac{GMm}{R}$, the negative sign shows the earth's gravitational field for mass is

(a) zero **(b)** attractive

(c) repulsive **(d)** none of these

(93) Escape velocity of a body depends upon

(a) mass of planet **(b)** velocity of planet

(c) mass of body **(d)** both a & c

(94) The escape velocity of the earth is

(a) greater than moon **(b)** less than moon

(c) equal to the moon **(d)** none of these

(95) The relation between orbital and escape velocity is

(a) $V_{esc} = \frac{1}{\sqrt{2V_0}}$ **(b)** $V_{esc} = \sqrt{2}V_0$

(c) $V_{esc} = 2V_0$ **(d)** $V_{esc} = \frac{1}{2V_0}$

(96) The ratio of escape velocity to the orbital velocity is

(a) $\frac{1}{\sqrt{2}}$ **(b)** $\sqrt{2}$

(c) 1 **(d)** 2

4.7 CONSERVATION OF ENERGY

(97) Energy can be transformed from one kind into another but the total amount of energy

(a) changes **(b)** decrease

(c) remain same **(d)** all of these

(98) The conservation of energy is written as

(a) Total energy = K.E + P.E **(b)** total energy = K.E - P.E

(c) K.E + total energy = P.E **(d)** P.E + Total energy = K.E

ANSWER KEYS

(Topic Wise Multiple Choice Questions)

1	d	16	a	31	d	46	c	61	a	76	a	91	b
2	a	17	d	32	d	47	d	62	a	77	d	92	b
3	c	18	d	33	a	48	c	63	d	78	b	93	a
4	d	19	d	34	c	49	a	64	c	79	d	94	a
5	b	20	b	35	c	50	b	65	b	80	d	95	b
6	b	21	b	36	d	51	d	66	c	81	c	96	b
7	a	22	b	37	a	52	a	67	a	82	a	97	c
8	c	23	b	38	c	53	b	68	b	83	b	98	a
9	c	24	c	39	c	54	c	69	b	84	b		
10	b	25	b	40	a	55	d	70	a	85	b		
11	b	26	d	41	c	56	c	71	a	86	a		
12	b	27	c	42	a	57	c	72	c	87	b		
13	b	28	b	43	d	58	a	73	a	88	c		
14	a	29	b	44	a	59	d	74	d	89	c		
15	a	30	b	45	b	60	a	75	c	90	d		

SHORT QUESTIONS

(From Textbook Exercise)

4.1. A person holds a bag of groceries while standing still, talking to a friend. A car is stationary with its engine running. From the stand point of work, how are these two situations similar?

Ans: These two situations are similar because in both the situations, work done is zero. The reason is that the displacement covered in both the cases is zero, As

$W = \vec{F}.d$

$W = \vec{F}.0 \qquad (\because d = 0)$

$W = 0$

4.2. Calculate the work done in kilo joules in lifting a mass of 10 kg (at a steady velocity) through a vertical height of 10m.

FSD-14(G-I), LHR-14(G-I)&(G-II), BWP-15(G-I), SWL-16, MTN-16 (G-II), DGK-16 (G-II), LHR-16 (G-II), MTN-18 (G-I), SWL-19, RWP-19 (G-I), MTN-19 (G-II), LHR-19 (G-II)

Ans: Data Mass = m = 10 kg

Height = h = 10 m

Required

Work done = W =?

Solution

As we know that

W = mgh

Putting values

W = 10 × 9.8 x 10 = 980 J = 0.98 KJ

Result

So, the work done in kilo joule is 0.98 kJ

4.4. In which case is more work done? When a 50 kg bag of books is lifted through 50 cm, or when a 50 kg crate is pushed through 2m across the floor with a force of 50 N.

