

Cork Institute of Technology  
Bachelor of Science (Honours) in Herbal Science – Stage 1

(NFQ Level 8)

Summer 2006

**Physics**

(Time: 3 Hours)

Instructions  
Answer FIVE questions.  
 $g = 9.8 \text{ ms}^{-2}$

Examiners: Ms. C. Devaney  
Dr. D. Corrigan  
Mr. E. Walsh

- Q1. (a) State Newton's laws of motion. (6 marks)
- (b) (i) Define coefficient of friction.
- (ii) Write a brief note on friction at the hip joint. (6 marks)
- (c) A skater with an initial speed of  $7.6 \text{ ms}^{-1}$  is gliding across ice. The coefficient of friction between the skate blades and the ice is 0.1.
- (i) Calculate the deceleration (uniform) caused by the frictional force.
- (ii) How far will the skater travel before coming to rest? (8 marks)
- Q2. (a) (i) What is centrifugal force?
- (ii) Give a brief account of a fixed angle rotor centrifuge. (8 marks)
- (b) The rotor of a laboratory centrifuge operates at a rotational speed of 12,000rpm (revs per min)
- (i) Express this speed in SI units ( $\text{rad s}^{-1}$ )
- (ii) Calculate the centripetal acceleration on a red blood cell at a radius of 8cm from the axis of rotation of the centrifuge.
- (iii) If the centrifuge starts from rest and reaches the above speed of 12,000rpm in 10 seconds, calculate the angular acceleration of the rotor. (12 marks)

- Q3. (a) Define (i) Specific heat capacity.  
(ii) Latent heat of vaporisation  
(iii) Power  
and state the SI units of each of the above. (6 marks)
- (b) A person's metabolic rate can be measured using a flow calorimeter. (The person is placed in a large insulated container through which water can flow, the flowing water carrying away the heat produced by the body). If a resting person has a thermal power output of 85W what will be the temperature difference between the intake and outflow water when the flow rate is 1kg each 5 minutes.  
Specific heat capacity of water  $C_w = 4200 \text{ J kg}^{-1} \text{ K}^{-1}$  (6 marks)
- (c) The latent heat of vaporisation of water at body temperature is  $2.42 \times 10^6 \text{ J kg}^{-1}$ . To cool the body of a 75kg jogger (specific heat capacity =  $3500 \text{ J kg}^{-1} \text{ K}^{-1}$ ) by  $1^\circ\text{C}$ , how many kilograms of water in the form of perspiration must be evaporated? (8 marks)

- Q4. (a) (i) Define pressure and give the SI unit in which it is measured. (3 marks)  
(ii) Derive the expression for the pressure due to a column of liquid of height,  $h$  and density  $\rho$ . (5 marks)
- (b) State Pascal's Principle. (2 marks)
- (c) Water is flowing in a horizontal pipe of varying cross section. At one point where the cross-sectional area is  $1 \times 10^{-2} \text{ m}^2$ , the velocity of the water is  $2 \text{ ms}^{-1}$  and the pressure is 15kPa ( $1 \text{ kPa} = 1 \times 10^3 \text{ Pa}$ ).  
In another region of the pipe the velocity of the water is  $3 \text{ ms}^{-1}$ . Calculate the cross-sectional area and the pressure at this second region. (10 marks)

- Q5. (a) (i) A sound wave has a frequency of 10,000 Hz. Is this wave ultrasonic, infrasonic or audible? (2 marks)
- (ii) Calculate the wavelength of the above sound wave.  
Speed of sound in air,  $v = 340 \text{ ms}^{-1}$ . (4 marks)
- (b) (i) What is the doppler effect? (2 marks)
- (ii) Briefly describe how this effect is used in the measurement of blood flow rate. (4 marks)
- (iii) A hawk is flying directly away from a bird watcher at a speed of  $11 \text{ ms}^{-1}$ . The hawk produces a shrill cry whose frequency is 865Hz. The speed of sound in air is  $343 \text{ ms}^{-1}$ . What is the frequency that the bird watcher hears? (8 marks)
- Q6. (a) Draw a ray diagram illustrating the optical arrangement of a compound microscope. (8 marks)
- (b) Give a brief account of the operation of a fibrescope, mentioning the principle on which it works. (4 marks)
- (c) A converging lens of focal length 12cm is held 8cm in front of a newspaper. Calculate the image distance and the magnification. (8 marks)

Q7. (a) For the circuit in Fig.1 calculate:

- (i) the total resistance
- (ii) the current drawn from the battery
- (iii) the voltage across the  $6\Omega$  resistor.

(12 marks)

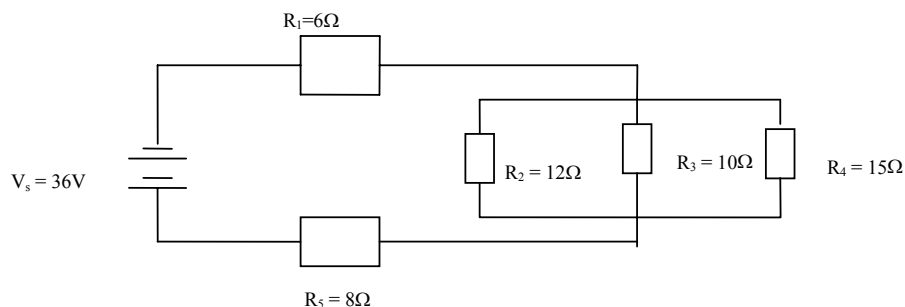


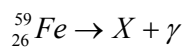
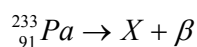
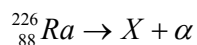
Fig 1

(b) “Mass spectrometers have many functions in modern laboratories”.

- (i) List two functions of mass spectrometers.
- (ii) Briefly outline how a mass spectrometer works.

(8 marks)

Q8. (a) Identify the nucleus designated by X in each of the following reactions:



(6 marks)

(b) A scintillation counter is a suitable detector of gamma radiation.

Describe, with the aid of a diagram how this detector works.

(8 marks)

(c) The function of the thyroid gland can be tested using radioactive iodine. Write a brief note on this procedure.

(6 marks)

