

Cork Institute of Technology

Higher Certificate in Science in Applied Biology - Stage 1

(NFQ level 6)

Summer 2006

PHYSICS

(Time: 3 Hours)

Answer **FIVE** questions only.

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SHOW ALL WORKING.

$$h = 6.6 \times 10^{-34} \text{ J s};$$

$$c = 3 \times 10^8 \text{ ms}^{-1};$$

$$g = 9.81 \text{ ms}^{-2};$$

- Q1 (a) A car, which is travelling on a horizontal road with an initial velocity of 15 ms^{-1} , accelerates uniformly at 5.5 ms^{-2} for 8.0 seconds.
- (i) How far does the car *travel* (s) while accelerating?
 - (ii) What is the *final velocity* (v) of the car? [8 marks]
- (b) A cooking apple of mass 1.25 kg falls from a branch 4.0 m above the ground. It falls onto the head of Isaac Newton, who is sitting under the tree. The top of his head is 1.0 m from the ground.
- (i) State the equations for *Gravitational Potential Energy* and *Kinetic Energy*.
 - (ii) Calculate the *potential energy* of the apple when it is on the tree.
 - (iii) Calculate the *kinetic energy* and the *velocity* of the apple when it hits Isaac Newton's head. [12 marks]

Q2 (a) A postal van has a total mass of 1800 kg when fully loaded. It accelerates at 5.0 ms^{-2} for 4.0 seconds as it overtakes a tractor over a distance of 80 m on a country road.

(i) State *Newton's Second Law* and hence calculate the *force (F)* of the engine of the van causing it to accelerate.

(ii) Calculate the *power* of the engine of the van.

(ii) What is *friction*? Give ONE example of friction in the movement of the van in (i).

[10 marks]

(b) A male ice skater of mass 90 kg moving to the right at 2.0 ms^{-1} on a horizontal ice rink, hits a female skater of mass 70 kg moving to the left at 4.0 ms^{-1} . They cling onto each other after collision and move off with a common velocity.

(i) State the *Law of Conservation of Linear Momentum*.

(ii) Hence calculate the *final common velocity (including direction)* after collision.

[10 marks]

Q3. (a) A whale with a body surface area of 25 m^2 has an average blubber thickness of 35 cm. The thermal conductivity of the blubber is $0.20 \text{ W m}^{-1} \text{ K}^{-1}$.

(i) Determine the *rate of heat loss* through the blubber when the internal body temperature of the whale is 37°C and the sea water temperature is 5°C .

(ii) How much *heat energy* is lost by the whale in 1 day? [10 marks]

(b) An artist preparing to make a statue, places 3.75 kg of copper into a furnace. Initially the furnace is at 20°C . It requires 1.50 MJ of heat to reach the melting point temperature of copper. The specific heat capacity of copper is $381 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$; the Specific Latent Heat of Vapourisation of copper is $2.05 \times 10^5 \text{ J kg}^{-1}$.

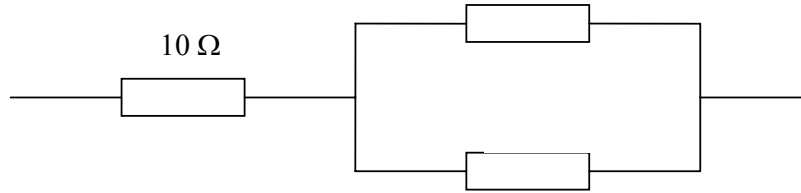
(i) Define *specific heat capacity*.

(ii) Determine the *melting point* temperature of copper.

(iii) Calculate how much more *heat energy* is required to completely melt the copper at its melting point. [10 marks]

- Q4 (a) A photon of red light has a frequency of 4.7×10^{14} Hz.
- What is a *photon*?
 - Calculate the *wavelength* of the photon.
 - Calculate the *energy* of the photon. [10 marks]
- (b) A sample of a radioactive form of carbon, $^{15}_6\text{C}$, which decays by beta emission, has a half-life of 2.5 seconds. There are initially 4.0×10^{18} atoms in the sample.
- How many *radioactive atoms* remain after 10 seconds?
 - Write the *nuclear reaction equation* for beta emission by carbon.
(Row 2 of the periodic table contains elements: Li Be B C N O F Ne)
 - State the *Half-life equation* and hence determine the decay constant for $^{15}_6\text{C}$. [10 marks]
- Q5 (a) Distinguish between *real* and *virtual images* formed by lenses. [4 marks]
- (b) A concave lens always produces a virtual upright image. Draw a clear ray diagram to illustrate this. [4 marks]
- (c) If an object is placed 1m in front of a concave lens, and the image is formed 0.125 m from the lens find:
- The *focal length* of the lens [4 marks]
 - The *magnification*. [2 marks]
- (d) A swimmer is treading water (with her head above the water) at the surface of a 3.0 m deep pool. She sees a coin on the bottom directly below. How deep does the coin appear to be? Refractive index of water = 1.33, refractive index of air = 1.00. [6 marks]

- Q6 (a) Calculate the *equivalent resistance* of the following combination of resistors. Draw diagrams to show the circuit at each stage of simplification. [6 marks]



- (b) A steady electric current of 0.87 A flows through a salt solution contained in a tube connected across the terminals of a 100 V voltage supply. What is the *resistance* of the salt solution? [4 marks]
- (c) If the inner radius of the tube is 12 mm and the tube is 20 cm long, estimate the *resistivity* of the salt solution. [10 marks]
- Q7 (a) A Jacuzzi has a width of 174 cm, a length of 218 cm and a depth of 99 cm. It contains water with a density of 1000 kg m^{-3} .
- (i) What *weight* of water is contained in the Jacuzzi?
- (ii) What is the *pressure* at the bottom of the Jacuzzi? [9 marks]
- (b) When measuring blood pressure two values are measured *systolic pressure* and *diastolic pressure*. Explain both of these terms. [4 marks]
- (c) A house has water flowing through a pipe of radius 4 cm at a velocity of 3 ms^{-1} . The water then flows into a narrow pipe of cross-sectional area $2.5 \times 10^{-3} \text{ m}^2$.
- (i) State the *Equation of Continuity* for the flow. [2 marks]
- (ii) Determine the *velocity of flow* in the narrow pipe. [5 marks]