THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATIONS

131/1 **PHYSICS 1**

(For Both School and Private Candidates)

Duration: 3 Hours **ANSWERS** **Year: 2025**

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 choose **two (2)** questions from section B.
3. Marks for each question or part thereof are indicated.
4. Mathematics tables and non-programmable calculators may be used.
5. All writing must be in **black** or **blue** ink except for drawings which must be in pencil
6. Communication devices and any unauthorised materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet(s).
8. The following information may be useful:

(a) Acceleration due to gravity, $g = 9.8\ m/s^2$
(b) Gravitational constant, $G = 6.67 \times 10^{-11}\ Nm^2kg^{-2}$
(c) Mass of earth, $M_E = 6.0 \times 10^{24}\ kg$
(d) Radius of earth, $R_E = 6.4 \times 10^{6}\ m$
(e) Distance of the moon from the earth, $r = 3.8 \times 10^{5}\ km$
(f) Density of water at $25^0C = 1000\ kgm^{-3}$
(g) Specific heat capacity of water is $4200\ Jkg^{-1}K^{-1}$
(h) Density of ice $= 1\ g/cm^3$
(i) Thermal conductivity of ice = 0.005 cal/sec.cm ^{o} C
(j) Latent heat of ice = 80 cal/g
(k) Pie, $\pi = 3.14$

1. (a)(i) Every measuring instrument has its limit of precision because no measurement can be infinitely accurate. Limitations arise due to the smallest scale division of the instrument, human error in reading, and environmental factors such as temperature, pressure, and humidity that affect instrument calibration.

   (ii) Torque (τ) = Force × Distance

   Force = Mass × Acceleration = MLT^{-2}

   Distance = L

   Therefore, dimension of torque = $M\,L^2\,T^{-2}$

   Given $\tau = (\pi\eta r^4\theta) / (2l)$

   Viscosity $\eta = (2l\tau) / (\pi r^4\theta)$

   Dimension of $\eta = (L \times M\,L^2\,T^{-2}) / (L^4) = M\,L^{-1}\,T^{-1}$

   (b) Specific gravity (S) = Wa / (Wa – Ww)

   = 5.0 / (5.0 – 4.0) = 5.0

   Percentage error in S = $(\Delta Wa/Wa + \Delta Wa/Wa–Ww + \Delta Ww/Wa–Ww) \times 100\%$

   = $(0.1/5 + 0.1/1 + 0.1/1) \times 100 = (0.02 + 0.1 + 0.1) \times 100 = 22\%$

2. (a)(i) Tangential acceleration arises due to change in the magnitude of velocity along the circular path, while centripetal acceleration arises due to continuous change in direction of velocity towards the centre of the circle.

   (ii) Given v = 72 km/h = 20 m/s, $a_t = 5\ m/s^2$, r = 100 m

   Centripetal acceleration $ac = v^2 / r = 400 / 100 = 4\ m/s^2$

   Net acceleration $a = \sqrt{(a_t^2 + ac^2)} = \sqrt{(5^2 + 4^2)} = 6.4\ m/s^2$

   Direction = $\tan^{-1}(ac / a_t) = \tan^{-1}(4/5) = 38.7°$ toward the centre.

   (b) The aircraft at height h = 4500 m subtends angle 60°, time = 10 s

   Distance $d = 2h \tan(30°) = 2 \times 4500 \times 0.577 = 5193$ m

   Speed = distance / time = 5193 / 10 = 519.3 m/s

3. (a)(i) Factors affecting SHM include mass of the oscillating body, stiffness of the spring, amplitude of oscillation, damping forces, and external periodic forces.

   (ii) Displacement equation: $x = A \sin(\omega t)$

   $\omega = 2\pi / T = 2\pi / 0.5 = 12.57$ rad/s

   $x = 0.12 \sin(12.57t)$

   (b) In SHM, total energy remains constant. At maximum displacement, potential energy is maximum while kinetic energy is zero. At mean position, kinetic energy is maximum and potential energy is zero.

4. (a)(i) A rigid body continues to rotate with constant angular velocity when there is no external torque acting on it, due to conservation of angular momentum.

   (ii) Work done by torque:

   $W = \int \tau \, d\theta$

   Since $\tau = I\alpha$, $W = \int I\alpha \, d\theta = I\omega^2 / 2 - I\omega_0^2 / 2$

   (b) For a freely rotating disc, angular acceleration $\alpha = \tau / I$

   If no external torque acts, $\tau = 0$, hence $\alpha = 0$.

5. (a)(i) Thermos flasks minimize heat loss by radiation, conduction, and convection using vacuum insulation and silvered surfaces.

   (ii) Metal chairs conduct heat away from the body faster than wooden ones, hence feel colder.

   (iii) Transformers are immersed in oil to cool the coils and act as an insulator.

