BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

ENGINEERING AND PHYSICS DEPARTMENT

NS101: APPLIED BIOPHYSICS

TIME: 3 HOURS

INSTRUCTIONS
Answer **ALL of question one** in Section A and **any three** questions from Section B. Section A carries 40 Marks and each question in Section B caries 20 marks.

Physical constants
Stefan-Boltzmann constant, $\sigma = 5.67\times10^{-8}Wm^{-2}K^{-4}$
Planck's constant, $h = 6.626 \times 10^{-34}$ Js
Speed of light, $c = 3 \times 10^{8}$ m s^{-1}

Note: Where no units are specified, assume they are S.I.

SECTION A

1. (a) . (i) Convert 77°F to °C [2]

(ii) Convert 40°C to °F [2]

(b) How much heat is required to melt 50g of ice at 0 ^{0}C, heat the resulting water from 0^{0}C to 100^{0}C and vaporise into steam at 100^{0}C? (Specific heat capacity of water = 4200Jkg^{-1}K^{-1}, latent heat of fusion of ice = 3.34×10^5 Jkg^{-1}, latent heat of vaporization of water = 2.3×10^6 Jkg^{-1}.) [6]

(b) Identify and describe the three types of radiation emitted by an unstable nucleus. [6]

(c) Explain concisely what is meant by following terms:

(i) *Scalar* quantity [2]

(ii) *Accuracy* of a measurement [2]

(iii) *Precision* of a set of measurements [2]

(iv) *work* [2]

(d) State Newton's first law of motion [2]

(e) A man exerts a force of a 50 N on a heavy cart and pushes it 60 m in 100s. Calculate the power used in pushing the cart. [3]

(f) The table below shows the properties of sub-atomic particles. Fill in the missing information.

PARTICLE	RELATIVE MASS	RELATIVE CHARGE	CHARGE (C)
Proton			$+1.6 \times 10^{-19}$
	1		
Electron		-1	

[5]

(g) What is ultrasonic sound? State any two medical uses of ultrasound. [4]

(h) Distinguish between *temperature* and *internal energy*. [2]

SECTION B

2. (a) Define work, energy and power. [6]

(b) State the principle of conservation of energy. [2]

(c) Explain the difference between first, second and third class levers. [6]

(d) A 60 N force moved an 8 kg object through a distance of 24 m in a 4 second interval. The frictional force opposing the motion was 36 N. Calculate the work done by the 60 N force and the velocity of the object at the end of 4 seconds. [6]

3. A nurse recorded the values shown in the table below for a patient's temperature.

Time	Decimal time	Temp (°C)
10:00 AM	10.0	37.8
10:30 AM	10.5	38.0
11:00 AM	11.0	38.3
11:30 AM	11.5	38.5
12:45 PM	12.75	39.2

(a) Plot a graph of temperature versus time [6]

(b) Find the patient's temperature at noon [4]

(c) Calculate the slope (including error in slope) of the graph. [6]

4. (a) Discuss three ways in which heat can be transferred between two points. [6]

(b) The skin temperature of a patient is 40°C and the temperature of the environment surrounding him is 23°C. If the total skin area is 2 m^2 and the radiation efficiency is 0.9, calculate the rate of loss of heat by the patient to the surroundings [8]

(c) A medication at the bed-side of this patient states that it should be kept below a temperature of -35°C or -31°F. Determine whether the two temperatures are the same. [6]

5. (a) List the three main constituents of an atom. [3]

(b) Describe radiation treatment of cancer and explain what the term therapeutic ratio means. [6]

(c) Discuss two methods a nurse can use to detect radiation as she moves around in the hospital. [7]

(d) List any three ways a nurse can minimize radiation exposure in the hospital. [4]

6. (a) The voltage across a resistor in a purely resistive circuit is given by

$$V_R = 10 \sin 2\pi t$$

i. What is the peak voltage across the resistor? [1]

ii. What is the angular frequency of the ac voltage? [1]

iii. Determine the period of the ac voltage. [2]

iv If the value of the resistance is 2 Ω, write the equation for the ac current. [2]

(b) Outline the major differences in the penetrating power and ionizing ability of the three types of radiation emitted by an unstable nucleus. [8]

(c) A radioactive isotope used for an organ scan has a physical half-life of 8 days. Given that the biological half-life of the isotope is 3 days, calculate:

(i) The effective half-life

(ii) The remaining dosage after 12 days if the initial amount was 100 μCu. [3,3]

END OF PAPER