

**SOUTH WEST REGIONAL MOCK EXAMINATION
GENERAL EDUCATION**

**THE TEACHERS' RESOURCE UNIT (TRU)
IN COLLABORATION WITH**

THE REGIONAL INSPECTORATES OF PEDAGOGY AND

THE SUBJECT TEACHERS' ASSOCIATIONS (STA)

MONDAY, 28/03/2022 (Afternoon)

ADVANCE LEVEL

Subject Title	Physics
Paper Number	Paper 2
Subject Code Number	0780

TWO HOURS THIRTY MINUTES

INSTRUCTIONS TO CANDIDATES:

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

SECTION – I is designed to be answered in 1 hour, SECTION – II in 30 minutes and SECTION – III is designed to be answered in 1 hour.

You are advised to design your time accordingly.

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

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

Calculators are and formulae booklets are allowed

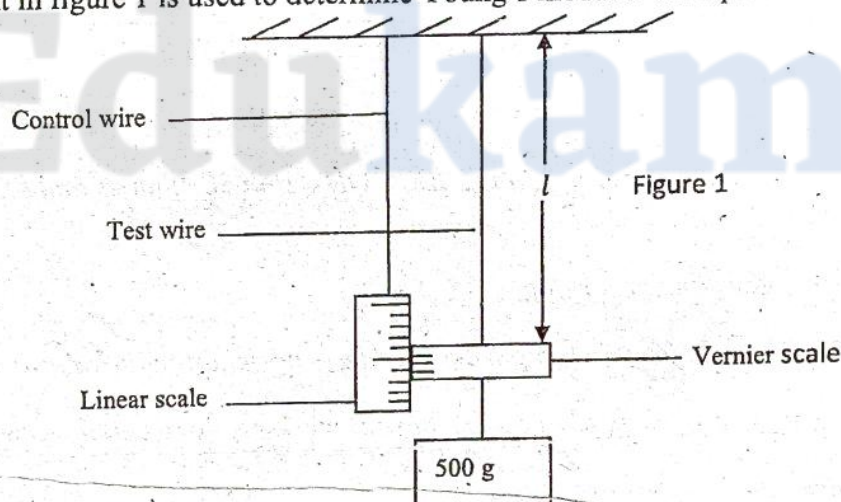
1. a) The EMF of a thermocouple is given approximately by the equation: $E = \alpha\Delta T + \beta(\Delta T)^2$, where ΔT is the thermodynamic temperature difference between the junctions. Given that the equation is homogeneous, determine the base units of the constants α and β .
- (b) Given that the values of the constants α and β in SI units are 6.93×10^{-6} and -2.10×10^{-9} respectively, and that the temperature of the cold junction is 273 K, calculate the probable temperature of the hot junction when $E = 3.25$ mV. (6 marks)

2. A highly insulated calorimeter contains 0.050 kg of ice and 0.10 kg of water. Steam at 100°C is passed in until the ice *just* melts. Determine the:
- a) quantity of water now in the container.
 b) equilibrium temperature attained by the mixture if the mass of the steam is doubled
 State any assumption made in your calculation (6 marks)

3. U-235 and U-238 are both **isotopes** of the same element
- a) Explain the meaning of the bolded word
 b) In the fission of U-235 energy is released. ${}^{235}_{92}\text{U} + {}^1_0\text{n} = {}^{90}_{36}\text{Kr} + {}^{144}_{56}\text{Ba} + 2{}^1_0\text{n}$
 Calculate the amount of energy released given that
 ${}^{235}_{92}\text{U} = 235.004 \text{ u}$; ${}^1_0\text{n} = 1.009 \text{ u}$; ${}^{90}_{36}\text{Kr} = 89.920 \text{ u}$; ${}^{144}_{56}\text{Ba} = 153.923 \text{ u}$. (5 marks)

