ATUL CLASSES

.ATUL CLASSES S.C.O.3 TOP FLOOR SOHI COMPLEX BALTANA

Test / Exam Name: 11th Class Work , Power And Energy Mcq 100 **Standard: 11th Science** **Subject: Physics**

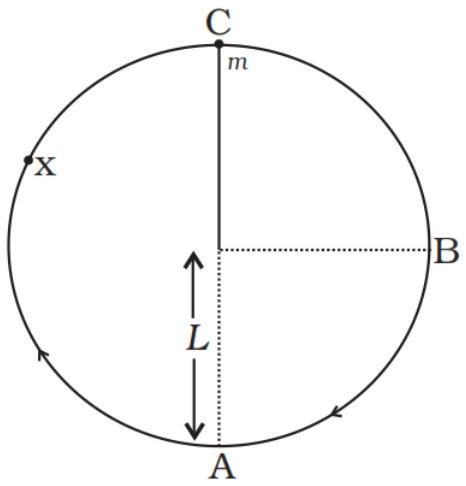
Student Name: ..... **Section:** ..... **Roll No.:** .....

Questions: 105 **Time: 01:30 hh:mm** **Marks: 488**

Instructions

1. 11th Clkass Work, Power and Energy MCQ 100

Q1. A bob of mass m suspended by a light string of length L is whirled into a vertical circle as shown in what will be the trajectory of the particle if the string is cut at: **8 Marks**



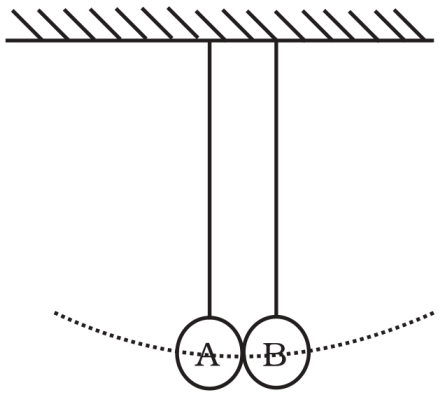
1. Point B?
2. Point C?P
3. oint X?

Q2. A baloon filled with helium rises against gravity increasing its potential energy. The speed of the baloon also increases as it rises. How do you reconcile this with the law of conservation of mechanical energy? You can neglect viscous drag of air and assume that density of air is constant. **8 Marks**

Q3. A bullet of mass 0.012kg and horizontal speed $70ms^{-1}$ strikes a block of wood of mass 0.4kg and instantly comes to rest with respect to the block. The block is suspended from the ceiling by means of thin wires. Calculate the height to which the block rises. Also, estimate the amount of heat produced in the block. **7 Marks**

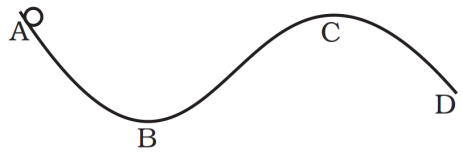
Q4. A rocket accelerates straight up by ejecting gas downwards. In a small time interval Δt, it ejects a gas of mass Δm at a relative speed u. Calculate KE of the entire system at $t + \Delta t$ and t and show that the device that gas does work $= \left(\frac{1}{2}\right)\Delta mu^2$ in this time interval (neglect gravity). **7 Marks**

Q5. Two pendulums with identical bobs and lengths are suspended from a common support such that in rest position the two bobs are in contact. One of the bobs is released after being displaced by 10° so that it collides elastically head-on with the other bob. **6 Marks**



1. Describe the motion of two bobs.
2. Draw a graph showing variation in energy of either pendulum with time, for where T is the period of each pendulum.

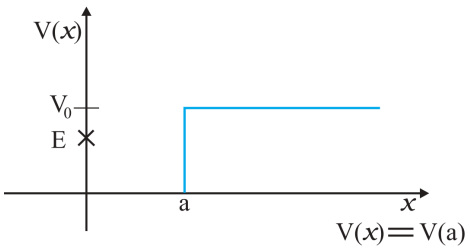
Q6. A curved surface is shown in. The portion BCD is free of friction. There are three spherical balls of identical radii and masses. Balls are released from rest one by one from A which is at a slightly greater height than C. **6 Marks**



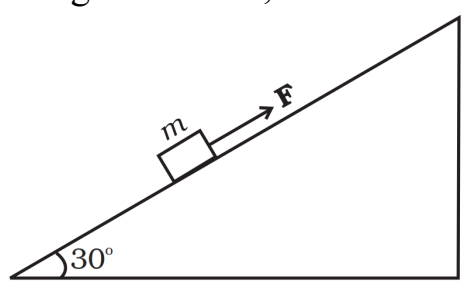
With the surface AB, ball 1 has large enough friction to cause rolling down without slipping, ball 2 has a small friction and ball 3 has a negligible friction.

1. For which balls is total mechanical energy conserved?
2. Which ball (s) can reach D?
3. For balls which do not reach D, which of the balls can reach back A?

Q7. Given fig. in are examples of some potential energy functions in one dimension. The total energy of the particle is indicated by a cross on the ordinate axis. In each case, specify the regions, if any, in which the particle cannot be found for the given energy. Also, indicate the minimum total energy the particle must have in each case. Think of simple physical contexts for which these potential energy shapes are relevan. **6 Marks**



Q8. A block of mass 1kg is pushed up a surface inclined to horizontal at an angle of 30º by a force of 10N parallel to the inclined surface. The coefficient of friction between block and the incline is 0.1. If the block is pushed up by 10m along the incline, calulate. **6 Marks**



1. Work done against gravity.
2. Work done against force of friction.
3. Increase in potential energy.
4. Increase in kinetic energy.
5. Work done by applied force.

Q9. A moving car encounters air resistance which is proportional to the square of the speed of the car. What is the ratio of the power required at 40kmh^{-1} to that required at 80kmh^{-1} with the same braking force? **5 Marks**

Q10. Calculate work done in raising a stone of mass 5kg of specific gravity 3 immersed in water from a depth of 6m to 1m below surface of water(g = 10ms^{-2}). **5 Marks**

Q11. Define conservative and non-conservative forces. Give example and properties of conservative forces. **5 Marks**
A 5kg rifle fires a 58 bullet with a speed of 500ms^{-1}. What kinetic energy is acquired.

1. By the bullet and.
2. By the rifle?
3. Find the the ratio of the distance which the rifle moves backward while the bullet is in the barrel to the distance the bullet moves forward.

Q12. The bob of a pendulum is released from a horizontal position. If the length of the pendulum is 1.5m, what is the speed with which the bob arrives at the lowermost point, given that it dissipated 5% of its initial energy against air resistance? **5 Marks**

Q13. A small block of mass m slides along the frictionless loop-to-loop track shown in the Figure. **5 Marks**

1. If it starts from rest at P what is the resultant force acting on it at Q?
2. At what height above the bottom of loop should the block be released so that the force it exerts against the track at the top of the loop equals its weight?

