THE UNITED REPUBLIC OF TANZANIA
PRESIDENT'S OFFICE, REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

FORM SIX SPECIAL SCHOOLS JOINT EXAMINATION

CODE: 131/1 **PHYSICS 1**

Time: 3:00 HRS Tuesday **18-February-2025 AM**

INSTRUCTIONS

1. This paper consists of sections A and B with a total of **ten (10)** questions.
2. Answer **ALL** questions in section A and any **TWO (2)** questions from section B.
3. Section A carries **seventy (70)** marks and section B carries **thirty (30)** marks.
4. Cellular phones and any unauthorized materials are not allowed in the examination room.
5. Mathematical tables and non-programmable calculator may be used.
6. Write your Examination **Number (Name)** on every page of your answer booklet(s).
7. Where necessary the following constants maybe used:
   (a) Acceleration due to gravity, g = 9.8 m/s^2.
   (b) Co-efficient of thermal conductivity of thermacole is 0.01 *J/smK*.
   (c) Charge of an electron, e = 1.6×10^{-19} C.
   (d) Radius of the earth, Re = 6.4×10^6 m.
   (e) Heat of fusion of water = 335×10^3 *J/kg*.
   (f) Stefan's constant, $\sigma = 5.67 \times 10^{-8}$ $Wm^{-2}K^{-4}$.
   (g) Universal gas constant, R = 8.314 $Jmol^{-1}K^{-1}$ = 0.0821 $atmdm^3mol^{-1}K^{-1}$.
   (h) Charge of electron = $1.6 \times 10^{-19} C$

SECTION A (70 Marks)

Answer **ALL** questions in this section.

1. (a) (i) What is meant by the statement that "an equation is homogenous with respect to its units"? **(01 mark)**

(ii) A student while doing an experiment finds that the velocity v of an object varies with time t, and it can be expressed as per equation $v = Xt^2 + Yt + Z$. If the units of v and t are expressed in terms of SI units, determine the unit of constants X, Y and Z. **(05 marks)**

(b) A stone weighs (10 ± 0.1) kg in air. The weight of the stone in water is (5.0 ± 0.1) kg. Find the maximum percentage error in the measurement of specific gravity. **(04 marks)**

2. (a) (i) Two bodies having different masses have the same linear momentum. Which one of them will move faster? Explain why. **(02 marks)**

(ii) A vertical wall deflects a ball by an angle of 45° without changing its initial speed which is equal to 54 *km/h*. What is the impulse imparted to the ball? (Mass of the ball is 0.15 *kg*) **(03 marks)**

(b) Two objects **A** and **B** are projected at the same time in the same vertical plane. **A** is projected at a height of 2 m above the ground and making an angle of 30º with the horizontal, **B** is projected with velocity of 30 m/s at the ground vertically below **A** making an angle of 60º with the horizontal. If they collide together, determine time taken until they collide. **(05 marks)**

3. (a) (i) Why are wheels of an automobile made circular? **(01 mark)**

(ii) A ballet dancer spins about a vertical axis at 1 r.p.s. with arms outstretched. With her arms folded, her moment of inertia about the vertical axis decreases by 60%. Calculate the new rate of revolution. **(04 marks)**

(b) A cyclist is riding with a speed of 27 *km/h*. As he approaches a circular turn on the road of radius 80 m, he applies brakes and reduces his speed at the rate of 0.50 *m/s* every second. What is the magnitude and direction of the net acceleration of the cyclist on the circular turn? **(05 marks)**

4. (a) (i) A wrist watch is taken to the top of a mountain. Will it give correct time? Support your answer with a reason. **(01 mark)**

(ii) A pendulum of mass 2.0 kg is attached to one end of a string of length 1.2 m. A bob moves in a horizontal circle in such a way that the string is inclined at 30º to the vertical. Calculate the tension in the string and the period of the motion. **(04 marks)**

(b) A satellite of mass 1000 kg moves in a circular orbit of radius 7000 km around the earth which is assumed to be a sphere.

(i) Derive an expression for the total energy needed to place the satellite in that orbit. **(03 marks)**

(ii) Compute the numerical value of the total energy described in part (b) (i) above. **(02 marks)**

5. (a) (i) The absolute temperature (Kelvin scale) T is related to the temperature t_c on the Celsius scale by $t_c = T - 273.15$. Why do we have 273.15 in this relation, and not 273.16? **(02 marks)**

(ii) A copper – constantan thermocouple with its cold at ice point had e.m.f. of 4.28 mV with its junction at 100°C. The e.m.f. became 9.229 V when the temperature difference was 200°C. If the thermocouple obeys the equation; $E = A\theta + B\theta^2$ Where, E is the e.m.f. and θ is the temperature difference. Find the values of A and B in the equation. **(03 marks)**

