

0780/2/2025  
PHYSICS

## 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/ENGINEERING SCIENCE TEACHERS  
(SWAPEST)

Friday: 21/3/2025- Afternoon

ADVANCED LEVEL

Subject Title	PHYSICS
Subject Code Number	780
Paper Number	2

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.

**SECTION – I**  
**(One hour 30 minutes)**  
**Answer all questions**

1. A communication satellite occupies a parking orbit around the Earth such that the radius,  $R_0$  of the orbit is given by:

$$R_0 = \sqrt[3]{\frac{GMT^2}{4\pi^2}}$$

where,  $T$  is the period of revolution of the satellite,  $G$  is the universal gravitational constant, and  $M$  is the mass of the Earth.

- (a) Determine the base unit of  $G$ .  
(b) Calculate  $R_0$ , the radius of the orbit.  
(c) Hence calculate the height,  $H$ , of the satellite above the earth's surface. And state any assumption made in your calculation.

(Period of rotation of the earth about its axis is 24 hours).

(7 marks)

2. (a) State Newton's Second Law of motion.  
(b) A bus of mass  $3.0 \times 10^3 \text{ kg}$  runs into an electric pole when moving at a speed of  $4 \text{ m s}^{-1}$  and it is brought to rest in  $2 \text{ s}$ .  
(i) Calculate the force the electric pole exerts to bring the bus to rest.  
(ii) Sketch a graph to show how the impact force varies with time during the entire collision.

(6 marks)

3. (a) Explain what is meant by a thermometric property.  
(b) The table below shows the specifications of some common thermometers.

Name of Thermometer	Property	Use
A	Change in length of mercury thread with temperature	B
C	D	Used to calibrate other thermometers
Platinum resistance thermometer	E	It is accurate or sensitive or can measure high liquid temperatures

Copy and complete the above table for A to E.

(6 marks)

4. (a) (i) State an advantage of a potentiometer over a voltmeter in voltage measurement.  
(ii) State an advantage of a voltmeter over a potentiometer in voltage measurement.  
(b) A student using a potentiometer moves the slider from the beginning to the end of the potentiometer wire, and there was no point where the galvanometer reads zero current. State one reason for the inability of finding a balanced point when using a potentiometer to measure the EMF of a cell.  
(c) The running temperature of the filament of a  $12 \text{ V}$ ,  $48 \text{ W}$  tungsten filament lamp is  $2700 \text{ }^\circ\text{C}$  and the average temperature coefficient of resistance for tungsten from  $0 \text{ }^\circ\text{C}$  to  $2700 \text{ }^\circ\text{C}$  is  $6.4 \times 10^{-3} \text{ K}^{-1}$ . By determining the resistance of the element at  $2700 \text{ }^\circ\text{C}$ , calculate the resistance of the element  $R_0$  at  $0 \text{ }^\circ\text{C}$ .

(6 marks)

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

- 6) (d) (i) Define the decay constant of a radio-active nuclide. (2 marks)  
 (ii) Describe an experiment to measure the decay constant of a named radioactive gas with a short half-life. Your description should include a setup, a brief procedure, measurements taken, how measurements are processed to reach a conclusion and a precaution. (8 marks)
- (e) The activity of carbon – 14 in living wood is 19 counts per minute per gram. Measuring the activity of the isotope in a piece of ancient wood three years ago gave an activity of 7 counts per minute per gram. Given that the decay constant of the isotope is about  $1.2 \times 10^{-4}$  per year, estimate the age of the piece of ancient wood. (4 marks)
- (f) A coil which has an inductance of  $0.4 \text{ H}$  and a resistance of  $5 \Omega$  is in series with resistor whose resistance is  $25 \Omega$ . The pair are connected across a  $200 \text{ V}$  r.m.s supply alternating at  $\left(\frac{50}{\pi}\right) \text{ Hz}$ . Calculate:  
 (i) The total impedance of the circuit.  
 (ii) The r.m.s current.  
 (iii) The r.m.s voltage across the coil. (6 marks)

SECTION – II  
 [Compulsory Question - DATA ANALYSIS]  
 (40 minutes)

7) The table below gives the values of the pressures,  $P$ , and the volumes,  $V$ , at different Celsius temperature,  $t$ , for an ideal gas.