GRW-14(G-II), SGD-14(G-I), SGD-16 (G-II), MTN-16 (G-I), RWP-16 (G-I), LHR-16 (G-I), SWL-18

Ans: Case: I

Mass = m = 50kg

Height = h = 50cm = 0.5 m

$W_1 = m \times g \times h$

$W_1 = 50 \times 9.8 \times 0.5 = 245$ J

$\mathbf{W_1 = 245\ J}$

Case II

Mass = m = 50kg

Distance = d = 2m

Force = F = 50 N

$W_2 = Fd$

$W_2 = 50 \times 2$

$W_2 = 100$ J

W2 = 100J

Result

This shows that work done in lifting the bag of books is greater than the work done in pushing the crate.

4.5. An object has 1 J of potential energy. Explain what does it mean?

LHR-12,LHR-13(G-I),SGD-14(G-I),RWP-14(G-I),GRW-14(G-II),BWP-15(G-I), MTN-15(G-I)&(G-II), FSD-15(G-I),GRW-15(G-I),MIRPUR (AJK) 15, DGK-16 (G-I), BWP-16 (G-I), RWP-16 (G-I), GRW-16 (G-I), LHR-16 (G-I) & (G-II), SWL-17, LHR-17 (G-II), FSD-18, DGK-18 (G-I), GRW-18, GRW 19 (G-II)

Ans: It means that 1J work is done in lifting the body through some height and this work is stored in a body as potential energy and the body has ability to do one joule of work.

OR

If a body of weight 1N is lifted through height of one meter. Then potential energy stored in the body is said to be 1 Joule.

4.7. When a rocket re-enters the atmosphere, its nose cone becomes very hot. Where does this heat energy come from?

GRW-12, LHR-13(G-II), DGK-15(G-I), BWP-15(G-I), SGD-15(G-II), MTN-15(G-I), LHR-15(G-I), SWL-16, BWP-16 (G-I), FSD-17, LHR-17(G-I), LHR-18 (G-I), BWP-19 (G-I), FSD-19 (G-I)

Ans: When a rocket re-enters the atmosphere. It has to do work against air friction. As a result, some of its kinetic energy is converted into heat energy and as a result, its nose becomes hot.

4.9. A girl drops a cup from a certain height, which breaks into pieces. What energy changes are involved?

GRW-12,GRW-13(G-I),LHR-14(G-I),RWP-14(G-I),DGK-15(G-I),SGD-15(G-I)&(G-II),FSD-15(G-I), GRW-15(G-I), MIRPUR (AJK) 15, DGK-16 (G-I), SWL-18, DGK-18 (G-I), LHR-18 (G-II)

Ans: When a girl has a cup at certain height, cup has P.E. During the fall of cup, PE changes to KE which becomes maximum when cup hits the floor. This KE at floor breaks the cup into pieces producing sound and heat. Thus, KE changes to work done in breaking, sound and heat dissipated. Therefore, changes can be given as

P.E $\rightarrow$ KE $\rightarrow$ work + sound + heat.

If air resistance is considered then

P.E $\rightarrow$ work against friction + KE $\rightarrow$ work + sound + heat

TOPIC WISE SHORT QUESTIONS

4.1 WORK DONE BY A CONSTANT FORCE

(1) What is meant by work done by a constant force?

Ans: The work done on a body by constant force is defined as the product of the magnitude of the displacement and the component of the force in the direction of displacement.

We define work done w by the force $\vec{F}$ as the scalar product of $\vec{F}$ *and* $\vec{d}$

$$W = \vec{F}.\vec{d} = Fd\cos\theta = (F\cos\theta)d$$

The quantity $(F\cos\theta)$ is the component of the force in the direction of the displacement $\vec{d}$.

(2) When a person pushing the wall away, then how much work is done on the wall?

Ans: When the person pushes the wall away then displacement is zero

$$W = \vec{F}.\vec{d}$$

$$= Fd\cos\theta \qquad As \quad d = 0$$

$$= F(0)\cos\theta$$

W = 0

Hence, work is zero.

(3) What is the unit and dimension of work?

