HSPTA MALAPPURAM

PHYSOL_*The solution for learning Physics*

Question Bank

Work Energy & Power

Each question scores One

1	When a conservative force does positive work on a body, the potential energy of the body......... Ans: Decreases.
2	Work was done by a body against friction always results in a loss of its.............(KE/PE) Ans: Kinetic Energy.
3	Calculate the work done in lifting a body of mass 10 kg to a height of 10 m above the ground ($g=10m/s^2$) Ans: W=mgh =10 x10 x10=1000J
4	Unit of work is........ Ans: joule.
5	1J=......... erg Ans: 10^7
6	Is work a scalar or vector? Ans: Scalar.
7	The area under F-S graph will give....... Ans: Work done.
8	Gravitational force is a ....force (Conservative, Non Conservative) Ans: Conservative.
9	Energy associated with motion is called..... Ans: Kinetic energy.
10	Energy associated with position is called..... Ans: Potential energy.
11	Energy associated with wound watch is..... Ans. Potential.
12	Energy associated with spring is called..... Ans: Potential.
13	Energy associated with water in a dam is..... Ans : Potential.
14	Force × velocity is called....... Ans: Power.
15	Unit of power is....... Ans: watt or J/s
16	Dimension of power is..... Ans: $[M^1 L^2 T^{-3}]$
17	kWh is the unit of...... Ans: Energy.
18	Is power a scalar or vector?

	Ans: Scalar.
19	Horse power is the unit of..... Ans: Power
20	1hp=....... watt Ans: 746 watt.
21	1kW =..... watt Ans: 1000 watt.
22	Unit of Kinetic energy is....... Ans: joule.
23	Relation between kinetic energy and momentum is....... Ans: $\frac{p^2}{2m}$
23	A constant force of 200 N displaces a body through 5m in the direction of force. The work done on the body is...... Ans.1000J
24	A car is moving with a constant speed on a straight road. The net work done by external force on the car is..... Ans. Zero
25	The work done in sliding load is.....with respect to frictional force Ans. negative
26	1kWh = ----------- joule Ans:3600000 joule
27	A man carefully brings down a glass sheet from a height 2m to the ground. The work done by him is ...... Ans. Negative
28	A man holds a heavy object weighing 50kg perfectly still for an hour. Calculate the work done by him. Ans. Zero
29	Work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket is..... Ans: Positive

Each question scores Two

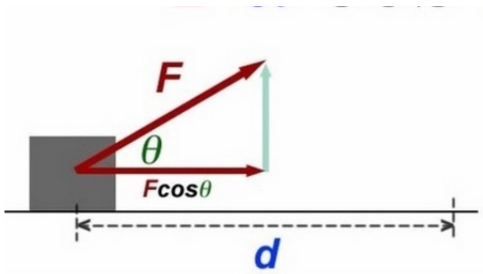
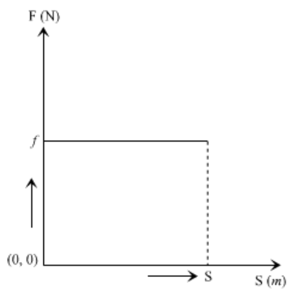
1	Find out the sign of work done in the following cases: a) Work done by a man in lifting a bucket out of well. b) Work done by friction on a body sliding down an inclined plane. c) Work done by an applied force on a body moving on a rough horizontal surface. d) Work done by the resistive force of air on a vibrating pendulum. Ans: a) Positive. b) Negative. c) Positive d) Negative.
2	Two bodies of masses m_1 and m_2 have the same linear momentum. What is the ratio of their kinetic energies ? Ans: Kinetic Energy $KE=\frac{P^2}{2m}$

