THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL
ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

131/1 **PHYSICS 1**
(For both School and Private Candidates)

Time 2½ Hours **10 May 2000 A.M.**

Instructions

1. This paper consists of sections A, B and C.
2. Answer any FOUR questions in section A and any THREE questions from each of sections B and C, making a total of 10 questions.
3. Write your examination number on every page of your answer booklet provided.
4. The marks for each question or part thereof are given in brackets.
5. Mathematical tables, slide rules and calculators may be used.
6. You may use the following information if needed.

Acceleration due to gravity	$g = 9.8\ m/s^2$.
Electric charge	$e = 1.6 \times 10^{-19}c$
Mass of an electron	$Me = 9.1 \times 10^{-31}kg$
Mass of a proton	$Mp = 1.67 \times 10^{-27}kg$
Pi	$\pi = 3.14$

SECTION A (40 MARKS)

Answer any four questions from this section.

1. (a) (i) What is an error? Mention two causes of systematic and two causes of random errors. (2 marks)

(ii) The pressure P is calculated from the relation $P = \frac{F}{\pi R^2}$ where F is the force and R the radius. If the percentage possible errors are ± 2% for F and ± 1% for R. Calculate the possible percentage error for P. (2 marks)

(b) The speed v of a wave is found to depend on the tension T in the string and the mass per unit length μ (linear mass density). Using dimensional analysis derive the relationship between v, T and μ. (3 marks)

(c) The longitudinal wave speed in gases is given by $v = \sqrt{\gamma p/\rho}$; where $\gamma = \frac{C_p}{C_v}$, P is the pressure and ρ the density of gas. If v_1 and v_2 are the speeds of sound in air at temperature T_1 and T_2 respectively, show that $\frac{v_1}{v_2} = \sqrt{T_1/T_2}$

NOTE: C_p and C_v are the specific heats of the gas at constant pressure and constant volume respectively. (3 marks)

2. (a) Show that the period of a body of mass m revolving in a horizontal circle with constant velocity v at the end of a string of length l is independent of the mass of the object. (3 marks)

(b) A ball of mass 100g is attached to the end of a string and is swung in a circle of radius 100cm at a constant velocity of 200cm/s. While in motion the string is shortened to 50cm. Calculate:
(i) the new velocity of the motion.
(ii) the new period of the motion. (4 marks)

(c) A car travels over a humpback bridge of radius of curvature 45m. Calculate the maximum speed of the car if the wheels are to remain in contact with the bridge. (3 marks)

3. (a) Mention two motions that add up to make projectile motion. (1 marks)

(b) (i) In long jumps does it matter how high you jump? State the factors which determine the span of the jump. (2 marks)
(ii) Derive an expression that relates the span of the jump and the factors you have mentioned. (3 marks)

(d) A bullet is fired from a gun on the top of a cliff 140m high with a velocity of 150m/s at an elevation of 30° to the horizontal. Find the horizontal distance from the foot of a cliff to the point where the bullet lands on the ground. (4 marks)

4. (a) Define simple harmonic motion. (2 marks)

(b) Two simple pendulums of length 0.4m and 0.6m respectively are set oscillating in step.
(i) After what further time will the two pendulums be in step again? (3 marks)

(ii) Find the number of oscillations made by each pendulum during the time in (i) above. (2 marks)

(c) Cite two examples of SHM which are of importance to everyday life experience. (2 marks)

5. (a) What does one require in order to establish a scale of temperature? (2 marks)

(b) A copper-constantan thermocouple with its cold junction at 0°C had an emf of 4.28mV when its other hot junction was at 100°C. The emf became 9.29mV when the temperature of the hot junction was 200°C. If the emf E is related to the temperature difference θ between hot and cold junctions by the equation $E = A\theta + B\theta^2$, calculate:

(i) the values of A and B.

(ii) the range of temperature for which E may be assumed proportional to θ without incurring an error of more than 1%. (4 marks)

(c) The resistance R_t of a platinum varies with temperature t according to the equation $R_t = R_0(1 + 8000bt - bt^2)$ where b is a constant. Calculate the temperature on platinum scale corresponding to 400°C on the gas scale. (4 marks)

6. (a) Define the thermal conductivity of a material (2 marks)

(b) Write down a formula for the rate of cooling under natural convection and define all the symbols used. (2 marks)

(c) Heat is supplied at a rate of 80W to one end of a well lagged copper bar of uniform cross section area $10cm^2$ having a total length of 20cm. The heat is removed by water cooling at the other end of the bar. Temperature recorded by two thermometers T_1 and T_2 at distances 5cm and 15cm from the hot end are 48°C and 28°C respectively.

(i) Calculate the thermal conductivity of copper. (2 marks)

(ii) Estimate the rate of flow (in g/min) of cooling water sufficient for the water temperature to rise 5K. (2 marks)

(iii) What is the temperature at the cold end of the bar? (2 marks)

SECTION B (30 Marks)

Answer any THREE questions from this section.

