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No. of Printed Pages : 11

MG-160

HALF YEARLY EXAMINATION 2024-25

PHYSICS

Time : 3 hrs.] Class XI [M.M. : 70

General Instructions—

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

(ii) This question paper has 5 sections : Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.

(iii) 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.

(iv) There is no overall choice. However, an internal choice has been provided. You have to attempt only one of the choices in such questions.

(v) Use of calculators is not allowed.

SECTION-A

1. Given that the displacement of an oscillating particle is given by Y=Asin(Bx+Ct+D). The dimensional formula for (ABCD) is : 1

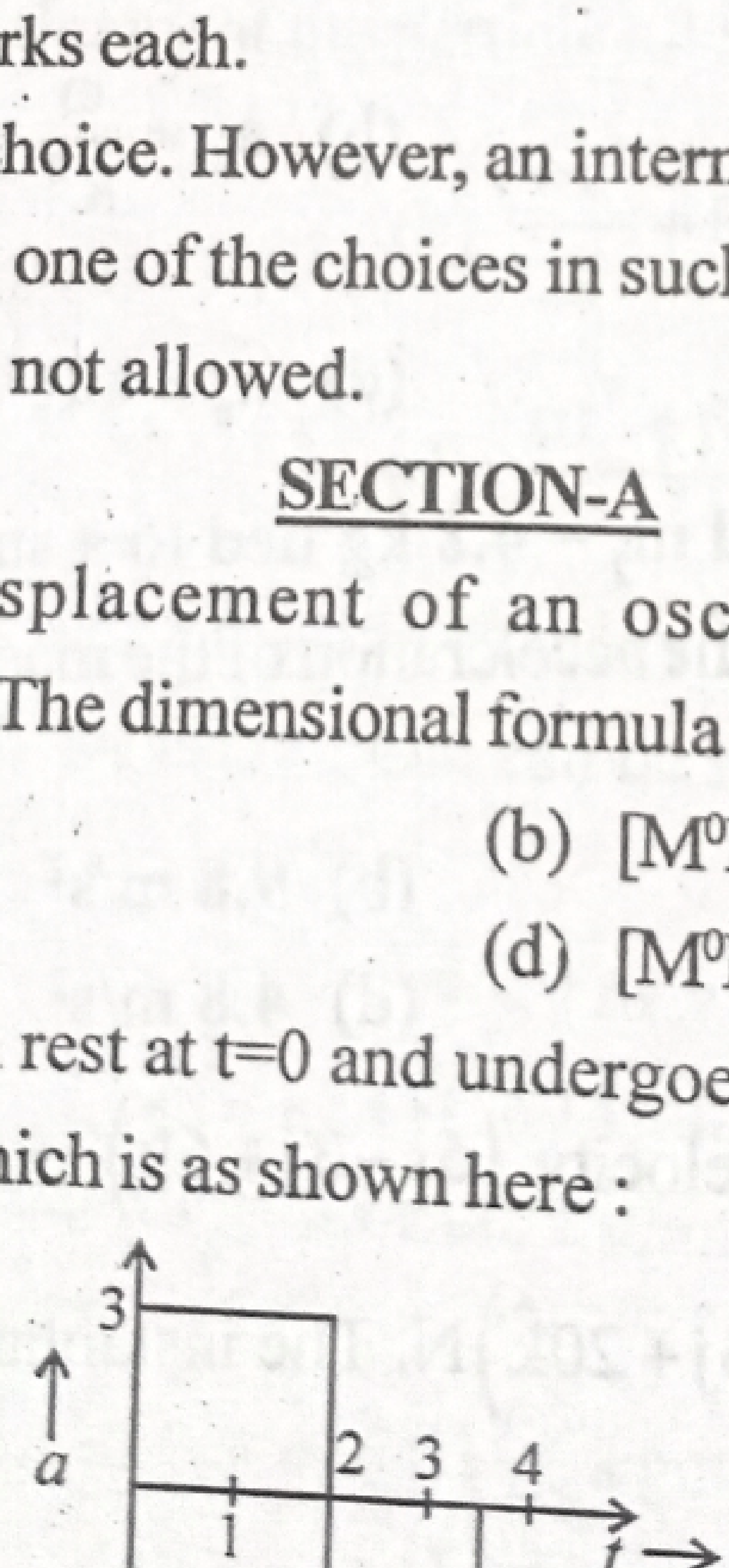
(a) $[M^0L^{-1}T^0]$

(b) $[M^0L^0T^{-1}]$

(c) $[M^0L^{-1}T^{-1}]$

(d) $[M^0L^0T^0]$

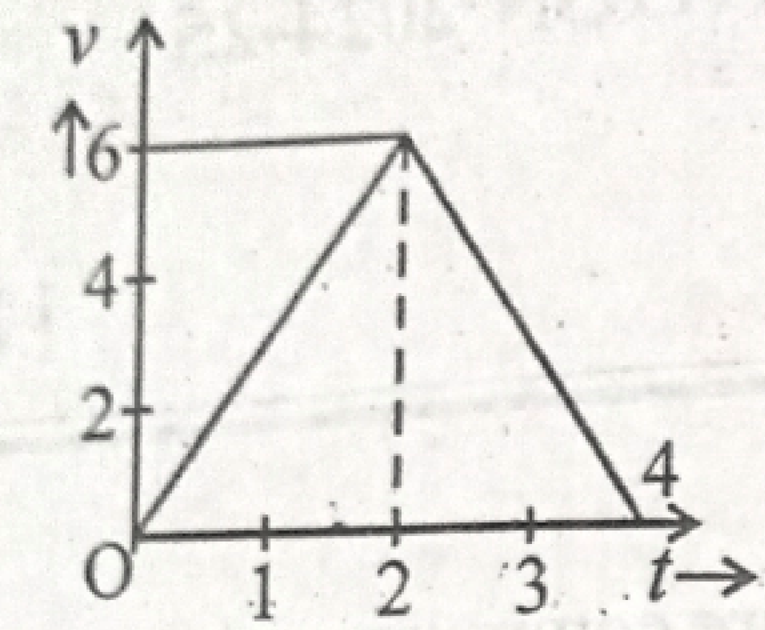
2. A particle starts from rest at t=0 and undergoes an acceleration 'a' in m/s² with time 't' in seconds which is as shown here : 1



P. T. O.

Which one of the following plots represents velocity 'v' in m/s verses time 't' in seconds ?

(a)



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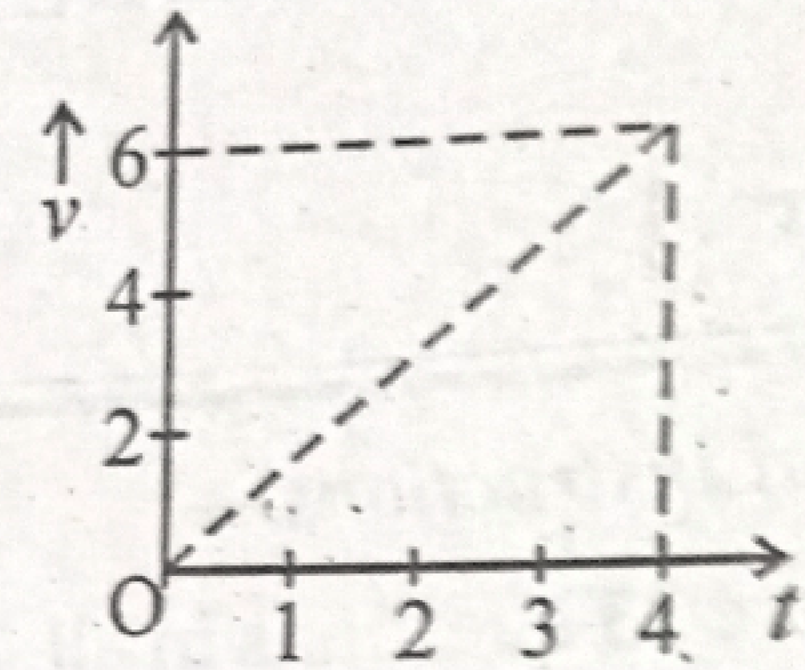

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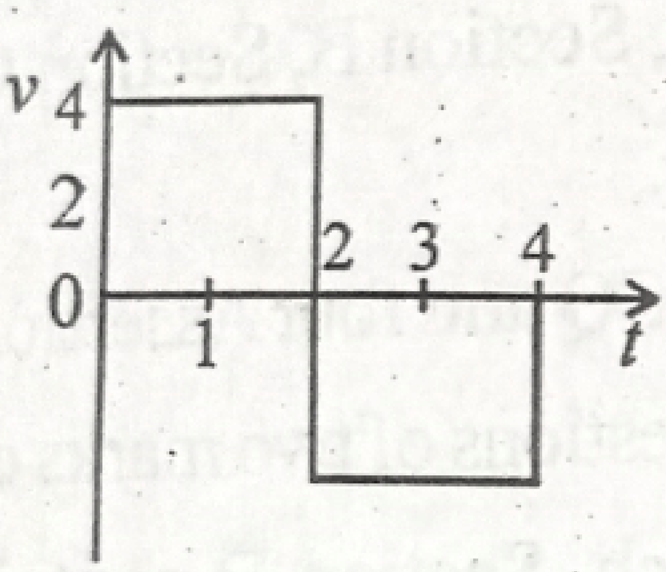
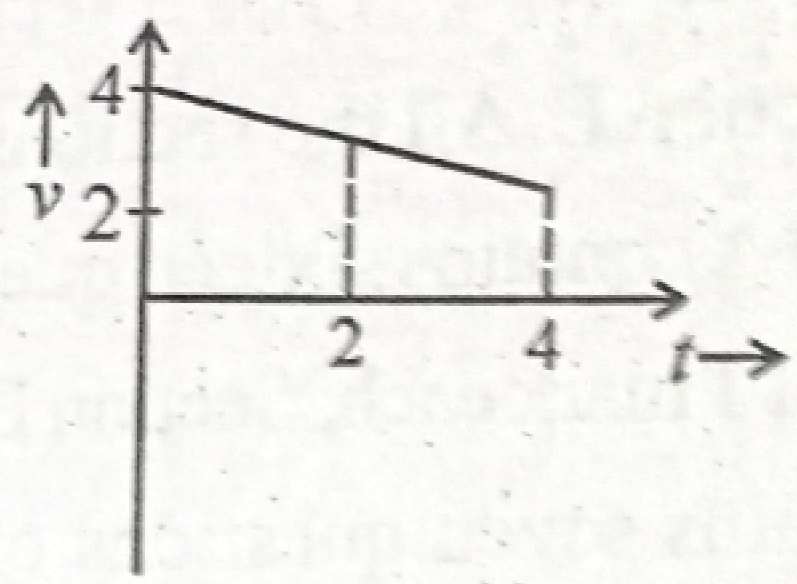


