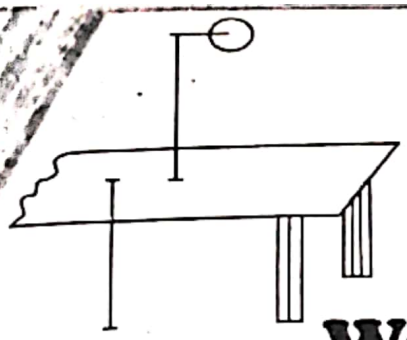


Chapter 4

WORK AND ENERGY

KEY POINTS

Work:

The product of the magnitude of the displacement and the component of force in the direction of displacement is called work

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

- SI unit of work is joule (J).
- The dimension of work is $[ML^2T^{-2}]$.
- Work is a **scalar** quantity.
- ***Positive Work***
  For $\theta < 90°$, work done is positive.
  Maximum positive work when $\theta = 0°$
- ***Negative Work***
  For $\theta > 90°$, work done is negative.
  Maximum negative work when $\theta = 180°$
- ***Zero work***
  Work will be zero
  When $\theta = 90°$,

Work done by variable force:

Work done by variable force is computed by dividing the path into very small displacement intervals and then taking the sum of works done for all such intervals.

i.e, $$\text{Work done} = \sum_{i=1}^{n} F_i \cos\theta_i \Delta d_i$$

Graphical Method:

Graphically, work done by a variable force in moving a particle between two points is equal to the area under the F Cosθ verses d curve between these two points.

Conservative Field:

The field in which the work done is independent of the path followed or work done in a closed path is zero, is called Conservative field

Conservative Forces:

Gravitational force, Elastic spring force, Electric Force etc.

Non Conservative Forces:

Frictional force, Air Resistance, Normal force, Tension in a string, propulsion force of a rocket and motor

Power: Time rate of doing work is called power.

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

Or $P = \mathbf{F.v}$

- Instantaneous power is given as;

$$P = \text{Lim}_{\Delta t \to 0} \Delta W / \Delta t$$

- Dimension of power: $[ML^2T^{-3}]$
- Unit of power: Watt or Js^{-1}

Work energy Principle

"Work done on the body equals change in its K.E" i.e.

$$\text{Work} = (K.E)_f - (K.E)_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

Energy: Ability of a body to do work is called energy.

- SI unit of work is joule (J).

Kinetic Energy:

- The energy possessed due to motion of an object is called K.E
- $K.E = \frac{1}{2}mv^2$

Gravitational potential Energy:

- The energy possessed by a body due to change in its position is called G.P.E
- P.E = mgh

Absolute P.E:

The absolute P.E on the surface of the earth is

$$U = -\frac{GMm}{R}$$

Inter Conversion of K.E and P.E.

- In absence of air friction, we get

Loss in P.E = Gain in K.E

$$mg(h_1 - h_2) = \frac{1}{2}m(v_2^2 - v_1^2)$$

- If a body is dropped from height 'h' to earth's surface in presence of air, then;

Loss in P.E = gain in K.E + work done against air friction.

$$mgh = \frac{1}{2}mv^2 + f\,h$$

$$mgh - fh = \frac{1}{2}mv^2$$

$$mgh = \frac{1}{2}mv^2 + fh$$

Conservation of Energy:

Energy cannot be destroyed. It can be transformed from one kind into another, but the total amount of energy remains constant

Non Conventional Sources of Energy:

1. Solar Energy
2. Energy from waves
3. Energy from the tides
4. Energy from waste products
5. Energy from Biomass
6. Geothermal Energy

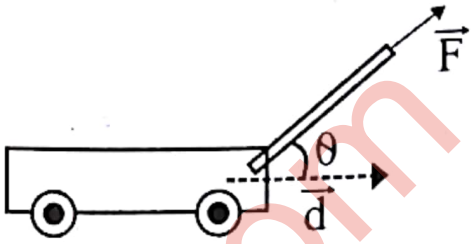
TOPICAL MULTIPLE CHOICE QUESTIONS

Topic 4.1:

