Bhavan's Tripura Vidyamandir

2nd Terminal Examination: (2024-2025)

Class:- 11 **Subject: Physics**

Time:- 3 Hours Total :- 70 Marks

Name of the student : Roll: Sec:

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. All the sections are compulsory.

3. Section A contains 12 MCQ and 4 Assertion Reasoning of 1 mark each, Section B contains 5 questions of 2 marks each, Section C contains 7 questions of 3 marks each, section D contains 2 case study based questions of 4 marks each and Section E contains 3 long questions of 5 marks each

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

5. Use of calculators is not allowed.

SECTION-A [1X16=16]

Each of the following carries 1 mark:

1.The velocity v of a particle at time t is given by v = at +b/(t+c) dimensions of a, b, and c are respectively:

a. $[LT^{-2}]$, [L], [T] b. $[L^2]$, [T] and $[LT^2]$

c. $[LT^2]$, [LT] and [L] d. [L], [LT], and $[T^2]$

2.A particle moves a distance x in time t according to equation $x = (t+5)^{-1}$. The acceleration of the particle is proportional to,

a. $(\text{velocity})^{3/2}$ b. $(\text{distance})^2$ c. (distance) - 2 d. $(\text{velocity})^{2/3}$

3. A body is moving according to the equation $x = at + bt^2 - ct^3$ where x = displacement and a, b and c are constants. The acceleration of the body is

a. a + 2bt b. 2b +6ct c. 2b-6ct d. $3b-6ct^2$

4. An object is thrown along a direction inclined at an angle of 45° with the horizontal direction. The horizontal range of the particle is equal to

a.Vertical height b.Twice the vertical height

c.Thrice the vertical height d. Four times the vertical height

5. A missile is launched with a velocity less than the escape velocity. The sum of its kinetic and potential energy is

a. Positive b. Negative

c. Zero d. may be positive or negative

6. In a wire, when elongation is 2 cm energy stored is E. if it is stretched by 10 cm, then the energy stored will be

a. E b. 2 E c. 4 E d. 25 E

7. When the angle of contact between a solid and a liquid is 90°, then

a. Cohesive force > Adhesive force b. Cohesive force < Adhesive force

c. Cohesive force = Adhesive force d. Cohesive force >> Adhesive force

8.The volume thermal expansion coefficient for an ideal gas at constant pressure is:

a. 1/T b. 1/3T c. 1/2T d. 1/5T

9. By Wein's displacement law,

a. λmT^2 = constant b. λmT^3 = constant

c. λmT = constant d. λmT^4 = constant

10.If r.m.s. speed of a gas increases, then its pressure :

a. increases b. decreases

c. remains same d. may increase or decrease

11.The pressure P and density p of a gas are related as

a. $P \propto \rho$ b. $P \propto 1/\rho$ c. $P \propto \rho^2$ d. $P \propto 1/\rho 2$

12.The energy associated with each degree of freedom of a gas molecule is

a. Zero b. ½ kT c. kT d. 3/2kT

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion

(c) Assertion is correct, reason is incorrect

(d) Assertion is incorrect, reason is correct.

13. Assertion : Two particles of different mass, projected with same velocity at same angles. The maximum height attained by both the particle will be same.

Reason : The maximum height of the projectile is independent of particle mass.

14. Assertion : When you lean behind over the hind legs of the chair, the chair falls back after a certain angle.

Reason : Centre of mass lying outside the system makes the system unstable.

15. Assertion (A): When a material is under tensile stress, its length increases.

Reason (R): Tensile stress produces a force that pulls the material apart.

16. Assertion : Sound would travel faster on a hot summer day than on a cold winter day.

Reason : Velocity of sound is directly proportional to the square of its absolute temperature.

SECTION-B **[2X5=10]**

Each of the following carries 2 marks:

17. Consider a simple pendulum, having a bob attached to a string, that oscillates under the action of the force of gravity. Suppose that the period of oscillation of the simple pendulum depends on its length (l), mass of the bob (m) and acceleration due to gravity (g). Derive the expression for its time period using the method of dimensions.

18.A projectile is thrown at an angle θ from the horizontal with velocity 'u' under the gravitation field of the earth. Derive expressions for its:

a) Time of its flight

b) Horizontal Range

Or,

Find the unit vectors that are perpendicular to both i+2j+k and 3i-4j+2k.

