Mid Term Examination
PHYSICS
MT-2017-11-(A)

Time : 3 hrs. **M. Marks : 70**

General instructions:

(1) All questions are compulsory.

(2) There are 26 questions in total. Question 1 to 5 very short answer type questions and carry one mark each.

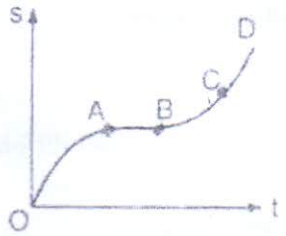
(3) Questions 6 to 10 carry two marks each, questions 11 to 22 carry three marks each, questions 23 four marks and questions 24 to 26 carry five marks each.

(4) Use of calculator is not permitted.

1. Write the dimension of a in the relation $F = a\sqrt{x} + bt^2$, where F is force, x is distance and t is time. (1)

2. A marble block of mass 2kg lying on ice, when given a velocity of 6m/s, is stopped by friction in 10s.Find the coefficient of friction. (1)

3. The graph between the displacement x and time t for a particle moving in a straight line is shown in the diagram. Identify the interval in which acceleration is (i) positive and (ii) zero. (1)



4. Can body have zero velocity and still accelerating? If yes, give an example and if not explain why? (1)

5. Draw a graph to show the variation of linear momentum P with mass m of different bodies, if kinetic energy is kept constant. (1)

6. Name any two physical quantities having dimensions $[MLT^{-1}]$.State two limitations of dimensional analysis. (2)

7. A boat crosses a river of width D from port A to port B, which are just on the opposite side. The speed of water is Vw and that of boat is $V_b = 2V_w$ relative to water. What is the time taken by the boat, if it has to cross the river directly on the line AB? (2)

8. A particles moves a distance x in time t according to equation $\sqrt{x} = (t+5)$, where x is in meter. Find the velocity and acceleration at t=1 second. (2)

OR

A ball is dropped from a high rise platform at t=0 starting from rest. After 6s another ball is thrown downwards from the same platform with a speed V. Find the value of V if two balls meet at t=18s. Take $g=10ms^{-2}$. (2)

9. (a) Why does a pilot looping a vertical loop not fall down even at the highest point?

(b) Why does a heavy rifle not kick as strongly as a light rifle using the same cartridge? (2)

10. When a horse pulls a cart, according to Newton's third law, the cart also pulls the horse with an equal and opposite force. What causes the motion of the horse, cart and the system as a whole? Explain with a diagram. (2)

11. State parallelogram law of vector addition and find the magnitude and direction of resultant of two vectors $\vec{A}$ and $\vec{B}$ inclined at an angle θ. (3)

12. Answer the following:

(i) Springs A and B are identical except that A is stiffer than B($K_A > K_B$).In which spring is more work expanded if they are stretched by the same amount?

(ii) An artificial satellite orbiting the earth in very thin atmosphere loses its energy gradually due to dissipation against atmospheric resistance, however small. Why then does its speed increase progressively as its come closer to the earth?

(iii) Will water at the foot of the fall be at a different temperature from that at the top? If yes explain. (3)

13. A particle is projected at an angle of 30^0 w.r.t. horizontal with speed 20 m/s :

(i) Find the position vector of the particle after 1s.

(ii) Find the angle between velocity vector and position vector at t = 1s. (3)

14. A police van starts from rest with constant acceleration of $5ms^{-2}$.At the same time a car travelling with a constant velocity of 90 km/h overtakes and passes the police van.

(i) Find at what distance will the police van overtake the car?

(ii) How fast will the police van be travelling then? (3)

15. A tennis ball is dropped on to the floor from a height of 4m.It rebounds to a height of 3m.If the ball was in contact with the floor for 0.01s,what was its average acceleration during contact? (3)

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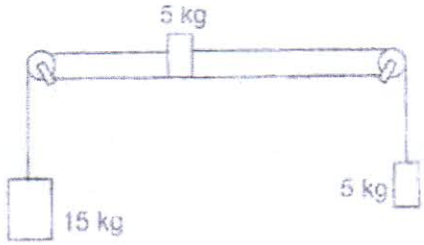
16. Find acceleration a of the system and tensions in the strings. (3)



OR

Ten one rupee coins are put on top of each other on a table. Each coin has mass 0.1Kg. Give the magnitude and direction of

(i) The force on the 7th coin (counted from the bottom) due to all the coins on its top.