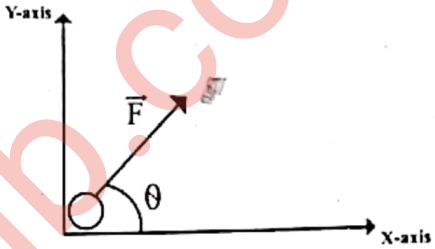
Work done by a constant force

(1) **Work becomes maximum for**
(a) θ=0°
(b) θ=90°
(c) θ=180°
(d) Both A and C

(2) **A grocery trolley is shown in the figure. For which value of "θ" the work done becomes half of its maximum?**
(a) 45°
(b) 30°
(c) 60°
(d) 90°



(3) **A force $\vec{F}$ acts on a body as shown in the figure due to which body moves along Y-axis. Which component of force does work in this car?**
(a) F_x
(b) F_y
(c) Fcosθ
(d) Both B and C



(4) **Work can be defined as**
(a) $W = Fd\cos\theta$
(b) $W = Fd\sin\theta$
(c) $W = \vec{F} \times \vec{d}$
(d) $W = \vec{F}.\vec{v}$

(5) **Work done is negative if θ is**
(a) 30°
(b) 60°
(c) 180°
(d) 90^0

(6) **At which angle between force and displacement work done by force is half than its maximum**
(a) 30^o
(b) 45°
(c) 60^o
(d) 90^o

(7) **Dimension of work is same that of**
(a) momentum
(b) torque
(c) power
(d) inertia

(8) **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)

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

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

(11) **1 Joule =**
(a) N m
(b) Ns
(c) $N\ m^{-1}$
(d) $N\ s^{-1}$

(12) **Which of the following work is greater?**
(a) +1000J
(b) 100J
(c) -1000J
(d) Both A and C are same

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

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

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

(16) 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

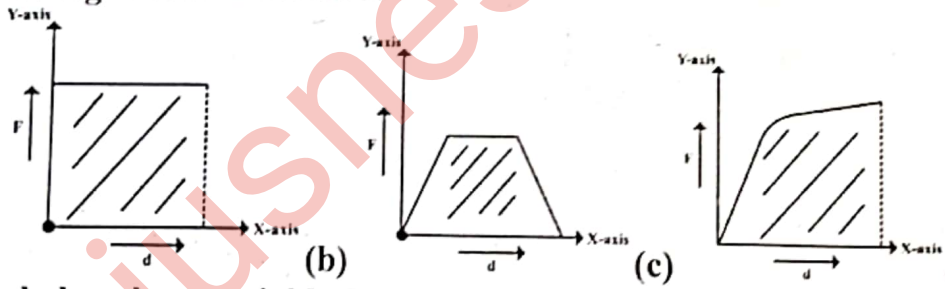
(17) 1 erg =
(a) 10^{10} J
(b) 10^{-7} J
(c) 10^7 J
(d) 10^{-5} J

Topic 4.2:

Work Done by a Variable Force

(18) 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

(19) A variable force "F" acts on a body such that it covers some distance then graphically work done can be calculated from area under F-d curve. Which of the following curves is suitable?



(a) (b) (c) (d) Both B and C

(20) 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

(21) 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

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

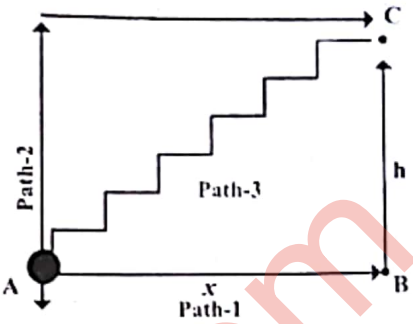
Topic 4.3:

Work Done by Gravitational Field

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

4) 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

5) A spherical object has to be taken to the point "C" from "A" through three different paths as shown in the figure. Considering the work to be done in the gravitational field, which path represent least change in energy?
(a) Path-1
(b) Path-2
(c) Path-3
(d) All have same change in energy



