Cork Institute of Technology

Higher Certificate in Science in Applied Biology - Stage 1

(NFQ level 6)

Autumn 2006

PHYSICS

(Time: 3 Hours)

Answer **FIVE** questions only.

SHOW ALL WORKING.

Examiners: Dr. C. Frehill
Dr. M. E. Woods
Prof. R. J. Fitzgerald

$h = 6.6 \times 10^{-34}$ J s; $c = 3 \times 10^{8}$ ms^{-1};
$g = 9.81$ ms^{-2};

Q1 (a) Sketch a labelled diagram of an *optical spectrometer*. (4 marks)

(b) Light from a sodium discharge lamp reaches Young's slits mounted on a spectrometer. The light reaching Young's slits is monochromatic and a parallel beam.

(i) What is *monochromatic* light?

(ii) How does the spectrometer produce a *parallel beam* onto Young's slits?

(iii) Describe the *interference pattern* viewed by an observer. What *differences* would be seen in the pattern if a *diffraction grating* was used instead of Young's slits?

(8 marks)

(c) A diffraction grating with 400 lines per mm is used to measure the wavelength of the green line from a cadmium discharge lamp. The angle of diffraction for the *second order* line is 24.1^{o}. Determine:

(i) The *slit separation (d)* of the diffraction grating;

(ii) The *wavelength (λ)* of the green cadmium line. (8 marks)

Q2. (a) A botanist studying a flower, places it 2.0 cm in front of a biconvex magnifying glass of focal length 5.0 cm. The flower has a length of 1.8 mm.

(i) Determine the *location*, *nature* (real/virtual) and *orientation* of the image of the flower.

(ii) Calculate the *magnification* of the image and the *length of the image* of the flower. (10 marks)

(b) (i) State the TWO *Laws of refraction.*

(ii) Calculate the *angle of refraction* of a light ray in a glass prism of refractive index $n_g = 1.52$ when it is incident at an angle of 45^O in air at the air/glass interface.

(iii) Determine the *critical angle* for light incident in the prism.

(iv) State what happens when the angle of incidence is *greater than the critical angle*.

(10 marks)

Q3 (a) (i) State *Ohm's Law.*

(ii) Define *electrical current*. (4 marks)

(b) (i) Determine the *equivalent resistance* of the circuit shown in figure 1.

(ii) If a battery of emf $\varepsilon = 12.0$ V is connected to connections A and B, what *current* flows through the equivalent resistance. (8 marks)

(c) The heating element of the heater used in a lab experiment has a resistance of 1.5 Ω. If the supply to the heater is 4.0 A and the heater is on for 5 minutes, how much *heat energy* is emitted by the heater? (5 marks)

(d) What *energy changes* occur when a light bulb is turned on? (3 marks)

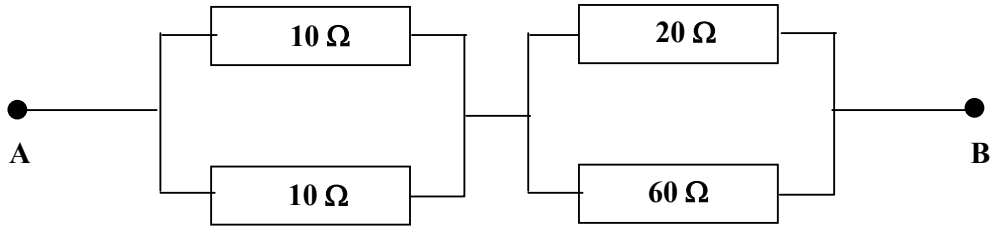

Figure 1

Q4 (a) A nut of mass 20 g falls off the branch of a tree. The branch of the tree is 15 m above the ground.

(i) State the equations for *Gravitational Potential Energy* and *Kinetic Energy*.

(ii) Calculate the *potential energy* of the nut when it is on the branch.

(iii) Calculate the *kinetic energy* and the *velocity* of the nut when it hits the ground.

(12 marks)

(b) State *Newton's second law of motion*. (2 marks)

(c) What *force* is required to stop a 1100 kg car in 8 s travelling at 25 ms^{-1}? (6 marks)

Q5 (a) (i) Define the mass number [A] and atomic number [Z] of a nuclide. (2 marks)

(ii) How many electrons, protons and neutrons are in the neutral atom $^{14}_{6}C$? (3 marks)

(iii) If $^{14}_{6}C$ decays with the emission of an alpha particle, write the *nuclear reaction equation* for the process.

(The elements of Period 2 of the Periodic Table are: *Li Be B C N O F Ne*)

(3 marks)

(iv) An unknown radioactive source emits either α-particles or β-particles. How could you determine experimentally, which type of particles was emitted by the source?

(3 marks)

(b) Explain what is meant by the term *Half Life* in relation to a radioactive material.

(3 marks)

(c) The half-life of radon is 3.5 days. What is its *decay constant*? (5 marks)

Q6 (a) A train on a straight level track has an initial velocity of 45 km h^{-1} (kilometers per hour). A uniform acceleration of 1.5 m s^{-2} is applied while the train travels 200m.

(i) What is the *final velocity* of the train at the end of this distance in units of ms^{-1}?

(ii) *How long* did it take the train to travel the 200 m?

(iii) If the work done by the engine of the train is 30 MJ, calculate the *force* which it exerts in producing this acceleration. (12 marks)

(b) Describe the following quantities and give the SI unit of measurement for each. Use words and a labelled diagram where appropriate to aid your description:

(i) *Wavelength*

(ii) *Amplitude*

(iii) *Frequency*

(iv) *Displacement* (8 marks)

Q7 (a) One end of a long metal bar is placed in an open fire. Name the dominant *process* by which heat energy transfers through the bar and give a brief description of this heat transfer mechanism. (5 marks)

(b) Explain what is meant by *Specific Heat Capacity* and *Specific Latent Heat of Vapourisation*. (4 marks)

(c) When 2100 J of heat is removed from 0.1 kg of a substance, its temperature is observed to decrease from 40°C to 10°C. What is the *specific heat capacity* of the substance? (6 marks)

(d) A diver is diving off the coast of Ireland and is planning to dive to a depth of 40 m. Calculate the *pressure* on the diver when he reaches the maximum depth if the density of seawater is 1020 kg m^{-3}. (5 marks)