Q14. A coconut is broken into pieces by throwing it with a velocity of 2m/ s from a height of 5m. What is the kinetic energy when it is at a height of 3m? What is its speed at the ground level? **5 Marks**

Q15. What do you mean by elastic collision? For an elastic head on collision, find expressions for final velocities of the bodies after collision. **5 Marks**

Q16. Read the passage given below and answer the following questions from 1 to 5. **5 Marks**

Principle of Conservation of Energy:

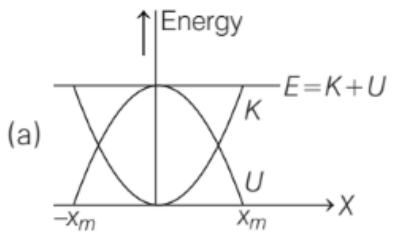
Total energy of an isolated system always remains constant. Since, the universe as a whole may be viewed as an isolated system, total energy of the universe is constant. If one part of the universe loses energy, then other part must gain an equal amount of energy. The principle of conservation of energy cannot be proved as such. However, no violation of this principle has been observed.

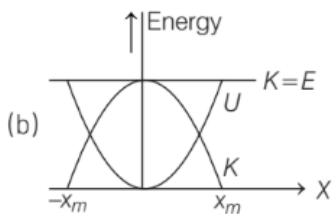
1. When we rub two flint stones together, got them to heat up and to ignite a heap of dry leaves in the form of:

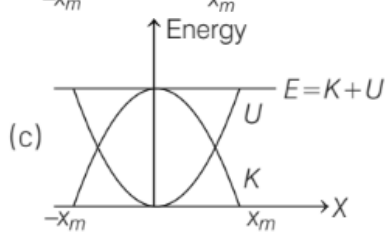
1. chemical energy
2. sound energy
3. heat energy

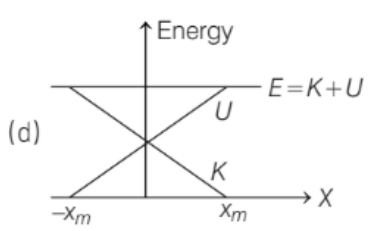
4. electrical energy

2. Which graph represents conservation of total mechanical energy?

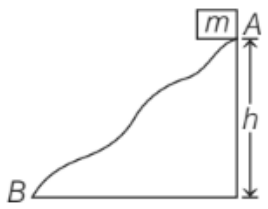
1. 

2. 

3. 

4. 

3. In the given curved road, if particle is released from A, then:



1. kinetic energy atB must be mgh
2. kinetic energy atB must be zero
3. kinetic energy atB must be less than mgh
4. kinetic energy atB must not be equal to potential energy

4. U is the potential energy, K is the kinetic energy and E is the mechanical energy. Which of the following is not possible for a stable system?

1. U > E
2. U < E
3. E > K
4. K > E

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

1. 12.5m
2. 10
3. 2.5m
4. 5m

Q17. The blades of a windmill sweep out a circle of area A. **5 Marks**

1. If the wind flows at a velocity v perpendicular to the circle, what is the mass of the air passing through it in time t?
2. What is the kinetic energy of the air?
3. Assume that the windmill converts 25% of the wind's energy into electrical energy, and that A = 30 m^2, v = 36km/h and the density of air is 1.2kgm^{-3}. What is the electrical power produced?

Q18. Read the passage given below and answer the following questions from 1 to 5. **5 Marks**

Power is defined as the time rate at which work is done or energy is transferred. The average power of a force is defined as the ratio of the work, W, to the total time t taken

$P_{av} = W/t$

The instantaneous power is defined as the limiting value of the average power as time interval approaches zero.

$P = dw/dt$

The work dW done by a force F for a displacement dr is dW = F.dr. The instantaneous power can also be expressed as

$P = F.dr/dt$

$P = F.v$

Where v is the instantaneous velocity when the force is F. Power, like work and energy, is a scalar quantity. Its dimensions are $[ML^2 T^{-3}]$. In the SI, its unit is called a watt (W). The watt is 1 J s^{-1}. The unit of power is named after James Watt, one of the innovators of the steam engine in the eighteenth century. There is another unit of power, namely the horse-power (hp)

1 hp = 746W

This unit is still used to describe the output of automobiles, motorbikes.

1. The time rate at which work is done or energy is transferred is called as:
   1. Energy
   2. Force
   3. Power
   4. None of these
2. Limiting value of power as time interval approaches zero is called as:
   1. Average power
   2. Instantaneous power
   3. Both a and b
   4. None of these
3. Power is directly proportional to:
   1. Force
   2. Velocity
   3. Both
   4. None of these
4. Define instantaneous power. Give its SI unit and dimensions.
5. 1 horse power is equal to how many watt?

Q19. The linear momentum of a body is increased by 10%. What is the percentage change in kinetic energy? **5 Marks**

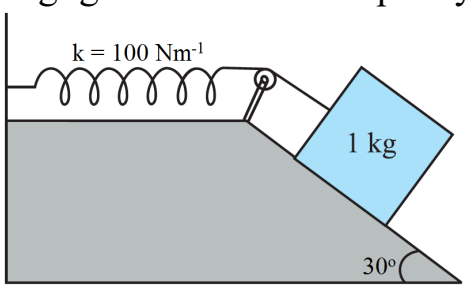
Q20. If the linear momentum is increased by 50%, what is the change in its kinetic energy? **5 Marks**

Q21. 1. Discuss the motion of a body in a vertical circle. Find the expressions for the minimum velocity at the lowest and highest points while looping a loop. **5 Marks**

2. A bullet of mass 0.01kg travelling at a speed of 500m/ s strikes a block of mass 2kg which is suspended by a string of length 5m. The centre of gravity of the block is found to rise a vertical distance of 0.1 m. What is the speed of the bullet after it emerges from the block? ($g = 9.8ms^{-2}$)

Q22. A mass m moving with a speed u collides with a similar mass m at rest, elastically and obliquely. Prove that they will move in directions making an angle $\frac{\pi}{2}$ with each other. **5 Marks**

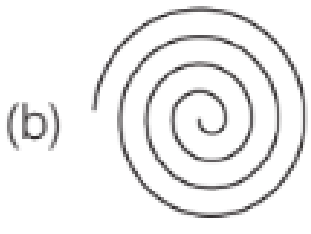
Q23. A 1kg block situated on a rough incline is connected to a spring of spring constant 100Nm as shown below. The block is released from rest with the spring in the unstretched position. The block moves 10cm down the incline before coming to rest. Find the coefficient of friction between the block and the incline. Assume that the spring has a negligible mass and the pulley is frictionless. **5 Marks**



Q24. Read the passage given below and answer the following questions from 1 to 5. **5 Marks**

PE of Spring

There are many types of spring. Important among these are helical and spiral springs as shown in figure.



Usually, we assume that the springs are massless. Therefore, work done is stored in the spring in the form of elastic potential energy of the spring. Thus, potential energy of a spring is the energy associated with the state of compression or expansion of an elastic spring.

