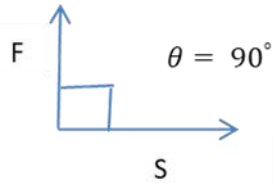


	Chapter-3 (2 marks questions)	Taxonomy level	Marking scheme
Q-1	Define work done and write its SI unit & CGS unit.	L1`	F.M-2
Ans:	<p>Work done can be defined as the dot product of force & displacement.</p> $W = \vec{F} \cdot \vec{S}$ <p>SI unit of work done is joule & CGS unit is erg.</p>		<p>1</p> <p>1</p>
Q-2	Write the conditions for zero work done.	L2`	F.M-2
Ans:	<p>(i) When applied force (F) = 0</p> <p>(ii) When net displacement (r) = 0</p> <p>(ii) When applied force is perpendicular to displacement i.e.</p>		<p>0.5</p> <p>0.5</p> <p>1</p>
Q-3	Write any two examples of Zero work.	L2`	F.M-2
Ans:	<p>Work done when (i) walking forward while lifting some object</p> <p>(ii) a moving car is stopped by applying brakes</p>		<p>1</p> <p>1</p>
Q-4	Give two examples of negative work done.	L2`	F.M-2
Ans:	<p>(i) Friction force acting on a rolling ball in opposite direction to displacement.</p> <p>(ii) Force due to gravity acting on a ball thrown vertically upwards.</p>		<p>1</p> <p>1</p>
Q-5	Write any two examples of Positive work.	L2`	F.M-2
Ans:	<p>Work done by (i) force due to gravity acting on a ball falling on the ground</p> <p>(ii) force applied by either crane or a helicopter for lifting heavy objects from the ground.</p>		<p>1</p> <p>1</p>
Q-6	Give comparison between positive work done & negative work done.	L2`	F.M-2
Ans:	<p><u>Positive work done :</u></p> <p>When applied force is parallel to displacement, then angle between them is 0°. So $W = +FS$. This is called positive work done.</p> <p><u>Negative work done :</u></p> <p>When applied force is anti-parallel to displacement, then angle between them is 180°. So $W = -FS$. This is called negative work done.</p>		<p>1</p> <p>1</p>
Q-7	If a porter uses 50 N force to lift a luggage bag and walk forward to cover 100 m of displacement, then calculate the amount of work done by porter.	L3`	F.M-2
Ans:	<p>Given F = 50 N And S = 100 m</p>		<p>0.5</p>



We observed that $\theta = 90^\circ$
 We know $W = F S \cos \theta$
 $W = F S \cos 90^\circ$
 $W = 50 \times 100 \times 0$
 $W = 0 \text{ J}$

0.5
 0.5
 0.5

Q-8 Define friction and write its dimensional formula.

L1`

F.M-2

Ans: Friction is an opposing force which act in the opposite direction of our applied fore or motion when a body moves or tends to move on a surface.

Dimensional formula of friction :

$$[F] = [M^1L^1T^{-2}]$$

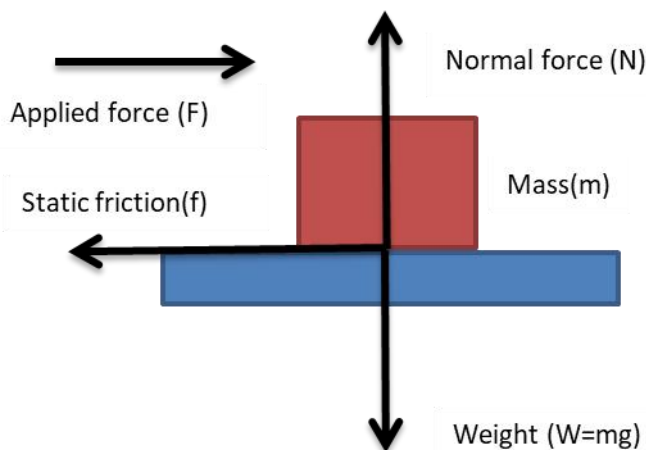
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Q-9 Explain static friction with figure.

L2`

F.M-2

Ans: Static friction comes into play When the object is in contact with the surface and the force is applied on the object,. Static friction exists between two surfaces till the objects starts to move by the application of applied force. The direction of static friction is opposite to applied force.



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Q-10 Define co efficient of friction.