7. (a) What vibrates in the following types of wave motion?

(i) Light waves

(ii) Sound waves

(iii) X-rays

(iv) Water waves. (2 marks)

(b) A plane progressive wave on a water surface is given by the equation $y = 2 \sin 2x(100t - \frac{x}{30})$; where x is the distance covered in a time t. x, y and t are in cm and seconds respectively.

Find:

(i) the wavelength, and frequency of the wave motion. (2 marks)

(ii) the phase difference between two points on the water surface that are 60cm apart. (1 mark)

(c) (i) Show how wavelength and frequency of a wave are related. (1 mark)

(ii) Two open organ pipes of length 50cm and 51cm respectively give beat frequency of 6.0Hz when sounding their fundamental notes together, neglecting end corrections. What value does this give for the velocity of sound in air? (4 marks)

8. (a) (i) What is electric potential at a point in an electrostatic field? (1 mark)

(ii) Derive an expression for an electric potential at a point a distance a from a positive point charge Q. (3 marks)

(b) Positive charge is distributed over a solid spherical volume of radius R and the charge per unit volume is σ

(i) Show that the electric field inside the volume at a distance r < R from the centre is given by $E = \frac{\sigma r}{3\varepsilon_o}$ (3 marks)

(ii) What is the electric field at a point r > R (i.e. outside the spherical volume). (3 marks)

9. (a) What is meant by the terms electrical resistivity and ohmic conductor. (1 mark)

(b) A 4m long resistance wire has a cross-sectional area of $0.8mm^2$ and has a resistance of 2.80Ω. Determine:

(i) the resistivity of the wire. (1 mark)

(ii) the length of a similar wire which when joined in parallel will give a total resistance of 2.0Ω. (2 marks)

(c) (i) State Kirchhoff's laws of electric circuits. (2 marks)

(ii) Two cells of emf 1.5V and 2.0V and internal resistances of 1Ω and 2.0Ω respecitvely are connected in parallel and across them an external resistance of 5.0Ω. Calculate the currents in each of the three branches of the network. (4 marks)

10. (a) An electron with charge e and mass m_e is initially projected with a speed v at right angles to a uniform magnetic field of flux density B.

(i) Explain why the path of the electron is circular. (2 marks)

(ii) Show also that the time to describe one complete circle is independent of the speed of the electron. (3 marks)

(b) Calculate the radius of the path traversed by an electron of energy 450 eV moving at right angles to a uniform magnetic field of flux density 1.5×10^{-3}T (5 marks)

SECTION C (30 Marks)

Answer any THREE (3) questions from this section.

11. (a) Distinguish between metals and semiconductors in terms of energy bands. (3 marks)

(b) Briefly discuss the formation of the potential difference barrier (depletion layer) of a p-n junction diode. (2 marks)

(c) (i) What is a rectifier? (2 marks)

(ii) Using p-n junction diodes, draw the arrangement of a full-wave rectifier and briefly explain how it works. (3 marks)

12. (a) Define the electron - volt. (1 mark)

(b) Electrons in a certain television tube are accelerated through a potential difference of 2.0kV

(i) Calculate the velocity acquired by the electrons. (2 marks)

(ii) If these electrons lose all their energy on impact and given that 10^{12} electrons pass per second in the TV tube, calculate the power dissipated. (2 marks)

(c) (i) Explain why Audio amplification is necessary for a practical radio set. (2 marks)

(ii) A coil and a capacitor in parallel are used to make a tuning circuit for a radio receiver. Sketch the resonance curve for the circuit. State two ways of changing the circuit to increase the resonant frequency. (3 marks)

13. (a) Mention any three uses of a CRO. (3 marks)

(b) A proton is placed in a uniform electric field E. What must be the magnitude and direction of the field if the electrostatic force acting on the proton is just to balance its weight? (3 marks)

(c) A small charged oil drop is allowed to fall under gravity in the Millikan experiment, it is then made to remain stationary under the application of an electric field. Show that the charge Q of the oil drop is given by

$$Q = \frac{6\pi\eta}{E}\left(\frac{9\eta v}{2(\rho_o - \rho_a)g}\right)^{1/2}(v - v')$$

where η is the coefficient of viscosity of air, v the terminal velocity, ρ_o, ρ_a densities of air and oil respectively and v' the new terminal velocity. (4 marks)

14. (a) With reference to an earthquake on a certain point of the earth explain the terms 'Focus' and 'Epicentre'. (2 marks)

(b) What is the importance of the following layers of the atmosphere?

(i) The lowest layer

(ii) The ionosphere. (3 marks)

(c) (i) Describe two ways by which seismic waves may be produced.

(ii) Describe briefly the meaning and application of "seismic prospecting". (5 marks)