1. The potential energy of a body is increases in which of the following cases?
1. If work is done by conservative force
2. If work is done against conservative force
3. If work is done by non-conservative force
4. If work is done against non- conservative force
2. The potential energy, i.e. U (x) can be assumed zero when:
1. x = 0
2. gravitational force is constant
3. infinite distance from the gravitational source
4. All of the above
3. The ratio of spring constants of two springs is 2 : 3. What is the ratio of their potential energy, if they are stretched by the same force?
1. 2 : 3
2. 3 : 2
3. 4 : 9
4. 9 : 4
4. The potential energy of a spring increases by 15 J when stretched by 3cm. If it is stretched by 4cm, the increase in potential energy is:
1. 27 J
2. 30 J
3. 33 J
4. 36 J
5. The potential energy of a spring when stretched through a distance x is 10 J. What is the amount of work done on the same spring to stretch it through an additional distance x?
1. 10 J
2. 20 J
3. 30 J
4. 40 J

Q25. An elastic spring of spring constant 'k' is compressed by an amount x. Show that its potential energy is $\frac{1}{2}kx^2$. **5 Marks**

Q26. Read the passage given below and answer the following questions from 1 to 5. **5 Marks**

The impact and deformation during collision may generate heat and sound. Part of the initial kinetic energy is transformed into other forms of energy. A useful way to visualize the deformation during collision is in terms of a 'compressed spring'. If the 'spring' connecting the two masses regains its original shape without loss in energy, then the initial kinetic energy is equal to the final kinetic energy but the kinetic energy during the collision time Δt is not constant. Such a collision is called an elastic collision. On the other hand the deformation may not be relieved and the two bodies could move together after the collision. A collision in which the two particles move together after the collision is called a completely inelastic collision. The intermediate case where the deformation is partly relieved and some of the initial kinetic energy is lost is more common and is appropriately called an inelastic collision. If the initial velocities and final velocities of both the bodies are along the same straight line, then it is called a one-dimensional collision, or head-on collision.

When two equal masses undergo a glancing elastic collision with one of them at rest, after the collision, they will move at right angles to each other.

1. After collision when two particles moves together then collision is:
1. Elastic collision
2. Completely inelastic collision
3. Both a and b
4. None of these
2. In elastic collision, loss in kinetic energy is:
1. Zero
2. Positive
3. Negative
4. None of these
3. What is head on collision?
4. What is elastic collision?
5. What is inelastic collision?

Q27. When slow neutrons are incident on a target containing $\frac{235}{92}\mathrm{U}$, a possible fission reaction is **5 Marks**

$$\frac{235}{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow \frac{141}{56}\mathrm{Ba} + \frac{92}{36}\mathrm{Kr} + 3{}_{0}\mathrm{n}^{1}$$

Estimate the amount of energy released using following data :

$M\left(\frac{235}{92}U\right) = 235.04amu$

$\left(M\frac{92}{36}Kr\right) = 91.926amu$

$M\left(\frac{141}{56}Ba\right) = 140.91amu$

$M = 1.0087\ amu$

Q28. A car of mass 1000kg accelerstes uniformly from rest to I veloclty of 54km/ h in 5 seconds. Calculate: **5 Marks**

1. Its acceleration.
2. Its gain in K.E.
3. Average power of the engine during this period Neglect friction.

Q29. A rain drop of radius 2mm falls from a height of 500m above the ground. It falls with decreasing acceleration (due to viscous resistance of the air) until at half its original height, it attains its maximum (terminal) speed, and moves with uniform speed thereafter. What is the work done by the gravitational force on the drop in the first and second half of its journey? What is the work done by the resistive force in the entire journey if its speed on reaching the ground is 10 m s^{-1}? **5 Marks**

Q30. Read the case study given below and answer any four subparts: **5 Marks**

Potential energy is the energy stored within an object, due to the object's position, arrangement or state. Potential energy is one of the two main forms of energy, along with kinetic energy. Potential energy depends on the force acting on the two objects.

1. A body is falling freely under the action of gravity alone in vacuum. Which of the following quantities remain constant during the fall?
    1. kinetic energy
    2. potential energy
    3. mechanical energy
    4. none of these
2. Work done by a conservative force is positive, if
    1. potential energy decreases
    2. potential energy increases
    3. kinetic energy decreases
    4. kinetic energy increases
3. When does the potential energy of a spring increases?
    1. only when spring is stretched
    2. only when spring is compressed
    3. both a and b
    4. none of these
4. Dimension of k/m is, here k is force constant
    1. T^2
    2. T^{-2}
    3. T^1
    4. T^{-1}
5. A vehicle of mass 5000kg climbs up a hill of 10 m. The potential energy gained by it
    1. 5J
    2. 500J
    3. 5×10^4J
    4. 5×10^5J

Q31. Estimate the amount of energy released in the nuclear fusion reaction. **5 Marks**

$_1H^2 +_1 H^2 \rightarrow_2 He^3 +_0 n^1$

Given: $M(_1H^2) = 2.0141u,$

$M(_2He^3) = 3.0160u.$

$M(_2n^1) = 1.0087u,$

$1amu = 1u$

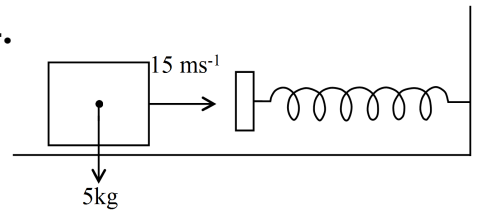
$= 1.661 \times 10^{-27}\ kg$

$= 931Mev$

Q32. A mass 1kg is thrown up with a K.E. of 50joules. If 10% of the energy is lost in overcoming air resistance, find the height to which it will rise? **5 Marks**

Q33. An icecream vendor applies a 20kg wt of force at an angle 60° with the horizontal. If the displacement is 20m, estimate the work done. **5 Marks**

Q34. **5 Marks**



If the spring constant of the spring is 250N/ m, find the maximum compression of the spring.

Q35.A mass is dropped from a height h on to a floor with coefficient of restitution 'e'. Find **5 Marks**

1. The height to which, it will go after n collisions.
2. The velocity after 'n' collisions with the floor.
3. The time taken till the n^{th} collision.

Q36. Read the passage given below and answer the following questions from 1 to 5. **5 Marks**

The gravitational potential energy of an object at a point above the ground is defined as the work done in raising it from the ground by height h to that point against gravity. Let the work done on the object against gravity be W. That is, work done,

W = force × displacement

= mg × h

Therefore potential energy (PE) = mg*h. The dimensions of potential energy are $[ML^2T^{-2}]$ and the unit is joule (J), the same as kinetic energy or work. To reiterate, the change in potential energy, for a conservative force, $\triangle V$ is equal to the negative of the work done by the force $\triangle v = -F(x)\triangle x$.

Conservation of mechanical energy: Suppose that a body undergoes displacement $\triangle x$ under the action of a conservative force F. Then from the WE theorem we have, $\triangle K = F(x)\triangle x$

If the force is conservative, the potential energy function V(x) can be defined such that

$-\triangle V = F(x)\triangle x$

The above equations imply that $\triangle K + \triangle V = 0$ or $\triangle(K + V) = 0$.