Ans: **Unit:** S.I unit of work is Joule. 1 Joule = 1N x 1m = Nm

Dimension:

$$W = Fd$$

$$[W] = [F][d]$$

Where $[F] = [MLT^{-2}]$

$[d] = [L]$

$$\Rightarrow [W] = [ML^2T^{-2}]$$

(4) Show that work done against frictional force is negative?

Ans: We know that $W = \vec{F}.\vec{d}$

$= Fd\cos\theta$

Since the frictional force is always opposite to the displacement. So θ = 180^o

$$W = Fd\cos(180^o)$$

$$W = -Fd \qquad \because \cos 180^o = -1$$

Hence work done against the frictional force is negative.

(5) Define work. Explain when it is maximum and when it is zero.

Ans: **Work:** The dot product of force and displacement is called work.

$W = \vec{F}.\vec{d}$

Maximum work:

The work done has its maximum value, when force $\vec{F}$ and displacement $\vec{d}$ are parallel to each other.

$W = \vec{F}.\vec{d}$

$= Fd\cos\theta \qquad \theta = 0^o$

$= Fd\cos(0^o)$

$W = Fd \qquad \because \cos 0^o = 1$

Zero work:

The work done has its minimum value, when force $\vec{F}$ and displacement $\vec{d}$ are perpendicular to each other.

$W = \vec{F}.\vec{d}$

$= Fd\cos\theta \qquad \theta = 90^o$

$= Fd\cos(90^o)$

$W = 0 \qquad \because \cos 90^o = 0$

(6) In what situation work done by a force on a body in positive, negative and zero?

FSD-2018

Ans: Work done is positive when force and displacement are in same direction.

W = F.d

= Fd cosθ

If θ = 0° =Fd cos (0^o) =Fd

Work done is negative when force and displacement are opposite to each other

$$W = \vec{F}.\vec{d}$$
$$= Fd\cos\theta$$
If $\theta = 180^o$
$$= Fd\cos\left(180^o\right)$$
$$W = -Fd$$

When the person pushes the wall away then displacement is zero

$$W = \vec{F}.\vec{d}$$
$$= Fd\cos\theta \qquad As \quad d = 0$$
$$= F(0)\cos\theta$$
$$W = 0$$

Hence work is zero.

(7) Define "Joule". **MTN-2018 (G-I)**

Ans: It is defined as:

"When a force of 1N acts on a body and it moves through a displacement of 1m in the direction of force then 1J of work is said to be done".

SI unit of work is joule. 1J=1Nm.

(8) Under what condition that work done on a body has its positive value?

Ans: Work done is given by $W = \vec{F}.\vec{d} = Fd\cos\theta$ --------- (i)

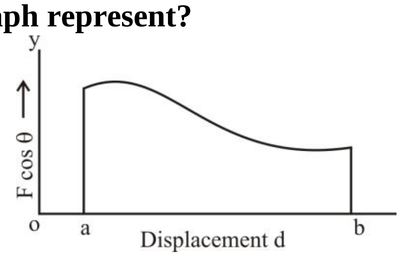
If the angle between force $\vec{F}$ and displacement $\vec{d}$ is less than 90^o then in this case $\cos\theta$ will have positive value.

So work will be positive according to above relation.

4.2 WORK DONE BY A VARIABLE FORCE

(9) What does the area under the force - displacement graph represent?

Ans: The area under the force – displacement graph represents the work done on the body. If a body covers some displacement $\vec{d}$ under the application of force $\vec{F}$ such that they are oriented at an angle θ. Then graph is drawn between d along x – axis and force along y – axis.



Area under graph = $\left(F\cos\theta\right)$ (d)

= Work done

(10) How can we calculate the work done in case of variable force?