	Given momentum of masses m_1 and m_2 are same. Therefore $\frac{KE_1}{KE_2}=\frac{m_2}{m_1}$
3	Write any two properties of conservative force Ans: 1. The work done by the conservative force depends only on the end points. 2. The work done by this force in a closed path is zero.
4	A light body and a heavy body have equal kinetic energies, which one has greater momentum? Why? Ans: Heavy body. Kinetic Energy $KE=\frac{P^2}{2m}$ Given Kinetic Energy are same. There fore $P^2 \alpha m$ Thus heavy body have greater momentum.
5	Write the work done in each of the following cases as zero, positive or negative. a. Work was done by centripetal force in circular motion. b. Work was done by friction. c. Work was done by the gravitational force on a freely falling object. d. Work was done by the applied force in lifting an object Ans: a. Zero b. Negative. c. Positive d. Positive.
6	A ball at rest is dropped from a height of 12 m. It loses 25% of its kinetic energy on striking the ground. Find the height at which it bounces. Ans: Given $KE_f=0.75\,KE_i$ (because 25% loss of KE) Therefore $mgh'=0.75\,mgh$ $h'=0.75h=0.75\,x\,12=9\,m.$ This is the height it bounces to loss 25% of its KE.
7	A car is moving with a constant speed on straight line, what is the network done by the external force on the car? Justify Ans: Zero. As the car is moving with constant speed, acceleration a=0 and hence F=0. Therefore work done =0.
8	Fill in the blanks:

a)	-------------	$\vec{F}.\vec{S}$	Scalar quantity
b)	Mass , m	Momentum , P	KE=--------
c)	Body of mass , m	At a height , h	PE = --------
d)	Power P	P= ----------	Scalar product.

Ans:

a)	Work	$\vec{F}.\vec{S}$	Scalar quantity
b)	Mass , m	Momentum , P	KE= $\frac{P^2}{2m}$
c)	Body of mass , m	At a height , h	PE = mgh
d)	Power P	P= $\vec{F}.\vec{v}$	Scalar product.

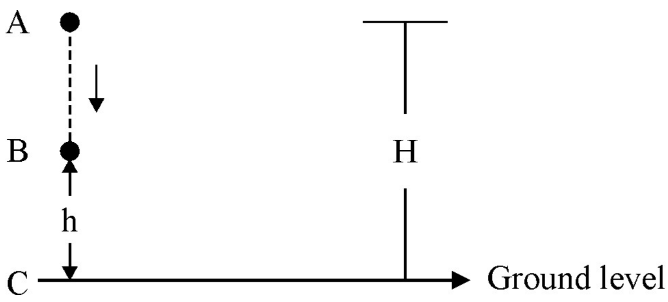
9	A force is required to do work. The work done by a force is the product of displacement and the component of force in the direction of displacement. Prove this statement. Ans:  From the diagram ,Work W= (Fcosθ) d = $\vec{F}.\vec{d}$
10	Ramesh lifts a body of mass 'm' to a height 'h' near the surface of the earth in a time 't'. a) Draw the force-displacement graph. b) If 'A' is the area of the graph, what quantity does $\frac{A}{t}$ indicate? Ans: a)  b) Area under the graph , A = Work. Therefore $\frac{A}{t}=\frac{Work}{time}=Power$
11	Raju increased the speed of moving mass 50kg from 2 m/s to 4 m/s. a) How much force will be required, if velocity change takes place within 0.2s? b) How much work is done by Raju? Ans: (a) F = mass × acceleration = 50 × $\frac{(4-2)}{0.2}$ = 500N (b) W = $\frac{1}{2}mv^2$ - $\frac{1}{2}mu^2$ = $\frac{1}{2}\times 50(4^2-2^2)$ = 300J
12	In a nuclear reactor if 5g of fuel is completely converted into energy. (a) Find the amount of energy released (b) The average power of reactor is 3000MW.How long does this fuel last? Ans: (a) E= mc^2 = $\frac{5}{1000}$ x (3x 10^8)^2 = 4.5 x 10^{14} J (b) P = $\frac{E}{t}$, ie, t = $\frac{E}{P}$ = $\frac{4.5\,x\,10^{14}}{3000\,x\,10^6}$ = 150000 = 41.6h