Which means that K + V, the sum of the kinetic and potential energies of the body is a constant? Over the whole path, x_i to x_f, this means that $K_i + V(x_i) = Kf + V(x_f)$. The quantity K +V(x), is called the total mechanical energy of the system. Individually the kinetic energy K and the potential energy V(x) may vary from point to point, but the sum is a constant. The aptness of the term 'conservative force' is now clear.

Let us consider some of the definitions of a conservative force.

- A force F(x) is conservative if it can be derived from a scalar quantity V(x).
- The work done by the conservative force depends only on the end points. This can be seen from the relation, W = Kf – Ki = V (xi) – V(xf) which depends on the end points.
- A third definition states that the work done by this force in a closed path is zero. This is once again apparent since xi = xf .

Thus, 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.

1. Dimensions of potential energy is given by:
1. $[ML^2T^{-2}]$
2. $[M^2 L^2T^{-2}]$
3. $[ML^3T^{-3}]$
4. None of the above
2. SI unit of potential energy is:
1. Joule(J)
2. Newton meter(N-m)
3. Both a and b
4. None of these
3. Define the gravitational potential energy.
4. Define conservative force.
5. State conservation of mechanical energy.

Q37. What should be the power of an engine required to lift 90 metric tonnes of coal per hour from a depth of 200m? **5 Marks**

Q38. An electron and a proton are detected in a cosmic ray experiment, the first with kinetic energy 10keV, and the second with 100keV. Which is faster, the electron or the proton? Obtain the ratio of their speeds. (electron mass = 9.11×10^{-31}kg, proton mass = 1.67×10^{-27}kg, 1eV = 1.60×10^{-19}J). **5 Marks**

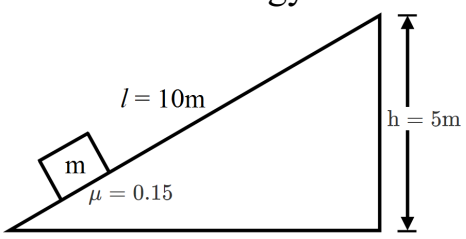
Q39. Derive an expression for the velocity of the two masses m_1 and m_2 moving with speeds u_1 and u_2 undergoing elastic collision in one dimension. **5 Marks**

Q40.A neutron (um/ s) collides with a nucleus at rest of mass number A. How muchenergy is transferred to the nucleus by the neutron? **5 Marks**

Q41. **5 Marks**

A body of mass 0.3kg is taken up an inclined plane length 10m and height 5m and then allowed to slide down the bottom again. The coefficient of friction between the body and the plane is 0.15. What is the

1. Work done by gravitational force over the round trip?
2. Work done by the applied force over the upward journey?
3. Work done by the frictional force over the round trip?
4. Kinetic energy of the body at the end of trip? ($g = 10ms^{-2}$)



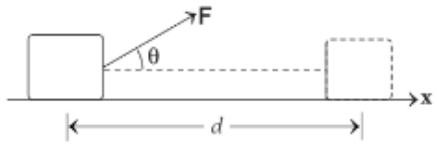
Q42. A hammer of mass M drops from a height h. It strikes a nail placed vertically on the ground and drives it into the ground through a distance D. Calculate. **5 Marks**

1. The average resistance offered by the ground, assuming that the hammer and nail remain stuck together after impact.
2. The time for which the nail is in motion and.
3. The loss in kinetic energy in impact.

Q43. Read the passage given below and answer the following questions from 1 to 5. **5 Marks**

Work

A farmer ploughing the field, a construction worker carrying bricks, a student studying for a competitive examination, an artist painting a beautiful landscape, all are said to be working. In physics, however, the word 'Work' covers a definite and precise meaning. Work refers to
the force and the displacement over which it acts. Consider a constant force F acting on an object of mass m. The object undergoes a displacement d in the positive x-direction as shown in figure.



The work done by the force is defined to be the product of component of the force in the direction of the displacement and the magnitude of this displacement, thus
$W = (F \cos\theta)\, D = F.\, D.$

1. The earth is moving around the sun in a circular orbit, is acted upon by a force and hence work done on the earth by the force is:

1. zero
2. positive
3. negative
4. None of the above

2. In which case, work done will be zero?

1. A weight-lifter while holding a weight of 100 kg on his shoulders for 1 min
2. A locomotive against gravity is running on a level plane with a speed of 60 kmh - 1
3. A person holding a suitcase on his head and standing at a bus terminal
4. All of the above

3. Find the angle between force $F = (3\hat{i} + 4\hat{j} - 5\hat{k})$ unit and displacement $d = (5\hat{i} + 4\hat{j} + 3\hat{k})$ unit.

1. $\cos^{-1}(0.49)$
2. $\cos^{-1}(0.32)$
3. $\cos^{-1}(0.60)$
4. $\cos^{-1}(0.90)$

4. Which of the following statement(s) is/ are correct for work done to be zero?

1. I. If the displacement is zero.
2. II. If force applied is zero.
3. III. If force and displacement are mutually perpendicular to each other.

(a) Only I (b) I and II
(c) Only II (d) I, II and III

5. A proton is kept at rest. A positively charged particle is released from rest at a distance d in its field. Consider two experiments; one in which the charged particle is also a proton and in another, a positron. In same time t, the work done on the two moving charged particles is:

1. same as the same force law is involved in the two experiments
2. less for the case of a positron, as the positron moves away more rapidly and the force on it weakens
3. more for the case of a positron, as the positron moves away a larger distance

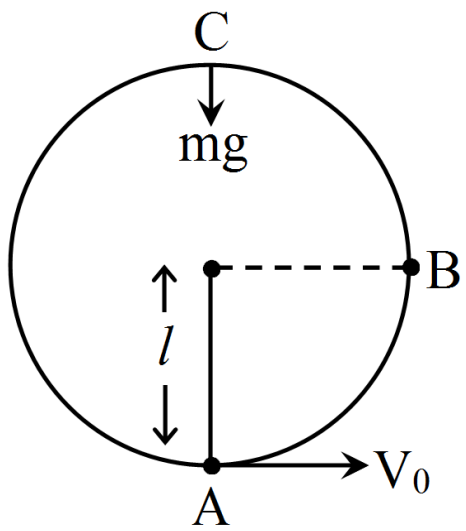
4. same as the work is done by charged particle on the stationary proton

Q44. What is a conservative force? Prove that gravitational force is conservative, while frictional force is non-conservative. **5 Marks**

Q45. A bob of mass m is suspended by a light string of length l. It is imparted a horizontal velocity v_o at the lowest point A so that it completes a semi-circular trajectory in the vertical plane with the string becoming slack only on reaching the topmost point C. This is shown in the figure. **5 Marks**

Obtain an expression for:

1. Horizontal velocity v.
2. The speed at point B and C.
3. The ratio of the kinetic energies $\left(\frac{K_B}{K_C}\right)$ at B and C.
4. Comment on the nature of the trajectory of the bob after it reaches the point C.