(ii) The force on the 7th coin by the 8th coin.

(iii) The reaction of the 5th coin on the 6th coin. (3)

17. A small body tied to one end of the string is whirled in a vertical circle. Derive the expression for the tension in the string at any point and hence find minimum velocity at lowest point so that it just able to loop the loop. (3)

18. State work energy theorem. Prove it for a variable force. (3)

19. (a) On what factors, does the position of Centre of mass of a rigid body depend?

(b) Three particles each of mass m are placed at three corners of an equilateral triangle of length d. Find the position of Centre of mass in terms of coordinates. (3)

20. Explain with the help of a diagram, how banking provides the centripetal force necessary for a car to go in a circular track. Derive an expression for the maximum turning speed on a curved road banked at an angle θ? The coefficient of friction between the wheels and road is μ. (3)

21. A large fluid star oscillates in shape under the influence of its own gravitational field. Using dimensional analysis, find the expression for period of oscillation (T) in terms of radius(R),mean density of fluid(ρ) and gravitational constant(G). (3)

22. Find an expression for the centripetal acceleration of a body moving with uniform speed v along a circle of radius r. If the speed of the body is doubled and radius of circular path of a body reduces to half, how will the centripetal acceleration change? (3)

23. Suresh noticed a big Granite Rock in his locality. He thought that if they worked upon it they could earn money. He took permission from the Government, completed all the formalities .He broke the Rock using a bomb. The rock was made into slices .They established a Granite industry. Many of the people in the surroundings

started to earn and live comfortably.

(a) What values of Suresh impress you?

(b) State principle of conservation of linear momentum.

(c) A bomb is thrown in a horizontal direction with a velocity of 50 m/s. It explodes into two parts of masses 6 Kg and 3 Kg. the heavier fragment continues to move in the horizontal direction with a velocity of 80 m/s. Calculate the velocity of the lighter fragment. (4)

24. (i) A body is projected at an angle θ with the horizontal, derive the expression for the trajectory and maximum height attained by the body.

(ii) A projectile of mass 1kg is thrown with velocity 40m/s from the ground at an angle of 45^0 with the horizontal.

(a) What is the linear momentum at the highest point of its trajectory?

(b) Find time taken by the projectile to reach the ground. (5)

OR

(i) A particles starts from origin at t=0 with a velocity of $10.0\ \hat{j}$ m/s and moves in x-y plane with a constant acceleration of $(8.0\,\hat{i} + 2.0\,\hat{j})\ ms^{-2}$.

(a) At what time is the x -coordinate of the particle 16m?

(b) What is y-coordinate and speed of the particle at that time?

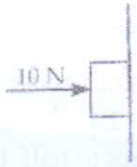
(ii) Find a vector whose length is 7 and which is perpendicular to each of the vectors: (5)

$\vec{A} = 2\hat{i} - 3\hat{j} + 6\hat{k}$ and $\vec{B} = \hat{i} + \hat{j} - \hat{k}$

25. (a) Draw a graph to show the variation of force of friction with the applied force.

(b) Define angle of repose and deduce its relation with coefficient of static friction.

(c) A horizontal force of 10N is necessary to just hold a block stationary against a wall. Find the weight of the block if coefficient of friction between the block and wall is 0.2. (5)



OR

(a) What is the significance of area under the force time graph?

(b) Show that Newton's second law of motion is the real law of motion.

(c) A motor car running at the rate of 7 m/s can be stopped by applying brakes in 10m. Show that total resistance to the motion, when brakes are on, is one fourth of the weight of the car. (5)

26. (i) Define the term elastic collision. Show that in an elastic one dimensional collision between two bodies, the relative velocity of approach before collision is equal to the relative velocity of separation after the collision.

(ii) The kinetic energy of a body decreases by 19%. What is the percentage decrease in the magnitude of linear momentum of the body? (5)

OR

(i) What are conservative and non- conservative forces? Give one example of each.

(ii) A rain drop of radius 2mm falls from a height of 500m above the ground. It falls with decreasing acceleration (due to various resistance of 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 10m/s. Density of water is $10^3 kgm^{-3}$. (5)