DELHI PUBLIC SCHOOL, KNOWLEDGE PARK V
CLASS : XI SUBJECT : PHYSICS
HALF YEARLY EXAMINATION SESSION: 2024-25

TIME: 03 Hours **MM: 70**

General Instructions:

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in sections B, C, D and E. You have to attempt only one of the choices in such questions.

(6) Use of calculator is not allowed.

Section-A

Q1. One watt hour contains how many joules ? (1)

(a) 3.6×10^8 J (b) 3.6×10^2 J

(c) 3.6×10^3 J (d) 10^{-3} J

Q2. The sum of the numbers 436.32, 227.2 & 0.301 in appropriate significant fig. (1)

(a) 663.821 (b) 664

(c) 663.8 (d) 663.82

Q3. If force (F), velocity (V) and time (T) are taken as fundamental units, then the dimensions of mass are : (1)

(a) FVT^{-1} (b) FVT^{-2}

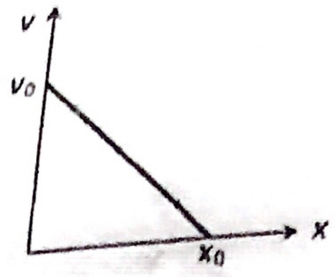
(c) $FV^{-1}T^{-1}$ (d) $FV^{-1}T^{1}$

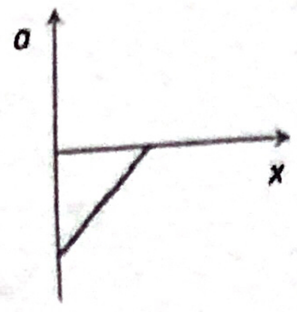
Q4. The position x of a particle varies with time t as $x = at^2 - bt^3$. The acceleration of the particle will be zero at time t equal to: (1)

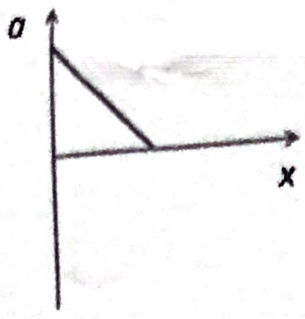
(a) a/b (b) 2a/3b

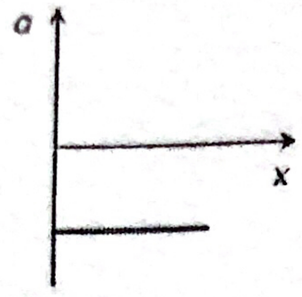
(c) a/3b (d) Zero

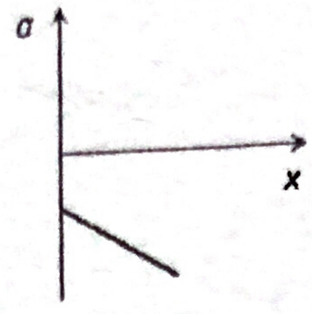
Q5. The given graph shows the variation of velocity with displacement. Which one of the graph given below correctly represents the variation of acceleration with displacement : (1)



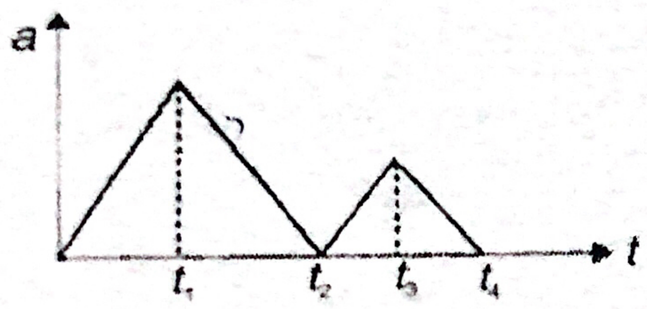
(a)


(b)


(c)


(d)


Q6. A particle starts moving from rest on a straight line. Its acceleration "a" verses time "t" is shown in the figure. The speed of the particle is maximum at the instant (1)



(a) t_1
(b) t_2
(c) t_3
(d) t_4

Q7. A body is released from certain height. After falling for sometime, if acceleration due to gravity vanishes, then (1)

(a) the body continues to move with uniform velocity
(b) the body continues to move with uniform acceleration
(c) the body continues to move with uniform retardation
(d) the body continues to move with variable acceleration

Q8. A body of mass 2 kg is hung on a spring balance mounted vertically in a lift. If the lift descends with an acceleration equal to the acceleration due to gravity 'g', the reading on the spring balance will be (1)

(a) 2 Kg
(b) 2g Kg
(c) 4g Kg
(d) Zero

Q9. The upper half of an inclined plane of inclination θ is perfectly smooth while the lower half is rough. A body starting from the rest at top comes back to rest at the bottom if the coefficient of friction for the lower half is given by (1)