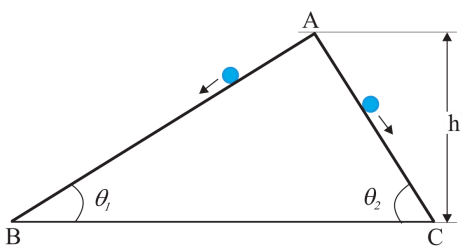


Q46. A trolley of mass 200kg moves with a uniform speed of 36km/h on a frictionless track. A child of mass 20kg runs on the trolley from one end to the other (10m away) with a speed of $4ms^{-1}$ relative to the trolley in a direction opposite to the its motion, and jumps out of the trolley. What is the final speed of the trolley? How much has the trolley moved from the time the child begins to run? **5 Marks**

Q47. Define elastic and inelastic collisions. Write their basic characteristics. A bullet is fired into a block of wood. If it gets totally embedded in it and the system moves together as one entity, then state what happens to the initial kinetic energy and linear momentum of the bullet? **5 Marks**

Q48. A force $3\hat{i} + 2\hat{j}$ displaces a 1kg mass from $\hat{i} + \hat{j}$ to $-\hat{i} + 2\hat{j}$. Find the work done. **5 Marks**

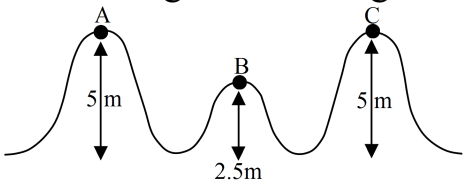
Q49. Two inclined frictionless tracks, one gradual and the other steep meet at A from where two stones are allowed to slide down from rest, one on each track. Will the stones reach the bottom at the same time? Will they reach there with the same speed? Explain. Given $\theta_1 = 300, \theta_2 = 600$, and h = 10m, what are the speeds and times taken by the two stones? **5 Marks**



Q50. 1. Discuss elastic collision in one dimension. Obtain expressions for velocities of the two bodies after such collision. **5 Marks**

2. A railway carriage of mass 9000kg moving with a speed of 36km/ h collides with a stationary carriage of the same mass. After the collision, the two get coupled and move together. What is the common speed and what type of collision is this?

Q51. A mass 5kg starts sliding from A on a smooth surface shown in the figure. Find the velocity of the mass at B and C? **5 Marks**



Q52. Read the passage given below and answer the following questions from 1 to 5. **5 Marks**

The kinetic energy possessed by an object of mass, m and moving with a uniform velocity, v is

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

Kinetic energy is a scalar quantity. The kinetic energy of an object is a measure of the work and The energy possessed by an object is thus measured in terms of its capacity of doing work. The unit of energy is, therefore, the same as that of work, that is, joule (J).

Work energy theorem: The change in kinetic energy of a particle is equal to the work done on it by the net force.

Mathematically

$K_f - K_i = W$

Where Ki and Kf are respectively the initial and final kinetic energies of the object. Work refers to the force and the displacement over which it acts. Work is done by a force on the body over a certain displacement.

1. Kinetic energy is:
1. Scalar quantity
2. Vector quantity
3. None of these
2. Which of the following has same unit?
1. Potential energy and work
2. Kinetic energy and work
3. Force and weight
4. All of the above
3. What is work energy theorem?
4. Kinetic energy is scalar quantity. Justify the statement.
5. Give formula for kinetic energy of body.

Q53. Read the passage given below and answer the following questions from 1 to 5. **5 Marks**

The scalar product or dot product of any two vectors A and B, denoted as A.B (read A dot B) is defined as

$\mathrm{A} \cdot \mathrm{B} = \mathrm{AB}\cos\theta$

Where q is the angle between the two vectors. Since A, B and $\cos\theta$ are scalars, the dot product of A and B is a scalar quantity. Each vector, A and B, has a direction but their scalar product does not have a direction. Following are properties of dot product

- the scalar product follows the commutative law: A.B = B.A
- Scalar product obeys the distributive law: (B + C) = A.B + A.C Further, A. $(\lambda \mathrm{B}) = \lambda(\mathrm{A} \cdot \mathrm{B})$ where λ is a real number.
- For unit vectors i, j, k we have

$i \times i = j \times j = k \times k = 1$ and $i \times j = j \times k = k \times i = 0$

$\mathrm{A} \times \mathrm{A} = \mid \mathrm{A} \parallel \mathrm{A} \mid \cos\theta = \mathrm{A}^2.$

B = 0, if A and B are perpendicular.

The work done by the force is defined to be the product of component of the force in the direction of the displacement and the magnitude of this displacement. Thus

$\mathrm{W} = (\mathrm{F}\cos\theta)\mathrm{d} = \mathrm{F} \cdot \mathrm{d}$ (We see that if there is no displacement, there is no work done even if the force is large. Work has only magnitude and no direction. Its SI unit is (N m) or joule (J). Thus, When you push hard against a rigid brick wall, the force you exert on the wall does not work.

No work is done if:

- The displacement is zero.
- The force is zero. A block moving on a smooth horizontal table is not acted upon by Horizontal force (since there is no friction), but may undergo a large displacement.
- The force and displacement are mutually perpendicular. This is so since, for $\theta = \frac{\pi}{2}$ rad
- $\cos\left(\frac{\pi}{2}\right) = \theta$. For the block moving on a smooth horizontal table, the gravitational force mg does no work since it acts at right angles to the displacement. If we assume that the moon's orbits around the earth are perfectly circular then the earth's gravitational force does no work. The moon's instantaneous displacement is tangential while the earth's force is radially inwards and $\theta = \frac{\pi}{2}$.

1. Scalar product A.B = B.A is:
1. Commutative law
2. Distributive law
3. Both a and b
4. None of these
2. When force acts in the direction of displacement then work done will be:
1. Positive
2. Negative
3. Both a and b can possible
4. None of these
3. Define scalar product. give its properties:
4. Define work done. Give its SI unit
5. Write down the conditions for which work done is zero

Q54. The potential energy of a spring when stretched through a distance x is 25J. What is the amount of work done on the same spring so as to stretch it by an additional distance 5x ? **5 Marks**

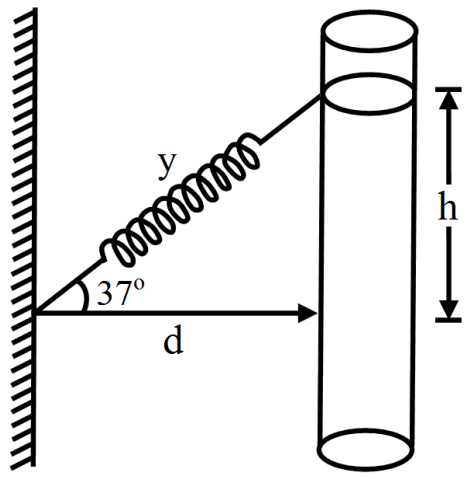
Q55. **4 Marks**

A boy has a bag of sand of mass 20 kg. First of all, he keeps the bag on his head and moves 10m. Second time, he drags the bag through 10m on a frictionless surface with coefficient of friction u = 0.1. In which case, he does more work?

