RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

B.A./B.SC. FIRST SEMESTER EXAMINATION, DECEMBER 2011

FIRST YEAR

Date : 23/12/2011 **PHYSICS (General)**

Time : 10.30am – 12.30pm Paper : I Full Marks : 50

Group–A

Answer **any two** questions from Q. No. 1 to Q. No. 4:

1. a) State Gauss's Divergence theorem. 2
   b) State Stoke's theorem in connection with vector calculus. 2
   c) Prove that $\vec{A} = -(4xy - z^3)\hat{i} + 2x^2\hat{j} - 3xz^2\hat{k}$ is an irrotational vector. 3
   d) Show that $\nabla^2 r^2 = n(n+1)r^{n-2}$ where $\vec{r}$ is the position vector. 3

2. a) What do you mean by Path Integral of force? 2
   b) What is conservative force? Give an example. State the necessary condition for a force to be conservative. 2+1+1
   c) $\vec{F} = 2xz\vec{i} + (x^2 - y)\vec{j} + (2z - x^2)\vec{k}$, find whether $\vec{F}$ is conserve or not. 2
   d) If $\left|\vec{a} + \vec{b}\right| = \left|\vec{a} - \vec{b}\right|$, prove that $\vec{a} \perp \vec{b}$. 2

3. a) Deduce an equation of motion of a system with variable mass. Hence find an expression for velocity of rocket moving with initial velocity *u* in upward direction in gravitational field. 3+3
   b) Find an expression for the gravitation potential due to a solid sphere at any point inside the sphere. 4

4. a) State and prove the theorem of perpendicular axes for moment of inertia. 2+3
   b) Applying the theorem of perpendicular axes, calculate the moment of inertia of a circular disc about its diameter. 3
   c) Two rotating bodies *A* and *B* of moments of inertia I_A and I_B respectively $(I_A > I_B)$ have equal angular momentum which one will have greater kinetic energy. 2

Answer **any one** question from Q. No. 5 & Q. No. 6:

5. a) What do you understand by Gravitational potential and intensity? 2
   b) A sphere of mass 40kg attracts a second sphere of mass 15kg with a force equal to $\frac{1}{10}$th of a milligram weight, when their centers are 20cm apart. Calculate the value of the gravitational constant. 3

6. a) Is angular momentum an axial vector or a polar vector? Justify your answer. 2
   b) Give a geometric interpretation of the product $\vec{a} \cdot (\vec{b} \times \vec{c})$. 3

Group–B

Answer **any two** questions from Q. No. 7 to Q. No. 10:

7. a) State the law of equipartition of energy. Calculate the specific heats (C_p and C_v) and hence find the value of their ratio for monatomic and diatomic gases. 2+3+2

   b) The average kinetic energy of a molecule of hydrogen at 0°C is 5.64×10^{-21} J/K and the gram molecular gas constant (R) is 8.32 J/K. Calculate Avogadro's number. 3

8. a) State Van der Waal's equation of state for a real gas. What are critical constants? 2+3

   b) Calculate the values of critical constants in terms of Van der Waal's constants. 5

9. a) Write Maxwell's law of distribution of molecular speed. Find an expression for root mean square speed. Hence explain why light gases like Hydrogen, Helium etc. are rare in earth's atmosphere. 2+3+2

   b) At what temperature, pressure remaining constant, will the r.m.s. velocity of a gas molecule be half its value at 0°C? 3

10. a) What do you mean by thermometric conductivity of a substance? Distinguish it from thermal conductivity. 2+2

    b) Derive Fourier's equation for conduction of heat in one dimension. 6

Answer **any one** question from Q. No. 11 & Q. No. 12:

11. a) Write Planck's distribution law. 2

    b) What is critical temperature? Distinguish between gas and vapour using the concept of critical temperature. 1+2

12. a) State the conditions of receibility of a thermodynamic process. 2

    b) State second law of thermodynamics. Define efficiency of a Carnot's engine. 3

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