L1

F.M-2

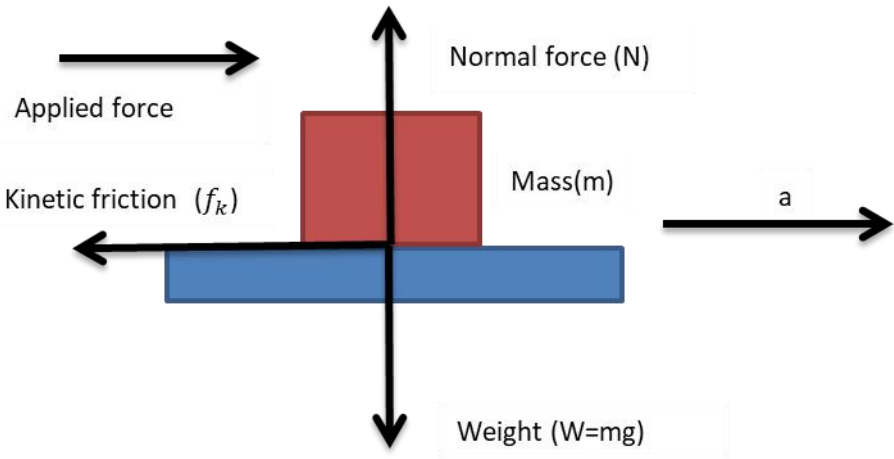
Ans: Co efficient of friction can be defined as the ratio between magnitude of limiting friction to normal reaction. It is a unitless , dimensionless physical quantity.


1

	$\mu = \frac{F}{R}$		1
Q-11	Define energy and write its SI & CGS unit.	L1	F.M-2
Ans:	Energy is the ability to do work. It is a scalar quantity. SI unit of energy is Joule or N.m and C.G.S unit is erg or dyne.cm.		1 1
Q-12	List out various types of friction with example.	L2	F.M-2
Ans:	There are 2 types of friction. (i) Static friction: It is the type of friction which opposes motion when there is no relative motion between the surfaces. Ex : Applying small amount of force for moving heavy box (ii) Kinetic or dynamic friction: It is of 2 types. (a) Sliding friction: It is the type of friction which opposes motion when one surface is sliding over another surface. Ex : A Pushing a machine on the floor (b) Rolling friction: It is the type of friction which opposes motion when one surface is rolling over another surface. Ex : Rolling of a wheel or ball		1 0.5 0.5
Q-13	What is meant by conservation of energy?	L2	F.M-2
Ans:	No energy can be created or destroyed, and it can only change from one type to another. This law is called conservation of energy. For example, when a car slips down from a slanted road, the potential energy that the vehicle has from being positioned high up on the slanted road is transformed into kinetic energy. As the car slows down to a halt through friction, the kinetic energy from the vehicle's motion is transformed into thermal energy that heats the car's surface, which is in contact with the road.		
Q-14	Compare kinetic energy and gravitational potential energy with example.	L2	F.M-2
Ans:	Kinetic energy (KE) : kinetic energy is the ability of a moving object to do work When an object moves with mass 'm' is in motion with some velocity 'v', it is said to possess kinetic energy. $K.E. = \frac{1}{2}mv^2$ Ex: Bullet fired from gun. Gravitational Potential energy (PE) :		0.5 0.5 0.5