Q56. Two particles A and B of masses m and 2m, are moving along the X and Y-axes, respectively with the same speed of V. They collide at the origin and coalesce into one body after the collision. What is the velocity of the coulesced mass? What is the loss of energy during this collission? **4 Marks**

Q57. A group of clouds at a height of 500m above the earth burst and cause enough rainfall to cover an area of 106m 2 with a depth of 2cm. How much work would have been done in raising water to the height of clouds? **4 Marks**

Q58. One end of a light spring of natural length d and spring constant k is fixed on a rigid wall and other end is fixed in a smooth ring of mass m as shown in figure. Initially, the spring is stretched such that it makes an angle of 37° with the horizontal. **4 Marks**



Now, the ring is stretched from rest, find the speed of the ring when it will become horizontal, assume that ring slides on the vertical wall without friction.

Q59. A family uses 8kW of power. **4 Marks**

1. Direct solar energy is incident on the horizontal surface at an average rate of 200W per square meter. If 20% of this energy can be converted to useful electrical energy, how large an area is needed to supply 8kW?
2. Compare this area to that of the roof of a typical house.

Q60. A and B are two identical balls. A moving with a speed of $6ms^{-1}$ along the positive x-axis, undergoes a collision with B, intially at rest. After collision each ball moves and the directions making of $\pm 30^\circ$ with the x-axis. What are the speeds of A and B after the collision? Is the collision perfectly elastic? **4 Marks**

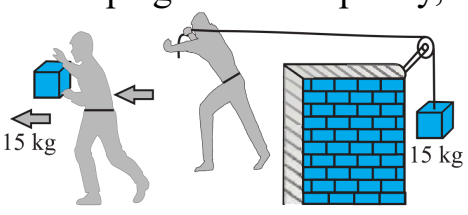
Q61. A bullet of mass m moving with a velocity v is embedded into a block of mass M suspended by a thread. As a result of this collision, the block along with the bullet rises to a height h. Prove that velocity of bullet was $\left(\frac{m+M}{m}\right)\sqrt{2gh}$. **4 Marks**

Q62. How high must a body be lifted to gain an amount of potential energy equal to the kinetic energy it has, when moving at speed 20 ms^{-1}. The value of acceleration due to gravity at that place is g = 9.8 ms^{-2}. **4 Marks**

Q63. A pump on the ground floor of a building can pump up water to fill a tank of volume $30m^3$ in 15min. If the tank is 40m above the ground, and the efficiency of the pump is 30%, how much electric power is consumed by the pump? **4 Marks**

Q64. Answer the following: **4 Marks**

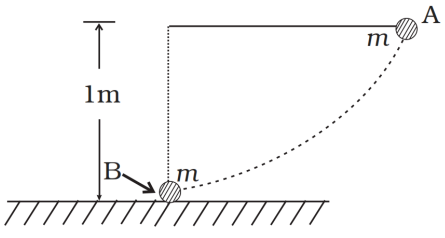
In the man walks 2m carrying a mass of 15kg on his hands. In he walks the same distance pulling the rope behind him. The rope goes over a pulley, and a mass of 15kg hangs at its other end. In which case is the work done greater?



Q65. A synchronous motor is used to lift an elevator and its load of 1500kg to a height of 20m. The time taken for job is 20s. What is work done? What is the rate at which work is done? If the efficiency of the motor is 75%, at which rate is the energy supplied to the motor? **4 Marks**

Q66. When a 300g mass is hung from a vertical spring, it stretches from equilibrium by 10cm. What work is required to stretch it by next 5cm? **4 Marks**

Q67. The bob A of a pendulum released from horizontal to the vertical hits another bob B of the same mass at rest on a table as shown in. **4 Marks**



If the length of the pendulum is 1m, calculate.

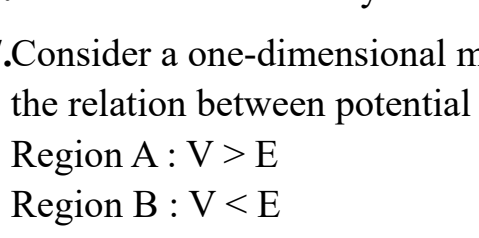
1. The height to which bob A will rise after collision.
2. The speed with which bob B starts moving. Neglect the size of the bobs and assume the collision to be elastic.

Q68. An object of mass 0.4kg moving with a velocity of $4ms^{-1}$ collides with another object of mass 0.6kg moving in same direction with a velocity of $2ms^{-1}$. If the collision is prefectly inelastic, what is the loss of K.E. due to impact? **4 Marks**

Q69. A block of mass m moving with speed v compresses a spring through a distance x before its speed is halved. What is the value of spring constant? **4 Marks**

Q70. A man weighing 50kg supports a body of 25kg on his head. What is the work done when he moves a distance of 20m up an incline of 1 in 10? Take, $g = 9.8m/ s^2$. **4 Marks**

Q71. For three situations, the initial and final positions respectively, along x-axis for the block in Fig are (a) - 3cm, 2cm. (b) 2cm, 3 cm and (c) -2cm, 2cm. In each situation, is the work done by the spring force on the block positive, negative or zero? **4 Marks**



Q72. The blades of a windmill sweep out a circle of area A. **4 Marks**

1. If the wind flows at a velocity v perpendicular to the circle, what is the mass of the air passing through it in time t?
2. What is the kinetic energy of the air?
3. Assume that the windmill converts 25% of the wind's energy into electrical energy, and that $A = 30m^2$, v = 36km/ h and the density of the air is $1.2kg/ m^{-3}$. What is the electrical power produced?

Q73. A particle of mass 0.2kg, has an initial speed of $5ms^{-1}$ at the bottom of a rough inclined plane of inclination 30° and vertical height 0.5m. What is the speed of the particle as it reaches the top of the inclived plane? **4 Marks**

[Take $\mu = \frac{1}{\sqrt{3}}$]

$g = 10m/ s^{-2}$

Q74. A ball of mass m, moving with a speed $2v_0$, collides inelastically ($e > 0$) with an identical ball at rest. Show that: For a general collision, the angle between the two velocities of scattered balls is less than 90° **4 Marks**

Q75. Show that in case of one dimensional elastic collision of two bodies, the relative velocity of separation after the collision is equal to the relative velocity of approach before the collision. **4 Marks**

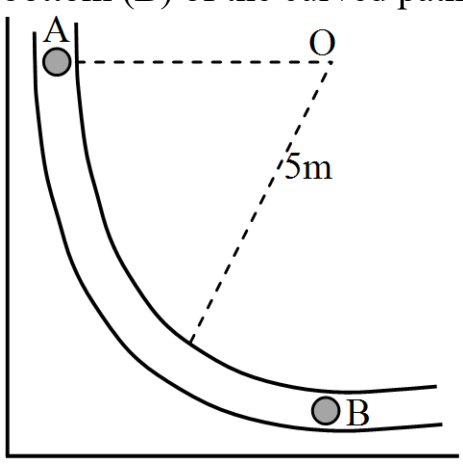
Q76. If momentum of a body increased by 300%, then what will be percentage increase in momentum of a body? **4 Marks**

Q77. Consider a one-dimensional motion of a particle with total energy E. There are four regions A, B, C and D in which the relation between potential energy V, kinetic energy (K) and total energy E is as given below: **4 Marks**

Region A : V > E
Region B : V < E
Region C : K > E
Region D : V > K
State with reason in each case whether a particle can be found in the given region or not.