(d)



3. Centripetal acceleration can be mathematically expressed as : 1

(a) $a_c = \frac{\omega^2}{R}$

(b) $a_c = \frac{\omega}{R^2}$

(c) $a_c = \frac{R^2}{\omega}$

(d) $a_c = \omega R^2$

4. Two masses $m_1 = 5$ kg and $m_2 = 4.8$ kg tied to a string are hanging over light frictionless pulley. What is the acceleration of the masses, when left free to move? (Given $g = 9.8$ m/s²) 1

(a) 0.2 m/s²

(b) 9.8 m/s²

(c) 5 m/s²

(d) 4.8 m/s²

5. A particle moves with a velocity $(5\hat{i} - 3\hat{j} + 6\hat{k})$ m/s under the influence of a constant force $\vec{F} = (10\hat{i} + 10\hat{j} + 20\hat{k})$N. The instantaneous power applied to the particle is : 1

(a) 200 J/s

(b) 40 J/s

(c) 140 J/s

(d) 170 J/s

6. A man is standing on an international space station, which is orbitting earth at an altitude 520 km with a constant speed 7.6 km/s. If man's weight is 50 kg, then his acceleration is : 1

(a) 7.6 km/s² (b) 7.6 m/s²

(c) 8.4 m/s² (d) 10 m/s²

7. The SI unit of physical quantity is Pascal-second. The dimensional formula of this quantity will be : 1

(a) $[ML^{-1}T^{-1}]$ (b) $[ML^{-1}T^{-2}]$

(c) $[ML^{2}T^{-1}]$ (d) $[M^{-1}L^{3}T^{0}]$

8. If $t = \sqrt{x} + 4$, then velocity at t = 4 sec is : 1

(a) 4 (b) zero

(c) 8 (d) 16

9. The acceleration 'a' of a particle starting from rest varies with time according to relation $a = \alpha t + \beta$. The velocity of the particle after time 't' will be : 1

(a) $\frac{\alpha t^2}{2} + \beta$ (b) $\frac{\alpha t^2}{2} + \beta t$

(c) $\alpha t^2 + \frac{1}{2}\beta t$ (d) $\frac{\alpha t^2 + \beta}{2}$

10. If the coefficient of static friction between the tyres and road is 0.5. What is the shortest distance in which an automobile can be stopped when travelling of 72 km/h. 1

(a) 50 m (b) 60 m

(c) 40.8 m (d) 80.16 m

11. A ball moves on a frictionless inclined table without slipping. The work done by the table surface on the ball is : 1

(a) + (positive) (b) – (negative)

(c) 0 (zero) (d) none of all

12. Acceleration due to gravity : 1

(a) decreases from equator to poles

(b) decereases from poles to equator

(c) is max. at centre of earth

(d) is max. at equator

Q.No. 13 to 16 are Assertion-Reasoning questions. Choose the correct option from the following—

(a) Both Assertion and Reason are correct and (R) is the correct explanation of (A).

(b) Both Assertion and Reason are correct but (R) is not the correct explanation of (A).

(c) Assertion is true and Reason is false.

(d) Assertion is false and Reason is true.

13. **Assertion :** When we change the unit of measurement of a physical quantity, its numerical value changes. 1

Reason : Smaller the unit of measurement smaller is its numerical value.

14. **Assertion :** For an object having uniformly accelerated motion, the position time graph is parabolic in nature. 1

Reason : In a uniformly accelerated motion, the acceleration is constant.

