RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree
First Year – Semester I Examination – September/October 2013

PHY 1201- GENERAL AND THERMAL PHYSICS

Answer any FOUR questions — Time: 2 Hours

Acceleration due to gravity $g = 9.8\ m\ s^{-2}$

Use of a non-programmable calculator is permitted.

1. Write short notes on

   a) Nuclear force

   b) Intensity of gravity

   c) Contact and non contact collisions

   d) Steady flow and turbulent flow

2. a) According to Ptolemy's theory, earth was assumed to be at the centre of the universe with the planets and stars revolving around it in cycles. This is referred to as geo-centric theory.
   Compare the above theory with Keplers' laws of planetary motion.

   b) Assuming that the planets move in approximately circular orbits around the Sun, obtain Newton's law of gravitation from Keplers' third law.

c) The rings of Saturn consist of many small particles, with each particle following its own circular orbit in Saturn's equatorial plane. The inner edge of the innermost ring is about 14000 km from Saturn's centre. The outer edge of the outermost ring is about 27000 km from the centre. Find the orbital period of the outermost particles as a multiple of the orbital period of the innermost particle.

3. a) Discuss an incident where the law of conservation of linear momentum is applied.

b) Consider a rocket in space, where the effect of gravity and the frictional forces are negligible. If m is the instantaneous mass of the rocket and the fuel, v_0 is the speed of the discharged gas relative to the rocket, show that the speed- mass relation for the rocket is given by,

$$v_0 dm + m dv = 0$$

If the initial and final values of m are m_i and m_f, show that the velocity gain is given by $v_0 \ln(m_i/m_f)$

b) A rocket whose initial mass is 850 kg consumes fuel at the rate of 2.3 kg s^{-1}. The speed of the exhaust gases relative to the rocket engine is 2800 m s^{-1}. What thrust does the rocket engine provide?

4. a) i. Illustrate the conservation of angular momentum using an example.
ii. The period of Earth is a constant (24 hours). Why?

b) What is it meant by "precession"? How do you apply law of conservation of angular momentum for a spinning top?

c) Show that the angular speed of precession is $\Omega = \frac{mgr}{I\omega}$ for a spinning top having a mass m. where r is the distance from the centre of mass of the top and the pivoted point. I is the moment of inertia of the spinning top about the spin axis and ω is the angular velocity of the spinning top.

If I= 5 x 10^{-4} kg m^2, r =4 cm, m= 0.5 kg and spin rate is 30 revolutions per second, find the angular velocity of precession of the top.

5. a) State and prove the Bernoulli's theorem, identifying clearly the quantities involved.

State the conditions under which the Bernoulli's theorem is valid.

b) Discuss an application of the Bernoulli's theorem.

c) Ethanol of density $\rho = 791\,kg\,m^{-3}$ flows smoothly through a horizontal pipe that tapers in cross- sectional area from $A_1 = 1.2 \times 10^{-3}\,m^2$ to $A_2 = \frac{A_1}{2}$. The pressure difference between the wide and narrow sections of pipe is 4120 Pa. What is the volume flow rate R_v of ethanol.