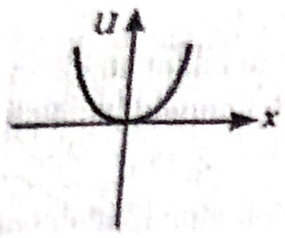
(a) $\mu = \sin\theta$
(b) $\mu = \cot\theta$
(c) $\mu = 2\cos\theta$
(d) $\mu = 2\tan\theta$

Q10. Two masses of 1 gm and 4 gm are moving with equal kinetic energies. The ratio of the magnitudes of their linear momenta is (1)

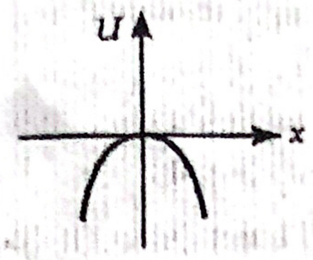
(a) 4 : 1
(b) 2 : 1
(c) 1 : 2
(d) 1 : 16

Q11. A particle is acted by a force F = kx, where k is a +ve constant. Its potential energy at x = 0 is zero. Which curve correctly represents the variation of potential energy of the block with respect to x? (1)

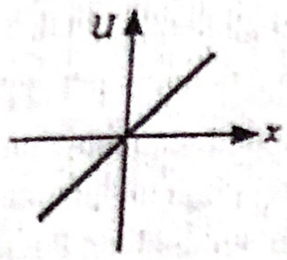
(a)



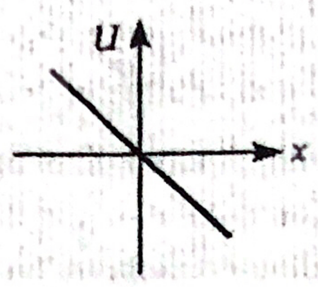
(b)



(c)



(d)



Q12. The centre of mass of a body is moving with a uniform velocity of 10 cm/s. Three forces are applied on the body, which are in equilibrium. The velocity of centre of mass would become (1)

(a) Zero
(b) > 10 cm/s
(c) < 10 cm/s
(d) 10 cm/s

The following question consist of two statements each, printed as **Assertion** and **Reason.** While answering these questions, you are required to choose any one of the following four responses.

A. Both, **Assertion** and **Reason** are true and the **Reason** is the correct explanation of the **Assertion.**

B. Both, **Assertion** and **reason** are true but **Reason** is not a correct explanation of the **Assertion.**

C. **Assertion** is true but the **Reason** is false.

D. Both, **Assertion** and **Reason** are false.

Q13. Assertion: A positive acceleration of a body can be associated with a 'slowing down' of the body.

Reason: Acceleration is a vector quantity. (1)

(a) A
(b) B
(c) C
(d) D

Q14. Assertion: A quick collision between two bodies is more violent than a slow collision, even when the initial and the final velocities are identical.

Reason: The rate of change of momentum which determines the force is greater in the first case. (1)

(a) A
(b) B
(c) C
(d) D

Q15. Assertion: During turning, a cyclist leans towards the centre of the curve; while a man sitting in the car leans outwards of the curve.
Reason: An acceleration is acting towards the centre of the curve. (1)
(a) A (b) B (c) C (d) D

Q16. Assertion: The position-time graph of a uniform motion in one dimension of a body can have negative slope.
Reason: When the speed of body decreases with time, the position-time graph of the moving body has negative slope. (1)
(a) A (b) B (c) C (d) D

SECTION-B

Q17. If momentum (p), area (A) and time (T) are taken to be fundamental quantities, then find the dimensional formula of Energy. (2)

Q18. Find the value of a force of 100 dyne on a system based on meter, kilogram and minute as fundamental units. (2)

Q19. Derive an expression for work done against friction when a body is made to slide up an inclined plane though distance "s". (2)

Q20. A sphere of mass 200 g is attached to an inextensible string of length 130 cm whose upper end is fixed to the ceiling. The sphere is made to describe a horizontal circle of radius 50 cm. Calculate the periodic time of this conical pendulum and the tension in the string. (2)

Q21. Three identical spheres each of radius R are kept touching each other on horizontal table. Find the coordinates of centre of mass of the system. (2)

SECTION-C

Q22. The critical angular velocity ω_c of a cylinder inside another cylinder containing liquid at which its turbulence occurs depends on viscosity η, density ρ & distance d between walls of the cylinder. Obtain an expression for ω_c by method of dimensions. (3)

Q23. A particle of mass m rests on a horizontal floor with which it has a coefficient of static friction μ. It is desired to make the body move by applying minimum possible force F, Find its magnitude and direction. (3)

