

**CORK INSTITUTE OF TECHNOLOGY
INSTITIUID TEICNEOLAIOCHTA CHORCAI**

Autumn Examinations 2007/08

Module Title: PHYSICS

Module Code: PHYS6012

School: SCIENCE

Programme Title:

Bachelor of Science – Applied Physics and Instrumentation, Year 1
Higher Certificate in Science – Industrial Measurement and Control, Year 1
Bachelor of Science – Applied Biosciences, Year 1
Bachelor of Science – Biomedical Science, Year 1

Programme Code: SPHYS_7_Y1
 SIMCT_6_Y1
 SBIOS_7_Y1
 SBMSC_7_Y1

External Examiner(s): Dr N. McMillan

Internal Examiner(s): Mr S. Cotter
 Ms C. Devaney
 Dr A. O'Connor

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

Duration: 2 Hours

Sitting: Autumn 2008

Requirements for this examination: Log tables.

<p>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.</p>
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- 1 (a) A ball is thrown downwards from a height of 1.5 m with a speed of 30 m/s.
 - (i) With what speed does it hit the ground?
 - (ii) How long does it take to reach the ground?
 - (iii) What is the maximum height reached after rebounding from the ground?

(The acceleration due to gravity is $g = 9.8 \text{ m/s}^2$.) [12 marks]
 - (b) State Newton's second law of motion. What force is needed to uniformly accelerate a car of mass 1400 kg from rest to 100 kph in 8.9 seconds? [9 marks]
 - (c) Give an example of where conservation of (i) energy (ii) momentum is useful. [4 marks]
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- 2 (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 a Young's double-slit experiment, the angle spanned by seven fringes is found to be 0.47° . If the slit separation is 0.5 mm, what is the wavelength of the light in m? [6 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? A car has headlights separated by 1.1 m. Assuming light of wavelength 550 nm and a pupil diameter for the eye of 5 mm, at what distance can the headlights just be resolved as two separate sources?
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- 3 (a) Explain how α -, β - and γ -rays ionise and hence compare their ionising and penetrating ability. [7 marks]
 - (b) What is meant by the decay constant for a radioactive source? How is the becquerel defined? What is the activity of 2.6 μg of Ca-45? (The half life is 162.6 days.) What will be the activity after a year? ($N_A = 6 \times 10^{23} \text{ mol}^{-1}$) [12 marks]
 - (c) For the following decay processes, identify the type of decay and the unknowns A and Z:
 - (i) $U_{92}^{235} \rightarrow Z_Z^A + \alpha$; (ii) $K_{19}^{42} \rightarrow Z_Z^A + e^- + \text{neutrino}$. (N.B. The element Z may be identified *either* by its atomic number or name.) [6 marks]
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- 4 (a) State Faraday's law of induction. Hence explain how an a.c. generator works. What factors affect the size of the induced voltage? [17 marks]
 - (b) The armature of an a.c. generator has 80 rectangular turns, each turn being 18 cm by 7 cm. The generator produces a sinusoidal voltage of amplitude 17 V and frequency 40 Hz. Calculate the magnetic flux density required for this. [8 marks]

- 5 (a) Distinguish between gauge pressure and absolute pressure. Give the SI unit for pressure and one other common pressure unit. 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. [9 marks]

- (b) State the continuity equation for gases. A gas of density 1.44 kg/m^3 flows through a cylindrical pipe of diameter 17 cm at a speed of 8.2 m/s. If the pipe narrows to 16 cm and the density changes to 1.28 kg/m^3 , estimate the new speed of the gas. [8 marks]
- (c) Give a brief account of capillary action. How does the height of the column of liquid depend on the width of the tube? [8 marks]

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

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

- (a) For diffraction at a slit of width b , explain briefly why the condition

$$b \sin \theta = m \lambda \quad (m = 1, 2, 3, \dots)$$

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

- (b) What force is required to move a block of mass 50 kg at constant speed across a surface where the coefficient of friction is 0.5? What work is done in moving the block 5 m? [6 marks]
- (c) Describe the operation of a scintillation counter. [6 marks]
- (d) The primary coil of an ideal transformer has 700 turns and the secondary coil has 180 turns. If the current in the primary coil is 15 A when 720 V is applied to it, what is (i) the voltage (ii) the current in the secondary coil? [6 marks]
- (e) If atmospheric pressure is 1.013 bar, at what depth (in m) below the surface of water will you experience a pressure of twice this value? (Density of water = 1000 kg/m^3 .) [6 marks]