विद्या सर्वार्थि साधिका

ANANDALAYA

PERIODIC TEST – 2

Class : XI

Subject: Physics MM : 70

Date : 26-09-2022 Time: 3 hours

General Instructions:

1) All questions are compulsory. There are 37 questions in all.
2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3) Section A contains 14 very short answer questions and 4 assertion reasoning and 5MCQs of 1 mark each, Section B has 3 case based questions of 4 marks each, Section C contains 4 short answer questions of 2 marks each, Section D contains 4 short answer questions of 3 marks each and Section E contains 3 long answer questions of 5 marks each.
4) There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.

SECTION A

1. What is the dimension of (i) force and (ii) pressure? (1)
2. An object moving in a circular path of radius 7 m, starting from a point, reaches the diametrically opposite point on the circle in 2s. What is (i) the distance travelled and (ii) the displacement? (1)
3. An astronaut accidentally gets separated out of his small spaceship accelerating in inter stellar space at a constant rate of 100 ms^{-2}. What is the acceleration of the astronaut the instant after he is outside the spaceship? (Assume that there are no nearby stars to exert gravitational force on him.) (1)
4. What is the work done by gravity on mass 'm' kg moving through a distance of '*x*' meters on a horizontal surface? (1)
5. An object of mass 2 kg experiences a force of $\vec{F} = 10\,\hat{\imath} + 5\,\hat{\jmath}$ N. If the displacement of the object is $\vec{r} = 2\hat{\imath} + 3\hat{\jmath}$ meters. Find the workdone by the force. (1)
6. Does static friction depend on surface area of contact? If not, what does it depend on? (1)
7. A car travelling with a speed of 20 m/s is brought to rest in 5 s. What is the deceleration of the car? (1)
8. A ball is projected with a velocity of 30 m/s in air at an angle of 15°. How far will it travel horizontally? (1)
9. The distance travelled by a body is given by the equation $S_n = un + \frac{a}{2}(2n - 1)$ where S_n is displacement per unit time, *u* is initial velocity, *a* is acceleration and *n* is the time in seconds. Is the equation dimensionally correct? (1)
10. Determine π^2 with correct significant figures. Given $\pi = 3.14$. (1)
11. The position of a body is given by the equation $r = 2\,t - 5\,t^2$ where r is in m and t is in seconds. What is the dimension of the physical quantity having the magnitude 5 in the equation? (1)
12. State law of conservation of momentum. (1)
13. Two balls of same mass moving in the opposite direction with speeds 2 m/s and 5 m/s respectively undergo a perfect inelastic collision. What is the velocity of the first ball after the collision? (1)
14. SI unit of spring constant for a helical spring is _____. (1)

For question numbers 15, 16, 17 and 18, two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

A) Both assertion and reason are true and reason is the correct explanation of assertion.

B) Both assertion and reason are true but reason is NOT the correct explanation of assertion.

C) Assertion is true but reason is false
D) Assertion is false and reason is also false.

15. Assertion: Slope of a velocity – time graph gives acceleration (1)
Reason: Acceleration is rate of change of momentum.

16. Assertion: Work done by a frictional force is positive. (1)
Reason: This is because frictional force acts along the direction of motion

17. Assertion: An object can have constant speed but variable velocity. (1)
Reason: Speed is a scalar but velocity is a vector quantity.

18. Assertion: Two balls of different masses are thrown vertically upward with same speed. They will pass through their point of projection with same speed in downward direction. (1)
Reason: The maximum height and downward speed at the point of projection are independent of the mass of the ball.

The following questions 19 to 23 are multiple choice questions. Choose and write the correct option.

19. One end of a string of length l is connected to a particle of mass m and the other to a small peg on a smooth horizontal table. T is the tension in the string. If the particle moves in a circle with speed v the net force on the particle (directed towards the centre) is : (1)
(A) T (B) $T - \frac{mv^2}{l}$ (C) $T + \frac{mv^2}{l}$ (D) 0

20. The number of significant figures in 0.005430 is _____ (1)
(A) 6 (B) 4 (C) 3 (D) 2

21. Two cars A and B, are moving with speeds v_1 and v_2 ($v_1 > v_2$). Car B is ahead of car A by 'x' distance, when the driver of car A sees the car B. What minimum retardation 'a' should be given to car A to avoid collision? (1)
(A) $\frac{v_1 - v_2}{x}$ (B) $\frac{v_1 + v_2}{x}$ (C) $\frac{(v_1+v_2)^2}{2x}$ (D) $\frac{(v_1-v_2)^2}{2x}$

