0780/2/2023
PHY A/L

SOUTH WEST REGIONAL MOCK EXAMINATION
GENERAL EDUCATION

THE TEACHERS' RESOURCE UNIT (TRU)

IN COLLABORATION WITH

THE REGIONAL INSPECTORATE OF PEDAGOGY FOR SCIENCE

AND

THE SOUTH WEST ASSOCIATION OF PHYSICS TEACHERS (SWAPT)

Monday: 23/3/2023- Afternoon **ADVANCED LEVEL**

Subject Title	**PHYSICS**
Paper Number	**2**
Subject Code Number	**780**

Three hours

INSTRUCTIONS TO CANDIDATES:

Answer all the questions in sections I and II and any two from section III

SECTION – I is designed to be answered in $1\frac{1}{2}$ *hours, SECTION – II in 40 minutes and SECTION – III is designed to be answered in 50 minutes.*

You are advised to design your time accordingly.

You are reminded of the necessity of good English and orderly presentation in your answers.

In calculations you must show all the steps in your working, giving your answer at each stage.

Calculators and formulae booklets are allowed.

Turn over

Section 1: (One hour). Answer all the questions

1. Einstein's Photo-electric equation is a homogeneous equation of the form $E = af_0 + bv^2$, where E is the energy of the incident radiation on a clean metal surface, f_0 is the threshold frequency, v is the maximum speed of ejected electrons and a and b are constants.
   a) Explain the meaning of the underlined phrase
   b) Determine the base units of a and b **(5 marks)**

2. The graph in figure 1 shows the variation of $N(c)$ with C, where N(c) is defined such that $N(c)\Delta C$ is the number of molecules with speeds between C and $C + \Delta C$ at a temperature T.

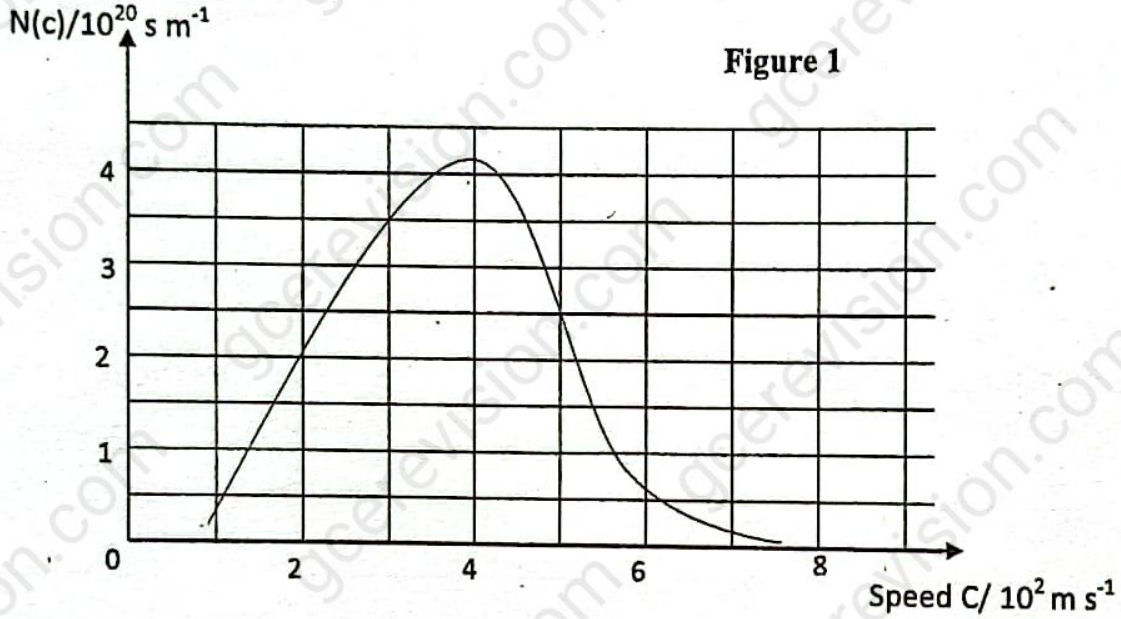

Figure 1

   a) Estimate the total number of molecules in the gas under investigation at the particular temperature.
   b) Determine from the graph, the most probable speed
   c) Assuming that the most probable speed is equal to the r.m.s value, calculate the temperature, T, of the gas, if the mass is 12 g **(6 marks)**

3. a) Distinguish clearly between diffraction and interference.
   b) Monochromatic light of wavelength $5.0\ x\ 10^{-7}m$ falls normally on a diffracting grating which has 425 lines per millimetre.
      i. What is the highest order of diffraction?
      ii. Find the angular separation between the first and the third ordered lines. **(6 marks)**

4. A 70 μF capacitor, a 0.3 H inductor and a 50 Ω resistor are connected in series with a 120 V, 60 Hz power source as shown in figure 2.