Q78. A mass m is placed on a platform from a height 'h'. The platform is attached to a spring whose other end is fixed to the ground. Find the compression in the spring, if the spring constant is k. **4 Marks**

Q79. A ball moves along a curved path of radius 5m as shown in figure. It starts from point A and reaches point B. If there is no force of friction between the ball and surface of the path, then find the normal force that acts on the ball at the bottom (B) of the curved path. **4 Marks**



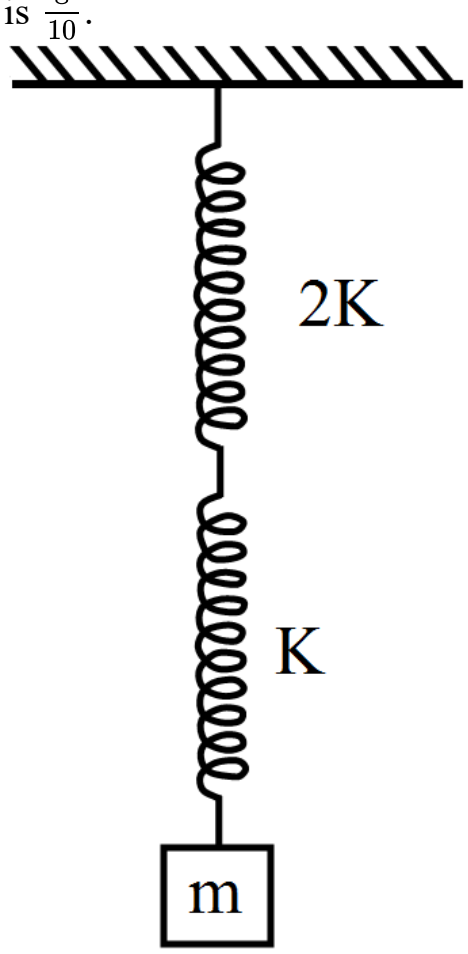
Q80. A body of mass 3kg is under a constant force, which causes a displacement S in metre in it, given by the relation $S = \frac{1}{2}t^2$, where t is in second. Find the work done by the force in 2s. **4 Marks**

Q81. **4 Marks**

A person trying to lose weight (dieter) lifts a 10kg mass, one thousand times, to a height of 0.5m each time. Assume that the potential energy lost each time she lowers the mass is dissipated.

1. How much work does she do against the gravitational force?
2. Fat supplies 3.8 × 107J of energy per kilogram which is converted to mechanical energy with a 20% efficiency rate. How much fat will the dieter use up?

Q82. A helicopter lifts a 72kg astronaut 15m vertically from the ocean by means of a cable. The acceleration of the astronaut is $\frac{g}{10}$. **4 Marks**



How much work is done on the astronaut by:

1. The force from the helicopter and
2. The gravitational force on him?
3. What are the kinetic energy and
4. The speed of the astronaut just before he reaches the helicopter?(Take, g = 10ms^{-2})

Q83. Two identical balls A and B undergo a perfectly elastic two dimensional collision. Initially A is moving with a speed of 10ms^{-1} and B is at rest. Due to collision A is scattered through angle of 30°. What are the speed of A and B after the collision? **4 Marks**

Q84. A particle of mass 0.2kg, has an initial speed of 5ms^{-1} at the bottom of a rough inclined plane of inclination 30° and vertical height 0.5m. What is the speed of the particle as it reaches the top of the inclived plane? **4 Marks**

Q85. A and B are two particles having the same mass 'm'. A is moving along x-axis with a speed of 10ms^{-1} and B is at rest. After undergoing a perfectly elastic collision with B, particle A get scattered through an angle of 30°. What is the direction of the motion of B and the speeds of A and B after the collision? **4 Marks**

Q86. Read the case study given below and answer the questions that follow: **4 Marks**

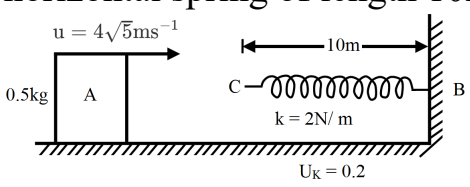
Potential Energy of Spring There are many types of spring. Important among these are helical and spiral springs. Usually, we assume that the springs are massless. Therefore, work done is stored in the spring in the form of elastic potential energy of the spring. Thus, potential energy of a spring is the energy associated with the state of compression or expansion of an elastic spring.

1. Define potential energy of a spring.
2. What types of springs are commonly discussed in the context of potential energy?
3. Explain why springs are often assumed to be massless when calculating potential energy.

OR

3. Explain why we assume springs to be massless when calculating potential energy.

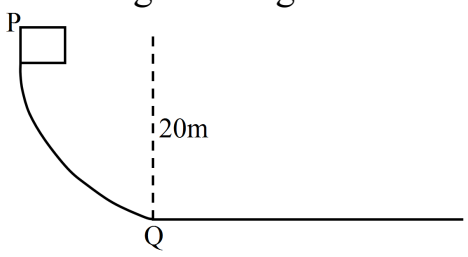
Q87. A 0.5kg block slides from the point A on a horizontal track with an initial speed $4\sqrt{5}\text{ms}^{-1}$ towards a weightless horizontal spring of length 10m and spring constant 2 N/ m. **4 Marks**



The initial track is frictionless and part BC under the unstretched length of spring has coefficient of kinetic friction $\mu_k = 0.2$ Calculate total distance by which the block move before coming finally to rest. (g = 10ms^{-1}).

Q88. A block of mass 200g is released from P which slides down without friction till it reaches a point Q of a circular path of radius 2.0m. Find. **4 Marks**

1. The velocity of the block at point Q and.
2. The coefficient of friction if the block comes to rest 2.0m from Q, assuming the horizontal part of the path is rough. Take g = 10ms^{-2}.



Q89. A bullet of mass 20g is moving with a speed of 150ms^{-1}. It strikes a target and is brought to rest after piercing 10cm into it. Calculate the average force of resistance offered by the target. **4 Marks**

Q90. Two identical steel cubes (masses 50g, side 1cm) collide head-on face to face with a speed of 10cm/ s each. Find the maximum compression of each. Young's modulus for steel = Y = 2 × 1011 N/ m^2. **4 Marks**

Q91. A particle of mass 1kg moving with a velocity $V_1 = (3\hat{i} - 2\hat{J})m/s$ experience a perfectly inelastic collision with another particle of mass 2kg having velocity $v_2 = 4\hat{j} - 6\hat{k}m/s$. Find the velocity and speed of the particle formed. **4 Marks**

Q92. Read the case study given below and answer the questions that follow: **4 Marks**

The impact and deformation during collision may generate heat and sound. Part of the initial kinetic energy is transformed into other forms of energy. A useful way to visualize the deformation during collision is in terms of a 'compressed spring'. If the 'spring' connecting the two masses regains its original shape without loss in energy, then the initial kinetic energy is equal to the final kinetic energy but the kinetic energy during the collision time Δt is not constant. Such a collision is called an elastic collision. On the other hand the deformation may not be relieved and the two bodies could move together after the collision. A collision in which the two particles move together after the collision is called a completely inelastic collision. The intermediate case where the deformation is partly relieved and some of the initial kinetic energy is lost is more common and is appropriately called an inelastic collision. If the initial velocities and final velocities of both the bodies are along the same straight line, then it is called a one-dimensional collision, or head-on collision.