15. **Assertion :** A uniform circular motion is an accelerated motion. 1

Reason : Direction of acceleration is parallel to the velocity vector.

16. **Assertion :** It is difficult to move a bike with its brakes on. 1

Reason : Rolling friction is converted into sliding friction, which is comparatively larger.

SECTION-B

17. A planet moves around the sun in a circular orbit. Assuming that the period of revolution 't' of the planet depends upon radius (R) of its orbit, mass of the sun (M) and universal gravitational constant (G) then prove dimensionally $t^2 \propto \frac{R^3}{GM}$ or $t = 2\pi\sqrt{\frac{R^3}{GM}}$, where 2π is value of constant. 2

18. Derive the given equations by graphical method— 2

(a) $v^2-u^2=2as$ (b) $s=ut+\frac{1}{2}at^2$

19. Two vectors, both equal in magnitude have their resultant equal in magnitude of either. Find the angle between them. 2

20. A gun weighing 4 kg fires a bullet of 80 g with a velocity of 120 m/s. With which velocity does the gun recoils ? What is the combined momentum of the gun & bullet before firing & after firing. 2

21. Give the expression for coefficient of restitution. Write its value for perfectly elastic collision, for perfectly inelastic collision and for inelastic collision. 2

OR

A ball is dropped from a height h. It rebounds from the ground a number of times. If coefficient of restitution is e, to what height does it go after n^{th} rebounding ?

<u>SECTION-C</u>

22. Show that the total mechanical energy of a body falling freely under the effect of gravity is conserved. 3

Also show the variation of K.E. and P.E. and constancy of total energy with height.

23. (a) Surface tension of water is 72 dyne cm^{-1}. Express it in SI system. 3

(b) Write the dimension of $\frac{a}{b}$ in the relation $a\sqrt{x}+bt^2$ where F is the force, x is the distance and t is the time.

24. Two cyclists A and B return from picnic spot O to their homes P and Q respectively. The position time graph are shown in figure given below— 3

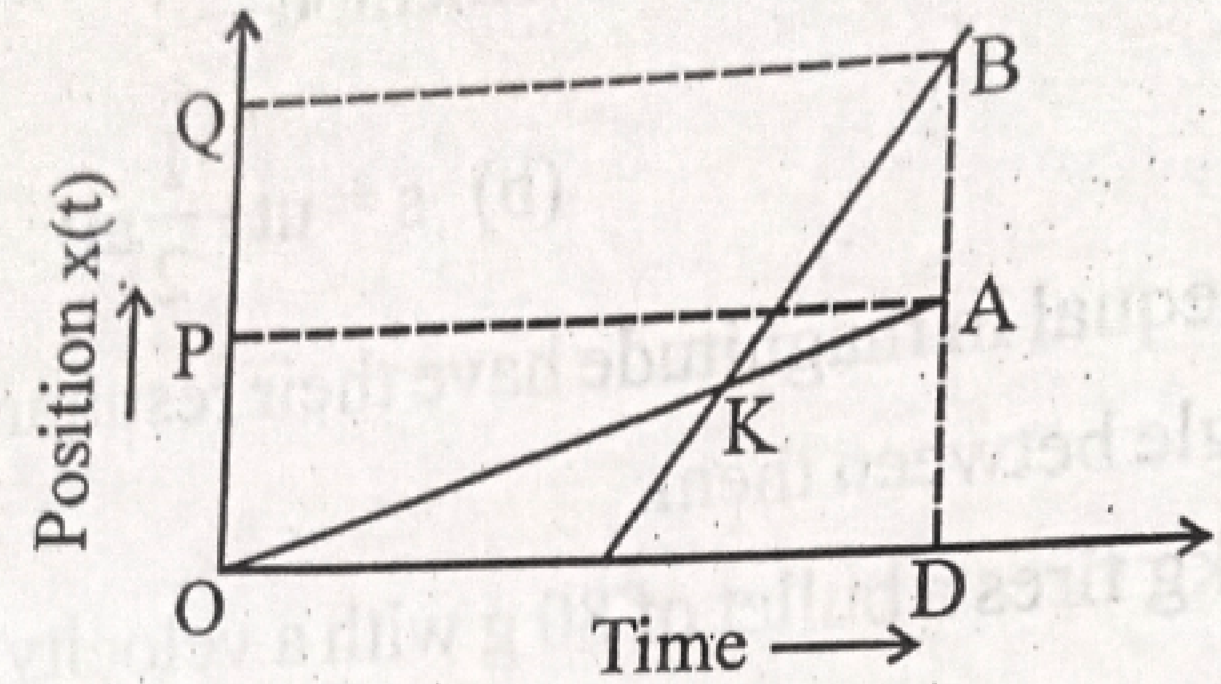
(a) Which of the two is closer to the picnic spot ?