19.The average depth of the Indian Ocean is about 3000 m. Calculate the fractional compression, $\Delta V/V$, of water at the bottom of the ocean, given that the bulk modulus of water is 2.2×10^9 N m^{-2}. (Take g = 10 m s^{-2})

20.The triple points of neon and carbon dioxide are 24.57 K and 216.55 K respectively. Express these temperatures on the Celsius and Fahrenheit scales.

21.There are N molecules of a gas in a container . If the number of molecules is increased to 2N . What will be (i) pressure of the gas (ii) r.m.s speed of the gas ?

SECTION-C [3X7=21]

Each of the following carries 3 marks:

22.How does the distribution of mass within the Earth affect the variation of g with depth?

Or,

Define orbital velocity of a satellite. Derive expression for the orbital velocity of a satellite. (1+2)

23.Obtain an expression for the escape velocity of a body from the surface of earth.

24.A cricket ball is thrown at a speed of 28 m s–1 in a direction 30° above the horizontal. Calculate (a) the maximum height, (b) the time taken by the ball to return to the same level, and (c) the distance from the thrower to the point where the ball returns to the same level.

Or,

A particle starts from the origin at t = 0 with a velocity 5.0 î m/s and moves in the x-y plane under action of a force which produces a constant acceleration of (3.0î +2.0j) m/s^2. (a) What is the y-coordinate of the particle at the instant its x-coordinate is 84 m ? (b) What is the speed of the particle at this time ?

25.A ball is thrown vertically upwards with a velocity of 20 m s^{-1} from the top of a multi-storey building. The height of the point from where the ball is thrown is 25 m from the ground. (a) How high will the ball rise ? and (b) how long will it be before the ball hits the ground? Take g = 10 m s^{-2}.

Obtain equation (i) v = u + at using method of calculus.(1+1+1)

26.Explain the concept of Elastic Potential Energy in a stretched wire and hence obtain the expression for it.

27. State and prove Pascal's law.(1+2)

28.Define terminal velocity and derive an expression for it.

SECTION-D [4X2=8]

Each of the following carries 4 marks:

29. Radius of gyration: The radius of gyration of a body about an axis may be defined as the distance from the axis of a mass point whose mass is equal to the mass of the whole body and whose moment of inertia is equal to the moment of inertia of the body about the axis.The moment of inertia of a rigid body analogous to mass in linear motion and depends on the mass of the body, its shape and size; distribution of mass about the axis of rotation, and the position and orientation of the axis of rotation.

Theorem of perpendicular axes

It states that the moment of inertia of a planar body (lamina) about an axis perpendicular to its plane is equal to the sum of its moments of inertia about two perpendicular axes concurrent with perpendicular axis and lying in the plane of the body. If we consider a planar body, An axis perpendicular to the body through a point O is taken as the z-axis. Two mutually perpendicular axes lying in the plane of the body and concurrent with the z-axis, i.e., passing through O, are taken as the x and y-axes. The theorem states that,

I z = I x + I y. Theorem of parallel axes

The moment of inertia of a body about any axis is equal to the sum of the moment of inertia of the body about a parallel axis passing through its centre of mass and the product of its mass and the square of the distance between the two parallel axes.z and z' are two parallel axes, separated by a distance a. The z-axis passes through the centre of mass O of the rigid body. Then according to the theorem of parallel axes $Iz' = Iz + Ma^2$

Where Iz and Iz' are the moments of inertia of the body about the z and z¢ axes respectively, M is the total mass of the body and a is the perpendicular distance between the two parallel axes.

i. What is the radius of gyration of a body about an axis?

a) The distance from the axis to the center of mass of the body
b) The distance from the axis to a point whose mass equals the entire body's mass and whose moment of inertia equals the body's moment of inertia
c) The distance from the axis to the edge of the body
d) The distance from the axis to a point whose mass equals half of the body's mass

ii. Which of the following does the moment of inertia of a rigid body NOT depend on?

a) Mass of the body
b) Shape and size of the body
c) Temperature of the body
d) Distribution of mass about the axis of rotation

iii. According to the theorem of perpendicular axes, the moment of inertia of a planar body about an axis perpendicular to its plane is equal to:

a) The moment of inertia about one of the perpendicular axes
b) The difference between the moments of inertia about two perpendicular axes lying in the plane
c) The sum of its moments of inertia about two perpendicular axes lying in the plane of the body
d) Twice the moment of inertia about one of the perpendicular axes

iv. What does the theorem of parallel axes state about the moment of inertia of a body?