Ans: Work done by a variable force is computed by dividing the path into very small displacement intervals such that during each displacement, force remained nearly constant. Then calculate the work done during each interval and take the sum of work done for all displacement intervals which gives

$$W = \sum_{i=1}^{n} F_i \cos\theta_i \Delta d_i$$

(11) What do you mean by variable force? Give its two examples. **SWL-2016 (G-I)**

Ans: The force whose value vary from point to point is called variable force.

OR

Force whose value does not remain same at different instant.

Examples:

- Motion of rocket against the gravity.
- Elongation of spring.

4.3 WORK DONE BY GRAVITATIONAL FIELD

(12) What is essential condition for conservative field?

Ans: A field is said to be conservative field if it follows the following conditions:

(i) In conservative field the work done is independent of the path followed.

(ii) Work done in a closed path must be zero in conservative field.

(13) Define Gravitational field. Is it conservative field?

Ans: Gravitational Field:

The space around the earth in which its gravitational force acts on a body is called gravitational field.

Yes, gravitational field is a conservative field because work done along a closed path in gravitational field is zero. Also work done in a gravitational field is independent of path follow.

(14) Define conservative field Give its two examples. LHR-2016 (G-II)

Ans: "The field in which the work done in moving a body from one place to another place is independent of the path followed."

Example: Gravitational field
Electric field

(15) Define work, gravitational field. SGD-2013

Ans: Work:

"The product of the magnitudes of the displacement and the component of force in the direction of displacement is called work".

Mathematically, $W=\vec{F}.\vec{d}$

$W=Fd\cos\theta$

Gravitational Field:

"The space around the earth in which its gravitational force acts on a body is called gravitational field."

(16) Differentiate between conservative and non-conservative forces. Give examples. FSD-2017

Ans:

Conservative Force	Non Conservative Force
• Work done by conservative force is independent of path followed	• Work done by non conservative force depends upon the path followed.
• Work done by conservative force along a closed path is zero.	• Work done by non conservative force along a closed path is not zero.
• Examples of conservative forces are gravitational force, elastic spring force and electric force etc.	• Example of non conservative forces are frictional force, air resistance, tension in string, normal force, propulsion force of rocket or motor.

(17) A car is moving in a circle of radius r. It completes four revolutions and terminates its journey at starting point. How much work is done by the car? Explain. LHR-2019 (G-I)

Ans: When a body move in a circle, force and displacement are perpendicular to each other

$W = \mathbf{F.d}$

$= Fd\cos\theta$

$= Fd\cos 90°$

$= 0$

So total work done will be zero to complete four revolution. Also in this case, the displacement of body is equal to zero because its initial and final position is same. So, when the displacement is work done will be zero.

4.4 POWER

(18) Define average power and instantaneous power.

Ans: Average Power:

It is the ratio of total work done to the total time taken by a body. If work ΔW is done in a time interval Δt then

$$P_{av} = \frac{\Delta W}{\Delta t}$$

Instantaneous Power:

It is defined as the work done in an extremely small interval of time (approaching to zero). $P_{ins} = \lim_{\Delta t \to 0} \frac{\Delta W}{\Delta t}$

(19) A 70 kg man runs up a long flight of stairs in 4s. The vertical height of the stairs is 4.5m. Calculate power output in watts.

Ans: m = 70kg

h = 4.5 m

t = 4sec

P =?

$$P = \frac{mgh}{t}$$

$$= \frac{70 \times 9.8 \times 4.5}{4}$$

$$P = 7.7 \times 10^2 W$$

(20) Prove the relation $P = \vec{F}.\vec{V}$

Ans: Consider a constant force $\vec{F}$ acts on a body and it moves through a displacement $\overrightarrow{\Delta d}$ in time Δt, then instantaneous power is given by

$$P_{ins} = \lim_{\Delta t \to 0} \frac{\Delta W}{\Delta t}$$

We know that $\Delta W = \vec{F}.\Delta\vec{d}$

$$P = \lim_{\Delta t \to 0} \frac{\vec{F}.\overrightarrow{\Delta d}}{\Delta t}$$

$$= \vec{F}.\lim_{\Delta t \to 0} \frac{\Delta\vec{d}}{\Delta t}$$

$$Since \lim_{\Delta t \to 0} \frac{\overrightarrow{\Delta d}}{\Delta t} = \vec{V}$$

Hence $P = \vec{F}.\vec{V}$

(21) What is the S.I unit of power? Define it.