(b) A 'thermacole' icebox is a cheap and efficient method for storing small quantities of cooked food in summer in particular. A cubical icebox of side 30 cm has a thickness of 5.0 cm. If 4.0 kg of ice is put in the box, estimate the amount of ice remaining after 6 h. The outside temperature is 45°C. **(05 marks)**

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6. (a) (i) Why animals curl into a ball when they feel cold? **(02 marks)**

(ii) At what temperature will the filament of a 100 W lamp operate if it is supposed to be a perfectly black body of area 1 cm^2? **(03 marks)**

(b) (i) The specific heat capacities of air are 1 040 $Jkg^{-1}K^{-1}$ when measured at constant pressure and 840 $Jkg^{-1}K^{-1}$ when measured at constant volume. Why are the values different? **(02 marks)**

(ii) How much work is required to compress five moles of air at 20°C and 1 atmosphere to $1/10^{th}$ of the original volume isothermally? (Given: $C_v = \frac{5}{2}R$). **(03 marks)**

7. (a) Plant growth is influenced by many factors. Briefly explain how the following factors influences.

(i) Air temperature. **(03 marks)**

(ii) Wind. **(03 marks)**

(b) The blades of a windmill sweep out a circle of area ***A***. Assume that the windmill converts 25% of the wind's energy into electrical energy, and that A = 30 m^2, v = 36 km/h and the density of air is 1.2 kg m^{-3}. What is the electrical power produced? **(04 marks)**

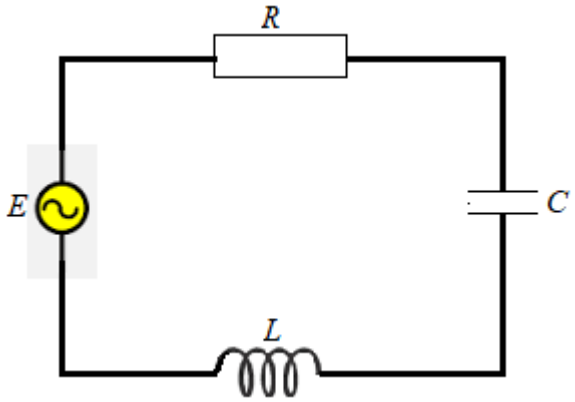
SECTION B (30 Marks)

Answer any **two (2)** questions from this section.

8. (a) (i) When are resistors said to be connected in series? **(01 mark)**

(ii) An aluminium wire which is found in TANESCO network has a cross-sectional area of 100 mm^2. If there is 2×10^{35} electrons per m^3 and a current of 13 A is flowing through the wire, what is the drift velocity of the electrons? **(03 marks)**

(b) A figure below shows a series LCR circuit connected to a variable frequency 230 *V* source, L = 5.0 *H*, C = 80 μF, R = 40 Ω.



(i) Determine the source frequency which drives the circuit in resonance. **(01 mark)**

(ii) Obtain the impedance of the circuit and the amplitude of current at the resonant frequency. **(01 mark)**

(iii) Determine the ***rms*** potential drops across the three elements of the circuit, and hence find the potential drop across the LC combination at resonance frequency. **(03 marks)**

(c) Battery **A** of e.m.f. 12 V and internal resistance 0.5 Ω and battery **B** of e.m.f. 6 V and internal resistance 1.5 Ω are connected in parallel across an external resistor of 10 Ω. Calculate the value of current through:

(i) cell **A**. **(02 marks)**
(ii) cell **B**. **(02 marks)**
(iii) the external resistor. **(02 marks)**

9. (a) (i) Explain *unidirectional* conducting property of diode? **(02 marks)**

(ii) Explain how a diode acts as a rectifier? **(02 marks)**

(b) For a CE-transistor amplifier, the audio signal voltage across the collected resistance of 2 kΩ is 2 V. Suppose the current amplification factor of the transistor is 100. If the base resistance is 1 kΩ, find:

(i) The input signal voltage. **(03 marks)**

(ii) The base current. **(03 marks)**

(c) Show that the current gain (γ) in the common collector configuration is greater than the current gain (β) in the common emitter configuration. Explain why its greater. **(05 marks)**

10. (a) (i) State four assumptions made for analyzing an ideal op-amp. **(02 marks)**

(ii) An inverting Opamp has a voltage amplification of 100 and supply of ± 9 V. If an alternating current input of voltage 50 Hz has a peak value of 0.6 V, find the time t of saturation. **(03 marks)**

(b) It is desired to use logic gates in control of a central heating system of a hotel room. The boiler is ON, if the switch is ON and the room thermostat is ON or, there is a frost outside. Construct its truth table. **(05 marks)**

(c) A message signal of frequency 20 *kHz* and peak voltage of 20 *volts* is used to modulate a carrier signal of frequency 2 MHz and peak voltage of 40 volts. Determine

(i) modulation index. **(01 marks)**

(ii) the side bands produced. **(02 marks)**

(iii) Draw the corresponding frequency spectrum of amplitude modulated signal. (02 marks)