a) It is equal to the product of its mass and the square of the distance between two parallel axes
b) It is equal to the moment of inertia of the body about a parallel axis passing through its center of mass
c) It is equal to the sum of the moment of inertia about a parallel axis passing through the center of mass and the product of its mass and the square of the distance between the two parallel axes
d) It is equal to the moment of inertia of the body about any random axis

Or,

v. In the theorem of parallel axes, what is represented by 'a' in the formula $Iz' = Iz + Ma^2$?

a) The radius of the body
b) The moment of inertia about the z-axis
c) The perpendicular distance between two parallel axes
d) The moment of inertia about the z'-axis

30.Simple harmonic motion is the simplest form of oscillation. A particular type of periodic motion in which a particle moves to and fro repeatedly about a mean position under the influence of a restoring force is termed as simple harmonic motion (S.H.M).A body is undergoing simple harmonic motion if it has an acceleration which is directed towards a fixed point, and proportional to the displacement of the body from that point.

$$\text{Acceleration } a \propto -x \Rightarrow a = -kx \quad \text{or} \quad \frac{d^2x}{dt^2} = -kx$$

i. Which of the following is not a characteristic of simple harmonic motion?

(a) The motion is periodic.
(b) The motion is along a straight line about the mean position.
(c) The oscillations are responsible for the energy conversion.
(d) The acceleration of the particle is directed towards the extreme position.

ii. The equation of motion of a simple harmonic motion is

(a) $\frac{d^2x}{dt^2} = -\omega^2 x$ (b) $\frac{d^2x}{dt^2} = -\omega^2 t$

(c) $\frac{d^2x}{dt^2} = -\omega x$ (d) $\frac{d^2x}{dt^2} = -\omega t$

iii. Which of the following expressions does not represent simple harmonic motion?

(a) $x = A\cos\omega t + B\sin\omega t$ (b) $x = A\cos(\omega t + a)$

(c) $x = B\sin(\omega t + b)$ (d) $x = A\sin\omega t \cos^2\omega t$

iv. The time period of simple harmonic motion depends upon

(a) amplitude (b) energy (c) phase constant (d) mass

Or,

v. Which of the following motions is not simple harmonic?

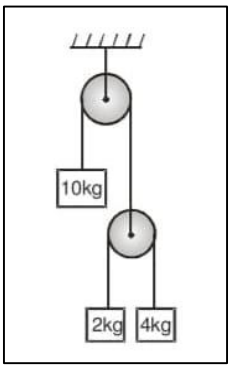
(a) Vertical oscillations of a spring (b) Motion of a simple pendulum

(c) Motion of planet around the Sun (d) Oscillation of liquid in a U-tube

SECTION-E [5X3=15]

Each of the following carries 5 marks:

31. Two blocks of mass 2 kg and 5 kg are connected by an ideal string passing over a pulley. The block of mass 2 kg is free to slide on a surface inclined at an angle of 300 with the horizontal whereas the 5 kg block hangs freely. Find the acceleration of the system and the tension in the string. Given coefficient of friction= 0.30.



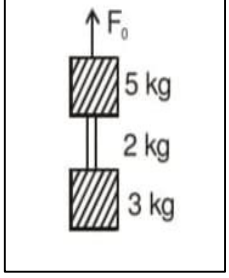
What would be the readings on the scale of a man of mass 70 kg stands on a weighing scale in a lift which is moving

a. upwards with a uniform speed of 10 m/s,

b. downwards with a uniform acceleration of 5 m/s^2. (3+2)

Or,

A 5 kg block has a rope of mass 2 kg attached to its underside and a 3 kg block is suspended from the other end of the rope. The whole system is accelerated upward is 2 ms^{-2} by an external force F_o.



(a) What is F_0?

(b) What is the force on rope? (g = 10m / s ^{2}) (1+1)

In the figure shown, find out the acceleration of each block. (3)

32. Show that the total mechanical energy of a freely falling body remains constant throughout its fall.

If the kinetic energy of a body increases by 300%, by what %will the linear momentum of the body increase? (3+2)

33. Derive Mayer's formula.

A geyser heats water flowing at the rate of 3.0 litres per minute from 2 7°C to 77°C. If the geyser operates on a gas burner, what is the rate of consumption of the fuel if its heat of combustion is 4.0 x 104 J/g? (3+2)