6) When work done by gravitational field is negative then P.E of the system.
(a) Increases
(b) Decreases
(c) Remains same
(d) None of these

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

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

9) When gravitational field does positive work then P.E of body
(a) Increase
(b) Decrease
(c) Remains same
(d) None of these

0) 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

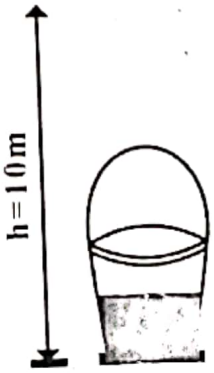
Topic 4.4:

Power

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

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

3) A bucket full of water having mass of 1000 kg is taken upto height of 10m in 10 seconds. What is the power developed?
(a) 1000 watt
(b) 10 kw
(c) 100 kw
(d) 1000 kw



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

5) 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

6) 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

7) 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

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

Topic 4.5 & 4.6:

Energy & Interconversion of P.E and K.E

39) A loaded and unloaded bus both are moving with the same K.E such that equal forces act on them and they finally stop. If S_1 is the distance covered by loaded bus and S_2 by unloaded before coming to rest then what is the true about them?
(a) $S_2=2S_2$ (b) $S_1=4S_2$
(c) $S_2=2S_1$ (d) $S_1=S_2$

40) The K.E of a body depends upon
(a) mass of body (b) displacement of body
(c) speed of body (d) both a and c

(41) A force of 100N acts on a body at angle 60° such that K.E of body increases to 800J from 200J. What is the work done by the force?
(a) 600J (b) 800J
(c) 1000J (d) -600J

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

(43) Escape velocity of a body is independent of
(a) mass of earth (b) radius of earth
(c) mass of body (d) both a & c

(44) Escape velocity from the surface of the moon is
(a) 11 km/sec (b) 2.4 km/sec
(c) 4.3 km/sec (d) 5 km/sec

(45) Absolute P.E of a body of mass one kg over the surface of the earth is
(a) $-\frac{GMm}{R}$ (b) $-\frac{GM}{R}$
(c) $\frac{GMm}{R}$ (d) $-\frac{GRm}{M}$

(46) Work energy principle is applicable on
(a) K.E (b) gravitational P.E
(c) elastic P.E (d) all of these

(47) A body of mass five kg has P.E 98J. Its height from the ground is
(a) 10m (b) 5m
(c) 2m (d) 8m

(48) 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

(49) **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

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

(51) **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

(52) **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

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

(54) **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

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

(56) **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

(57) **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) $15ms^{-1}$

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

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

(60) **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

(61) **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

(62) **The expression for the escape velocity on the surface of earth**
(a) $V_{esc} = \sqrt{2gR}$
(b) $V_{esc} = \sqrt{2GM_e}$
(c) $V_{esc} = 2g\sqrt{R}$
(d) $V_{esc} = 2\sqrt{gR}$

3) 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) $U_g = -\frac{GM}{2gR}$

4) 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

5) 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

66) The energy stored in the catapult when it pulls is

(a) elastic P.E (b) P.E

(c) K.E (d) all of these

67) 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) $Fd = \frac{1}{2}mv_f^2 + \frac{1}{2}mv_i^2$

(68) 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

(69) The energy of all the fossil fuel on the Earth is less than the energy reaching the earth from sunlight

(a) in 1 month (b) in 1 year

(c) in 10 days (d) in 10 minutes

(70) Escape velocity of a body depends upon

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

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

(71) 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

(72) The escape velocity of the earth is

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

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

(73) 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) $V_{esc} = \frac{1}{2V_0}$

(74) The ratio of escape velocity to the orbital velocity is
(a) $\frac{1}{\sqrt{2}}$ (b) $\sqrt{2}$
(c) 1 (d) 2

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

(76) 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) $mgh = fg + \frac{1}{2}mv^2$

(77) Which of the following is mechanical energy
(a) P.E (b) K.E
(c) both a and b (d) none of these