OR

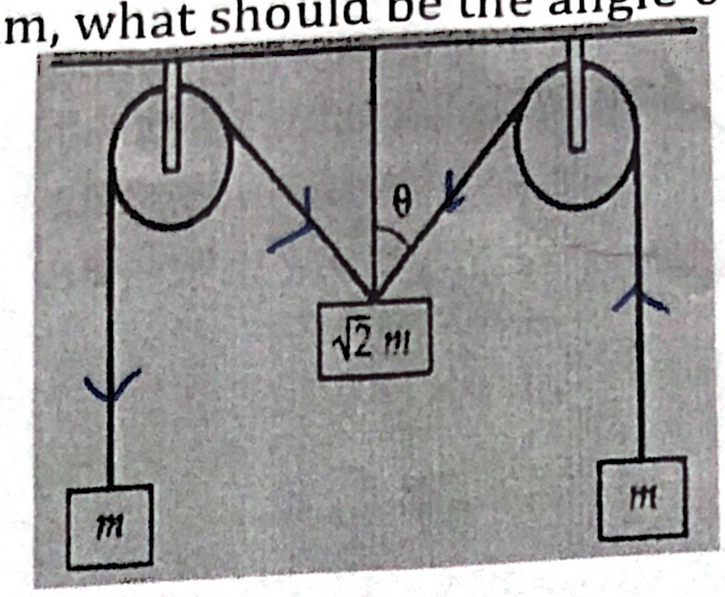
A mass of 200 kg is placed on a rough inclined plane of angle 30°. If coefficient of limiting friction is $1/\sqrt{3}$, find the least forces in newton, acting parallel to the plane (i) to keep the mass from sliding down, (ii) to move the mass up the plane. (3)

Q24. A Hunter aims his gun and fires a bullet at a monkey on a tree. At the instant the bullet leaves the barrel of the gun, the monkey drops. Will the bullet hit the monkey? Explain your answer with the help of equations. (3)

Q25. A train is moving along a straight line with a constant acceleration a. A boy standing in the train throws a ball forward with a speed of 10 m/s, at an angle of 60° to the horizontal. The boy has to move forward by 1.15 m inside the train to catch the ball back at the initial height. Find the acceleration of the train, in m/s^2. (3)

Q26. State & Prove Work Energy Theorem by method of calculus. (3)

Q27. The pulleys and strings shown in figure are smooth and of negligible mass. For the system to remain in equilibrium, what should be the angle θ ? (3)



Q28. From a uniform circular disc of radius R, a circular disc of radius R/6 and having centre at a distance R/2 from the centre of the disc is removed. Determine the centre of mass of remaining portion of the disc. (3)

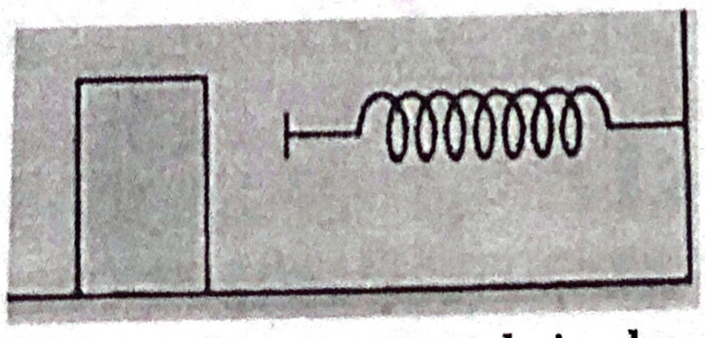
SECTION-D

Read the passage & answer the following questions :

Q29. **Potential Energy of Spring :**
Potential energy is defined only for conservative forces. In the space occupied by conservative forces every point is associated with certain energy which is called the energy of position or potential energy When a spring is stretched or compressed from its normal position (x= 0) by a small distance x, a restoring force is produced in spring to bring it to the normal position. According to Hooke's law this restoring force is proportional to the displacement x and its direction is always opposite to displacement. Then potential energy of spring is given by: $U = 1/2\ kx^2$. If spring is stretched from initial position x1 to final position x2 then work done = Increment in elastic potential energy = $\frac{1}{2}\ k\ (x_2^2 - x_1^2)$.

