

**CORK INSTITUTE OF TECHNOLOGY  
INSTITIUID TEICNEOLAIOCHTA CHORCAI**

**Semester 2 Examinations 2009/2010**

**School:** SCIENCE

**Programme Title:**

Bachelor of Science in Applied Physics and Instrumentation, Year 1

Bachelor of Science in Applied Biosciences, Year 1

**Programme Code:** SPHYS\_7\_Y1  
SBIOS\_7\_Y1

<b>Module Title:    PHYSICS</b>
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**Module Code:** PHYS6012

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**Internal Examiner(s):** Ms C. Devaney  
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**Instructions:** Answer any **four** questions. All questions carry equal marks.

**Duration:** 2 Hours

**Sitting:** Autumn 2010

**Requirements for this examination:** Log tables.

- 1
  - (a) A car is travelling at 72 km/hr when the driver notices a road block ahead. He applies the brakes and decelerates at  $7 \text{ m/s}^2$ . If his reaction time is 0.53 s, what is the stopping distance (measured from when he just notices the road block)? [10 marks]
  - (b) If a force of 46 N is required to slide a 10 kg block across a table at a constant speed, what is the coefficient of friction between the block and the table? Calculate the work done against friction in moving the block a distance of 5 m. [6 marks]
  - (c) A 55 kg swimmer is standing on a stationary raft of mass 210 kg. The swimmer jumps off the raft with a speed of 4.6 m/s. Calculate the recoil velocity of the raft. [5 marks]
  - (d) Distinguish between kinetic and potential energy and give two examples of forms of potential energy. [4 marks]
  
- 2
  - (a) What is meant by (i) the *amplitude* of a wave (ii) *coherence* for light? [4 marks]
  - (b) Discuss the conditions necessary to observe interference for light. Explain briefly why it is easier to detect wave-like behaviour for sound. Sketch the interference pattern you would expect for 2 slits, 3 slits and 1000 slits using the same horizontal axis for all three. Hence explain briefly the advantage of a diffraction grating over Young's slits. [13 marks]
  - (c) Explain what is meant by the resolution of an optical instrument. Use the single-slit diffraction formula to show that two objects are just resolved at an angular separation of

$$\theta_{\min.} = \Delta\theta = \frac{\lambda}{a}$$

What size aperture would be required to give a resolution of  $0.001^\circ$ ? (Take the wavelength of light to be  $\lambda = 550 \text{ nm}$ .) [8 marks]

- 3
  - (a) State the three main causes of instability in a nucleus and identify the type(s) of decay associated with each. For each type of decay, write an equation to represent it, including any secondary process where appropriate. [13 marks]
  - (b) What is meant by the *activity* of a radioactive isotope? Define the SI unit of activity. Gold-198 ( $^{198}_{79}\text{Au}$ ) has a half-life of 2.7 days. Find the activity of  $0.2 \mu\text{g}$  of it. Calculate the fraction that remains after 9 days. (Avogadro's number is  $N_A = 6 \times 10^{23} \text{ mol}^{-1}$ .) [12 marks]
  
- 4
  - (a) Explain how a transformer works. (Refer to *Faraday's Law* in your answer.) [8 marks]
  - (b) Sketch the magnetic field surrounding a long straight conductor. What factors influence the magnetic flux density at a distance  $r$  from the conductor? State the relationship between *magnetic flux* and *magnetic flux density* and give the SI unit for each. [9 marks]

- (c) A coil of diameter 12 cm is placed in a magnetic field. If the magnetic field increases from zero to 0.2 T in 1.5 s, how many turns are needed in the coil to produce an induced emf of 6 V? [8 marks]

- 5 (a) Show that pressure varies with height  $h$  as  $p = \rho gh$  and hence express a pressure of 770 mm Hg in SI units. (The density of mercury is  $13.6 \times 10^3 \text{ kg/m}^3$ .) State one other commonly used pressure unit. [10 marks]
- (b) State the continuity equation for gases. On what conservation law is it based? How does it simplify for liquids? Water flows through a pipe of diameter 18 cm at a speed of 6.3 m/s. What diameter would be needed for the water to exit the pipe at 14 m/s? [8 marks]
- (c) Give a brief account of capillary action. [7 marks]

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

- (a) Compare the ionising ability of  $\alpha$ -,  $\beta$ - and  $\gamma$ -rays. Which type of radiation is a Geiger counter best suited to detect? Explain briefly. [7 marks]
- (b) A laser beam of wavelength 633 nm is obstructed by a hair. If the fifth minimum in the diffraction pattern occurs at an angle of  $4^\circ$ , what is the width of the hair? [6 marks]
- (c) Calculate the force necessary to accelerate 5 kg from rest to a speed of 12 m/s in 4 seconds. What is the kinetic energy of the body at this point? [6 marks]
- (d) A wire of length 2.7 m and mass 750 g is in a region of space with a magnetic field of 0.84 T. What is the minimum current needed to lift 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  $g = 9.8 \text{ m/s}^2$ .