(b) Which of the two started earlier ?

(c) Which of the two was faster ?

(d) Do both of them reach their home at the same time.

(e) Who overtakes whom and how many times ?



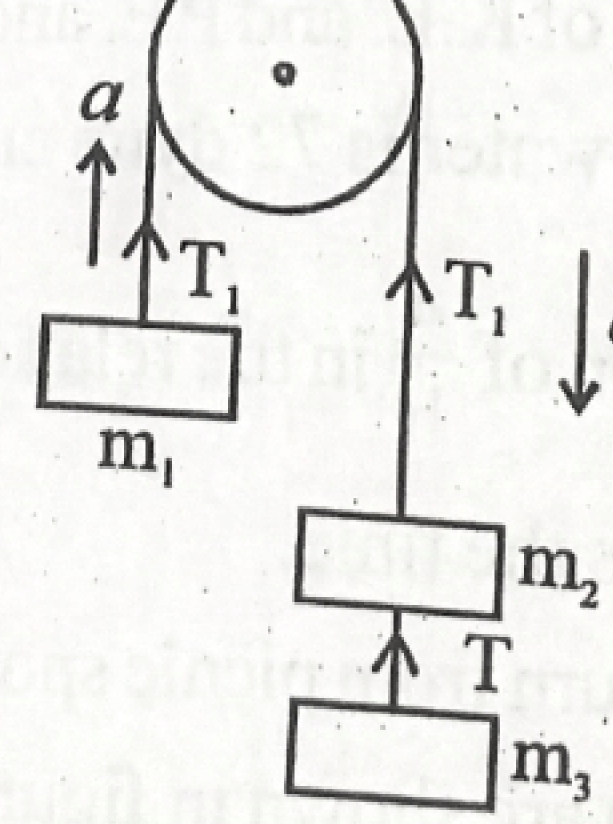
25. The resultant of 2 vectors $\vec{A}$ and $\vec{B}$ is perpendicular to vector $\vec{A}$ and its magnitude is half of $\vec{B}$. What is the angle between $\vec{A}$ and $\vec{B}$. 3

26. (a) Define angle of Repose with diagram. 3

(b) A coin is placed on an inclined plane which makes an angle θ with the horizontal. When θ becomes 13°, the coin begins to slide down. What is the coefficient of static friction between the, coin and inclined plane ?

OR

In the arrangement shown in figure, show that tension in the string between masses m_2 and m_3 is $T = \dfrac{2m_1m_3g}{m_1+m_2+m_3}$. 3



27. Derive the expression for escape velocity of a body whose mass is m, write the formula for escape velocity when object is near to the surface of earth. 3

28. A body of mass m is raised to a height h from the surface of earth where the acceleration due to gravity is g. Prove that loss of weight due to variation in g is approximately $\dfrac{2mgh}{R}$, where 'R' is radius of earth.

SECTION-D

29. (a) Obtain the expression of 5

(i) Time of flight

(ii) Range for an object in projectile motion.

(b) A particle is projected with a velocity 'u' so that its horizontal range is twice the greatest height attained. Find the horizontal range io it.

(c) A bullet fired at an angle of 30° with the horizontal his the ground 3.0 km away. By adjusting its angle of projection, can one hope to hit a target 5 km away? Assume the muzzle speed to be fixed, and neglect air resistance.

OR

(a) A projectile is thrown from the top of the tower of height 'H' falls on the ground at a horizontal distance of 'R' from the ground. Calculate the value of time for which projectile is in the air and the horizontal distance 'R'. 5

(b) For the angular projection θ, the velocity of projectile is u. Let H be the maximum height reached by the projectile and R be its horizontal range; show that $\frac{R^2}{8H} + 2H$ is equal to its maximum range.

(c) A particle is projectile at an angle θ from the horizontal with kinetic energy K. What is the kinetic energy of the particle at the highest point ?

30. (a) What is the need of banking of roads ? 5

(b) Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at angle θ with friction.

