

**CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ**

Autumn Examinations 2008/09

Module Title: PHYSICS

Module Code: PHYS 6012

School: Science

Programme Title:

Bachelor of Science in Applied Physics and Instrumentation – Stage 1

Higher Certificate in Science in Industrial Measurement and Control – Stage 1

Bachelor of Science in Applied Biosciences – Stage 1

Bachelor of Science in Biomedical Science – Stage 1

**Programme Code: SPHYS_7_Y1
 SIMCT_6_Y1
 SBIOS_7_Y1
 SBMSC_7_Y1**

External Examiner(s): Dr V. Casey
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Internal Examiner(s): Ms C. Devaney
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 Dr M. Woods

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

Duration: 2 Hours

Sitting: Autumn 2009

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) An exploding volcano projects a rock of mass 7 kg from ground level upwards with an initial velocity of 70 m s^{-1} .
- What is its *velocity* after 5 seconds?
 - What is the *maximum height* that the rock reaches before falling back to earth?
 - Calculate the *initial kinetic energy* of the rock. [13 marks]
- (b) A car of mass 1000 kg accelerates over a distance of 0.75 km. It is driven by an engine with a force of 4200 N and it experiences a frictional force of 1600 N.
- State *Newton's Second Law* and hence determine the acceleration of the car.
 - Calculate the *net work done* by the forces. [10 marks]
- (c) What is the difference between the *mass* and the *weight* of an object? [2 marks]

- 2 (a) Outline the conditions necessary to observe interference for light. Show that, for Young's slits of separation d , the condition for constructive interference is that

$$d \sin \theta = m \lambda \quad (m = 0, 1, 2, \dots) \quad [12 \text{ marks}]$$

- (b) Using a diffraction grating with 600 lines/mm, at what angle (from the centre) will the red line of cadmium be in *second* order? The wavelength of Cd red is 644 nm. [7 marks]
- (c) If the headlights on a car have a separation of 1.5 m, at what distance can they just be resolved? Take the aperture of the eye to be 7 mm and the wavelength of the light to be 550 nm. [6 marks]

- 3 (a) Discuss the factors that influence the stability of the nucleus. [12 marks]
- (b) Explain the terms (i) *half-life* (ii) *atomic number* (iii) *mass number*. Calculate the decay constant and activity of 1 mg of strontium-90 (${}^{90}_{38}\text{Sr}$). What fraction of the nuclei will remain after 60 years? (The half-life of strontium-90 is 29 years. Avogadro's number is $N_A = 6 \times 10^{23} \text{ mol}^{-1}$.) [13 marks]

- 4 (a) 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]
- (b) State Faraday's law of electromagnetic induction. Describe, with the aid of a sketch, how an a.c. generator works. (Refer to Faraday's law in your answer.) [8 marks]

- (c) A coil of 50 mm radius and 50 turns is oriented perpendicular to a magnetic field. The coil is turned through 180° about its diameter in 0.07 s and the maximum induced emf is 2 V. What is the strength of the field in the region of the coil? [9 marks]
- 5 (a) A cylindrical tank of height 5 m and radius 70 cm contains liquid of density 1400 kg/m^3 . What is the pressure at the bottom of the tank due to the liquid? What is the force exerted on the base of the tank? [8 marks]
- (b) State the continuity equation. A liquid is flowing through a pipe of diameter 12 cm at a speed of 5.8 m/s. If the speed of the liquid is to be increased to 8.5 m/s, what must be the new diameter of the pipe? [8 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]
- 6 ***Answer part (a) and THREE other parts.***
- (a) Sketch the diffraction pattern from a single slit and from a circular aperture. Explain the relevance of the latter to the resolution of an optical instrument. [7 marks]
- (b) An arrow of mass 0.20 kg is fired horizontally at 15 m/s into a stationary wooden block of mass 0.60 kg resting on the ground. The arrow sticks in the block and they then move along the ground with a common velocity v . Use the law of conservation of linear momentum to determine the common velocity. [6 marks]
- (c) Write down the decay equation for each of the following:
- (i) alpha (α) decay of ${}^{238}_{92}\text{U}$;
 - (ii) beta (β^-) decay of ${}^{24}_{11}\text{Na}$.
- (The atomic number will suffice to identify the daughter nucleus.) [6 marks]
- (d) A magnetic field has a magnitude of 0.078 T and is uniform over a circular surface of radius 10 cm. The field is oriented at an angle of 25° with respect to the normal to the surface. What is the magnetic flux through the surface? [6 marks]
- (e) Give an account of surface tension. [6 marks]

Useful information

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