

CORK INSTITUTE OF TECHNOLOGY
INSTITIUID TEICNEOLAIOCHTA CHORCAI

Autumn Examinations 2010/11

School: SCIENCE

Programme Title:

Bachelor of Science (Hons) – Analytical Chemistry with Quality Assurance, Year 1
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 (Hons) – Instrument Engineering, Year 1
Bachelor of Science (Hons) – Environmental Science and Sustainable Technology, Year 1
Bachelor of Science – Applied Biosciences, Year 1
Bachelor of Science – Analytical and Pharmaceutical Chemistry, Year 1
Bachelor of Science – Applied Physics and Instrumentation, Year 1
Higher Certificate in Science – Industrial Measurement and Control, Year 1

Programme Code: SCHQA_8_Y1
SHERB_8_Y1
SNHSC_8_Y1
SPHBI_8_Y1
SBIOS_7_Y1
SCHEM_7_Y1
SPHYS_7_Y1
SIMCT_6_Y1
SESST_8_Y1
SINEN_8_Y1

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| Module Title: INTRODUCTION TO PHYSICS C/A |
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Module Code: PHYS6011

External Examiner(s): Dr V. Casey, Dr. Siobhan Daly

Internal Examiner(s): Ms C. Devaney
Ms E. Norris
Dr M. Woods

Instructions: Answer **any FOUR** questions. All questions carry equal marks.
Write sufficient steps of calculations to justify your answer.

Duration: 2 Hours

Sitting: Autumn 2011

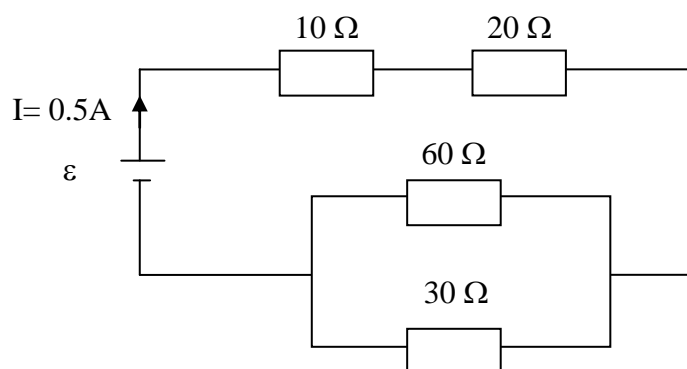
Requirements for this examination: Log tables.

1 **Answer ANY FIVE parts. Each part carries 5 marks.**

- (a) (i) Express an energy of $336 \mu\text{J}$ in Joules written in standard scientific notation.
 (ii) State the SI unit for *electrical current* and the unit for *power*.
- (b) Sketch a diagram to show how a (i) *voltmeter*, (ii) an *ammeter* should be connected to a resistor to measure its potential difference and current.
- (c) A water wave travels with a velocity of 4.5 ms^{-1} and the distance between two consecutive wave peaks is 2.5 m . Calculate the *frequency* of the wave. What type of wave is a water wave?
- (d) Explain with a sketch what is meant by *total internal reflection* and give one *application* of it.
- (e) State the *Laws of Reflection*. What is the difference between the reflection from a rough surface and a smooth surface?
- (f) A fish *appears* to be at a depth of 120cm in water. What is the *actual depth* of the fish below the surface of the water?
Draw a diagram of the arrangement.
Refractive index for water = 1.33.
- (g) What is the difference between *transverse waves* and *longitudinal waves*? Give ONE example of each of these categories of waves.
- (h) Distinguish between *intensity* and *intensity (noise) level* and give the SI unit in each case.

- 2
- (a) What is meant by the term '*thermometric property*' for a thermometer? For ONE named type of thermometer state its *thermometric property*. (4 marks)
 - (b) A climber on Mount Everest is wearing clothing covering a surface area of 1.64 m^2 and fabricated from [#]ThinsulateTM material with an average thickness of 3.5 mm . The climber's surface temperature within the clothing is maintained at 18.0°C . Thinsulate has a thermal conductivity $k = 0.033 \text{ W m}^{-1}\text{K}^{-1}$.
 - (i) State the *thermal conductivity equation* and hence determine the temperature on Mount Everest if the rate of heat loss through the clothing is 220 W .
 - (ii) How many kilojoules of heat does the climber expend when climbing for 8 hours? (15 marks)
 - (c) Two of the methods that a radiator transfers heat in a room are by '*thermal convection*' and '*radiation*'. Describe these heat transfer processes for the radiator. (6 marks)

- 3 (a) The figure below shows an electrical circuit consisting of a battery with an electromotive force ϵ , and four resistors. (Assume the internal resistance of the battery is negligible)



