

2025

PHYSICS

(Theory)

Full Marks : 70

Pass Marks : 21

Time : Three hours

*All the questions are compulsory.**The figures in the right margin indicate full marks for the questions.*

Question Nos. 1 to 10 are 'Multiple Choice Type' questions carrying 1 mark each. Choose the correct answer out of the four alternatives and rewrite the correct answer.

1. The significant numbers of 4200 kg is 1
(A) 2 (B) 4
(C) 3 (D) zero

2. Two projectile of same mass and same angle of projection have their maximum kinetic energy in the ratio 4:1 but have different initial velocities, what is the ratio of their horizontal ranges? 1
(A) 2:1 (B) 4:1
(C) 8:1 (D) 16:1

P.T.O.

3. A kite of mass m is skillfully held stationary in the sky. The net force on the kite is 1
- (A) zero (B) mg
 (C) $3mg$ (D) $2mg$
4. The kinetic energy and potential energy of a helicopter flying horizontally at a height $400m$, are in the ratio $5:2$. The velocity of the helicopter is ($g = 9.8m/s^2$) 1
- (A) $65 m/s$ (B) $56 m/s$
 (C) $140 m/s$ (D) $14 m/s$
5. The motion of a planet in our solar system is an example of conservation of 1
- (A) mass (B) linear momentum
 (C) angular momentum (D) kinetic energy
6. If the radius of the earth were to shrink by 2% its mass remaining same. The acceleration due to gravity on the earth is 1
- (A) decreased by 2% (B) increased by 2%
 (C) increased by 4% (D) decrease by 4%
7. A perfect gas at $27^\circ C$ is heated at constant pressure then its volume becomes thrice times, the temperature of the gas will be 1
- (A) $81^\circ C$ (B) $27^\circ C$
 (C) $9^\circ C$ (D) $45^\circ C$
8. In which of the following thermodynamics process heat is neither absorbed nor released by a system 1
- (A) isothermal (B) adiabatic
 (C) isobaric (D) isochoric

Question Nos. 9 and 10 are Assertion (A) and Reason (R) type questions.

Two statements are given one labelled Assertion (A) and the other labelled Reason(R). Select the correct answer from the codes (A), (B), (C) and (D) as given below.

- (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (C) Assertion (A) is true, but Reason (R) is false.
- (D) Assertion (A) is false and Reason (R) is also false.
9. Assertion(A) : In winter , birds often swell their feathers .
Reason (R) : Strength of feathers of bird are weakened in winter. 1
10. Assertion(A) : A uniform circle motion is a simple harmonic motion.
Reason (R) : The projection of uniform circular motion on any diameter of a circle of reference is simple harmonic motion. 1

Question Nos. 11 to 17 are "Very Short Answer Type" questions carrying 1 mark each.

11. Define angle of repose. 1
12. A ball is drop from height h , it bounces 80% of its original height . How much mechanical energy lost? 1
13. Gravitational force is the weakest force in nature but still it is considered the most important force. Why? 1
14. State Wien's displacement law. 1
15. "The blood pressure is greater at the feet than at the brain". Explain it. 1

16. Why is the internal energy of a compressed gas less than that of a rarefied gas at same temperature? 1
17. At what condition real gas becomes ideal gas? 1

Question Nos. 18 to 27 are "Short Answer Type-II" questions carrying 2 marks each.

18. If the force(F), velocity(V) and time(T) are chosen as fundamental units, what are the dimension of mass and energy? 2
19. The position of an object moving along x-axis is given by $x = 2t^2 + 3t + 5$, where x in meter and t in second.
- Calculate :
- (i) the initial position
- (ii) average velocity between 3s and 5s 2
20. Two position vectors $\vec{A} = 3\hat{i} - 5\hat{j} + 7\hat{k}$ and $\vec{B} = 2\hat{i} + 4\hat{j} - 3\hat{k}$. Find the vector that must be added to the resultant of \vec{A} and \vec{B} which gives a unit vector along y-direction. 2
21. Define impulsive force. State two phenomenon which are related with the impulse. 1+1=2
22. What are the conservative and non-conservative forces? 2
23. When a force is acting on a body, it moves in the direction of applied force. The kinetic energy of the body is increased. Show that the increased in kinetic energy is equal to the work done on the body by the force. 2
24. Prove that the center of mass of a rod having uniformly distributed mass lies in the middle of the rod. 2
25. Draw a neat and label diagram of hydraulic brake. 2

26. In simple harmonic motion the displacement becomes half of its amplitude. Calculate the kinetic energy and total energy of the SHM at that instant. 2

27. Draw normal mode of air column open at one end and closed other end for 1+1=2

(i) third harmonic

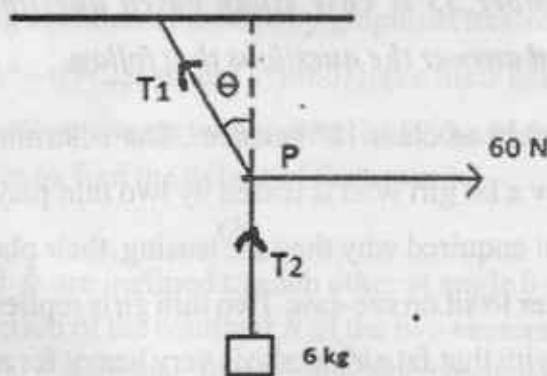
(ii) fifth harmonic

Question Nos. 28 to 33 are "Short Answer Type-I" questions carrying 3 marks each.

