CORK INSTITUTE OF TECHNOLOGY
INSTITIUID TEICNEOLAIOCHTA CHORCAI

Autumn Examinations 2011/12

Module Title: INTRODUCTION TO PHYSICS (CA)

Module Code: PHYS6011

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
SINEN_8_Y1
SESST_8_Y1
SBIOS_7_Y1
SCHEM_7_Y1
SPHYS_7_Y1
SIMCT_6_Y1

External Examiner(s): Dr Siobhán Daly, Mr W. Power
Internal Examiner(s): Ms. E. Baldwin
Ms C. Devaney
Dr A. O'Connor

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

Duration: 2 Hours

Sitting: Autumn 2012

Requirements for this examination: Log tables.

Note to Candidates: Please check the Programme Title and the Module Title to ensure that you have received the correct examination paper.
If in doubt please contact an Invigilator.

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

(a) Explain with the aid of a sketch why the apparent depth of a body under water is less than its real depth.

(b) Sketch the formation of an image by a concave (diverging) lens for an object placed outside the focus.

(c) For each of the following situations, state which is the **dominant** method of heat transfer: (i) a poker in a fire (ii) heating of the earth by the sun (iii) the Gulf stream (iv) heating of a room by a fan heater (v) heating of a room by a radiator.

(d) An aluminum flag pole is 20 m tall when the temperature is -15 ^{0}C. What is the increase in length of the flag pole when the temperature increases to 30 ^{0}C? (The linear expansivity of aluminum, $\alpha = 24 \times 10^{-6}\ \mathrm{K}^{-1}$.)

(e) Explain what is meant by *saturation vapour pressure*.

(f) If you have two cylindrical copper rods and one of them has twice the length and twice the diameter of the other, how will their resistances compare?

(g) Calculate the maximum current and the maximum voltage obtainable from a battery of emf 3 V and internal resistance 5 Ω.

(h) With reference to waves, explain the terms *wavelength* and *frequency*. Calculate the wavelength of a sound wave that has a frequency of 30 kHz. Take the speed of sound in air as 340 m/s. Is this sound audible?

(i) How is the decibel scale of sound intensity level defined? What is the intensity corresponding to a 20 dB whisper? (The threshold of human hearing is $I_0 = 1 \times 10^{-12}\ \mathrm{W/m^2}$.)

2 (a) What property of the molecules of a substance does its temperature measure? Give one example of when heat can be added to a body without changing its temperature. What is happening to the heat energy in this case? What is meant by absolute zero? [8 marks]

(b) Explain what is meant by *specific heat capacity*. Ice at an initial temperature of -16 ^{0}C is added to an aluminium beaker of mass 150 g, containing 90 g of water. Both are at 38 ^{0}C. State clearly the way(s) by which each substance gains or loses heat. What mass of ice must be added to give a final equilibrium temperature of 12 ^{0}C ? (Relevant specific heat capacities (in J/kg·^{0}C) are: water, 4186; ice, 2300; aluminium, 900. The latent heat of fusion of ice is 330 kJ/kg.) [17 marks]

3 (a) Sketch the Maxwell-Boltzmann distribution of molecular energies for two different temperatures, indicating which temperature is higher. [5 marks]

(b) State the factors which determine the rate of heat flow (i.e., the power loss) through a material and indicate whether they cause it to increase or decrease. Hence write down a formula for the rate of heat flow. The window in a room is 1.2 m high by 80 cm wide and has a thickness of 7 mm. If the inside temperature is $24\ ^0$C and the external temperature is $-4\ ^0$C, calculate the rate of heat flow through the window. (The thermal conductivity of glass is 1.05 W/m·K.) [12 marks]

(c) What is meant by a black-body? Calculate the rate of heat loss **absorbed** by a cube of sides 6 cm in a room at $22\ ^0$C, assuming an emissivity of 0.7. (Stefan's constant is $\sigma = 5.67 \times 10^{-8}$ W/m^{2}K^4.) [8 marks]

4 (a) State Snell's law of refraction. A ray of light travelling through water strikes the surface at an angle of $24\ ^0$. 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 11 mm and an eyepiece of focal length 16 cm with a separation of 12 cm. Both lenses are convex (focusing). An object is placed 14 mm in front of the objective. Sketch the formation of the final image and calculate the final image position and the overall magnification. [18 marks]

5 For the following circuit, calculate

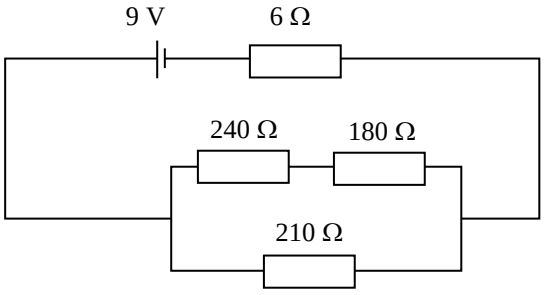
(i) the resistance of the parallel combination; [6 marks]

(ii) the total current drawn from the battery; [4 marks]

(iii) the voltage drop across the parallel combination; [4 marks]

(iv) the current in each branch of the parallel combination; [6 marks]

(v) the power dissipated in the 210 Ω resistor. [5 marks]



6 (a) Define pressure and state its SI unit. Organisms have been found living in oceans under pressures as high as 1×10^8 Pa. To what depth does this pressure correspond? (The density of seawater is $\rho = 1026\ \text{kg/m}^3$; the acceleration due to gravity is 9.8 m/s^2.)

(b) The diameter of an artery decreases from 1.1 cm to 0.75 cm as a result of a build-up of plaque. The speed of blood flow is 15 cm/s in the wider section of the artery.

(i) Use the continuity equation to calculate the speed of blood flow in the narrower section.

(ii) Use Bernoulli's equation to calculate the pressure difference between the wider and narrower sections of the artery.

(The density of blood is 1060 kg/m^3.) [12 marks]

(c) Describe how blood pressure is measured. [5 marks]

Useful information

Absolute zero = -273 ^{0}C.