Semester 2 Examinations 2011/2012

Module Title: PHYSICS

Module Code: PHYS6012

School: Science

Programme Titles:
Bachelor of Science (Honours) in Environmental Science and Sustainable Technology, Year 1
Bachelor of Science (Honours) in Instrument Engineering, Year 1
Bachelor of Science in Applied Physics and Instrumentation, Year 1
Bachelor of Science in Applied Biosciences, Year 1
Bachelor of Science in Analytical and Pharmaceutical Chemistry, Year 1
Higher Certificate in Science in Industrial Measurement and Control, Year 1

Programme Code: SESST_8_Y1
SINEN_8_Y1
SPHYS_7_Y1
SBIOS_7_Y1
SCHEM_7_Y1
SIMCT_6_Y1

External Examiner(s): Dr S. Daly, Mr W. Power
Internal Examiner(s): Ms C. Devaney
Dr A. O'Connor

Instructions: Answer any **FOUR** questions. All questions carry equal marks.

Duration: 2 Hours

Sitting: Summer 2012

Requirements for this examination: Log tables.

Note to Candidates: Please check the Programme Title and the Module Title to ensure that you are attempting the correct examination paper.
If in doubt please contact an Invigilator.

1   (a)   A parachutist of mass 80 kg is free-falling at 190 km/hr when he opens his parachute. It takes 150 s to slow to 20 km/hr. Calculate (i) the deceleration produced by the parachute (ii) the distance over which he decelerates (iii) the force exerted by the parachute. (Ignore the effects of gravity.)   [10 marks]

    (b)   How is force related to momentum? A cannon ball of mass 150 kg is fired with a launch speed of 260 m/s from a stationary cannon of mass 5800 kg. If the cannon is mounted on a frictionless rail, calculate its recoil speed.   [8 marks]

    (c)   How is a coefficient of friction defined? A filing cabinet of mass 35 kg is resting on a carpeted floor. If the coefficient of friction between the cabinet and floor is 0.62, what force is necessary to get the cabinet to move?   [7 marks]

2   (a)   Explain what is meant by (i) *phase difference* and (ii) *monochromatic*.   [4 marks]

    (b)   Discuss the conditions necessary to observe interference for light. Why is it more difficult to observe interference for light than sound?
          In a Young's slits experiment with a laser, a fringe pattern is observed on a screen at a distance of 80 cm from the slits. The seventh fringe is measured to be 3.5 cm from the centre of the fringe pattern. If the laser wavelength is 633 nm, calculate the slit separation.   [11 marks]

    (c)   Explain with the aid of sketches what is meant by resolution and hence state the Rayleigh criterion for resolution. If the diameter of an owl's eye is 8.5 mm, what is the maximum distance at which it can discern a mouse of length 4 cm? (Take the wavelength of the light to be 550 nm.)   [10 marks]

3   (a)   Give an account of the main factors affecting the stability of the nucleus, with particular reference to the role of the neutron.   [13 marks]

    (b)   Explain the terms (i) *half-life* (ii) *activity*.
          A sample of platinum-199 $\left(^{199}\text{Pt}\right)$ has an initial activity of 7.56×10^{11} Bq. If its half-life is 30.8 minutes, what is the mass of the sample? What will be the activity after 90 minutes? (Avogadro's number is $N_A = 6 \times 10^{23}$ mol^{-1}.)   [12 marks]

4   (a)   State Faraday's law and use it to derive an expression for the emf generated when a coil of area A rotates in a magnetic field of magnetic flux density **B**.   [9 marks]

    (b)   A circular wire with a diameter of 28 cm carries a current of 2.5 A. Assuming that the magnetic field is constant across the whole area, calculate (i) the magnetic flux through the loop (ii) the emf induced if the current drops to zero in 0.35 s. (Take $\mu_0 = 4\pi \times 10^{-7}$ H/m.)   [8 marks]

    (c)   Discuss the role of transformers in the transmission of electrical power.   [8 marks]

5 (a) How is pressure defined? Distinguish between gauge and absolute pressure. Find the pressure increase in the fluid inside a syringe when a force of 60 N is applied to the piston, of radius 5 mm. [10 marks]

(b) State the continuity equation. Water enters a pipe of diameter 35 mm at a speed of 5 m/s. If the diameter of the pipe changes to 16 mm, what is its new velocity? [6 marks]

(c) Give an account of surface tension and give two examples of its effects. [9 marks]

6 *Answer part (a) and THREE other parts.*

(a) Explain with the aid of sketches what happens the interference pattern if we go from two slits to three to a very large number, without altering the slit separation. Hence explain why a diffraction grating is more useful than Young's slits. [7 marks]

(b) In two minutes, a ski lift raises a skier at constant speed to a height of 140 m. The mass of the skier is 65 kg. What happens the total energy of the skier over the trip? What work is done by the ski lift on the skier? What is the power used? [6 marks]

(c) For the following radioactive decays, identify the type of decay and the unknowns A and X: (i) $_{88}^{A}Ra \rightarrow {}_{Z}^{222}X + \alpha$; (ii) $_{11}^{22}Na \rightarrow {}_{Z}^{A}X^* + neutrino$. X may be identified by either its atomic number Z or its name. (The asterisk denotes an excited state.) [6 marks]

(d) A wire of length 280 cm is located in a region where the magnetic field is 0.84 T. If a current of 3 A is required to lift the wire, what is the mass of the wire? [6 marks]

(e) Give a brief explanation of what causes the "bends" (decompression sickness) for deep-sea divers. [6 marks]

Useful information

The acceleration due to gravity is $g = 9.8 \text{ m/s}^2$.