13	Force and displacement vector is given as $\vec{F}=3\hat{i}+4\hat{j}-5\hat{k}$ and $\vec{d}=5\hat{i}+4\hat{j}+3\hat{k}$ (a) Find work done. (b) State the conditions under which a force does no work. Ans: (a) $W=(3\hat{i}+4\hat{j}-5\hat{k})$ $(5\hat{i}+4\hat{j}+3\hat{k})$ = 15 + 16-15 = 16joule (b) 1.displacement is zero 2. force and displacement are perpendicular to each other
14	Can a body have energy without momentum or vice versa? explain. Ans: Yes a body can have energy without momentum, that is Potential energy. But a body can't have momentum without energy.
15	a) What is the quantity that remains conserved in all types of collisions? b) Suppose an electron and a proton are projected with equal kinetic energy, what will be the ratio of their linear momentums if the proton is 1830 times heavier than an electron? Ans: a) Momentum b) We have P = $\sqrt{2mE}$ $\frac{P_e}{P_p} = \frac{\sqrt{2m_e E}}{\sqrt{2m_p E}} = \frac{\sqrt{m_e}}{\sqrt{m_p}} = \sqrt{\frac{1}{1830}}$
16	A bullet of mass 10g and velocity 800 m/s is passed through a mud wall of thickness 1 m. Its velocity reduces to 100m/s. Find the average resistance offered by the mud wall. **Ans:** Deceleration = a = $\frac{v^2-u^2}{2s} = \frac{100^2-800^2}{2x1}$ = - 315000 m/s^2. F = m x a = 10 x 10^{-3} x 315000 = 3150 N
17	Work is required to lift a body through a height from the ground. Calculate the work done in lifting a body of mass 10 kg to a height of 10 m above the ground. **Ans:** Work done= m g h = 10×9.8×10 = 980 J
18	A body of mass 5kg is thrown vertically up with a kinetic energy of 490 J. Find the height at which the kinetic energy of the body becomes half of the original value. **Ans:** Let it be at a height h$^/$ say. At this height, the potential energy becomes half of the maximum value. PE maximum = 490 J. mgh$^/$ = $\frac{1}{2}$ × 490 h$^/$ = $\frac{490}{2XmXg} = \frac{490}{2X5X9.8}$ = 5 m
19	A car and a truck have the same kinetic energies at a certain instant while they are moving along two parallel roads. a) Which one will have greater momentum? Ans KE is same = E say. We have P = $\sqrt{2mK.E}$ $P_c = \sqrt{2m_c E}$ $P_t = \sqrt{2m_t E}$ since $m_t > m_c$ we get $P_t > P_c$ b) If the mass of truck is 100 times greater than that of the car, find the ratio of the velocity of the truck to that of the car.

	Ans: E = $\frac{1}{2}m_c v_c^2 = \frac{1}{2}m_t v_t^2$ => $\frac{V_t}{V_c} = \sqrt{\frac{m_c}{m_t}} = \sqrt{\frac{1}{100}} = \frac{1}{10}$ c) A motorcycle and a bus are moving with same momentum. Which of them has greater kinetic energy? Justify. **Ans:** $P_m = P_b = P$ (say) K. E = $\frac{P^2}{2m}$ $E_m = \frac{P^2}{2m_m}$ $E_b = \frac{P^2}{2m_b}$ since $m_m < m_b$ we get $E_m > E_b$
20	Total energy of a system is always conserved, no matter what internal or external forces on the body are present. a).State true/ false. b).Justify your answer. Ans: a).False. b).External forces can change the total energy of the system

Each question scores Three

1 An object is dropped from a height H as shown below :



Show that total energy is conserved at the points A, B and C.

Ans: **At the point 'A':-**

Kinetic Energy , KE =0 (because velocity u=0)
Potential Energy , PE =mgH
Therefore,
Total Energy , TE = KE+PE
=**mgH**.-------(1)

At the point 'B' :-

Kinetic energy , KE = $\frac{1}{2}mv_1^2$
But $v_1^2 = 2g(H-h)$ (because u=0, a=g)
Therefore , KE =mg(H-h)
and PE = mgh
Therefore TE = KE +PE
=mg(H-h)+ mgh
=**mgH** --------(2)

At the point 'C':-

Kinetic energy , KE = $\frac{1}{2}mv^2$
But $v^2 = 2gH$ (because u=0, a=g)
Therefore , KE =mgH
and PE = 0

Therefore TE = KE +PE

$= mgH + 0$

$= \mathbf{mgH}$ --------(3)

Thus Equation (1) , (2) and (3) shows that the total energy of a freely falling body is constant at every point along its path.