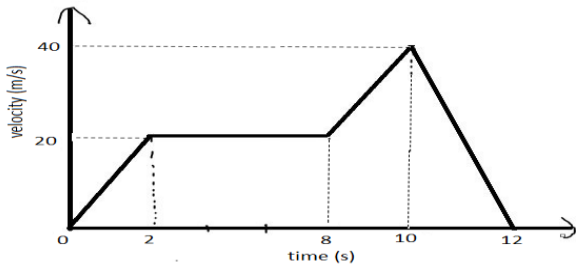
22. A mass 4 kg is placed on an inclined plane inclined at an angle 30° with horizontal. Find the frictional force acting on the mass if the mass is stationary. (1)
(A) 40 N (B) $20\sqrt{3}$ N (C) 20 N (D) 10 N

23. A mass ('*m'* kg) falls freely from a height of 'h' m. What will be the velocity of mass at a height where the potential energy of the mass becomes half? (1)
(A) $v = \sqrt{gh}$ (B) $v = \sqrt{8gh}$ (C) $v = gh$ (D) $v = 8gh$

SECTION B

Questions 24, 25 and 26 are Case Study based questions and are compulsory. Attempt the sub parts from each question. Each question carries 1 mark.

24. Study the following graph for an object moving along a straight line and answer the following questions. (4)



(i) What can you say about the sign and magnitude of acceleration between t = 10s to t = 12s?
(A) positive and increasing (B) negative and increasing
(C) positive and constant (D) negative and constant

(ii) Find the magnitude of the acceleration between t = 10s and t = 12s.
(A) 20 m/s^2 (B) – 20 m/s^2 (C) 10 m/s^2 (D) – 10 m/s^2

(iii) What is the distance travelled between t = 2 s and t = 10 s?
(A) 180 m (B) 160 m (C) 120 m (D) 140 m

(iv) What is the velocity at t = 9.5 s?
(A) 20 m/s (B) 25 m/s (C) 30 m/s (D) 35 m/s

25. Momentum of a body is defined to be the product of its mass m and velocity v, and is denoted by p: (4)

$$\vec{p} = m\,\vec{v}$$

Momentum is clearly a vector quantity. The following common experiences indicate the importance of this quantity for considering the effect of force on motion.

If two stones, one light and the other heavy, are dropped from the top of a building, a person on the ground will find it easier to catch the light stone than the heavy stone. The mass of a body is thus an important parameter that determines the effect of force on its motion.

Speed is another important parameter to consider. A bullet fired by a gun can easily pierce human tissue before it stops, resulting in casualty. The same bullet fired with moderate speed will not cause much damage. Thus for a given mass, the greater the speed, the greater is the opposing force needed to stop the body in a certain time. Taken together, the product of mass and velocity, that is momentum, is evidently a relevant variable of motion. The greater the change in the momentum in a given time, the greater is the force that needs to be applied.

(i) What is the SI unit of momentum?
(A) kg s^{-1} (B) Ns (C) Js (D) J

(ii) Momentum is _____ (scalar / vector) quantity.

(iii) From the two examples discussed in the case, what can say about the relation between the force and momentum?

(iv) A force 'F' acting on a mass 10 kg moving with a velocity 2 m/s for 3s changes its momentum by 'p' units. If the same force acting on another mass of 20 kg moving with 5 m/s for the same time duration would change its momentum by _____.
(A) 5p (B) 2p (C) 2.5p (D) p

26. The scalar product or dot product of any two vectors A and B, denoted as A.B is defined as (4)

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

where θ is the angle between the two vectors.

Geometrically, B cos θ is the projection of B onto A and A cos θ is the projection of A onto B. So, $\vec{A} \cdot \vec{B}$ is the product of the magnitude of A and the component of B along A. Alternatively, it is the product of the magnitude of B and the component of A along B.

The scalar product follows the commutative law : $\vec{A}.\vec{B} = \vec{B}.\vec{A}$

Scalar product obeys the distributive law: $\vec{A}.(\vec{B} + \vec{C}) = \vec{A}.\vec{B} + \vec{A}.\vec{C}$

Further, $\vec{A}.(\lambda\vec{B}) = \lambda\,(\vec{A}.\vec{B})$ where λ is a real number.

(i) What is $\vec{A}.\vec{A}$ equal to?

(ii) What is the angle between two vectors whose dot product is zero?

(iii) $\vec{A}$ and $\vec{B}$ are two vectors whose magnitudes are 10 units and 20 units respectively. The angle between them is 30°. What is the projection of $\vec{B}$ on $\vec{A}$?

(iv) Given: $\vec{X}.\vec{Y} = 30$ units and $\vec{X}.\vec{Z} = 20$ units. What is $\vec{X}\,.(\vec{Y} + \vec{Z})$?

