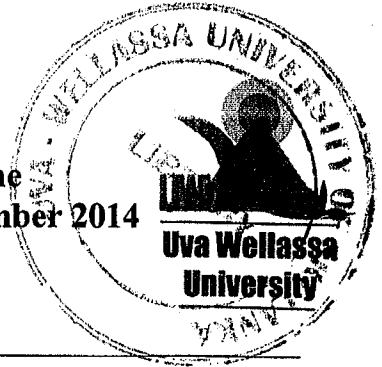


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Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Science and Technology Degree Programme
1st Year 1st Semester Examination – August/September 2014



SCT 151-1 Physics I

Number of questions: Three (03)
Answer **Two** (02) questions only
Time allocation: One (01) hour
Total marks: 100

1. a. Describe the following

(i) Position vector, (ii) Displacement, (iii) Average and instantaneous velocity, (iv) Average and instantaneous acceleration, of a particle moving on xy plane.

(10 mark)

b. An eagle flies across the sky searching for a target. The coordinates (meters) of the eagle's position as a function of time t (seconds) are given by $x = -0.31t^2 + 7.2t + 28$ and $y = 0.22t^2 - 9.1t + 30$.

(i) At $t = 1.5$ s, what are the Eagle's position vector \vec{r} , its magnitude and the angle it makes with the x axis?

(ii) Graph the eagle's path from $t = 0$ to $t = 25$ s.

(iii) Find the velocity \vec{v} at time $t = 15$ s.

(15 mark)

c. (i). Write equations for the centripetal force F and the period of revolutions T experienced by an object of mass m undergoing a circular motion in a circle with radius r and velocity v .

(5 mark)

(ii). Outline three examples from the physical world to show this force is fundamental and acting universally on objects having all types of circular motions regardless of where the motion occurs.

(10 mark)

(iii). Calculate the magnitude of the acceleration in g units of a pilot whose aircraft enters a horizontal circular turn with a velocity of $\vec{v} = (400i + 500j)m/s$ and leaves the turn with a velocity of $\vec{v} = (-400i + (-500j)$ after 24.0 seconds.

(10 mark)

2. a. (i). What is gravitation? Write Newton's universal gravitation law. What is the importance of the value of G in our everyday lives?

(10 mark)

(ii). An astronaut whose height h is 1.68 m floats "feet-down" in a space shuttle located at distance $r = 6.67 \times 10^6 m$ away from the center of Earth. What is the difference between the gravitational acceleration at her feet and at her head?

(10 mark)

(iii). If the astronaut is now in the same position at the same orbital of radius $r = 6.77 \times 10^6 m$ about a black hole of mass $M_h = 1.99 \times 10^{31} kg$ (this is about 10 times our Sun's mass), what changes would you expect to see in the answer in part (ii) ? If, for some reason, she drifted closer to the black hole, what would be the net effect on her body?

(10 mark)

b. (i). Compare Coulomb law with Newton's gravitational law

(iii). The nucleus in a Fe atom has a radius of about $4.0 \times 10^{-15} m$ and contains 26 atoms. What is the magnitude of the repulsive electrostatic force between two of the protons that are separated by $4.0 \times 10^{-15} m$? What is the magnitude of the gravitational force between the same two protons?

(20 mark)

3. a. What do you mean by *linear charge density*, *surface charge density* and *volume charge density* in a *continuous charge distribution* in a region where billions of electric point charges have been immobilized?

(10 mark)

b. A plastic rod having uniformly distributed $-Q$ charge is bent in a 120° circular arc of radius r . In terms of Q and r , what is the electric field strength E due to the rod at the origin?

(20 mark)

c. Extend your results obtained in (b) to find out the electric field strength of a point in a central axis of a charged disk.

(20 mark)