2 a. State and explain the work done in the following situations:

i) A person carrying a heavy load walks on a level road.

ii) A man spending his energy by pushing on a concrete wall.

b. A constant force of 200 N displaces a body through 5m in the direction of the force. Find the work done on the body.

Ans: a) i) Zero

ii) Zero.

b) Work done $W= F.S=200\times5 =1000J$

3 A man tries to lift a mass 200kg with a force 100N.

(a)Is he doing work? Explain.

(b) If yes, find the amount of work done. if no,find the force required to lift it.

(c) If it is lifted to 2m in 10 s, Find power.

Ans:

(a) No work is done because there is no displacement.100N force is insufficient to raise 200kg.

(b) Force required to lift is $mg = 200\times9.8 = 1960N$

(c) Power = $\frac{mgh}{t} = \frac{200\times9.8\times2}{10} = 392W$

4 A constant force of 5N is applied on a body whose displacement with time is given in the table below.

Time(s)	0	1	2	3	4
Displacement (m)	0	2	4	6	8

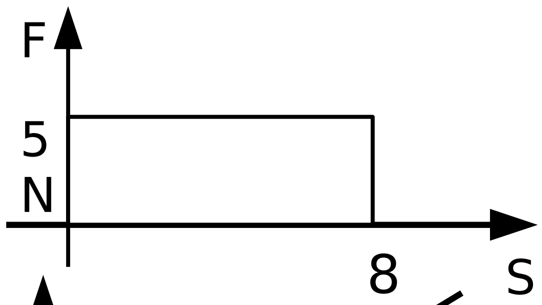
(a) Draw the force displacement graph

(b) What is the significance of this graph?

(c) Draw displacement-time graph and from that determine the power.

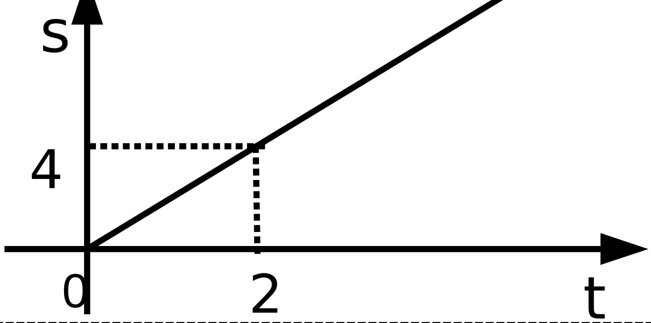
Ans:

(a)



(b) Area represents Work done

(c)



slope = 4/2 = 2 = v

Power = $F.v = 5\times2 = 10$ W

5	(a)A truck and a car are moving with the same kinetic energy are stopped by applying same retarding force by means of brakes. Which one will stop at a smaller distance. (b) How the work energy theorem helps us to generate electricity? Ans: (a) Here the work done is equal to the loss of K.E. So both will stop at the same distance. (b) P.E of water at the top of dam is converted to K.E of the bottom which is used to turn the turbine and electricity(or electrical energy) is produced.
6	A cyclist comes to a skidding stop in 10m. During this process, the force on the cycle dur to the road is 200N and is directly opposed to the motion. (a) How much work does the road do on the cycle? 1.5 score (b) How much work does the cycle do on the road? 1.5 score Ans: (a) The work done on the cycle by the road is the work done by the frictional force on the cycle. W = $\vec{F}\cdot\vec{S}$ .The frictional force and displacement make an angle 180° with each other. Iet, W= FS cos ϴ = Fscos180° = -FS = -200×10 = -2000J (b) Since the displacement of the road is zero, the work done by the cycle on the road is zero.
7	A ship of mass 10^5 kg moving with a velocity of 10 m/s is stopped by brake. Find the work done to stop the ship? Ans: W= change in KE $W=\frac{1}{2}mv^2-\frac{1}{2}mu^2$ $W=\frac{1}{2}.10^5.10^2=50*10^5 J$
8	A motor pump can fill water in a tank of 40 m^3 at a height 5m from the ground in 30 minutes. Find the power required for this process? Given density of water is 1000 kg/m^3. $Power=\frac{Work}{time}$ $Power=\frac{mgh}{t}$ mass=volume×density $Power=\frac{volume*density*g*h}{t}$ $Power=\frac{40*1000*9.8*5}{30*60}=1111.11 W=P=1.11 KW$
9	a)Write the equation for potential energy of a spring. b)A spring extended to a length x the energy stored is E. If it is extended a distance 2x, find the energy developed in the spring in terms of E. Ans: a) $E=\frac{1}{2}kx^2$ b) $E^1=\frac{1}{2}k(2x)^2=4E$