4. a) State the laws of Electromagnetic induction.
 (b) You are provided with a bar magnet, a centre – zero galvanometer, a long copper wire (about 150 cm long). With the aid of a diagram, explain briefly how any of the above laws can be investigated. (6 marks)

5. The arrangement in figure 1 is used to determine Young's modulus for a piece of wire of length l



If the test wire is of diameter 0.01cm and the shift of the vernier scale down the reference scale is 6.0 mm giving a strain of 2.96×10^{-3} , then calculate the

- a) Length, l , of the wire
 b) Stress on the wire.
 c) Young's Modulus for the wire (7 marks)

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

6. a) i) Explain the meaning of simple harmonic motion (2 marks)

- (ii) Describe an experiment using a simple pendulum to determine the acceleration due to gravity near the surface of the Earth. Your description should include a diagram, procedure, observations, processing, precautions and conclusion. **(8 marks)**
- (b) A machine fires bullets at a rate of 360 *per minute*. The bullets have a mass 20 g and a speed of 500 m s^{-1} . Calculate the average force exerted by the gun on the person holding it. **(4 marks)**
- (c) A capacitor of capacitance C_1 is charged to a voltage V and discharged through a resistor R . Another capacitor of capacitance C_2 ($C_2 < C_1$) is charged to the same voltage V and discharged through same R .
- i) Sketch on the same axis graphs of voltage against time for the two discharges.
- ii) State and explain the effect on the rate of discharge of C_2 using a larger resistor. **(6 marks)**

6. d) i) Explain the meaning of longitudinal waves
- (ii) Describe an experiment to determine the speed of sound in free air. Your description should include a diagram, procedure, observations, processing, precautions and conclusion **(8 marks)**
- (e) A source of sound of frequency 620 Hz emits waves of wavelength 500 mm in air at a temperature of 25°C . Calculate
- i) The speed of sound in air at this temperature
- ii) The wavelength of the sound from this source at 0°C . **(4 marks)**
- (f) A piece of copper wire, silicon wire and tungsten wire are each connected in series with a battery, rheostat and an ammeter. A voltmeter is used to check the variation of the potential difference V with current I across each of the components
- i) Sketch on the same axis labelled graphs of current versus voltage for the three components
- ii) State and explain the effect of increasing temperature on the conductivity of the copper wire **(6 marks)**

Section II (30 minutes) DATA ANALYSIS

7) The thermionic current density J (current per unit area) through a diode is related to the thermodynamic temperature T by the equation $J = J_0 T^2 e^{-(\alpha/T)}$ ----- (1)

Where J_0 and α are constants.

A student investigated this relationship during a thermionic emission process of a tungsten filament and had the following results.

$J / \text{A m}^{-2}$	$T / 10^3 \text{ K}$
12.59	2.00
25.35	2.05
49.42	2.10
93.51	2.15
172.1	2.20
308.4	2.25
539.6	2.30
922.5	2.35
1544	2.40
2532	2.45
4075	2.50

- a) Plot a suitable graph from which values of J_0 and α can be determined **(11 marks)**
- b) Hence determine the values of J_0 and α **(7 marks)**
- c) Determine the thermionic current density for a thermodynamic temperature of $3.00 \times 10^3 \text{ K}$ **(2 marks)**

Section 3 (1 hour)

Answer any two questions from the four options

Option 1: Energy Resources and Environmental Physics

8) a) i) What do you understand by finite and renewable energy resources? Give an example of each type (4 marks)

ii) Given that the mean distance from the Earth to the sun is $1.5 \times 10^{11} \text{ m}$ and the power output of the sun is $4 \times 10^{26} \text{ W}$, calculate a value for the Solar constant. State the assumption made in your calculation. (3 marks)

(b) Describe briefly how Global Warming has affected the following:

i) Human health

ii) The environment. (4 marks)

(c) Draw a block diagram to show how a nuclear fuel can be transformed into electrical energy (4 marks)

Option 2: Communication

9) a) i) Distinguish between amplitude modulation (AM) and frequency modulation (FM) (2 marks)

ii) State three advantages of FM over AM. (3 marks)

b) i) State two physical quantities that can be varied in order to capture a particular radio using a mobile phone (2marks)

ii) State and explain two uses of cell phone in communication (4 marks)

c) An optical fibre transmission system consists of a transmitter, an optical fibre of length 30 km and a receiver. The minimum detectable power leaving the fibre and entering the receiver is $1.5 \times 10^{-8} \text{ W}$.

