

**CORK INSTITUTE OF TECHNOLOGY
INSTITIUID TEICNEOLAIOCHTA CHORCAI**

Semester 2 Examinations 2010/2011

Module Title: PHYSICS

Module Code: PHYS 6012

School: Science

Programme Title:

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

**Programme Code: SESST_8_Y1
 SINEN_8_Y1
 SPHYS_7_Y1
 SBIOS_7_Y1**

External Examiner(s): Dr V. Casey, Dr. S. Daly, Dr. E. Burke

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 2011

Requirements for this examination: Log tables.

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

- Q1. (a) A car of mass 1000 kg travelling at 90 km/hr brakes and comes to rest in 92 m. Calculate (i) the deceleration of the car (ii) how long it takes to come to rest (iii) the force needed to bring it to rest. [10 marks]
- (b) State the law of conservation of momentum. An arrow of mass 140 g is fired horizontally at 22 m/s into a stationary wooden block of mass 0.45 kg resting on the ground. Assuming that the collision is inelastic, calculate the final velocity of the arrow and block. [8 marks]
- (c) Explain what is meant by (i) *potential energy* and (ii) *power*. A stone of mass 5 g is dropped from a height of 10 m. Calculate its kinetic energy just before it hits the ground. [7 marks]
- Q2. (a) Explain what is meant by (i) *phase difference* and (ii) *monochromatic*. [4 marks]
- (b) 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. Monochromatic light of wavelength 633 nm is incident on a grating with 600 lines per millimetre. Calculate the angle at which the second-order line occurs. [11 marks]
- (c) Explain briefly the factors on which the resolution of an optical instrument depends. How may the resolution of (i) a microscope (ii) a telescope be improved? The pupil of an eagle's eye has a diameter of 6 mm. From a height of 175 m, can it resolve (i) a mouse of length 5 cm (ii) a rabbit of length 30 cm? (Take $\lambda = 550 \text{ nm}$.) [10 marks]
- Q3. (a) Give an account of the main types of radioactive decay. Mention two applications of radioactivity. [13 marks]
- (b) Explain the terms (i) *half-life* (ii) *decay constant*. A mass of 7 ng of lead-212 (^{212}Pb), with a half-life of 10.64 hours, is injected into a patient. What activity does this correspond to? How long will it take for the activity to decrease to $2.25 \times 10^7 \text{ Bq}$? (Avogadro's number is $N_A = 6 \times 10^{23} \text{ mol}^{-1}$.) [12 marks]

- Q4. (a) State Faraday's law of electromagnetic induction. Explain how a transformer works, referring to this law in your answer. [9 marks]
- (b) A generator rotates at 85 Hz in a magnetic field of 0.03 T. The generator has 1000 turns and produces an rms voltage of 150 V and an rms current of 70 A. Calculate (i) the peak current produced and (ii) the area of each turn. [8 marks]
- (c) Sketch the magnetic field surrounding a solenoid. What factors influence the magnetic flux density at the centre of the solenoid? State the relationship between *magnetic flux* and *magnetic flux density* and give the SI unit for each. [8 marks]

- Q5. (a) Show that the pressure of a fluid varies as $p = \rho gh$. If standard atmospheric pressure is 760 mm Hg, make a crude estimate of the height of the atmosphere assuming that the density of air is 1.2 kg/m^3 and that the density of mercury is $13.6 \times 10^3 \text{ kg/m}^3$. Briefly explain why this estimate is incorrect. [12 marks]
- (b) Water enters a pipe of cross-sectional area 350 cm^2 at a speed of 5.6 m/s. If the area of the pipe changes to 0.042 m^2 , what is its new velocity? [4 marks]
- (c) Give an account of viscosity under the following headings: (i) definition (ii) origin for liquids and gases (iii) variation with temperature (iv) effect on fluid flow. [9 marks]

Q6. **Answer part (a) and THREE other parts.**

- (a) For a single slit of width a , explain why the condition
- $$a \sin \theta = m\lambda \quad (m = 1, 2, 3, \dots)$$

represents a *minimum* in the diffraction pattern. [7 marks]

- (b) Calculate the work done against friction in pushing a 160 kg cart 4 m along a floor if the coefficient of friction between the cart and the floor is 0.15. [6 marks]
- (c) Describe how a Geiger counter works. [6 marks]
- (d) Calculate the current flowing in a straight wire of length 40 cm if the force on it is 0.04 N when it is placed in a 500 mT magnetic field perpendicular to the wire. [6 marks]
- (e) State the continuity equation for gases and show that this is a consequence of conservation of mass. [6 marks]

Useful information

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