

**CORK INSTITUTE OF TECHNOLOGY**  
**INSTITIUID TEICNEOLAIOCHTA CHORCAI**

**Semester 2 Examinations 2008/09**

**Module Title:     PHYSICS**

**Module Code:        PHYS6012**

**School:                SCIENCE**

**Programme Title:**

Bachelor of Science in Applied Physics and Instrumentation, Year 1  
Bachelor of Science in Applied Biosciences, Year 1  
Bachelor of Science in Biomedical Science, Year 1  
Bachelor of Science (Honours) in Computerised Instrumentation Systems – Year 2

**Programme Code:**   SPHYS\_7\_Y1  
                             SCISY\_8\_Y2  
                             SBIOS\_7\_Y1  
                             SBMSC\_7\_Y1

**External Examiner(s):**        Dr. Norman McMillan  
**Internal Examiner(s):**        Ms C. Devaney, Dr A. O'Connor and Dr M. Woods

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

**Duration:**        2 Hours

**Sitting:**            Summer 2009

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

- 1 (a) The winning car of a drag race reached a final velocity of  $48 \text{ ms}^{-1}$  at the finish line after travelling a distance of 500 m from a standing start.
- What was the *acceleration* ( $a$ ) of the car?
  - What time ( $t$ ) did it take to reach the finish line?
  - If the speedometer of the car was in  $\text{km hr}^{-1}$  (kilometres per hour) what value did it read for the final velocity? [10 marks]
- (b) A rail trolley loaded with coal in a mine has a total mass of 450 kg and is travelling at  $40 \text{ ms}^{-1}$  when it collides with a stationary trolley of mass 150 kg left on the track. After collision, the two trolleys remain joined and move with a common velocity  $v$ .
- State the *Law of Conservation of Linear Momentum*.
  - Determine the *common velocity*  $v$  of the trolleys after collision. [7 marks]
- (c) After sliding down a hill, a sledge and passenger with a total mass of 60 kg travelling on snow is slowed to a halt in a distance of 20 m by a frictional force of 147.2 N. What is the *coefficient of friction* between the snow and the sledge? What is the *work done* by the frictional force? [8 marks]
- 2 (a) What is meant by the terms (i) *monochromatic* (ii) *coherent* as applied to light? [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. [7 marks]
- (c) Using a diffraction grating of 650 lines/mm, the green line in cadmium in *second* order is measured to be at an angle of  $41.32^\circ$ . What is its *wavelength* in metres? [7 marks]
- (d) Explain what is meant by the *resolution* of an optical instrument and briefly discuss the factors on which it depends. [7 marks]
- 3 (a) Describe how *alpha*, *beta* and *gamma* radiation ionises matter. [7 marks]
- (b) Write down the decay equation for **any two** of the following:
- alpha ( $\alpha$ ) decay of  $^{220}_{86}\text{Rn}$ ;
  - electron capture in  $^{107}_{47}\text{Ag}$ ;
  - beta ( $\beta^-$ ) decay of  $^{214}_{84}\text{Po}$ .
- (The atomic number will suffice to identify the daughter nucleus.) [6 marks]
- (c) What do the terms (i) *isotope* (ii) *half-life* mean?
- Iodine-131 ( $^{131}_{53}\text{I}$ ) is used in the treatment of some disorders of the thyroid. If a patient is to be subjected to an activity of  $3.7 \times 10^9 \text{ Bq}$ , how many grams of iodine-131 should be injected? What fraction of the iodine-131 will remain after 24 days? (The half-life of iodine-131 is 8.04 days. Avogadro's number is  $N_A = 6 \times 10^{23} \text{ mol}^{-1}$ .) [12 marks]

- 4 (a) Describe the operation of a transformer. [8 marks]
- (b) The turns ratio of a step-up transformer is 50:1. The voltage applied to the primary coil is 120 V and the current in the secondary coil is 1.7 mA. Calculate the *voltage* of the secondary and the power consumed. Assume 100 % efficiency. Comment on this assumption. [8 marks]
- (c) An a.c. generator has a rectangular coil (8 cm×20 cm) of 150 turns. The maximum (peak) output voltage of the generator is to be 20 V and the frequency 50 Hz. Calculate the *magnetic flux density* (B) required and the *angular speed* at which the coil should turn. Calculate the *root-mean-square voltage* ( $V_{rms}$ ) corresponding to a peak voltage of 20 V. [9 marks]
- 5 (a) Distinguish between *gauge* and *absolute pressure*. Find the pressure increase in the fluid inside a syringe when a force of 50 N is applied to the piston, of radius 6 mm. [10 marks]
- (b) State the *continuity equation* for gases. A gas of density  $1.3 \text{ kg/m}^3$  is flowing through a pipe of diameter 11 cm at a speed of 4.8 m/s. If the pipe broadens to 14 cm and the density drops to  $1.2 \text{ kg/m}^3$ , estimate the *new speed* of the gas. [8 marks]
- (c) Give an account of capillary action. Give an example of where it is important. [7 marks]
- 6 ***Answer part (a) and THREE other parts.***
- (a) Describe the operation of a *Geiger counter*. [7 marks]
- (b) A stone of mass 2.5 kg falls off a cliff from a height of 150 m above the ground. What is its *potential energy* at this height? What is the *kinetic energy* when it has reached a velocity of  $15 \text{ ms}^{-1}$ ? [6 marks]
- (c) A satellite is orbiting at a height of 75 km above the surface of the earth. What *aperture (diameter)* of camera will be needed to just resolve two objects with a separation of 80 cm? (Take the wavelength of light to be 550 nm.) [6 marks]
- (d) A straight wire, carrying a current of 6 A makes an angle of  $31.2^\circ$  with a 0.01 T uniform magnetic field. What is the *force* exerted on a 10 mm length of the wire? [6 marks]
- (e) State the SI unit of *pressure* and any one other commonly used pressure unit. What *increase in pressure* does a diver experience at a depth of 5 m below the surface of water? (The density of water is  $1000 \text{ kg/m}^3$ .) [6 marks]

## Useful information

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