- (i) State the equations for combining resistors (i) in parallel; (ii) in series. (4 marks)
- (ii) Hence determine the equivalent resistance (R_p) of the parallel resistors and the equivalent resistance (R_e) of the complete circuit. (6 marks)
- (iii) State Ohm's Law and hence determine the emf (ϵ) of the battery. (4 marks)
- (iv) Determine the power (P) dissipated in the $20\ \Omega$ resistor. (4 marks)
- (b) Calculate the resistance (R) of a copper wire of length 2.5 m and diameter 0.74 mm. The resistivity ρ of copper is $1.7 \times 10^{-8}\ \Omega\text{m}$. (7 marks)
- 4 (a) (i) Convert a temperature of $220\ ^\circ\text{C}$ to a temperature in units of Kelvin. (2 marks)
- (ii) Which of the following temperature units is one of the fundamental units of the SI system: Celcius, Kelvin or Fahrenheit? Name ONE other fundamental unit of the SI system. (2 marks)
- (iii) What is meant by a 'fixed point' of a temperature scale? State the fixed points of the Celcius scale. (4 marks)
- (b) What is the expansion in millimetres of a steel bridge of length 200 m if its temperature changes from 20°C to 40°C .
(The coefficient of linear expansion for steel, $\alpha = 1.2 \times 10^{-5}\ ^\circ\text{C}^{-1}$.) (6 marks)
- (c) Define (i) Specific Heat Capacity; (ii) Specific Latent Heat. (4 marks)
- (d) An experiment is performed to measure the specific latent heat of ice using an insulated copper calorimeter filled quantities of ice and water. The copper calorimeter of mass 100g was initially filled with 160g of water, both being at a temperature of 25°C . A mass of 40g of ice at 0°C was then added to the water. When the ice melted the final temperature of the water and calorimeter was 5.3°C . Determine the specific latent heat of fusion of the ice assuming no heat losses or gains from the surroundings to the calorimeter.
(Specific heat capacity of water = $4.18\ \text{kJ kg}^{-1}\ ^\circ\text{C}^{-1}$;
specific heat capacity of copper = $381\ \text{J kg}^{-1}\ ^\circ\text{C}^{-1}$.) (7 marks)

- 5 (a) Sketch a labelled ray diagram to show the image formed by a bi-convex (converging) lens for an object placed inside its principal focus. (8 marks)
- (b) An object of height 5.0 cm is placed 60 cm in front of a thin bi-concave (diverging) lens of focal length 15cm.
- (i) Use the *lens equation* to determine the *distance of the image* from the lens.
- (ii) Calculate the *height of the image* and state with a reason its *orientation* and *nature*.

(11 marks)

Answer EITHER part (c) OR part (d).

- (c) A thin bi-convex (converging) lens of focal length 10 cm is now placed alongside the bi-concave lens. What is the *focal length* of the combination of lenses? State (with a valid reason) whether the combination acts as a *diverging* or *converging lens*. (6 marks)
- (d) Sketch a labelled ray diagram of a compound microscope to show the formation of the *intermediate* and *final* images. Label on the diagram the *location* and *nature* (real or virtual) of the final image. (6 marks)

- 6 (a) (i) Define *pressure* and state the SI unit of *pressure*. (4 marks)
- (ii) What factors determine the pressure at the *base of a tank of liquid*? (4 marks)
- ((iii) A saline drip is to be administered to a patient. How high above the insertion point

must the container of saline be hung so that the saline is administered at a pressure of $2.4 \times 10^3 \text{ Pa}$?

Density of saline, $\rho = 1000 \text{ kg m}^{-3}$

Acceleration due to gravity, $g = 9.8 \text{ m s}^{-2}$ (5 marks)

- (b) An aneurysm is an abnormal enlargement of a blood vessel such as the aorta.
- As a result of an aneurysm the cross sectional area of the aorta increases from $7.85 \times 10^{-5} \text{ m}^2$ to $1.33 \times 10^{-4} \text{ m}^2$. The speed of blood through a normal portion is 0.4 m s^{-1} .

- (i) Use the *continuity equation* to determine the *speed* of blood through the enlarged portion. (5 marks)

- (ii) State *Bernoulli's principle* and use it to determine the amount by which the pressure P_2 in the enlarged portion exceeds the pressure P_1 in the normal section, assuming the person is lying down.

Density of blood, $\rho = 1060 \text{ kg m}^{-3}$. (7 marks)

Useful information

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

Wien Law constant $= 2.898 \times 10^{-3} \text{ m} \cdot \text{K}$;

Absolute zero $= -273 \text{ }^{\circ}\text{C}$.

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