Questions:

(i) A block of mass 5.7 kg slides on a horizontal frictionless table with a constant speed of 1.2 ms^{-1}. It is brought momentarily to rest by compressing a spring as shown in figure in its path. By what maximum distance is the spring compressed ? The spring constant k = 1500 Nm^{-1} (1)



(ii) If stretch in a spring of force constant k is doubled then determine the ratio of elastic potential energy in the two cases. (1)

(iii) A spring of force constant 800N/m has an extension of 5cm. What is the work done in extending it from 5cm to 15 cm? (2)

OR

(iii) When a spring is stretched by 2cm, it stores 100 J of energy. If it is stretched further by 2cm, what will be the increase in stored energy? (2)

Q30. **MOTION UNDER GRAVITY:**

An object released near the surface of the Earth is accelerated downward under the influence of the force of gravity. The magnitude of acceleration due to gravity is represented by g. If air resistance is neglected, the object is said to be in free fall. If the height through which the object falls is small compared to the earth's radius, g can be taken to be constant, equal to 9.8 ms^{-2} . Free fall is thus a case of motion with uniform acceleration. We assume that the motion is in y-direction, more correctly in –y-direction because we choose upward direction as positive. Since the acceleration due to gravity is always downward, it is in the negative direction and we have = – g = – 9.8 m/sec^2 .

Questions:

(i) A stone of mass 0.05kg is thrown vertically upwards. What is the direction and magnitude of net force on the stone during its upward motion? (1)

(a) 0.49 N vertically downward
(b) 9.8 N vertically downwards
(c) 0.49 N vertically upwards
(d) 0.98 N vertically downwards

(ii) Free fall of an object (in vacuum) is a case of motion with (1)

(a) Uniform Velocity
(b) Uniform acceleration
(c) Variable acceleration
(d) constant momentum

(iii) Three different objects of masses m_1, m_2, m_3 are allowed to fall from rest and from the same point 'O' along three different frictionless paths. The speed of the three objects, on reaching the ground, will be in the ratio of (1)

(a) $m_1 : m_2 : m_3$
(b) $m_1 : 2m_2 : 3m_3$
(c) 1:1: 1
(d) $1/m_1 : 1/m_2 : 1/m_3$

(iv) A cricket ball is thrown up with a speed of 19.6 m/sec. The Maximum height it can reach is (1)

(a) 9.8 m
(b) 19.6 m
(c) 29.4 m
(d) 39.2m

SECTION-E

Q31. (a) Can you think of a situation where a body falling under gravity has constant velocity? (1)

(b) Give an example of a motion which even though is accelerated motion yet it is called uniform motion. (1)

(c) State and establish principle of conservation of Mechanical Energy? (3)

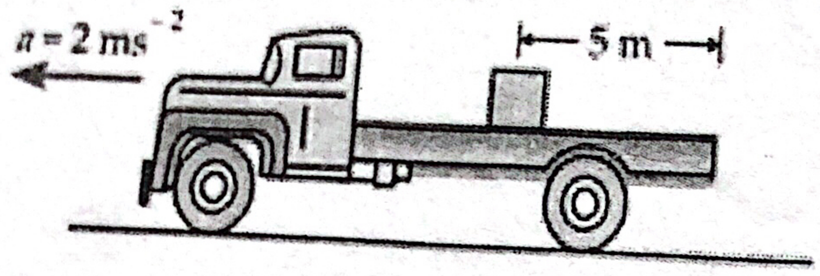
OR

(a) 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. (3)

(b) A bullet of mass 0.012 kg and horizontal speed 70 ms^{-1} strikes a block of wood of mass 0.4 kg and instantly comes to rest with respect to the block. The block is suspended from the ceiling by thin wire. Calculate the height to which the block rises. (2)

Q32. (a) What is meant by banking of roads? What is the need for banking a road? Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at an angle θ. The coefficient of friction is μ between tyres & road. (3)

(b) The rear side of a truck is open and a box of 40 kg mass is placed 5 m away from the open end as shown in Fig. The coefficient of friction between the box and the surface below it is 0.15. On a straight road, the truck starts from rest and accelerates with 2 ms^{-2}. At what distance from the starting point does the box fall off the truck? (2)



Or

(a) Define centripetal acceleration. (1)

(b) Derive an expression for centripetal acceleration of a particle moving with uniform Speed "v" along a circular path of radius r. (2)

(c)The angular velocity of a particle moving along a circle of radius 50 cm is increased in 5 minutes from 100 revolutions per minute to 400 revolutions per minute. Find: (i) angular acceleration and (ii) linear acceleration. (2)

Q33. (a) Derive an expression of Path of Projectile, Horizontal Range & Time of Flight for a projectile thrown with angular projection. (3)

(b) The maximum height attained by a projectile is increased by 10% by increasing its speed of projection, without changing the angle of projection. What will the percentage increase in the horizontal range.

OR

(a) Show that for two complementary angles of projection of a projectile thrown with the same velocity, the horizontal ranges are equal. (2)

(b) For what angle of projection of a projectile, is the range maximum? Prove it. (1)

(c) For what angle of projection of a projectile, are the horizontal range and maximum height attained by the projectile equal? (2)