Shah Jalal University of Science & Technology, Sylhet

Department of Physics

B. Sc. (Hons.) 1st Year 1st Semester Examination-2011 (Held in May-June, 2011)

Course: PHY107 (Mechanics, Structure of Matter, Waves and Oscillations) for IPE

Full Marks: 70, Credit: 3, Time: 3 hours.

[**Answer any five questions**. The figures on the right margin indicate full marks.]

1. (a) State Newton's law of gravitation. What is the numerical value of G? 3
   (b) Write down Kepler's law of planetary motion. Derive the law of gravitation by using Kepler's law. 6
   (c) Define escape velocity and find its value: $v = \sqrt{2gR}$, 5
   where the symbols have their usual meaning.

2. (a) What is collision? Write down different types of collision. 5
   (b) Show that, when a lighter particle moving with a certain velocity collides with a stationary heavier particle, it rebounds in the opposite direction with the same velocity. 9

3. (a) What is projectile motion? Give some examples for this motion. 2+1
   (b) Draw the trajectory of a projectile showing the velocity and its vector components at some arbitrary points on the path traversed and hence show that the trajectory is parabolic. 2+6
   (c) Show that the maximum height reached by a projectile is $y_{max} = \frac{(v_o \sin\theta_o)^2}{2g}$, where the symbols have their usual meaning. 3

4. (a) A particle is rotating in a circular way with a constant speed. Is there any acceleration with it? Explain. 3
   (b) Define torque and angular momentum, and derive relation between them. 4+4
   (c) What is the angular speed of a car rounding a circular turn of radius 360 ft at 30 miles/hr? 3

5. (a) Define lattice and basis. 2
   (b) Define primitive cell and unit cell of a crystal. 2
   (c) What is Miller indices? Draw the crystal planes for Miller indices (001), (010), (020) and (232) 6
   (d) Determine the actual volume occupied by the spheres in the simple cubic structure as a percentage of the total volume. 4

6. (a) Derive an expression for Bragg's law. Why X-ray but not the visible light is used in Bragg's diffraction? 8
   (b) Calculate the longest wavelength that can be analyzed by a rock salt crystal of spacing d=2.82 Å (i) in the first order, (ii) in the second order. 6

7. (a) What do you mean by crystalline solids, non-crystalline solids and polycrystalline solids? 6
   (b) Show that for a *bcc* and *fcc* crystal structure, the lattice constants are given by
   $$a_{bcc} = \frac{4r}{\sqrt{3}} \quad \text{and} \quad a_{fcc} = \frac{4r}{\sqrt{2}}.$$ 5
   (c) Distinguish among metal, insulator and semiconductor in connection with band theory. 3

8. (a) What is damped harmonic motion? Write down the differential form of damped harmonic motion. 4
   (b) Find out the average power dissipated in damped harmonic motion. 7
   (c) Show that the lower the value of damping (b), the higher the value of quality factor. 3