

**CORK INSTITUTE OF TECHNOLOGY
INSTITIUID TEICNEOLAIOCHTA CHORCAI**

Semester 2 Examinations 2012/2013

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| Module Title: HEAT AND LIGHT (CA) |
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Module Code: PHYS6044

School: SCIENCE

Programme Title:

Bachelor of Science (Hons) – Herbal Science, Year 1
Bachelor of Science (Hons) – Nutrition and Health Science, Year 1
Bachelor of Science (Hons) – Pharmaceutical Biotechnology, Year 1
Bachelor of Science in Applied Biosciences, Year 1

Programme Code: SHERB_8_Y1
 SNHSC_8_Y1
 SPHBI_8_Y1
 SBIOS_7_Y1

External Examiner(s): Dr S. Daly, Mr. W. Power
Internal Examiner(s): Dr A. O'Connor

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

Duration: 2 Hours

Sitting: Autumn 2013

Requirements for this examination: Log tables.

- 1
 - (a) Distinguish between kinetic and potential energy. Give two examples of how potential energy may be stored in a body. [6 marks]
 - (b) What is meant by a thermometric property? How is a temperature scale set up? What is the main limitation of this procedure? [7 marks]
 - (c) State what is meant by specific heat capacity. A copper container of mass 215 g is initially at 83 °C. What mass of water, at an initial temperature of 6 °C, must be added to cool the beaker down to 21 °C? (Relevant specific heat capacities (in J/kg · °C): water: 4186; copper: 389.) [12 marks]

- 2
 - (a) For each of the following situations, indicate which is the *dominant* method of heat transfer: (i) a block of ice on a hot plate; (ii) heating of the earth's atmosphere; (iii) heating of the earth by the sun; (iv) the Gulf stream; (v) heating of a room by a radiator. [5 marks]
 - (b) A panel consists of two 13 mm layers of plasterboard, of thermal conductivity 0.17 W/m·K, separated by 6 mm of corkboard, of thermal conductivity 0.043 W/m·K. The panel has width 85 cm and height 2.2 m. What is the power loss (rate of heat loss) if the inside temperature is 23 °C and the outside temperature is 8 °C? [10 marks]
 - (c) What is meant by a black-body? Give an example of an object that approximates to a blackbody.
 A cube of sides 90 cm has an emissivity of 0.72. What is the **net** power it emits if it is at a temperature of 215 °C in an environment at 16 °C?
 (The Stefan constant, σ , is $5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$; absolute zero = -273 °C.) [10 marks]

- 3
 - (a) Explain what is meant by the terms (i) *amplitude*, for a wave (ii) *monochromatic*, as applied to light. [4 marks]
 - (b) What is the periodic time of a light wave of wavelength 505 nm if the speed of light is $3 \times 10^8 \text{ m/s}$? [6 marks]
 - (c) Cadmium has blue lines at 569 nm and 580 nm. Using a diffraction grating with 600 lines per mm, find the angular separation of these lines in *second* order. [10 marks]
 - (d) Explain briefly why the conditions for interference must be satisfied more exactly for light than for sound. [5 marks]

- 4 (a) Explain with the aid of sketches what happens the interference pattern if we go from two slits to three to a large number, keeping the slit separation the same. Hence explain why a diffraction grating is more useful than Young's slits. [8 marks]
- (b) Monochromatic light passes through Young's slits, of separation 0.12 mm, and forms an interference pattern on a screen 1.3 m away. The separation between the central and the sixth bright fringe on the screen is measured to be 3.4 cm. What is the wavelength of the light in nm? [12 marks]
- (c) The angular separation between fringes using a diffraction grating is much greater than for Young's slits because the slit separation d is much smaller for a grating. Why is it not practical to simply use Young's slits with a very small slit separation? [5 marks]

5 ***Answer part (a) and TWO other parts.***

- (a) In choosing a thermometer, indicate in each case which option is preferable and briefly explain each choice:
 (i) large/small; (ii) metal/non-metal; (iii) high/low specific heat capacity. [9 marks]
- (b) State the SI unit of pressure and one other commonly used pressure unit. If the pressure at sea level is 1.013 bar, what pressure does a climber experience at a height of 1.5 km above sea level? (Take the density of air as 1.3 kg/m^3 ; $g = 9.8 \text{ m/s}^2$.) [8 marks]
- (c) Show that, for Young's slits, the condition for constructive interference is that

$$m\lambda = d \sin \theta \quad (m = 0, 1, 2, \dots)$$

Write down the corresponding condition for destructive interference. [8 marks]

- (d) Sketch the diffraction pattern from a single slit and a circular aperture. Explain the relevance of this for the resolution of an optical instrument. [8 marks]