(78) The total amount of energy at any point
(a) decreases (b) increases
(c) remain constant (d) zero

Topic 4.7:

Conservation of Energy

(79) 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

(80) The original source of energy of tides is
(a) earth (b) sun
(c) moon (d) star

(81) Which one is not a nonrenewable energy source
(a) wind (b) oil
(c) tar sands (d) natural gas

Topic 4.8:

Non Conventional Energy Sources

(82) The water rises along coasts due to gravitational pull of
(a) moon (b) sun
(c) earth (d) sky

(83) On a clear day solar energy reaching the earth's surface is about
(a) 1.4 Kwm^{-2} (b) $1Kwm^{-2}$
(c) $0.4kwm^{-2}$ (d) $1.4Wm^{-2}$

(84) Total solar energy lost while traveling through atmosphere of earth is
(a) $1KWm^{-2}$ (b) $1.4kWm^{-2}$
(c) $0.4kWm^{-2}$ (d) $1.9kWm^{-2}$

(85) Which one includes the biomass
(a) crop residues (b) natural vegetation
(c) animal dung (d) all of these

(86) Bio fuel ethanol is produced by
(a) direct combustion (b) fermentation of biomass
(c) radioactive decay (d) compression of material

(87) **Biomass is a potential source of**
(a) energy (b) non renewable energy
(c) renewable energy (d) power

(88) **A hot spring that discharges steam and hot water intermittently releasing an explosive column in air is called**
(a) stove (b) mountain
(c) burner (d) geyser

(89) **Wind is a**
(a) non renewable energy source (b) renewable energy source
(c) both a and b (d) none of these

(90) **Heat within the earth generated by the**
(a) compression of heat (b) residual heat of the earth
(c) radioactive decay (d) all of these

(91) **Electric energy can be stored during sunlight in**
(a) Aluminum batteries (b) lead batteries
(c) nickel cadmium batteries (d) graphite batteries

(92) **The igneous rocks with in the 10km of the Earth's surface having the temperature about**
(a) 2000 ^{0}C (b) 1500 ^{0}C
(c) 200 ^{0}C or more (d) 900 ^{0}C

(93) **The waste materials obtained in the formation of biogas is a**
(a) good fertilizer (b) good liquid
(c) good oil (d) all

(94) **The function of turbine in the dam is to change**
(a) solar energy into mechanical energy (b) mechanical energy into electric energy
(c) electrical energy into mechanical energy (d) heat energy into mechanical energy

(95) **The solar cells convert**
(a) mechanical energy into electric energy (b) chemical energy into electrical energy
(c) electrical energy into chemical energy (d) solar energy into electrical energy

(96) **The function of Photo cells is to convert the light energy in to**
(a) mechanical energy (b) electrical energy
(c) heat energy (d) chemical energy

(97) **Hot igneous rocks in molten or partly molten state are found usually within**
(a) 100km of earth's surface (b) 10km of earth's surface
(c) 20km of earth's surface (d) 1km of earth's surface

(98) **A method of harnessing wave energy is to use large floats which move up and down with the waves was given by**
(a) Newton (b) Professor Siemens
(c) Professor Shaun (d) Professor Salter

(99) **A device of harnessing wave energy, is known as**
(a) Salter's duck (b) Salter's digester
(c) Salter's engine (d) Salter's float

(100) **Salter's duck consists of**
(a) turbines (b) duck float
(c) balance float (d) both b and c

(101) **The relative motion of the duck float is used to run**
(a) electricity generators (b) heat engine
(c) vehicles (d) turbines

(102) **Electrons in the silicon gain energy from the sunlight to create a**
(a) current (b) voltage
(c) force (d) watt

(From past papers 2012-2017)

(Federal Board)

(1) A 1 kg block slides down a smooth inclined plane whose height is 5 m. The veloc of the body at the bottom is _____ (FED 2012)