(i) Calculate the minimum power P_0 entering the fibre from the transmitter, given that the power, P is related to the distance, x along the fibre by the expression $P = P_0 e^{-ax}$, a is a constant of value 0.20 km^{-1} .

(ii) State any possible source of power loss associated with an optical fibre. (4 marks)

Option 3: Electronics

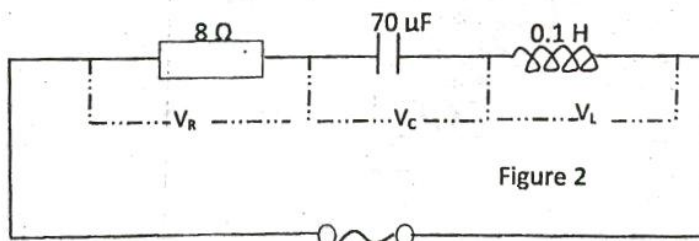
10) a) Distinguish between

i) intrinsic and extrinsic semiconductors.

ii) p-type and n-type semiconductors (4 marks)

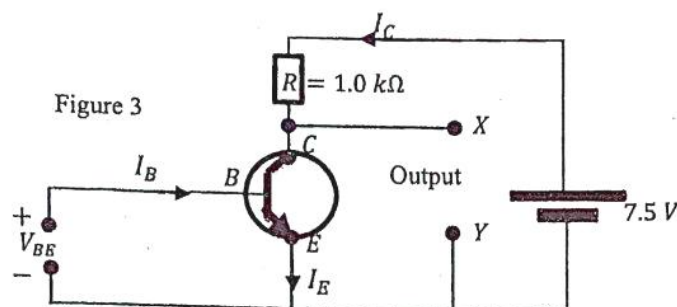
b) Figure 2 shows a resistor connected in series with a capacitor and an inductor

i) Calculate the resonant frequency of the circuit (2 marks)



ii) Draw a phasor diagram showing relationship between V_R , V_C , V_L and I (3 marks)

c) Figure 3 shows a transistor circuit used as a voltage amplifier. When V_{BE} is changed from 0.62 V to 0.64 V , then I_C changes from 2.0 mA and 4.0 mA .



Calculate the

- i) change in the p. d. V_R across the resistor, R ?
- ii) change in the p. d. V_{XY} between the output terminals X and Y ?
- iii) voltage gain ($\Delta V_{XY}/\Delta V_{BE}$)

(6 marks)

Option 4: Medical Physics

11)

- a) X-rays and ultrasound are two imaging techniques used for viewing different parts of the human body.
 - i) State a part of the body where each of the techniques would be more suitable and explain the reason for the suitability. (4 marks)
 - ii) Give one reason why Ultrasound is not likely to replace X-rays completely for medical diagnosis (1 mark)
- b) Name any one eye defect, explaining how it manifests and how it can be corrected. (3 marks)
- c) The heart is the pump of a closed circulatory system in a human system.
 - i) What is a closed circulatory system?
 - ii) How does the heart function as a pump?
 - iii) The aorta has a diameter of $10 \mu\text{m}$, blood flows at a rate of $250 \text{ cm}^3 \text{ s}^{-1}$ through it, while the average diameter of an artery is $1.0 \mu\text{m}$ and average speed of blood flow through each artery is 10 cm s^{-1} . Calculate the average number of main arteries from the aorta. (7 marks)