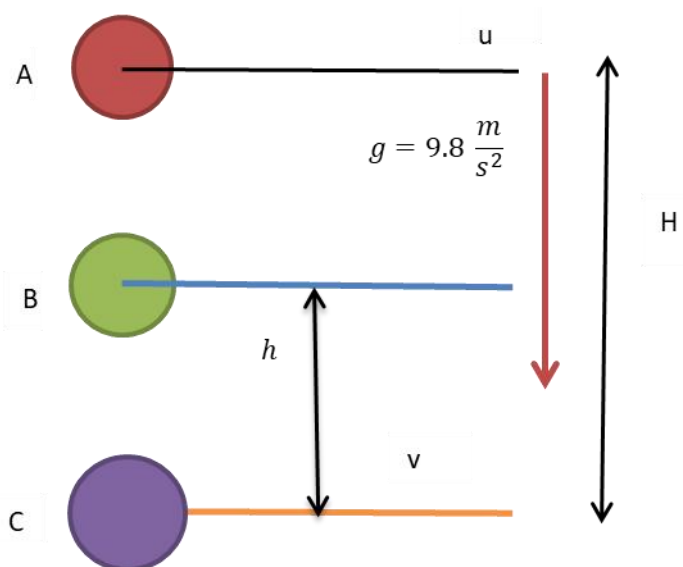
	<p>PE is the energy stored in an object due to its position.</p> <p>If an object of mass 'm' stored in the gravitational field at a height 'h' above the ground , then gravitational potential energy 'U' can be defined as</p> $U = mgh$ <p>It is a scalar quantity. Ex: Apple on the tree before it falls.</p>		0.5
Q-15	<p>A machine raises a load of 750 N through a height of 16 m in 5 seconds. Calculate the power at which the machine works.</p>	L3`	F.M-2
Ans:	<p>Given force, F = 750 N, displacement = height, h = 16 m and time, t = 5</p> <p>Work done by machine, W = Force × Displacement = F × h = 750 N × 16 joule Power of machine, P = Wt = 750N× 16 J ×5s = 2400 watt.</p>		
Q-16	<p>Give two examples of transformation of energy.</p>	L2	F.M-2
Ans:	<p>Electric energy to heat energy: Water heater, room heater etc.</p> <p>When electricity flows into water through heating element of water heater, then it converts into heat.</p> <p>Solar energy to electric energy: Solar cells or photovoltaic cells.</p> <p>When sunlight falls on solar cells, then it converts into electric energy.</p>		0.5 0.5 0.5 0.5
Q-17	<p>Define power with example. Write its SI unit.</p>	L1	F.M-2
Ans:	<p>Power is the time rate at which work is done or energy is transferred. It shows that not only work is done but also how fast it is done.</p> $P = \frac{dW}{dt}$ <p>Ex: Climbing a mountain shows your physical fitness but how fast you climb indicates the power of your muscles.</p> <p>SI unit of power is J/S or watt.</p>		1 0.5 0.5
Q-18	<p>What energy transformation takes place a)When an electric bulb is switched on b) at thermal power station</p>	L2`	F.M-2
Ans:	<p>a)Electric energy changes into light energy and heat energy b) Heat energy is converted into electrical energy</p>		
Q-19	<p>Derive the relation of power with a constant force and velocity.</p>	L3	F.M-2
Ans:	<p>We know that</p> $P_{avg} = \frac{W}{t}$ <p>Instantaneous power can be defined as</p> $P = \frac{dW}{dt}$ <p>Or,</p> $P = \frac{d(F \cdot S)}{dt}$		0.5 0.5

	For a constant force F , $P = F \frac{dS}{dt}$ Or $P = FV$		0.5 0.5
Q-20	A 2 kg body free falls from rest from a height of 12 m. Determine the work done by the force of gravity and the change in gravitational potential energy. Consider the acceleration due to gravity to be 10 m/s².		
Ans:	Since, W = mgh Substituting the values in the above equation, we get $W = 2 \times 12 \times 10 = 240 \text{ N}$ The change in gravitational potential energy is equal to the work done by gravity. Therefore, Gravitational Potential Energy= 240 Joule.		
Q-21	Derive the relation of power with a constant force and velocity. If 55 kg athlete runs 200 meters in 20 sec, then find her muscular power. Consider $g = 9.8 \text{ ms}^{-2}$	L3	F.M-2
Ans:	Given that m= 55 kg , S = 200 m and t = 20 sec We know that $P = \frac{dW}{dt} = F \frac{dS}{dt} = mg \frac{dS}{dt}$ or, $P = 55 \text{ kg} \times 9.8 \text{ ms}^{-2} \times \frac{200 \text{ m}}{20 \text{ s}}$ or, $P = 55 \times 9.8 \times \frac{200}{20} \text{ kgm}^2\text{s}^{-3}$ or, $P = 55 \times 9.8 \times 10 \text{ kgm}^2\text{s}^{-3}$ or, $P = 5390 \text{ Watt} = 5.39 \text{ KW}$		0.5 0.5 0.5 0.5
	Chapter-3 (5 marks questions)	Taxonomy level	Marking scheme
Q-1	Define limiting friction and state laws of limiting friction.	L2	F.M-5
Ans:	<u>Limiting friction:</u> Maximum value of static friction is called as Limiting friction . <u>Laws of limiting friction:</u> 1. The direction of limiting friction is always opposite to the direction of motion and it acts tangentially. 2. It depends upon the nature and state of polish of the surfaces in contact . 3. The magnitude of limiting friction is directly proportional to the magnitude of normal reaction of the body. 4. It is independent of shape and size of the body so long as normal reaction remains same.		1 1 1 1 1