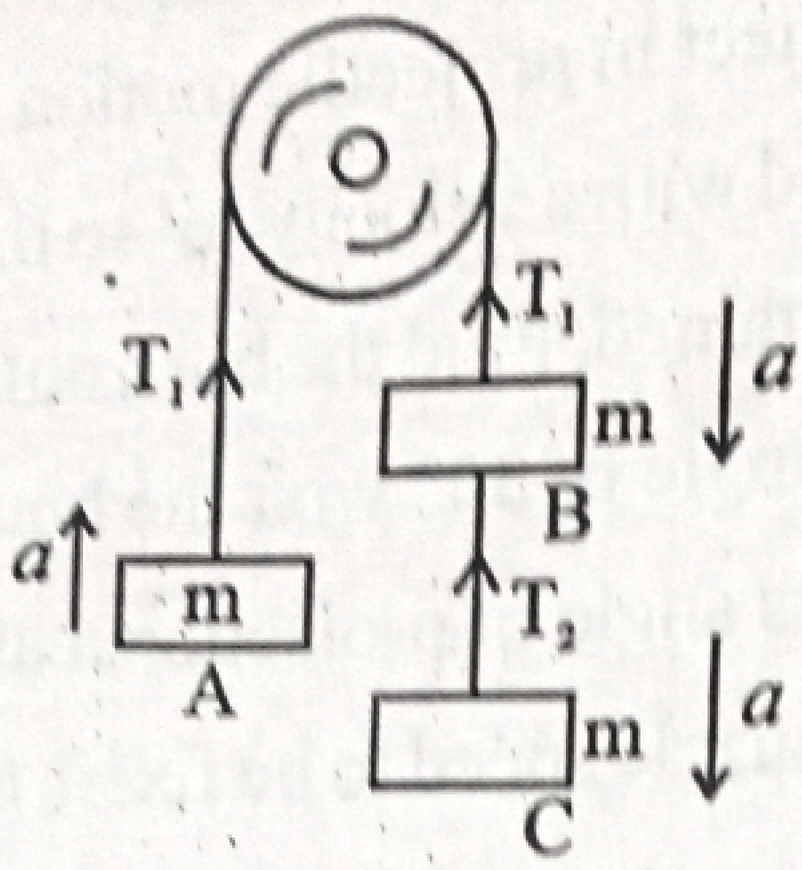
(c) A particle of mass 42 g attached to a string of 60 cm length is whirled in a horizontal circle. Its period of revolution is 2 second. Find tension in string.

OR

(a) Which friction is greater static or kinetic friction ? (1+1+3)

(b) Why is friction greatly reduced when a body rolls over a surface ?

(c) Three bodies A, B and C each of mass m are hanging on a string over a fixed pulley as shown. What are the tensions in the strings connecting bodies A to B and B to C ?



31. (a) Write the differences between head on collision and oblique collision.

(b) A lighter particle moving with a speed of 10 m/s collides with an object of double its mass moving in the same direction with half its speed. Assume that the collision is a one dimensional elastic collision. What will be the speed of both particles after the collosion ? (3+2)

OR

(a) Prove the work energy theorem for a variable force. (2+3)

(b) A body of mass 2 kg is resting on a rough horizontal surface. A force of 20 N is now applied to it. For 10 sec, parallel to the surface. If the coefficient of kinetic friction between the surfaces in contact is 0.2, calculate—

(i) work done by the applied force in 10 s.

(ii) change in kinetic energy of the object in 10 s. (Take $g = 10\ m/s^2$)