Each question scores Four

1 Power is the rate at which work is done.

a) Express power in terms of force and velocity.

b) An elevator carrying the maximum load of 1800 kg 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.

c) Express your above answer in horse power?

Ans: a) Power P= F v

b) The total down ward force , F=mg+Frictional force

= (1800×10) +4000=22000N

Thus minimum power to be supplied by the motor

P =F.V

=22000×2=44000W

c) 59 hp

2 a) State the work energy theorem.

b) Show that the potential energy of a body is completely converted into kinetic energy during its free fall under the gravity.

c) A man carefully brings down a glass sheet from a height 2 m to the ground. The work done by him is ....

(i) negative

(ii) zero

(iii) positive

(iv) unpredictable

Ans: a) Work -Energy theorem states that “Work done is equal to change in Kinetic energy”.

b)**At the point ‘A’:-**

Kinetic Energy , KE =0 (because velocity u=0)

Potential Energy , PE =mgH

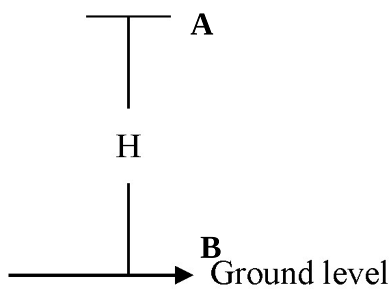
At the point ‘B’:-

Kinetic energy , KE = $\frac{1}{2}mv^2$

But $v^2 = 2gH$ (because u=0, a=g)

Therefore , KE =mgH

and PE = 0



This shows that the potential energy of a body is completely converted into kinetic energy during its free fall under the gravity.

c) negative.

3 Force is required to lift a body from the ground to a height h and work is measured as the product of force and magnitude of displacement.

a. Name the energy possessed by the body at maximum height. Write an equation for it.

b. A man of mass 60 kg carries a stone of mass 20 kg to the top of a multi-storied building of height 50m. Calculate the total energy spent by him? (9.8m/s ^{2})

Ans: a) Potential Energy.PE = mgh

b) Energy Spent = PE

=mgh

= (60+20) x 9.8×50

= 39.2 x 10^3J

Each question scores Five

1 The total mechanical energy of the system is conserved, if the forces doing work on it are conservative.

a) Derive a mathematical expression to explain work-energy theorem.

b) A particle of mass 4 m kg which is at rest explodes into three fragments. Two of the fragments each of mass 'm' kg are found to move in mutually perpendicular directions with speed 'v' m/s each. Find the energy released in the process of explosion.

Ans: a) Let m--> mass of the body

u--> initial velocity v--> final velocity

a--> acceleration

S--> displacement.

By equation of motion $v^2=u^2+2as$

$$v^2-u^2=2as$$

Therefore $as=\frac{(v^2-u^2)}{2}$

But W = F.S=m as

$$W=\frac{1}{2}mv^2-\frac{1}{2}mu^2=KE_f-KE_i$$

That is Work done is equal to change in Kinetic energy. This is the work energy theorm.