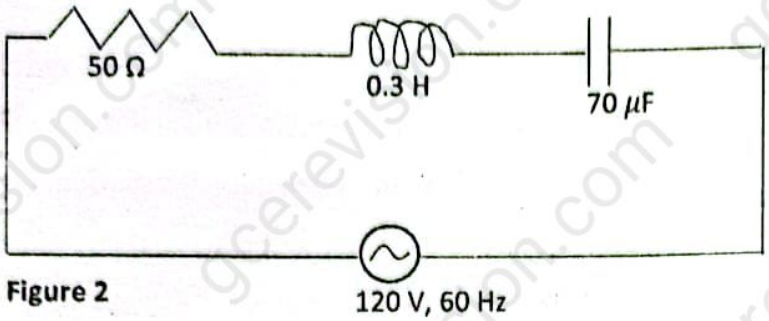

Figure 2

Calculate

i. The impedance of the circuit
ii. Power dissipated by the circuit
iii. What is its power factor? **(6 marks)**

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5. An aircraft has a wing span of $20\ m$ and is flying horizontally in a northern direction at a speed of $90\ m\ s^{-1}$. The vertical component of the Earth's magnetic field is $45\ \mu T$ in the downward direction.

(a) Calculate:
(i) the area swept out per second by the wings;
(ii) the magnetic flux cut per second by the wings,
(iii) the EMF induced between the wingtips.

(b) State with a reason, the wing-tip which will be at the higher potential. **(7 marks)**

Answer Either 6 (a), (b) and (c) OR 6 (d), (e) and (f)

6. a) i) State Newton's first and second laws of motion **(4 marks)**

ii) Describe and experiment to verify the law of conservation of linear momentum in one dimension. Your description should include a diagram, procedure, precaution, observation and conclusion. **(8 marks)**

(b) A wooden box is pushed along a horizontal floor by a force of 6.4 N. The motion is opposed by a frictional force of 1.2 N between the box and the floor and air resistance kv^2 where $k = 6.0\ x\ 10^{-2} kg\ m^{-1}$ and v is the speed.

i. Sketch a diagram showing all the forces acting on the box **(2 marks)**

ii. Calculate the maximum speed of the box. **(3 marks)**

(c) A satellite in a geostationary orbit circles the earth above the equator with a period of exactly 1 day, so it stays above a particular place all the time. Most of the satellites in such orbits acts as relays for telephone calls and TV programs. Find the altitude of the geostationary satellite from the surface of the earth. **(3 marks)**

OR 6 (d), (e) and (f)

6. (d) i. Define Young's Modulus of elasticity **(2 marks)**

ii. Describe an experiment to determine the Young modulus of a of a wire.

Your description should include a diagram, procedure, precaution, observation and conclusion. **(8 marks)**

(e) A steel wire of length 1.5 m is joint end to end to a phosphor-bronze wire to form a composite wire of length 4.0 m. If both wires have the same diameter of 0.40 cm, calculate the tension required to cause a total extension of 0.64 cm.

Youngs modulus of steel and phosphor-bronze is $2.0 \times 10^{11}\ Pa$ and $1.1 \times 10^{11}\ Pa$ respectively. **(5 marks)**

(f) i. State three assumptions of the kinetic theory of matter. **(3 marks)**

ii. Calculate the r.m.s. speed of the molecules of hydrogen at s.t.p, giving that the density of hydrogen at s.t.p. is $9.0 \times 10^{-2} kgm^{-1}$ and 1atm is $1.01 \times 10^{5} Pa$ **(2 marks)**

Section II (40 minutes) DATA ANALYSIS

7. The capacitor of a traffic light control system charges and discharges through the load circuit obeying the relationship $Q = Q_0 e^{-t/\beta}$ where Q is the charge at anytime t and Q_o is the initial charge. The data in table 1 shows the discharge process of a capacitor in one such system.

$Q/x10^{-3}$ C	t/minutes
82.0	0.25
72.0	0.50
50.0	1.25
38.0	1.75
34.0	2.00
30.0	2.25
27.0	2.50
22.0	3.00
18.0	4.00

Table 1

a) Plot a suitable graph from which values of β and Q_o can be determined. **(11 marks)**
b) Determine the values of β and Q_o **(7 marks)**
c) State and explain the physical significance of β. **(2 marks)**

SECTION III: 50 minutes

Answer any two options from the four options

OPTION 1: ENERGY RESOURCES AND ENVIRONMENTAL PHYSICS

8. (a) Differentiate between Primary and Secondary sources of energy, giving one example of each. **(4 marks)**