(a) $\sqrt{9.8}ms^{-1}$ (b) $5ms^{-1}$

(c) $9.8\ ms^{-1}$ (d) $7\sqrt{2}ms^{-1}$

(2) To evaluate gravitational P.E final point should be situate at _____.(FED 2013)

(a) Zero (b) 1000 km

(c) Infinite (d) None of these

(3) **The energy released by burning 1 liter of petrol is** **(FED 2014)**

(a) 1000J (b) $7 \times 10^5 J$

(c) $4 \times 10^5 J$ (d) $5 \times 10^7 J$

(4) **What is equal to one kilowatt-hour (1kWh)?** **(FDR 2016)**

(a) 3.6 kJ (b) 3.6 MJ

(c) 3.6 μJ (d) 3.6mJ

(5) **Which of the following expressions does not have the units equal to joule? Where 'P' is the linear momentum and 'm' is the mass of the object moving with velocity 'v'.** **(FDR 2016)**

(a) Fv (b) Fd

(c) $\frac{P^2}{2m}$ (d) mv^2

(6) **Which of the following is the example of conservative force?** **(FDR 2017)**

(a) Tension in the string (b) Propulsion force of rocket

(c) Gravitational field (d) Restoring force in compressed spring

(7) **Anybody requires _____ escape velocity, to escape from the gravitational pull of the mars.** **(FDR 2017)**

(a) 2.4 km/s (b) 4.3 km/s

(c) 5 km/s (d) 10.4 km/s

ANSWER KEYS

(Topical Multiple Choice Questions)

1	d	21	b	41	d	61	d	81	c	101	d
2	c	22	b	42	a	62	d	82	a	102	a
3	d	23	d	43	b	63	a	83	a	103	b
4	a	24	c	44	c	64	b	84	b		
5	c	25	d	45	b	65	c	85	c		
6	c	26	a	46	b	66	b	86	d		
7	b	27	a	47	d	67	a	87	b		
8	b	28	c	48	c	68	b	88	c		
9	b	29	b	49	a	69	b	89	d		
10	b	30	a	50	b	70	c	90	b		
11	a	31	c	51	b	71	a	91	d		
12	d	32	a	52	a	72	b	92	c		
13	a	33	b	53	a	73	a	93	c		
14	a	34	c	54	c	74	b	94	a		
15	d	35	d	55	a	75	b	95	b		
16	d	36	c	56	d	76	a	96	d		
17	c	37	a	57	c	77	b	97	b		
18	c	38	b	58	a	78	c	98	b		
19	d	39	d	59	d	79	c	99	d		
20	c	40	d	60	b	80	c	100	a		

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

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

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

$W = 0$

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.

Ans: Data Mass = m = 10kg
Height = h = 10m

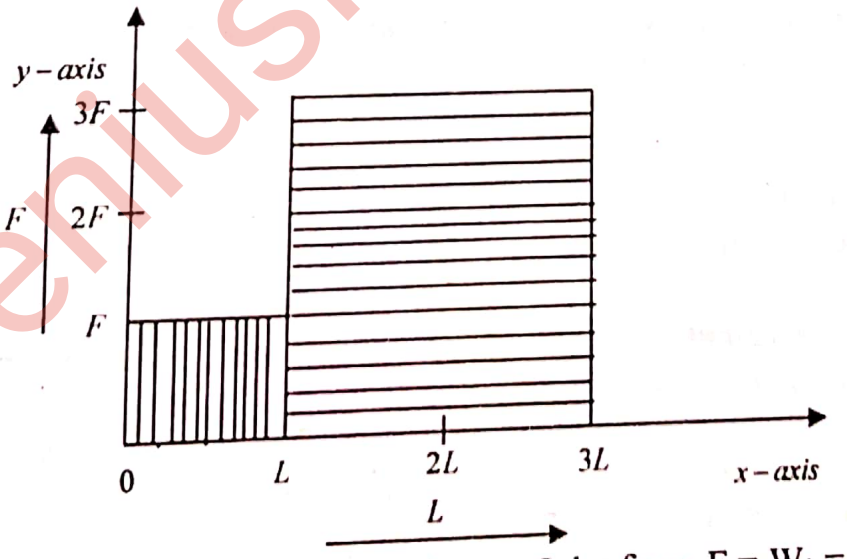
Required
Work done = W =?