$t / ^\circ\text{C}$	210	180	150	50	0	-80	-120
$P / 10^5 \text{ Pa}$	4.3	4.0	3.8	2.2	1.5	1.0	0.84
$V / \text{m}^3$	0.85	0.86	1.06	1.14	1.38	1.45	1.55

The equation of state for an ideal gas can be written in the form:

$$\frac{PV}{t - t_0} = Q \dots \dots \dots (1)$$

where  $t_0$  is the absolute zero temperature corresponding to  $PV = 0$ . According to Boltzmann, the constant,  $Q$ , depends on the number of gas molecules,  $N$  in the gas container and can be put in the form

$$Q = kN \dots \dots \dots (2),$$

where  $k$  is the Boltzmann's constant

- (a) Plot a suitable graph from which  $Q$  and  $t_0$  could be obtained. (10 marks)  
 (b) Determine the values of the constants  $Q$  and  $t_0$ . (8 marks)  
 (c) How many gas molecules were present in the gas container? (2 marks)

5. a) Differentiate between thermionic emission and photoelectric emission.

b) In a photoelectric experiment, two clean zinc plates P and Q, positively and negatively charged respectively, are placed in a dark room and illuminated with UV light, as shown in figure 1. Each plate is connected to a gold leaf electroscope which shows the leaves opened the same degree before the UV light is switched on.

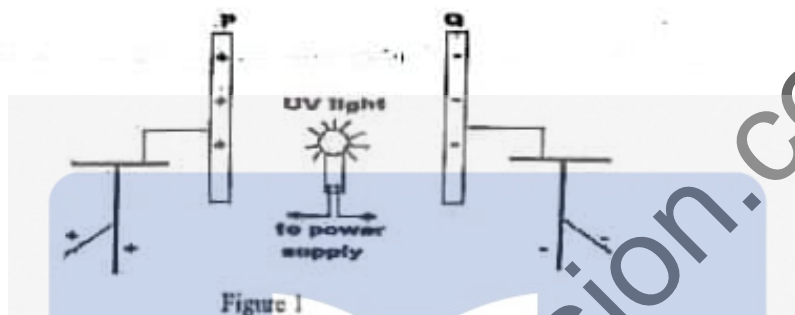


Figure 1

When the UV light is switched on, it is noticed that the electroscope attached to the plate P shows no change in divergence of the leaf while the electroscope attached to plate Q gradually shows a change in divergence of the leaf.

- (i) Explain why the electroscope attached to plate P showed no change in divergence of the leaf.
- (ii) State and explain the change in divergence of the leaf of the electroscope attached to plate Q.
- (iii) State a precaution taken during the experiment. (6 marks)

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

EITHER 6 (a), (b) and (c)

6. (a) (i) Define Young's modulus of a material. (2 marks)  
 (ii) Describe an experiment to measure the Young's modulus of a copper wire. Your description should include a setup, brief procedure, measurements taken, how measurements are processed to reach a conclusion and a precaution. (8 marks)
- (b) The resultant force,  $F$ , in  $N$ , between two adjacent atoms in a solid varies with the separation,  $d$ , in  $m$ , according to the relation:  $F = \frac{7.8 \times 10^{-28}}{d^3} - \frac{3.0 \times 10^{-96}}{d^{12}}$   
 (i) Identify the attractive component of the force.  
 (ii) Identify the repulsive component of the force.  
 (iii) Calculate the equilibrium separation. (4 marks)
- (c) (i) Distinguish between a longitudinal and a transverse wave. (2 marks)  
 (ii) As an Ambulance sounding a siren approaches a control point, the frequency of the siren is measured to be  $438 \text{ Hz}$  and as it passes and moves away, the frequency is presumed to be  $378 \text{ Hz}$ . Explain why there is this difference and calculate the speed of the ambulance if that the speed of sound in air is  $340 \text{ m s}^{-1}$ . (4 marks)