b) According to the law of conservation of linear momentum

$P_3=\sqrt{P_1^2+P_2^2}=\sqrt{(mv)^2+(mv)^2}=\sqrt{2}mv$ Thus , final Kinetic Energy of the system ,

$$KE=\frac{P_1^2}{2m}+\frac{P_2^2}{2m}+\frac{P_3^2}{2(2m)}$$

$$KE=\frac{1}{2}mv^2+\frac{1}{2}mv^2+\frac{1}{2}mv^2=\frac{3}{2}mv^2$$

2 Energy of a body is defined as its capacity of doing work".

a). The energy possessed by a body by virtue of motion is known as ....

b). A body of mass 5 kg initially at rest is subjected to a horizontal force of 20 N. What is the kinetic energy acquired by the body at the end of 10 s?

c). State whether the following statement is TRUE or FALSE. "The change in kinetic energy of a particle is equal to the work done on it by the net force".

Ans: a) Kinetic Energy.

b) Given m=5kg u=0 F=20N t=10s

We have $F=ma$

Therefore $a=\frac{F}{m}=\frac{20}{5}=4\,ms^{-2}$

Thus $v=u+at=0+4\,x\,10=40\,ms^{-1}$

Therefore $KE=\frac{1}{2}mv^2=\frac{1}{2}x\,5\,x\,40^2=4\,x\,10^3\,J$

c) True

3 The figure shows a body of mass m placed at a height h. A, B and C are the three points on the trajectory of this body.

a)Which is the type of energy possessed by this body at a height h?

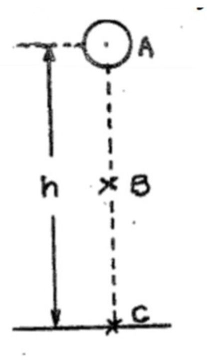
b) Prove that total mechanical energy is conserved at B and C

c) A body of mass 5kg is thrown vertically up with a kinetic energy of 490 J. Find the height at which the kinetic energy of the body becomes half of the original value.

Ans: a) Potential Energy.

b)**At the point 'B' :-**

Kinetic energy , KE = $\frac{1}{2}mv_1^2$



But $v_1^2 = 2g(h - BC)$ (because u=0, a=g)

Therefore , KE =mg(h-BC)

and PE = mg(BC)

Therefore TE = KE +PE

=mg(h-BC)+ mg(BC)

=**mgh** --------(1)

At the point 'C':-

Kinetic energy , KE = $\frac{1}{2}mv^2$

But $v^2 = 2gh$ (because u=0, a=g)

Therefore , KE =mgh

and PE = 0

Therefore TE = KE +PE

=mgh+ 0

=**mgh** --------(2)

Thus Equation (1) and (2) shows that the total energy of a freely falling body is constant at every point along its path.

c) $KE_f = \frac{KE_i}{2} = \frac{490}{2}$

Therefore $\frac{1}{2}mv^2 = \frac{490}{2}$

$\frac{1}{2} 5 x v^2 = \frac{490}{2}$

That is v^2 =98 m/s. Thus height $h = \frac{v^2}{2g}$ (because $u^2 = 2v^2$)

$h = \frac{98}{2x9.8} = 5m$

4 The scalar product of force and displacement gives work. It can be negative, zero or positive.

a) The work done in sliding a load is .... with respect to frictional force.
(zero, positive, negative, infinity)

b) State and prove the work energy theorem for constant force.

c) A pump on the ground floor of a building can pump water to fill a tank of volume 30 m^3 in 15 minutes. If the tank is 40 m above the ground and the efficiency of the pump is 30%, how munch electric power is consumed by the pump?

Ans: a) negative.

b)Work -Energy theorem states that "Work done is equal to change in Kinetic energy".

Let m--> mass of the body

u--> initial velocity v--> final velocity

a--> acceleration

S--> displacement.