Solution
As we know that
W = mgh
Putting values
W = 10 x 9.8 x 10 = 980 J = 0.98 KJ

Result
So, the work done in kilo joule is 0.98 kJ

.3. A force F acts through a distance L. The force is then increased to 3 F, and then acts through a further distance of 2 L. Draw the work diagram to scale.

ns:



Work done in moving the body through distance L by force F = W_1 = FL
Work done in moving the body from L to 3L by force 3F = W_2 = 3F x 2L = 6FL
Total work done = $W_1 + W_2$
W = FL + 6FL
W = 7 FL

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.

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
$W_1 = 245$ 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.

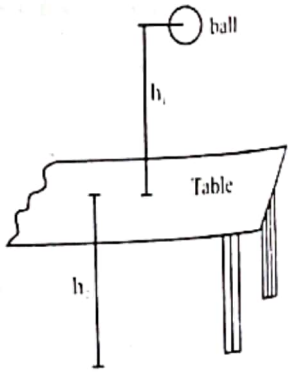
4.5. An object has 1 J of potential energy. Explain what does it mean?

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.

4.6. A ball of mass m is held at a height h_1 above a table. The table top is at a height h_2 above the floor. One student says that the ball has potential energy mgh_1 but another says that it is mg $(h_1 + h_2)$. Who is correct?



Ans: We know that P.E is always calculated with respect to some reference.
With respect to the table P.E. of the ball is mgh_1, and with respect to ground, the P.E. of ball is mg $(h_1 + h_2)$. Therefore both students are correct.

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

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.

4.8. What sort of energy is in the following?

(a) Compressed spring
(b) Water in a high dam
(c) A moving car

Ans: (a) Compressed Spring: Elastic P.E
(b) Water in a dam: Gravitational P.E
(c) A moving car: Kinetic Energy

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

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

$$P.E \rightarrow KE \rightarrow \text{work} + \text{sound} + \text{heat}.$$

If air resistance is considered then

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

4.10. A boy uses a catapult to throw a stone which accidentally smashes a green house window. List the possible energy changes.

Ans: When a stone is thrown by a catapult then elastic P.E is converted into K.E. of the stone and when the stone hits the window, K.E is converted into heat and sound energy and some of the K.E is used to break the glass.

SHORT QUESTIONS
(From past papers 2012-2017)
(Federal Board)

(1) A boy uses a catapult to throw a stone which accidentally smashes a greenhouse window list the possible energy changes **(FDR 2012)**

(2) Relate work done of a moving particle with energy. **(FDR 2013)**

(3) Give any three examples of non conventional energy sources. **(FDR 2013)**

(4) The absolute potential energy of a body on the surface of earth into pieces. What does it changes involved? **(FDR 2014)**

(5) A girl drop a cup from a certain height, which breaks into pieces. What are the energy changes involved? **(FDR 2014)**

(6) The absolute potential energy of a body on the surface of earth is negative. What does it mean? **(FDR 2014)**

(7) What is the "Salter's duck"? How is it used to run electricity generators? **(FDR 2015)**

(8) What are photovoltaic cell? How can solar energy be stored to use it as electrical energy in the absence of sunlight? **(FDR 2015)**

(9) Under what conditions the work done of an object is negative? Give two examples from your daily life. **(FDR 2016)**

(10) An object moves with constant velocity 'v' under the action of constant force '$\vec{F}$'. Show that power, $P = \vec{F}.\vec{v}$. **(FDR 2016)**

(11) How can we gain energy from tides? Explain. **(FDR 2016)**

(12) How large a force is required to accelerate an electron from rest to a speed of 2×10^{7} m/s through a distance of 5cm, while the mass of electron is 9.1×10^{-31} kg? **(FDR 2017)**