

**CORK INSTITUTE OF TECHNOLOGY
INSTITIUID TEICNEOLAIOCHTA CHORCAI**

Semester 2 Examinations 2011/2012

Module Title: PHYSICS

Module Code: PHYS6012

School: Science & Informatics

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

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: Autumn 2012

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.

- 1 (a) In a crash, a driver is brought to rest by an air bag from a speed of 30 km/hr over a distance of 25 cm. Calculate the deceleration of the driver and the time taken to bring him to rest. [10 marks]
- (b) In coming to a halt, a car of mass 1000 kg leaves skid marks that are 65 m long. The coefficient of friction between the road and the tyres is 0.71. Calculate the work done by friction in bringing the car to rest. If it takes the car 12 seconds to come to rest, what power was used? [7 marks]
- (c) A bullet of mass 65 g is fired upwards from a rifle at a speed of 150 m/s. What is the maximum height reached? What is the kinetic energy at a height of 500 m? [8 marks]
- 2 (a) Explain what is meant by (i) *frequency* and (ii) *path difference*. [4 marks]
- (b) Rank the following regions of the electromagnetic spectrum in order of increasing energy: *microwave, X-ray, ultraviolet, radio*. [4 marks]
- (c) Light from a cadmium lamp falls normally on a diffraction grating with 500 lines per mm. Find the angular separation between the first order red line and the second order green line. (The relevant wavelengths are 509 nm for green and 644 nm for red.) [7 marks]
- (d) Sketch the diffraction pattern from a single slit and a circular aperture. Explain the relevance of this to the resolution of an optical instrument. Two satellites at an altitude of 1200 km are separated by 28 km. If they both broadcast microwaves of wavelength 3.6 cm, what is the minimum diameter of satellite dish needed to resolve the two transmissions? [10 marks]
- 3 (a) Give an account of environmental radioactivity. [13 marks]
- (b) What do the terms (i) *isotope* (ii) *decay constant* mean?
Barium-131 (^{131}Ba) has a half-life of 12 days. Calculate the activity of 0.6 μg of it. What will be the activity after 25 days? (Avogadro's number is $N_A = 6 \times 10^{23} \text{ mol}^{-1}$.) [12 marks]
- 4 (a) Explain how a transformer works, referring to Faraday's law of induction in your answer. [8 marks]
- (b) The armature of an a.c. generator has 120 turns, each being a rectangular loop of dimensions 8 cm by 12 cm. State the relationship which gives the instantaneous voltage generated. If the magnetic flux density is 250 mT, calculate the number of revolutions of the armature in one minute when the amplitude is 24 V. [8 marks]
- (c) A solenoid with 375 turns per metre and a diameter of 15 cm has a magnetic flux through its core of $1.28 \times 10^{-4} \text{ Wb}$. Calculate the current in the solenoid. How would this change if the solenoid diameter were doubled? ($\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$). [9 marks]

- 5 (a) How is pressure defined? Give any two common units used to measure pressure. Explain how pressure is defined in molecular terms and hence show that, for an ideal gas in a box of volume V ,

$$pV \propto T$$

where T is the absolute temperature. [8 marks]

- (b) State the continuity equation for gases. On what conservation law is it based? How does it simplify for liquids? Blood flow through an artery at a speed of 0.1 m/s. If the artery narrows to one quarter of its original diameter, what is the new speed of the blood? [8 marks]
- (c) Give an account of capillary action. Give an example of where it is important. [9 marks]

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

- (a) Describe the operation of a Geiger counter. [7 marks]
- (b) An astronaut is stranded when the tether connecting him to his spacecraft breaks. Fortunately, he is carrying a spanner. How could he use it to get back to his ship? [6 marks]
- (c) Show that, for Young's slits, the condition for constructive interference is that

$$m\lambda = d \sin \theta \quad (m = 0, 1, 2, \dots) \quad [6 \text{ marks}]$$

- (d) A step-up transformer has 25 turns on the primary coil and 75 turns on the secondary coil. If it is to produce an output of 4800 V and 12 mA, what input voltage and current are needed? [6 marks]
- (e) The pressure at the surface of a lake is 765 mm Hg. At what depth will the **total** pressure be three times this value? (Relevant densities in kg/m^3 : mercury, 13600; water 1000.) [6 marks]

Useful information

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