28. A car of mass m moves on a banked road with velocity v , angle of banking θ . Find the expression for the maximum safe velocity of the car can negotiate with the circular road by taking account the friction between tyre and road. 3

29. A mass of 6kg is suspended by a rope of length 2m from a ceiling. A force of 60N in the horizontal direction is applied at the mid-point of the rope as shown in fig. below. What is the angle the rope makes with the vertical in equilibrium? And also calculate the tension in the string.

($g = 10\text{m/s}^2$ and neglect mass of string) 2+1=3



30. Determine the value of C_v , C_p and γ for diatomic gases by using the law of equipartition of energy for one mole of a gas. 1+1+1=3

31. A 400 kg satellite is in circular orbit of radius $2R_e$ about the earth. How much energy is required to transfer it to a circular orbit of $4R_e$? What are the changes in the kinetic energy and potential energy? $1\frac{1}{2} + 1\frac{1}{2} = 3$

Or

The magnitude of gravitational field intensities at a distance r_1 and r_2 from the center of a uniform sphere of radius R and mass M , are I_1 and I_2 respectively. Find the ratio of I_1 and I_2 if $r_1 > R$ and $r_2 < R$. $1\frac{1}{2} + 1\frac{1}{2} = 3$

32. Derive the expression for the work done during the isothermal expansion of an ideal gas in a closed system. 3

Or

By using the first law of thermodynamics, obtain the relation between two specific heat of a gas. 3

Question number 33 is case study based question. Read the following paragraph and answer the questions that follow.

33. Rakhi is a student of class 11th science. She is strolling in a park near to her house. She saw a fat girl who is teased by two thin playmates. They are playing see-saw. Rakhi enquired why they are teasing their playmate and why they are not allowing her to sit on see-saw. Two thin girls replies that it is not possible to play see-saw with that fat girl as she is very heavy for any of them. Rakhi told

them if the fat girl set slightly near towards middle part, then they can play see-saw even with her. And finally learn to play that game together.

- (i) What is the technique used by Rakhi to the little girls?
- (ii) Why is there no problem for playing see-saw by two thin girls?
- (iii) If the mass of fat girl is 30 kg and thin girls are of 20 kg each, they are playing see-saw properly. What will be the ratio of their distances from the pivot? 1+1+1=3

Or

In recently concluded Olympic games you might have seen the roller or ice-skating events where the athlete swings, moves and dances. During the show the athlete folds her/his hand and speed increases. But when she extends her hand the speed decreased by changing the pose she can show increased or decreased the speed when she intends according to the convenient show.

- (i) What is the laws of physics applied by the roller for such variation of speed?
- (ii) Write the relation between the speed, angular momentum, mass and distance from the axis of rotation.
- (iii) Ice skater spin with arms outstretched at 1.9 rps and moment of inertia is 1.33 kgm^2 . She pulls her arms to increase the rate of spin and moment of inertia 0.48 kgm^2 . What is new rate of rotation? 1+1+1=3

Question Nos. 34 to 36 are "Long Answer Type" questions carrying 5 marks each.

34. Derive the following equation of motion by graphical treatment :

- (i) $v = u + at$, (ii) $v^2 - u^2 = 2as$ where symbol have their usual meaning.

A ball thrown vertically upwards with a speed of 19.6 m/s^2 from the top of tower returns to the earth in 6s find the height of the tower. 3+2=5

Or

Two vectors \vec{A} and \vec{B} are inclined to each other at angle θ in a plane. Find the magnitude and direction of the resultant \vec{R} of the two vectors. If the magnitudes of \vec{A} , \vec{B} and resultant \vec{R} are equal, find the angle between \vec{A} and \vec{B} . 3+2=5

35. Show that the surface energy of a liquid is numerically equal to its surface tension. A liquid drop of diameter 4mm breaks into 1000 drop of equal size .Calculate the change in surface energy if the surface tension of a liquid is 0.07N/m .

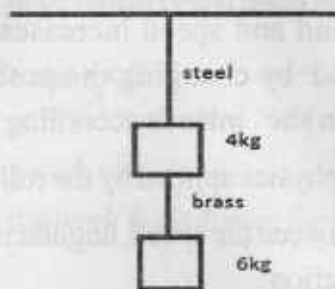
3+2=5

Or

Derive the expression for an elastic potential energy of stretched wire per unit volume. Two wires of diameter 0.25cm one made of steel and other made of brass are loaded in the figure below.

Unloaded length of steel wire is 1.5m and that of brass is 1.0 m . Young modulus of steel and brass are 2×10^{11} pa and 0.91×10^{11} pa respectively. Compute the elongation of steel and brass wires.

3+2=5



36. Derive the expression for time period of simple pendulum oscillating at small amplitude. Then acceleration due to gravity on the surface of moon is $1/6$ times the acceleration due to gravity on the surface of earth, what is ratio of time period of pendulum if we observed on the surface of the earth and on the surface of moon?

4+1=5

Or

If two sound waves travel in the same direction in a medium with slightly different frequency ν_1 and ν_2 respectively. Show that frequency of beats is equal to the difference in frequency of two sources of sound. A tuning fork of frequency 200Hz is in unison with a sonometer wire . How many beat per second will be heard if tension in the wire is increased by 2% .

4+1=5