**SECTION – III: (50 minutes)**

**OPTIONS**

Answer any two questions from this section

**OPTION 1: ENERGY RESOURCES AND ENVIRONMENTAL PHYSICS**

- 8) (a) (i) Distinguish between biofuels and fossil fuels. (2 marks)  
 (ii) What is a biofuel digester? (1 mark)  
 (iii) State the factors responsible for the amount of energy generated from the wind mill (2 marks)
- (b) (i) Why is the solar photovoltaic plate a clean energy resource? (1 mark)  
 (ii) Draw a block diagram of the major components of a hydroelectric plant. Explain the role of each component. (5 marks)  
 (iii) Why is energy generation from tides not very common in most countries? (1 mark)
- (c) (i) In recent times there have been more tornados and floods than is used to be. Account for the new observations in the environments. (2 marks)  
 (ii) State one way in which the cause of these hazards can be reduced. (1 mark)

**OPTION 2: COMMUNICATION**

- 9) (a) (i) Analogue transmission and digital transmission are two basic ways of signal transmission. Give any three differences between them. (3 marks)  
 (ii) Figure – 2 below shows the frequency spectrum of the signal from a radio transmitter. A carrier and two sideband frequencies are present.



What is the bandwidth of the transmitted signal? (2 marks)

- (b) (i) Draw the block diagram of a simple A. M. radio receiver. (4 marks)  
 (ii) Pa Peter has a radio set which he uses to listen to news from CRTV Buea. The tuning circuit of the radio set has a capacitor with a capacitance of  $4.00 \mu F$ . CRTV Buea broadcasts at a frequency of  $94.5 \text{ MHz}$ . Calculate the inductance of the inductor in the circuit. (3 marks)
- (c) Some mobile phone use SIM card and work in cells. When the mobile phone is used from one cell to another it undergoes handover. Explain the meaning of the underlined words. (3 marks)

**OPTION 3: ELECTRONICS**

- 10) (a) (i) Compare n-type semiconductors with p-type semiconductors. (3 marks)  
 (ii) Describe the formation of a p-n junction. (2 marks)
- (b) Figure 3 shows a simple alarm circuit. The device y could be a thermistor or an LDR.

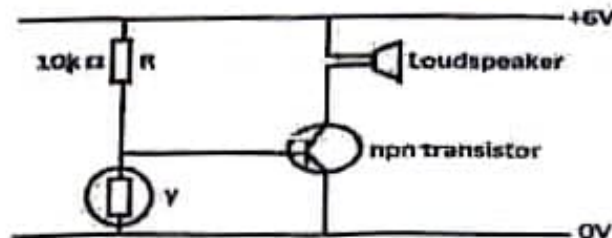


Figure 3

- (i) Explain how each of these devices could be used to make the figure function as an alarm. (4 marks)
- (ii) The resistance of the LDR in the position y for a given light intensity is  $1\text{ k}\Omega$ . Explain whether the alarm in figure 3 will be on or not. (2 marks)
- (c) A burglar alarm system is installed in a house with two sensors, one on the door and one on the window. The alarm will only go off if both the door and the window are opened simultaneously.
- Using an AND logic gate,
- (i) explain how this system works. (2 marks)
- (ii) why does it only activate when both inputs are triggered? (1 mark)

**OPTION 4: MEDICAL PHYSICS**

- 11) (a) Astigmatism is one of the numerous eye defects.
- (i) How does it affect vision?
- (ii) State one cause of astigmatism.
- (iii) How can astigmatism be corrected? (3 marks)
- (b) Blood pressure (BP) reading is often written as a ratio  $\frac{A}{B}$  in mm Hg.
- (i) Give the name and significance of each of the numbers A and B.
- (ii) Write down an example of a BP reading for a healthy (non-hypertensive) person
- (iii) Give an example of the BP reading for a high blood or hypertensive person.
- (iv) State one precaution / control of high blood pressure. (7 marks)
- (c) When assessing radiation damage to human beings, the quality factor of alpha particles is given as 20.
- (i) Explain what quality factor means, and how it affects the radiation dose equivalent which a person receives.
- (ii) Explain why alpha radiation from small particles of radioisotope which has been inhaled by a person is considered to be particularly dangerous while alpha radiation from an external source is considered less hazardous. (5 marks)