

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

(NFQ Level 8)

Summer 2007

**Physics**

(Time: 3 Hours)

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

Examiners: Ms. C. Devaney  
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- Q1. (a) (i) Explain the classification of levers and give an example of each class. (6 marks)  
(ii) With reference to a lever, what is the lever arm? (2 marks)  
(ii) Define torque and state the SI unit in which it is measured. (2 marks)
- (b) A 100 kg object falls off a truck travelling at 88 km/h (kilometres per hour).  
It lands flat and skids 100 m before coming to rest. Assuming uniform deceleration,  
calculate the coefficient of friction between the object and the road. (10 marks)
- Q2. (a) A test tube in a centrifuge is pivoted so that it swings out horizontally as the machine  
builds up speed. If the bottom of the test tube is 150 mm from the central axis and, if the  
machine spins at 50,000 rpm (revs per min)
- (i) What would be the centripetal force exerted on a giant amoeba of mass  $1 \times 10^{-8} \text{ kg}$   
at the bottom of the tube? (7 marks)
- (ii) What would be the RCF (relative centrifugal force)? (3 marks)
- (b) The centrifuge referred to in part (a) above is a horizontal rotor type centrifuge.  
Fixed angle rotor centrifuges have some advantages over horizontal tube designs.
- (i) Name two advantages of the underlined. (4 marks)
- (ii) List three precautions taken when using a centrifuge. (6 marks)

- Q3. (a) Write a brief note on heat transfer by conduction. (4 marks)
- (b) A person has a surface area of  $1.4 \text{ m}^2$  and an average tissue thickness of 2 cm between the inner and outer body. If the skin temperature is  $33^\circ\text{C}$  and the inner body temperature is  $37^\circ\text{C}$ , how much heat energy will be conducted to the surface per hour?  
Thermal conductivity constant for body tissue,  $k = 0.2 \text{ Wm}^{-1} \text{ }^\circ\text{C}^{-1}$ . (10 marks)
- (c) How much excess heat is produced when a 65 kg person with the flu experiences a rise in temperature from  $37^\circ\text{C}$  to  $38.9^\circ\text{C}$ ?  
Specific heat capacity of body tissue,  $c = 3500 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$  (5 marks)  
Considering your answers to (c) and (b), is conduction an efficient means of heat transfer for the human body? (1 mark)
- Q4. (a) Derive an expression for the pressure at the base of a column of liquid of height  $h$  and cross-sectional area,  $A$ . (5 marks)
- (b) Blood is pumped out of the heart via the aorta (inside diameter 18 mm) at an average speed of  $0.33 \text{ ms}^{-1}$ . The aorta branches into 32 arteries that are each 4 mm in diameter.
- (i) Calculate the speed of the blood through these arteries.
- (ii) Given that the net cross-sectional area of capillaries is  $2.5 \times 10^5 \text{ mm}^2$ , what is the speed of flow in a capillary? (10 marks)
- (c) Write a brief note on arteriosclerosis, referring to both the continuity equation and Bernoulli's Equation in your answer. (5 marks)
- Q5. (a) An ultrasonic wave at 80,000 Hz is emitted into a vein where the speed of sound is  $1.5 \text{ km s}^{-1}$ . The wave reflects off the red blood cells moving towards the stationary receiver. If the frequency of the returning signal is 80,020 Hz, what is the speed of the blood flow? (10 marks)
- (b) (i) What are ultrasonic waves? (1 mark)
- (ii) List two applications of ultra sonic waves in medicine. (4 marks)
- (iii) Name the device (instrument) used in (a) above and explain briefly the principle on which it works. (5 marks)

- Q6. (a) Explain with the aid of sketches:
- (i) Refraction of light
  - (ii) Critical angle
  - (iii) Total internal reflection
  - (iv) Describe the operation of a fiberscope. (10 marks)
- (b) A 1.7 m tall person is standing 2.5 m in front to a camera. The camera uses a converging lens whose focal length is 0.05 m. Calculate:
- (i) The image distance.
  - (ii) The magnification and height of the image
  - (iii) Sketch the ray diagram of the arrangement. (10 marks)
- Q7. (a) Explain, briefly in connection with wave motion
- (i) Interference
  - (ii) Polarisation
  - (iii) Diffraction (6 marks)
- (b) A nichrome wire with a cross-sectional area of  $1.5 \times 10^{-6} \text{ m}^2$  is to be used in a heater. If the design requires a  $3 \Omega$  coil, what length of wire will be needed?  
Resistivity of nichrome,  $\rho = 1 \times 10^{-6} \Omega \text{ m}$  (4 marks)
- (c) A coil of  $12 \Omega$  resistance is in parallel with a coil of  $20 \Omega$  resistance. This combination is connected in series with a third coil of resistance  $8 \Omega$ . The circuit is connected to a 30 V battery. Calculate:
- (i) Current drawn from the battery (8 marks)
  - (ii) The voltage across the  $8 \Omega$  coil. (2 marks)
- Q8. (a) Radioactive phosphorus  $^{32}\text{P}$  has been used to study bone metabolism and for the treatment of blood diseases.  
What is the activity of a sample of  $5 \times 10^{16}$  atoms if it has a half life of 14.3 days?(5 marks)
- (b) Phosphorus  $^{32}\text{P}$  decays by beta emission.
- (i) Write the decay equation. (2 marks)
  - (ii) Write a brief note on beta rays. (5 marks)
- (c) List three uses of radiation (radioisotopes). Give an account of one of the uses you have listed. (8 marks)