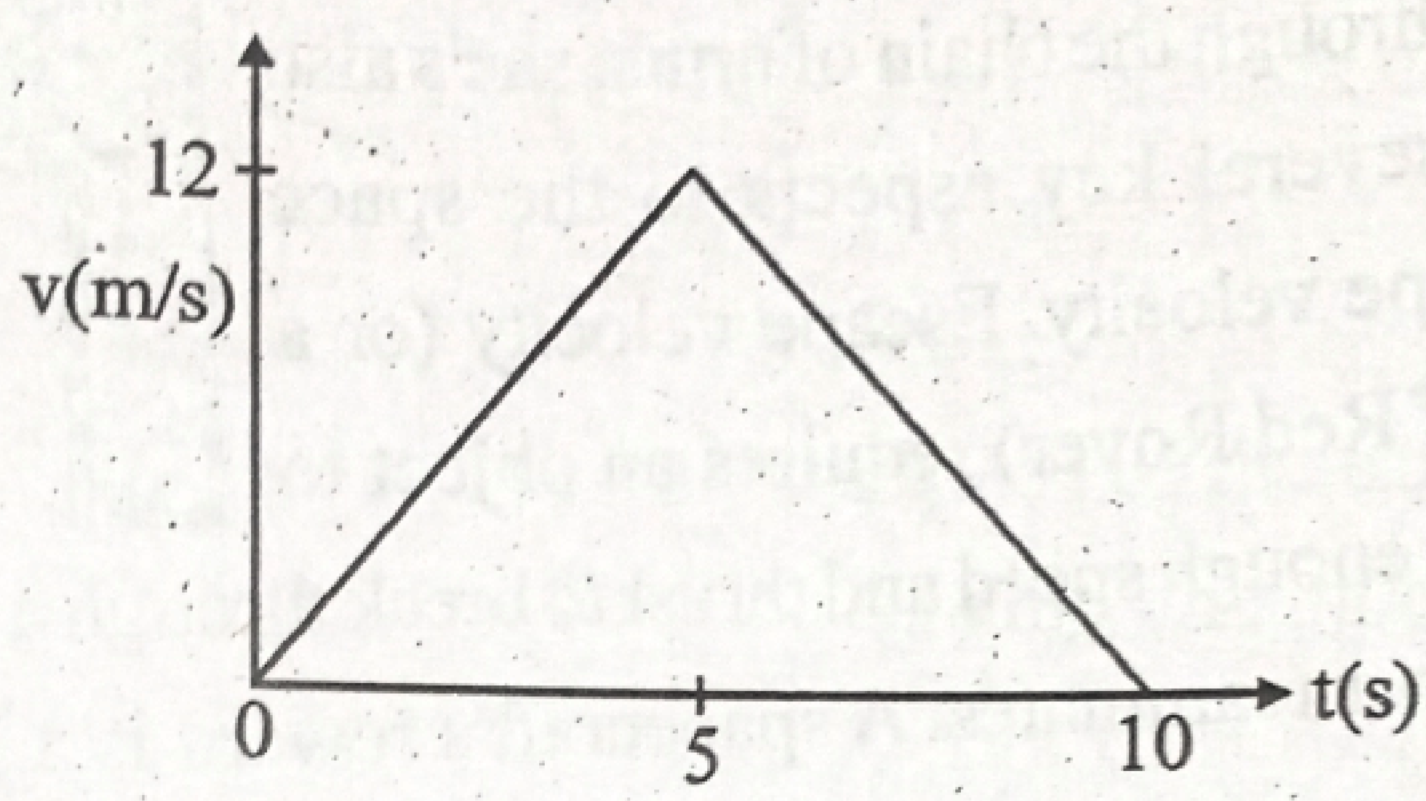
SECTION-E

Case Based Questions

Q.32 and Q.33 are case based questions. Do any four out of five questions in each question.

32. The time rate of change of position of the object in any direction is called speed

of the object. If an object covers equal distances in equal intervals of time, then its speed is called uniform speed and if it covers unequal distances in equal intervals of time, then its speed is called non- uniform or variable speed. The ratio of the total distance travelled by the object to the total time taken is called average speed of the object. The speed may be positive or zero but never negative. The speed-time graph of a particle moving along a fixed direction is shown in following Fig.



(i) Distance travelled by the particle between 0 to 10 seconds :

(a) 60 m (b) 50 m

(c) 120 m (d) zero

(ii) Average speed between time interval 0 to 10 s :

(a) 12 m/s (b) 6 m/s

(c) 10 m/s (d) 60 m/s

(iii) The time when the speed was minimum :

(a) at t = 0 s and t = 5 s (b) at t = 5 s and t = 20 s

(c) at t = 5 s and t = 10 s (d) at t = 0 s and t = 10 s

(iv) The time when speed was maximum :