By equation of motion $v^2 = u^2 + 2as$

$v^2 - u^2 = 2as$

Therefore $as = \frac{(v^2 - u^2)}{2}$

But W = F.S=m as

$$W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2 = KE_f - KE_i$$

That is Work done is equal to change in Kinetic energy. This is the work energy theorm.

c) Efficiency $\eta = \dfrac{Output\ power}{Input\ Power\,(Power\ consumed)} = 0.3$

Therefore $Input\ Power\,(Power\ consumed) = \dfrac{Output\ power}{0.3}$ -------(1)

$$Output\ Power = \frac{mgh}{t} = \frac{(Volume\ x\ Density)gh}{t}$$

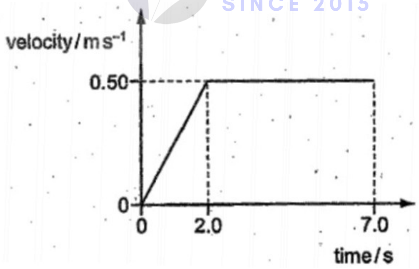
$$Output\ Power = \frac{(30\,x\,10^3)\,x\,10\,x\,40}{15\,x\,60} = 13.33\,x\,10^3 \quad W$$

Substituting in (1) , we get $Input\ Power\,(Power\ consumed) = \dfrac{13.33\,x\,10^3}{0.3} = 4.4\,x\,10^4 W$

5 From the table given below:

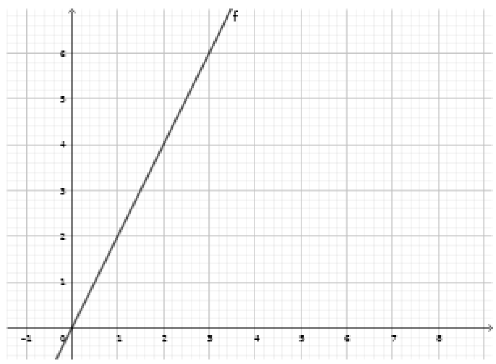
Force(N)	2	4	6	8	10
Displacement(M)	1	2	3	4	5

a) Draw the force –displacement graph.
b) How can you find the work done from the above graph?
c) Suggest any two situations in which the work done by a force is zero.
d) A ball is pushed with a force of 3N for 2s along a frictionless track. The graph shows the velocity of the body against time. How much work is done by the force?



Ans: a)

force



displacement

b) Area under the graph gives work done.
c) i) When displacement =0.
ii) When force and displacement are perpendicular to each other.
d) From the graph , Displacement during 2 s, S= area under the graph

$$= \frac{1}{2} x 2 x 0.5 = 0.5 m$$

Work done = F.S =3×0.5 =1.5 J

6 a) State and prove that the law of conservation of energy for a freely falling body.

b) Draw graphically the variation of kinetic energy and potential energy with the height of the body in the above case.

Ans: a) The principle of conservation of total mechanical energy can be stated as "The total mechanical energy of a system is conserved if the forces, doing work on it, are conservative"

Proof:

At the point 'A':-

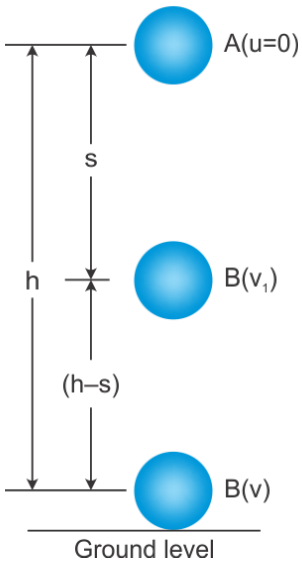
Kinetic Energy , KE =0 (because velocity u=0)

Potential Energy , PE =mgh

Therefore,

Total Energy , TE = KE+PE

=**mgh**.-------(1)



At the point 'B' :-

Kinetic energy , KE = $\frac{1}{2} m v_1^2$

But $v_1^2 = 2gs$ (because u=0, a=g)

Therefore , KE =mgs

and PE = mg(h-s)

Therefore TE = KE +PE

=mgs+ mg(h-s)

=**mgh** --------(2)

At the point 'C':-

Kinetic energy , KE = $\frac{1}{2} m v^2$

But $v^2 = 2gh$ (because u=0, a=g)

Therefore , KE =mgh

and PE = 0

Therefore TE = KE +PE

=mgh+ 0

=**mgh** --------(3)

Thus Equation (1) , (2) and (3) shows that the total energy of a freely falling body is constant at every point along its path.

b) Graph Showing the variation of KE, PE and TE with height for a freely falling body: