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: $2^1/_2$ Hours **Thursday 02 May 2002 p.m.**

Instructions

1. This paper consists of sections A, B and C.
2. Answer any **FOUR (4)** questions from section A and any **THREE (3)** questions from each of **sections** B and C.
3. Marks for each question or part thereof are indicated beside the question.
4. Mathematical tables and non-programmable calculators may be used.
5. Cellular phones are **not** allowed in the examination room.
6. Write your examination number on every page of your answer booklet.
7. The following information may be useful:

   (a) Acceleration due to gravity, $g = 9.8\ ms^{-2}$.
   (b) Specific heat capacity of copper $= 400\ Jkg^{-1}K^{-1}$
   (c) Thermal conductivity of copper, $c = 360\ Wm^{-1}K^{-1}$
   (d) Speed of light, $c = 3 \times 10^8\ m/s$
   (e) Electronic charge, $e = -1.6 \times 10^{-19}\ C$
   (f) Mass of an electron, $m_e = 9.1 \times 10^{-31}\ kg$
   (g) Rydberg's Constant, $R = 1.1 \times 10^7\ m^{-1}$.

This paper consists of 6 printed pages.

SECTION A (40 Marks)

Answer **FOUR (4)** questions from this section.

1. (a) (i) Explain briefly the meaning of an error and a mistake. (01 mark)

(ii) The resistivity ρ of the material of a wire of resistance R, length ℓ and diameter d, is given by $\rho = \frac{R \pi d^2}{4\ell}$

Derive the expression of the percentage error in the resistivity ρ. (03 marks)

(b) (i) What are dimensional equations? State any two uses of dimensional equations. (02 marks)

(ii) A gas bubble from an explosion under water is found to oscillate with a period T, which is proportional to P^a, d^b and E^c where P is the pressure, d is the density and E is energy of the explosion. Find the values of a, b and c; hence determine the units of the constant of proportionality. (04 marks)

2. (a) (i) State Newton's laws of motion . (01 ½ marks)

(ii) A bullet whose mass is 15 g is fired horizontally into a 3 kg block of wood suspended by a long cord. The bullet sticks in the block. Compute the initial velocity of the bullet if the impact causes the block to swing 10 cm above the initial level. (03 ½ marks)

(b) A car of mass 1000 kg tows a caravan of mass 600 kg up a road which rises 1.0 m vertically for every 20 m of its length. There are constant frictional forces of 200 N and 100 N to the motion of the car and to the motion of the caravan respectively. The combination has an acceleration of 1.2 m/s^2 with the engine exerting a constant driving force. Find:

(i) the driving force (02 ½ marks)

(ii) the tension in the tow bar. (02 ½ marks)

3. (a) (i) What is meant by the terms projectile and trajectory? (02 marks)

(ii) A package of medical supplies is released from a small plane flying over an isolated jungle settlement. The plane flies horizontally with a speed of 20 ms^{-1} at an altitude of 20 m. Where will the package strike the ground? (02 marks)

(b) A ball is thrown with an initial velocity, Vo, of 48 m/s directed at an angle, θ, of 37° with the vertical. Find:

(i) the x– and y– components of Vo (01 mark)

(ii) the position of the ball and the magnitude and direction of its velocity when t = 2 sec (02 marks)

(iii) the highest point of the ball and the time taken to reach there (02 mark)

(iv) the range of the ball. (01 mark)

4. (a) (i) A mass m (kg) is attached to the end of a spring of force constant k (Nm^{-1}). Show that $k = m\omega^2$, where ω is the angular velocity. (02 marks)

(ii) From the equilibrium position a particle oscillating in a SHM is displaced by a distance x measured in metres, given by equation $x = 0.08 \sin 9t$, where t is time in seconds measured from an instant when $x = 0$. Determine the period of oscillations and maximum acceleration of the particle. (03 marks)

(b) A body oscillates vertically in simple harmonic motion with an amplitude of 30 mm and a frequency of 5.0 Hz. Calculate the acceleration of the particle:

(i) at the extremities of the motion (02 marks)

(ii) at the centre of the motion (01 mark)

(iii) at the position midway between the centre and the extremity. (02 marks)

5. (a) (i) Define thermodynamic temperature scale. (01 mark)

(ii) How is thermodynamic temperature denoted and what is its SI unit? (01 mark)

(iii) Explain why a gas thermometer is seldom used for temperature measurement in the Laboratory. (01 mark)

(b) Study the table below and answer the questions which follow:

Type of thermometer	Property	Value of property		
		Ice point	Steam point	Room temperature
Gas	Pressure in mmHg	760.0	1240.0	895.0
Thermistor	Current in mA	12.0	70.0	28.0

(i) Calculate the temperature of the room for each thermometer. (02 marks)

(ii) Explain why the thermometers disagree in their value for room temperature. (02 marks)

(iii) What are the advantages of gas thermometers over liquid - in- glass thermometers? (03 marks)