(a) t = 0 s (b) t = 5 s

(c) t = 10 s (d) t = 12 s

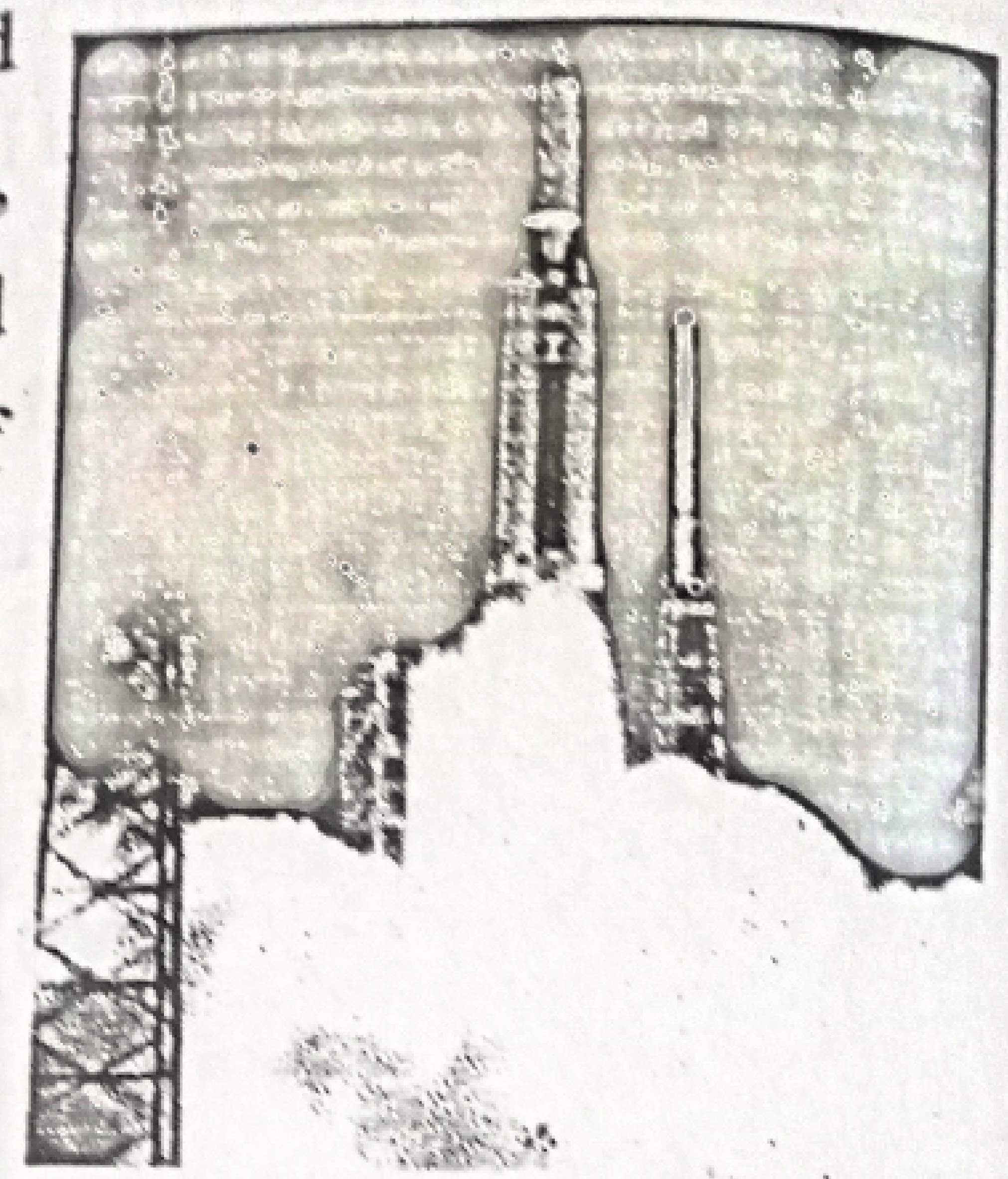
OR

(iv) Speed is positive at time interval :

(a) t = 0 to t = 5 s (c) t = 0 to t = 10 s

(b) t = 5 to t = 10 s (d) All of these

33. Escape Speed



Did you ever watch a group of children playing "Red Rover?" Arms linked up for strength, they chant, "Red Rover, Red Rover, let Sally come over," and Sally's challenge is to break through that chain of linked arms. If she does it, Sally wins.

If Sally breaks through the chain of arms, she's also demonstrated several key aspects to the space concept of escape velocity. Escape velocity (or a rousing game of Red Rover) requires an object to propel itself with enough speed and thrust to break through a barrier. Sally's reward is the cheers of her teammates. A spacecraft's reward is a journey into space or orbit.

Achieving escape velocity is one of the biggest challenges facing space travel. The vehicle requires an enormous amount of fuel to break through Earth's gravitational pull. All that fuel adds significant weight to the spacecraft, and when an object is heavier, it takes more thrust to lift it. To create more thrust, you need more fuel. It's a cycle that scientists are hoping to resolve by creating lighter vehicles, more efficient fuels and new methods of propulsion that don't require the same ingredients to attain great speeds.

The existence of escape velocity is a consequence of conservation of energy and an energy field of finite depth. For an object with a given total energy, which is moving subject to conservative forces (such as a static gravity field) it is only possible for the object to reach combinations of locations and speeds which have that total energy; and places which have a higher potential energy than this cannot be reached at all. By adding speed (kinetic energy) to the object it expands the possible locations that can be reached, until, with enough energy, they become infinite.

(1) For a planet having mass equal to mass of the earth but radius is one fourth of radius of the earth. The escape velocity of this planet will be :

(a) 11.2 km/s
(b) 22.4 km/s
(c) 5.6 km/s
(d) 44.8 km/s

(2) A black hole is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would earth (mass $= 5.98 \times 10^{24}$ kg) have to be compressed to be a black hole?

(a) 10^{-9} m
(b) 10^{-6} m
(c) 10^{-2} m
(d) 100 m

(3) The escape velocity of a body on the surface of the earth is 11.2 km/s. If a body is to be projected in a direction making an angle 45° to the vertical, then the escape velocity is :

(a) 11.2×2 km/s
(b) 11.2 km/s
(c) $11.2 \times \sqrt{2}$ km/s
(d) $11.2 \times 2\sqrt{2}$ km/s

(4) With what velocity should particle be projected so that its height becomes equal to radius of earth ?

(a) $\left(\frac{GM}{R}\right)^{1/2}$
(b) $\left(\frac{8GM}{R}\right)^{1/2}$
(c) $\left(\frac{4GM}{R}\right)^{1/2}$
(d) $\left(\frac{2GM}{R}\right)^{1/2}$

OR

An elephant and an ant are to be projected out of the gravitational pull of the earth. What should be the velocities of the elephant and the ant ?

(a) elephant has more escape velocity
(b) ant has more escape velocity
(c) different velocity
(d) same velocity