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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, $g = 9.8 \text{ m/s}^2$.
 - (b) Co-efficient of thermal conductivity of thermacole is 0.01 *J/smK*.
 - (c) Charge of an electron, $e = 1.6 \times 10^{-19}$ C.
 - (d) Radius of the earth, $Re = 6.4 \times 10^6 \text{ m}$.
 - (e) Heat of fusion of water = $335 \times 10^3 J/kg$.
 - (f) Stefan's constant, $\sigma = 5.67 \times 10^{-8} \text{ Wm}^{-2}\text{K}^{-4}$.
 - (g) Universal gas constant, $R = 8.314 \text{ Jmol}^{-1}\text{K}^{-1} = 0.0821 \text{ atmdm}^3\text{mol}^{-1}\text{K}^{-1}$.
 - (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 30° with the horizontal, **B** is projected with velocity of 30 m/s at the ground vertically below **A** making an angle of 60° 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 30° 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 = Aθ + Bθ² Where, E is the e.m.f. and θ is the temperature difference.
 Find the values of A and B in the equation.
 - (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)
- 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 cm²? (03 marks)
 - (b) (i) The specific heat capacities of air are 1 040 Jkg⁻¹K⁻¹ when measured at constant pressure and 840 Jkg⁻¹K⁻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 $1/10^{\text{th}}$ 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 m², v = 36 km/h and the density of air is 1.2 kg m⁻³. What is the electrical power produced? (04 marks)

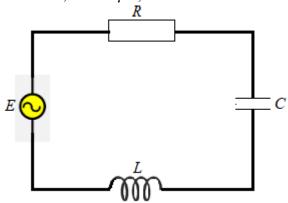
SECTION B (30 Marks)

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 m³ 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 μ F, 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) $\operatorname{cell} \mathbf{A}$. (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 k Ω is 2 V. Suppose the current amplification factor of the transistor is 100. If the base resistance is 1 k Ω , 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)