(b) i) Draw an energy flow diagram of a geothermal plant **(4 marks)**

ii) Calculate the thermal power per unit area as heat flows through an iron rod of length 80 cm, if both ends are maintained at 55 °C and 0 °C. Thermal conductivity of Iron is 75 $Wm^{-1}K^{-1}$ **(2 marks)**

(c) i) Define weather forecast **(2 marks)**

ii) State and describe a simple method of weather forecast. **(3 marks)**

OPTION 2: COMMUNICATION

9. (a) i) Define a Super-heterodyne system. **(2 marks)**

ii) Figure 3 shows the block diagram of a receiver circuit

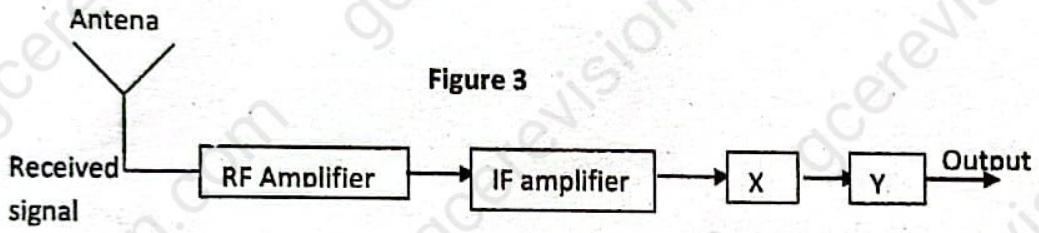

Figure 3

Identify the components X and Y and give their functions. **(4 marks)**

(b) Explain the following terms used in communication

i) Cross linking in mobile phone communication.

ii) Attenuation **(2 marks)**

(c) i) State two advantages of transmitting data in digital form

ii) State two advantages of AM over FM signals **(4 marks)**

(d) When the mean optical power launched into an 8 km length of fibre is 12 MW, the mean optical power at the output is 3 MW. Determine

i) The overall signal attenuation in decibel through the fibre

ii) The signal attenuation per kilometre for this fibre **(3 marks)**

OPTION 3: ELECTRONICS

10. (a) Describe the use of the following circuits in electronics

i. Bistable Circuit

ii. Astable Circuit **(4 marks)**

(b) The output characteristics of an n-p-n transistor in the CE configuration are shown

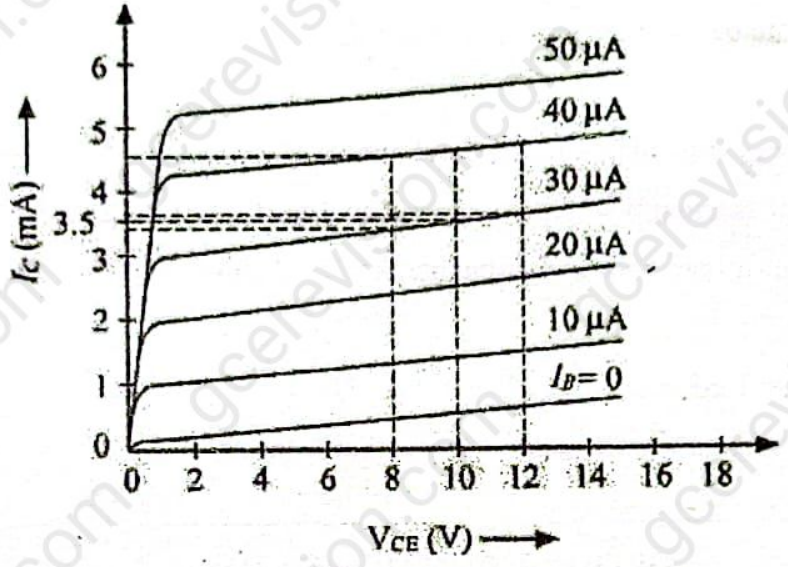

Figure 4

in figure 4.

Determine

i) Dynamic output resistance

ii) DC current gain **(4 marks)**

(c) i) Define a Semiconductor **(2 marks)**

ii) Differentiate between an intrinsic and an extrinsic semiconductor **(2 marks)**

(d) Explain the role of the following in an amplifier circuit

i) Coupling Capacitor

ii) Inductor **(3 marks)**

OPTION 4: MEDICAL PHYSICS

11. (a) Draw a simple diagram of the human ear indicating the parts responsible for collecting sound, creating compression wave and electrical signal. **(4 marks)**

(b) Define the following terms

i) Equal Loud Contours

ii) Hearing threshold **(4 marks)**

(c) i) What is the meaning of ECG? **(1 mark)**

ii) State two advantages and two disadvantages of ECG **(4 marks)**

(d) State two principles of radiological protection **(2 marks)**

END