



EXAMINATION PAPER : 2010

Time : 3 hours

Maximum Marks : 70

General Instructions :

- (i) All questions are compulsory.
- (ii) There are 30 questions in total. Questions 1 to 8 carry one mark each, questions 9 to 18 carry two marks each, questions 19 to 27 carry three marks each and question 28 to 30 carry five marks each.
- (iii) There is no overall choice. However, an internal choice has been provided in the one question of two marks; one question of three marks and all three questions of five marks each. You have to attempt only one of the choices in such questions.
- (iv) Use of calculators is not permitted.
- (v) Please write down the serial number of question before attempting it.
- (vi) You may use the following values of physical constant wherever necessary.

Boltzmann's constant $K = 1.38 \times 10^{-23} \text{ JK}^{-1}$

Avogadro's number $N_A = 6.022 \times 10^{23}/\text{mol}$

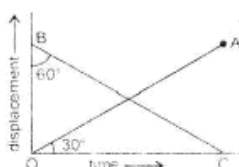
Radius of Earth $R = 6400 \text{ km}$.

1. Express one micron in metre. 1
2. What does the slope of velocity-time graph represent? 1
3. Are the magnitude and direction of $(\vec{A} - \vec{B})$ same as that of $(\vec{B} - \vec{A})$? 1
4. What is the principle of working of a rocket? 1
5. Why do we slip on a rainy day? 1
6. What is the source of the kinetic energy of the falling rain drop? 1
7. Two bodies move in two concentric circular paths of radii r_1 and r_2 with same time period. What is the ratio of their angular velocities? 1
8. State second law of thermodynamics. 1
9. If $x = at + bt^2$, where x is in metre and t in hour, what will be the unit of 'a' and 'b'? 2



10. The displacement-time graph of two bodies P and Q are represented by OA and BC respectively. What is the ratio of velocities of P and Q?

$$\angle OBC = 60^\circ \text{ and } \angle AOC = 30^\circ$$



OR

A car moving with a speed of 50 kmh^{-1} can be stopped by brakes after at least 6 m. What will be the minimum stopping distance, if the same car is moving at speed of 100 kmh^{-1} ? 2

11. A particle of mass m is moving in an horizontal circle of radius ' r ', under a centripetal force equal to (k/r^2) , where k is a constant. What is its potential energy? 2
12. Two solid spheres of the same are made of metals of different densities, which of them has larger moment of inertia about its diameter? Why? 2
13. If suddenly the gravitational force of attraction between the earth and a satellite revolving around it becomes zero, what will happen to the satellite? 2

14. When air is blown in between two balls suspended close to each other, they are attracted towards each other. Give reason. 2

15. What is an isothermal process?

Also give essential conditions for an isothermal process to take place. 2

16. Calculate the fall in temperature of helium initially at 15°C , when it is suddenly expanded to 8 times its volume. Given $\gamma = 5/3$. 2

17. Three vessels of equal capacity have gases at the same temperature and pressure. The first vessel contains neon (monoatomic), the second vessel contains chlorine (diatomic) and third contain polyatomic gas. Do the vessel contain equal number of molecules? Is the root-mean square speed of molecules same in three cases? 2

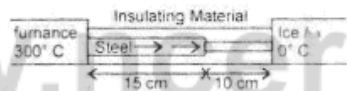


18. A particle is in linear simple harmonic motion between two points A and B, 10 cm apart, Take the direction from A to B as positive direction and give the signs of velocity and acceleration on the particle when it is
- at the end B
 - at 3 cm away from A going towards B 2
19. Draw displacement-time, velocity-time and acceleration-time graphs for a particle executing simple harmonic motion.

OR

A bat emits ultrasonic sound of frequency 1000 kHz in air. If the sound meets a water surface, what is the wavelength of (a) the reflected sound (b) transmitted sound? Speed of sound in air $v_a = 340 \text{ ms}^{-1}$, in water $v_w = 1486 \text{ ms}^{-1}$ 3

- Define Absolute Zero.
 - Deduce the dimensional formula for R, using ideal gas equation $PV = nRT$
 - Find degree of freedom of a monoatomic gas. 1+1+1=3
21. What is the temperature of the steel-copper junction in the steady state of the system shown in figure. The area of cross-section of steel rod is twice that of the copper rod, $K_{\text{steel}} = 50.2 \text{ Js}^{-1} \text{ m}^{-1}\text{K}^{-1}$, $K_{\text{cu}} = 385 \text{ Js}^{-1} \text{ m}^{-1}\text{K}^{-1}$



- Define the term gravitational potential. Give its S.I. unit. Also derive expression for the gravitational potential energy at a point in the gravitational field of the earth. 3
- Write S.I. unit of torque and angular momentum. Also deduce the relation between angular momentum and torque. 1/2+1/2+2=3
- Show that the total mechanical energy of a freely falling body remains constant through out the fall. 3
- Two masses 8 kg and 12 kg are connected at the two ends of a light inextensible string that goes over a frictionless pulley. Find the acceleration



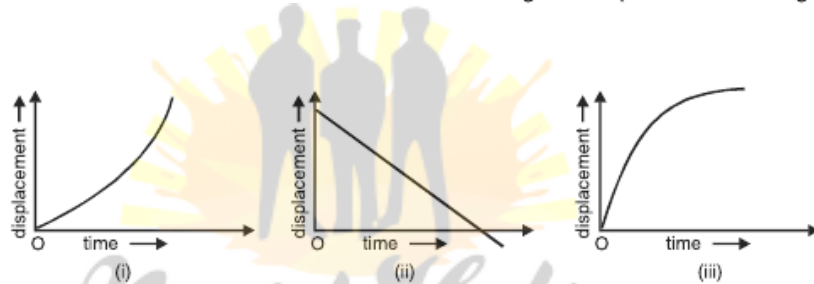
of the masses, and the tension in the string when the masses are released.
[$g = 9.8 \text{ ms}^{-2}$] 3

26. The position of a particle is given by

$$\vec{r} = 3.0t\hat{i} + 2.0t^2\hat{j} + 4\hat{k} \text{ m}$$

where t is in seconds, \vec{r} is in metres and the coefficients have the proper units.

- (a) Find the velocity v and acceleration a . 3
 (b) What is the magnitude of velocity of the particle at $t = 2 \text{ s}$? 3
27. Discuss the nature of the motion from the given displacement-time graph. 3

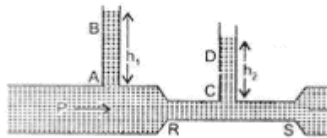


28. What is the need for Banking of road? Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at an angle θ . The coefficient of friction between the wheel and the road is μ .

OR

What do you understand by friction? Discuss about static friction, limiting friction, kinetic friction, rolling friction. Show how the force of friction f varies with the applied force F . 5

29. (i) State Pascal's law of transmission of fluid pressure. Explain how is Pascal's law applied in a hydraulic lift. (with suitable diagram)
 (ii) As shown in figure water flows from P to Q . Explain why height h_1 of column AB of water is greater than height h_2 of column CD of water.



OR

- (i) Explain the terms specific heat and heat capacity.
 - (ii) State Newton's law of cooling. Derive mathematical expression for it. 5
30. Show that total mechanical energy E of a particle executing simple harmonic motion is constant and equal to $\frac{1}{2}KA^2$, where $K = m\omega^2$, $m =$ mass and ω is angular velocity and A is the maximum amplitude. Also draw the graph of potential energy, kinetic energy and total energy of the particle.

OR

Obtain an expression for a standing wave formed and obtain the position of nodes and antinodes. 5

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