

**CORK INSTITUTE OF TECHNOLOGY
INSTITIUID TEICNEOLAIOCHTA CHORCAI**

Autumn Examinations 2013/2014

Module Title: Heat and Light CA
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Module Code: **PHYS6044**

School: **SCIENCE**

Programme Title: Bachelor of Science (Hons) – Herbal Science, Yr 1
Bachelor of Science (Hons) – Nutrition and Health Science, Yr 1
Bachelor of Science (Hons) – Pharmaceutical Biotechnology, Yr 1
Bachelor of Science in Applied Biosciences, Yr 1

Programme Code: **SHERB_8_Y1**
 SNHSC_8_Y1
 SPHBI_8_Y1
 SBIOS_7_Y1

External Examiner(s): **Dr S. Daly**
Internal Examiner(s): **Dr A. O'Connor**

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

Duration: 2 Hours

Sitting: Autumn 2014

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. If in doubt please contact an Invigilator.</p>
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- 1 (a) What property of the molecules of a substance is measured by its temperature? When heat is added to a solid, only half of it increases the temperature. What effect does the rest of the heat have on the body? What happens to the heat when the solid changes to a liquid? [6 marks]
- (b) What is meant by a thermometric property? How is a temperature scale set up? Why is the kelvin scale preferable to other temperature scales? [7 marks]
- (c) State what is meant by specific heat capacity. An aluminium pan of mass 185 g is initially at 13 °C. What mass of water, at an initial temperature of 86 °C, must be added to produce a final equilibrium temperature of 55 °C? (Relevant specific heat capacities (in J/kg · °C): water: 4186; aluminium: 900.) [12 marks]
- 2 (a) State the factors on which the power loss P through a solid material depends. In each case, state whether the factor causes P to increase or decrease.
- A wall comprises bricks of thickness 16 cm and a layer of felt insulation 5 mm thick. The wall is 2.4 m high and 5.6 m wide. If the temperature on one side is 23 °C and that on the other is 2 °C, calculate the power loss through the wall. The thermal conductivity for the brick is 0.77 W/m·K; for the felt, it is 0.04 W/m·K. [13 marks]
- (b) What is the connection between the ordinary colour of a body and the colour of the light it emits when heated? Hence explain what is meant by a black-body. Give an example of an object that is a good approximation to a blackbody.
- An oven is in the form of a cube of sides 85 cm. It has an emissivity of 0.67. What power must be supplied to the oven to maintain it at a temperature of 260 °C in an environment at 15 °C? [12 marks]
- 3 (a) State Snell's law of refraction. A ray of light travelling through water strikes the surface at an angle of 27°. If water has a refractive index of 1.33, at what angle is the light refracted into the air? [7 marks]
- (b) A microscope comprises an objective lens of focal length 27 mm and an eyepiece of focal length 25 cm. Both are convex (focusing) lenses. If an object is placed 3.2 cm in front of the objective, calculate the final image position and the overall magnification. (The separation between the lenses is 40 cm.) Sketch the formation of the final image. (You may assume that the final image is virtual.) [18 marks]

- 4 (a) Explain what is meant by the terms (i) *frequency* (ii) *amplitude* for a wave; and (iii) *monochromatic* for light. [6 marks]
- (b) What is the periodic time in seconds of a light wave of wavelength 644 nm? Roughly, what colour is the light? [6 marks]
- (c) Show that, for Young's slits of separation d , the condition for constructive interference is

$$d \sin \theta = m\lambda \quad (m = 0, 1, 2, 3, \dots)$$

Write down the corresponding condition for destructive interference.

Using a diffraction grating with 650 lines/mm, find the angle at which a green spectral line of wavelength 509 nm appears in **second** order. [13 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) Give a brief account of convection, illustrating your answer with an example from the environment. [8 marks]
- (c) Sketch the formation of an image by a concave (diverging) lens. [8 marks]
- (d) With the aid of sketches, compare the interference pattern that would be produced by
 (i) two slits (ii) three slits (iii) a large number of slits, assuming that the slit separation is the same in each case. [8 marks]

Useful information

The Stefan-Boltzmann law: $P = \epsilon\sigma AT^4$.

The Stefan constant: $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$.

Absolute zero = -273°C .

The speed of light: $c = 3 \times 10^8 \text{ m/s}$.