   (b) For adiabatic process, $T_1V_1^{(\gamma-1)} = T_2V_2^{(\gamma-1)}$

   $V_2/V_1 = (T_1/T_2)^{(1/(\gamma-1))} = (300/270)^{(1/0.4)} = 1.3$

   $V_2 = 500 \times 1.3 = 650$ cm³

6. (a)(i) A good absorber appears black because it absorbs all wavelengths of light without reflecting any.

(ii) The black body curves show that radiation intensity increases with temperature, peak wavelength shifts to shorter wavelengths, the area under the curve represents total emitted energy, and no radiation is emitted below absolute zero.

(b) Power = σAT^4

$A = 200\ cm^2 = 0.02\ m^2$, $T = 127 + 273 = 400\ K$

$\sigma = 5.67 \times 10^{-8}\ W/m^2K^4$

$E = 5.67 \times 10^{-8} \times 0.02 \times 400^4 \times 60 = 4.36 \times 10^3\ J$

7. (a)(i) Greenhouse effect is the natural process of trapping heat in the atmosphere by gases like CO_2 and CH_4, while global warming is the rise in Earth's average temperature due to excessive greenhouse gases.
   (ii) Human activities include burning fossil fuels, deforestation, industrial emissions, and poor waste management.

   (b)(i) Warning signs of earthquakes include unusual animal behavior and sudden ground vibrations recorded by seismographs.
   (ii) The troposphere provides weather and breathable air, while the stratosphere contains the ozone layer that protects from harmful UV radiation.

8. (a)(i) Series circuit of resistor (25 Ω) and inductor (0.4 H, 5 Ω).
   (ii) Total resistance $R = 25 + 5 = 30\ \Omega$,
   Inductive reactance $X_L = 2\pi fL = 2\pi \times 50 \times 0.4 = 125.6\ \Omega$
   Impedance $Z = \sqrt{(R^2 + X_L^2)} = \sqrt{(30^2 + 125.6^2)} = 129.1\ \Omega$
   Current $I = V / Z = 200 / 129.1 = 1.55\ A$

   (b)(i) Equivalent resistance and current depend on the network diagram (not shown).

   8(b)(i)
   $R_T = R1 + r$
   $R_T = 100\Omega + 75/4\Omega$
   $R_T = 475/4\Omega$

RT = 118.75Ω

∴ Equivalent resistance is 118.75Ω

(ii) Current passing through R2.

But since I = Total current,

I = E / RT

E = 6V

RT = 118.75Ω

I = 6V / 118.75Ω

∴ I = 0.0505A

8(b)(ii) Consider

Re = (R3 × R4) / (R3 + R4)

Re = (50Ω × 75Ω) / (50Ω + 75Ω)

∴ Re = 30Ω

Using KVL in loop 1

E − IR1 − I1R2 = 0

E = IR1 + I1R2

6 = (0.0505 × 100) + I1 × 50

6 − (0.0505 × 100) = 50I1

0.95 = 50I1

I1 = 0.019A

∴ Current through R2 is 0.019A.

8(c) Given

(i) By using Kirchhoff's voltage law (KVL):

7V − 5V − 3I − I = 0

$2V = 4I$

$I = 0.5A$

Using KVL for small loop:

$VAC - I + 7 = 0$

$VAC - 0.5 + 7 = 0$

$VAC = 6.5V$

∴ Potential difference between A and C is 6.5 volts.

8(c)(ii) Potential decreases from A to B because some of it drops across the 1Ω resistor.

Potential drop = IR

$= 0.5A \times 1\Omega$

$= 0.5V$

∴ 0.5V drops at the 1Ω resistor.

9. (a)(i) A transistor acts as an open switch when the base current is zero, meaning it is in cutoff mode.

   (ii) Voltage across capacitor C is determined by charge Q = CV.

(b)(i) Characteristics of an op-amp include very high input impedance and very high gain.

(ii) Output voltage VO = A(V+ – V−).

(c)(i) Integrated circuits save space and energy.

(ii) A p-n junction operates when electrons and holes diffuse across the junction forming a depletion layer allowing current flow in one direction.

10. (a)(i) truth tables

A	B	X	Y
0	0	1	0
0	1	1	0
1	0	1	0
1	1	0	1

(ii)

A	B	A'	B'	Y
0	0	1	1	0
0	1	1	0	1
1	0	0	1	1
1	1	0	0	1

(b)(i) A voltage follower is an op-amp circuit with unity gain used for buffering signals.

(ii) Factors in designing amplifiers include gain stability, frequency response, and input/output impedance.

(c)(i) The input and output characteristics of a common-base transistor show collector current versus collector voltage and base current versus base-emitter voltage.

(ii) $\alpha = Ic / Ie = 0.9$, hence $Ie = Ic / \alpha = 10 / 0.9 = 11.1$ mA

Base current $Ib = Ie – Ic = 11.1 – 10 = 1.1$ mA.