Q-2	Write methods to reduce friction.	L2	F.M-5
Ans:	<p>1. Rubbing or Polishing surfaces: By making the surfaces smooth by rubbing/polishing we can reduce friction.</p> <p>2. Use of ball bearings: Providing ball bearings between moving parts of machine or vehicles we can reduce friction and allow smooth movement.</p> <p>3. Using lubricants: Lubricating machinery parts with oil, grease etc. can reduce friction by creating thin layer between two surfaces.</p> <p>4. Make the object streamlined: Streamlined face of the objects we can reduce friction.</p> <p>5. By converting sliding friction into rolling friction: In this method sliding friction get converted into rolling friction which helps in reducing friction</p>		<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>
Q-3	Find an expression for the work done against friction when a body is moving on horizontal plane.	L3	F.M-5
Ans:			1
	<p>A block of mass 'm' is placed on the horizontal table. Then normal force which acts upwards cancels out with weight of block which acts downwards.</p> <p>And if A force is applied to move the block from the left side (as shown in figure) and it does not move, then the motion is opposed due to static friction.</p> <p>Suppose an external force is large enough to overcome the static friction, then it accelerates to move forwards towards right side.</p> <p>Hence as per the laws of limiting friction , the force of kinetic friction can be defined as</p> $f_k = \mu_k N = \mu_k mg$ <p>Where μ_k is the coefficient of kinetic friction</p> <p>Now the Work done against friction can be expressed as</p> $W = \vec{f}_k \cdot \vec{S}$		<p>1</p> <p>1</p>

	<p>Or, $W = f_k S \cos \theta$</p> <p>Or, $W = \mu_k mg S \cos \theta$</p> <p>Since $\theta = 180^\circ$, then $\cos 180^\circ = -1$</p> <p>$W = \mu_k mg S (-1)$</p> <p>Or, $W = -\mu_k mg S$</p>		1
			0.5
			0.5
Q-4	Derive the expression for gravitational potential energy in moving an object of mass 'm' from infinity to the surface of earth.	L3	F.M-5
Ans:			1
	<p>Let M = Mass of earth and R= Radius of earth</p> <p>If a test mass m is moved from infinity to the surface of earth in the x axis, then work done by gravitational force can be calculated as</p> $W = \int_{\infty}^R F \cdot dx$ <p>Where F is the gravitational force between the earth of mass 'M' and test mass 'm'</p> <p>As per Newton's laws of gravitation</p> $F = G \frac{Mm}{x^2} \quad \text{Where G= Gravitation constant}$ <p>Hence</p> $W = \int_{\infty}^R G \frac{Mm}{x^2} dx$ <p>Or, $W = GMm \int_{\infty}^R \frac{1}{x^2} dx$ Since $\int \frac{dx}{x^2} = -\frac{1}{x}$</p> <p>Or, $W = GMm \left[-\frac{1}{R} + \frac{1}{\infty} \right]$</p> <p>Or, $W = -\frac{GMm}{R}$</p> <p>Work done by the gravitational force is stored as gravitational potential energy.</p> <p>Hence</p> $U = -\frac{GMm}{R}$		1
			0.5
			0.5
			0.5
			0.5
			0.5
Q-5	Explain the conservation of mechanical energy for a freely falling body.	L3	F.M-5
Ans:	<p>Conservation of mechanical energy says that total mechanical energy i.e. Sum of kinetic energy and potential energy is conserved.</p> <p>Let's discuss the conservation law by using an example of freely falling object of mass</p>		0.5

'm' under the influence of gravitational field.



1

At point A:

Let u be the initial velocity. At point A, the object is at rest. So $u=0$.

H be the height of object at A from ground.

$$K.E. = \frac{1}{2}mu^2 = 0$$

$$P.E. = mgH$$

Mechanical energy at A = K.E + P.E = mgH

0.5

0.5

At point B:

Let v_i be the velocity of object at B and h be the height of the object from ground.

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

Applying equation of motion $v^2 - u^2 = 2aS$, we have

$$\text{Or, } v_i^2 - 0 = 2g(H - h)$$

$$\text{Or, } v_i = \sqrt{2g(H - h)}$$

$$P.E. = mgh$$

Mechanical energy at B = K.E + P.E

$$M.E. = \frac{1}{2}m\{2g(H - h)\} + mgh$$

$$\text{Or, } M.E. = mgH - mgh + mgh$$

$$\text{Or, } M.E. = mgH$$

0.5

0.5

0.5

At Point C:

Let v be the velocity at C.

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

Applying equation of motion $v^2 - u^2 = 2aS$, we have

$$\text{Or, } v^2 - 0 = 2gH$$

$$\text{Or, } v = \sqrt{2gH}$$

0.5

	<p style="text-align: center;">$P.E. = mgH = 0$ <i>since H = 0</i></p> <p>Mechanical energy at C = K.E + P.E</p> <p style="text-align: center;">$M.E. = \frac{1}{2}m\{2gH\} + 0$</p> <p style="text-align: center;">$M.E. = mgH$</p> <p>Thus, we found that mechanical energy is conserved or remain constant for a freely falling object under gravitational field.</p>		0.5
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