SECTION C

27. A projectile is projected in air with a velocity 28 m/s at an angle 30°. Find the maximum height the projectile would reach? What is the velocity at this position? (Take g = 9.8 m/s^2) (2)

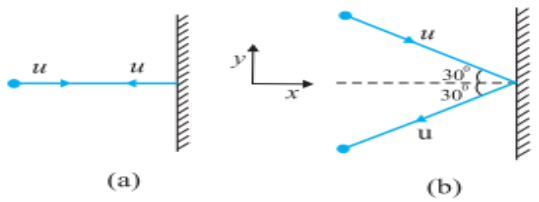
OR

The angular momentum $(\vec{L})$ is defined as $\vec{L} = \vec{r} \times \vec{p}$ where $\vec{r}$ is the position vector and $\vec{p}$ is the linear momentum of the object. If $\vec{p} = 3\hat{\imath} + 2\hat{\jmath}$ Ns and $\vec{r} = 5\hat{\imath} + 2\,\hat{\jmath}$ meters, find the angular momentum of the object.

28. A mass of 1 kg moving with a speed of 10 m/s is given acceleration on application of a force 20 N. If the speed increases to 30 m/s, find the displacement of the mass during this time? (2)

29. The surface tension is defined as the force acting per unit length on the surface of a liquid. When capillary tube immersed partially in a liquid the rise in liquid in the capillary (h) depends on the radius of the capillary (r), density of the liquid, acceleration due to gravity and the surface tension (T) of the liquid. Find the expression for h using dimensional analysis. (2)

30. Two identical billiard balls strike a rigid wall with the same speed but at different angles, and get reflected without any change in speed, as shown in figure. What is the change in the momentum imparted to the ball by the wall in each case? (2)



SECTION D

31. State parallelogram law of vector addition. Show that the magnitude of the addition of two vectors $\vec{A}$ and $\vec{B}$ is $R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$ (3)

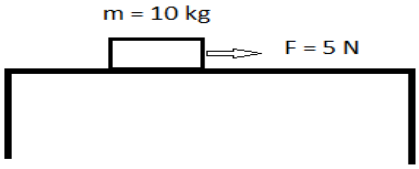
32. The position of a particle is given by $\vec{r} = 3.0\,t\,\hat{\imath} - 2.0\,t^2\hat{\jmath} + 4.0\,\hat{k}\,m$, where t is in seconds and the coefficients have the proper units for $\vec{r}$ to be in metres. (a) Find the $\vec{v}$ and $\vec{a}$ of the particle? (b) What is the magnitude and direction of velocity of the particle at t = 2.0 s? (3)

33. A car is making a turn on a banked road. Deduce the expression for the maximum velocity with which the car can negotiate the turn without skidding. (3)

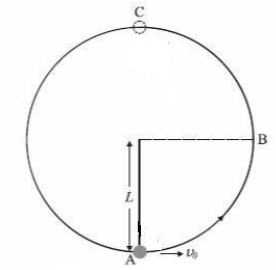
OR

(a) Is a frictional force conservative force? Support your answer with an example.

(b) In the figure the body of mass 10 kg is moving with constant speed. Determine the coefficient of friction. (Take g = 10 m/s^2)



34. A bob of mass m is suspended by a light string of length L. It is imparted a horizontal velocity v_0 at the lowest point A such that it completes a semi-circular trajectory in the vertical plane with the string becoming slack only on reaching the topmost point, C. Obtain an expression for (i) v_0 and (ii) the speeds at points B and C.



SECTION E

35. A projectile is projected in air at an angle of θ radian with a velocity u. Obtain the expressions for (a) the velocity at the maximum height, (b) maximum height and (c) range of the projectile. (5)

OR

A body moves in a circular path of radius 'r' with a constant speed 'v'. Show that, drawing a proper diagram, the acceleration on the body is directed towards the centre of the circular path. Also find the magnitude of the acceleration in terms of angular velocity and the radius of the circular path.

36. A mass m_1 moving with velocity u_1 collides head on with m_2 at rest. Find the velocities of the masses after collision. Assume the collision is elastic. (5)
Also find the same for the cases: (a) $m_1 = m_2$ and (b) $m_2 >> m_1$

OR

(a) How will you find the work done by a variable force? Explain using a graph of a varying force in one dimension.

(b) What is the relation between restoring force in a spring and its elongation?

(c) Derive the relation for potential energy of a stretched spring.

37. Derive the relation $s = ut + \frac{1}{2}at^2$ and $v = u + at$ plotting a graph of an object moving with a constant acceleration with initial velocity 'u'. (5)

OR

The distance travelled by a body between (n - 1) second and n second is the distance travelled during n^{th} second. Find the expression for the distance travelled during n^{th} second of an object moving with a constant acceleration.

A body is thrown vertically upward with a velocity 20 m/s. How high will the ball rise?