Ans: S.I unit of power is watt.

Watt: When one joule of work is done in one second, then power is said to be one watt.

$$1watt = \frac{1J}{1S}$$

Or 1watt =Js^{-1}

(22) Prove that 1kWh = 3.6 MJ.

Ans: 1kWh = 1000W × 1hour

1kWh = 1000W × 3600 s

1kWh = 3.6×10^6J = 3.6 MJ

(23) Define power. Write its SI unit. **LHR-2012**

Ans: Power is defined as the rate at which work is done.

Mathematically, $\text{Power} = \frac{\text{work}}{\text{time}} = \frac{W}{t}$

Units of power:

The SI unit of power is watt which is defined as:

If one Joule of work is done in one second then power will be one watt.

$W = Js^{-1}$

(24) Convert 1.4 kW into joules/second. **RWP-2019 (G-I)**

Ans: 1.4 kW

1kW = 1000W

$=1.4\times100\ Js^{-1}$ $\therefore\ W=Js^{-1}$

$=1400\ Js^{-1}$

4.5 ENERGY AND WORK ENERGY PRINCIPLE

(25) A car is moving with constant speed along a level road with no net force acting on it. Is any work being done on the car?

Ans: When a car is moving with constant speed along a level road with no net force acting on it, the net work done on it is zero.

According to work energy principle,

Work done equals the change in its kinetic energy.

As speed of car is constant, so change in kinetic energy = 0

Therefore, net work done will be equal to zero.

(26) Define energy and write its basic forms?

Ans: **Energy:** It is defined as the capacity of a body to do work is called energy.

There are two basic forms of energy.

(i) Kinetic Energy

(ii) Potential Energy

Kinetic Energy: It is possessed by a body due to its motion and is given by the formula

$$K.E = \frac{1}{2}mv^2$$

Potential Energy: The energy possessed by a body due to its position in a force field e.g gravitational field

Mathematically P.E = mgh

(27) Define elastic P.E?

Ans: **Elastic P.E**: The energy stored in a compressed spring is the P.E possessed by the spring due to its compressed or stretched state is called elastic P.E.

(28) Explain Work Energy Pricnciple.

Ans This principle states that

"The work done on the body is equal to the change in its kinetic energy"

Explanation:

Consider a body of mass m is moving with velocity v_i. A force F acts through a distance d increases the velocity to v_f, then from equation of motion.

$$2as = v_f^2 - v_i^2 \quad \text{(since s=d)}$$

$$2ad = v_f^2 - v_i^2$$

$$d = \frac{1}{2a}(v_f^2 - v_i^2) \quad \text{.........(1)}$$

From 2nd Law of motion, F = ma .... (2)

Multiplying eq (1) and (2) we get

$$F.d = ma.\ \frac{1}{2a}(v_f^2 - v_i^2)$$

$$\textbf{or } \mathbf{Fd} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = \mathbf{K.E_f - K.E_i}$$

4.6 INTERCONVERSION OF P.E. AND K.E

(29) When an arrow is shot from its bow? It has K.E. From where does it get the kinetic Energy?

Ans: When we pull the string, we have to do some work. This work is stored in the string as its elastic potential energy.

When an arrow is shot from its bow this elastic potential energy is converted into the kinetic energy of the arrow.

4. 7 CONSERVATION OF ENERGY

(30) Define law of conservation of energy. **FSD-2019 (G-I)**

Ans: Law of conservation of energy states that "Energy can never be created nor be destroyed but it can be converted from one form to other, and the total amount of energy remains constant".