When two equal masses undergo a glancing elastic collision with one of them at rest, after the collision, they will move at right angles to each other.

1. Define elastic collision in the context of physics.
2. What happens to the initial kinetic energy in an elastic collision?
3. Explain why a glancing elastic collision between two equal masses, with one initially at rest, results in them moving at right angles to each other.

OR

3. Differentiate between elastic and inelastic collisions based on the changes in kinetic energy and momentum.

Q93. A particle of mass m moving with an initial velocity u collides in elastically with a particle of mass M initially at rest. If the collision is completely inelastic, then find expressions for: **4 Marks**

1. Final velocity of combined entity and
2. Loss in kinetic energy during collision.

Q94. A block of mass m moving at speed 'v' collides with another block of mass 2 m at rest. The lighter block comes to rest after the collision. Find the coefficient of restitution. **4 Marks**

Q95. A particle moves along the x-axis from x = 0 to x = 5m under the influence of a force given by f(x) = 7 - 2x + 3x^2. Calculate the work done. **4 Marks**

Q96. A long spring of spring constant 500N/ m is attached to a wall horizontally and surface below the spring is rough with coefficient of friction 0.75. A 100kg mass block moving with a speed $10\sqrt{2}ms^{-2}$ strikes the spring. Find the maximum compression of the spring. (g = 10ms^{-2}) **4 Marks**

Q97. A body of mass 2kg is resting on a rough horizontal surface. A force of 20N is now applied to it for 10 seconds parallel to the surface. If the coefficient of kinetic friction between the surfaces in contact is 0.2, calculate. **4 Marks**

1. Work done by the applied force in 10 seconds.
2. Change in kinetic energy of the object in 10 seconds.

Take g = 10 m/ s^2

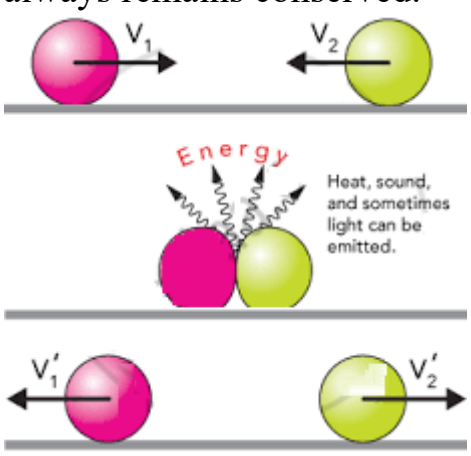
Q98. The displacement x of a particle moving in one dimension under the action of a constant force is related to time by the equation $t = \sqrt{x} + 3$ where x is in meter and t in second. Calculate the work done by the force in the first 6 second. **4 Marks**

Q99. Two ball bearings of mass m each moving in opposite directions with equal speed v collide head-on with each other. Predict the outcome of the collision, assuming it to be perfectly elastic. **4 Marks**

Q100 Read the case study given below and answer the questions that follow: **4 Marks**

Collision is an isolated event in which a strong force acts between two or more bodies for a short time as a result of which the energy and momentum of the interacting particle change. In collision particles may or may not come in real touch e.g. in collision between two billiard balls or a ball and bat, there is physical contact while in collision of alpha particle by a nucleus (i.e. Rutherford scattering experiment) there is no physical contact.

(A) Momentum conservation: In a collision, the effect of external forces such as gravity or friction are not taken into account as due to small duration of collision (At) average impulsive force responsible for collision is much larger than external force acting on the system and since this impulsive force is 'Internal' therefore the total momentum of system always remains conserved.



(B) Energy conservation: In a collision 'total energy' is also always conserved. Here total energy includes all forms of energy such as mechanical energy, internal energy, excitation energy, radiant energy or even mass energy.

These laws are the fundamental laws of physics and applicable for any type of collision but this is not true for conservation of kinetic energy. An elastic collision is a collision in which there is no net loss in kinetic energy in the system as a result of the collision. Both momentum and kinetic energy are conserved quantities in elastic collisions.

1. Explain why external forces like gravity or friction are neglected in the context of momentum conservation during a collision.
2. State the condition under which momentum conservation holds true in collisions.
3. Describe why energy conservation in collisions encompasses various forms of energy. Provide examples to support your explanation.

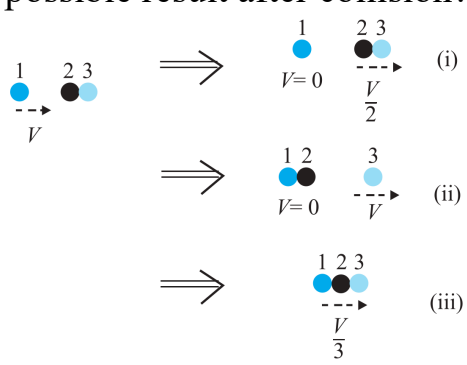
OR

3. Discuss the difference between elastic and inelastic collisions with respect to kinetic energy conservation.

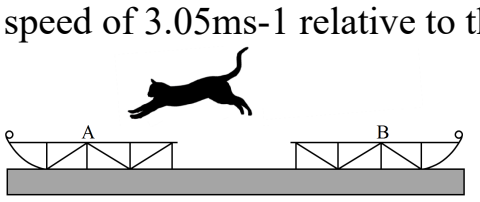
Q101 A particle of mass 0.1kg has an initial speed of $4ms^{-1}$ at a point A on a rough horizontal road. The coefficient of friction, between the object and the road is 0.15. The particle moves to a point B at a distance of 2m from A. What is the speed of the particle B? (Take $g = 10ms^{-2}$) **4 Marks**

Q102 Two identical masses, one at rest and the other moving, undergo elastic oblique collision. Prove that they will move at right angles to each other after collision. **4 Marks**

Q103 Two identical ball bearings in contact with each other and resting on a frictionless table are hit head-on by another ball bearing of the same mass moving initially with a speed V. If the collision is elastic, which of the following is a possible result after collision? **4 Marks**



Q104 Two 22.7kg ice sleds A and B are placed a short distance apart, one directly behind the other, as shown in Fig. A 3.63kg cat, standing on one sled, jumps across to the other and immediately back to the first. Both jumps are made at a speed of 3.05ms-1 relative to the ice. Find the final speeds of the two sleds. **4 Marks**



Q105 Prove that when a particle suffers an oblique elastic collision with another particle of equal mass and initially at rest, the two particles would move in mutually perpendicular directions after collisions. **4 Marks**