6. (a) (i) The thermal conductivity β of a substance may be defined by the equation

$$\frac{dQ}{dt} = -\beta A \frac{d\theta}{dx}$$

Identify briefly each term in this equation, and explain the minus sign. (03 marks)

(ii) Describe briefly one method of measuring the thermal conductivity of a bad conductor in the form of a disc. (04 marks)

(b) One end of a lagged copper rod is placed in a steam chest and a 0.6 kg mass of copper is attached to the other end of the rod which has an area of 2 cm^2. When steam at 100 °C is passed into the chest and a steady state is reached the temperature of the mass of copper rises by 4 °C per minute. If the temperature of the surrounding is 15 °C, calculate the length of the rod. (03 marks)

SECTION B (30 Marks)

Answer THREE (3) questions from this section

7. (a) (i) Give three basic differences between light waves and sound waves. (02 marks)

(ii) A vibrator attached and resting on the surface of water generates plane water-waves and its propagation is found to take 50 seconds to reach a floating cork 65 cm away. If the cork subsquently vibrates with SHM of a period 3.8 seconds, determine the wave-length of the water-waves produced by the vibrator. (03 marks)

(b) Part of a beam of light incident on a transparent rectangular glass prism of refractive index 1.5 is refracted and the other is reflected. If both, the refracted and reflected rays, are perpendicular to one another, determine:

(i) the angle of refraction (03 marks)

(ii) the velocity of the light beam in a glass. (02 marks)

8. (a) (i) State the Ohms law and define the resistivity of a material and its unit. (01½ marks)

(ii) Show that the resistance R of a conductor is given by:-

$$R = \frac{m\ell}{ne^2tA}$$

where
- m = the mass of the electron
- n = number of free electrons
- ℓ = the length of the conductor
- t = time
- A = cross sectional area
- e = the charge. (03½ marks)

(b) Two electric – light bulbs both marked 0.3 A, 4.5 V are connected (a) in parallel (b) in series, across a 4.5 V battery of negligible internal resistance. Assume that the resistance of the filament does not change in each case.

(i) State what might be seen (01 mark)
(ii) Calculate the current through each bulb (03 marks)
(iii) Calculate the current supplied by the battery. (01 mark)

9. (a) (i) Define flux and state its unit (02 marks)

(ii) A circular metal disc with a radius of 10 cm rotates at 10 revolutions per second. If the disc is in a uniform magnetic field of 0.020 T at right angles to the plane of the disc, calculate the e.m.f. induced between the centre and rim of the disc. (04 marks)

(b) A search coil with 20 turns, each of area $2.0\ 10^{-4}\ m^2$ is connected to aballistic galganometer, the total circuit resistance being 100 Ω. What charge will flow through the galvanometer when the coil is moved from a region, where the flux density at right angles to the plane of the coil is 0.10 T to a region where it is negligible? (04 marks)

10. (a) (i) What is the logic gate? (02 marks)

(ii) Draw the truth table of the circuit below (Figure 1), showing all values of A, B, C, D, E and F.

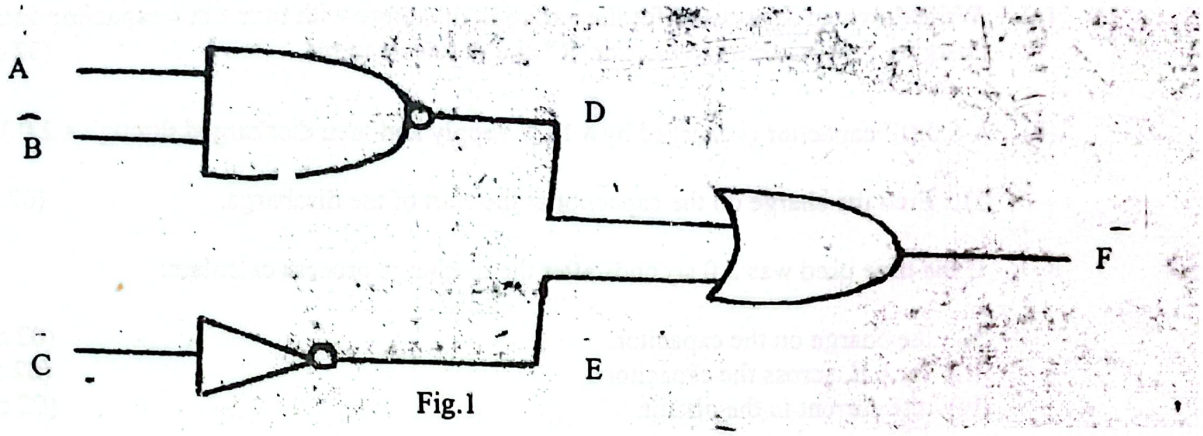

Fig.1

(b) Figure 2 below is an operational amplifier circuit where $R_1 = R_3 = 10\ k\Omega$ and $R_2 = 10\ R_1$

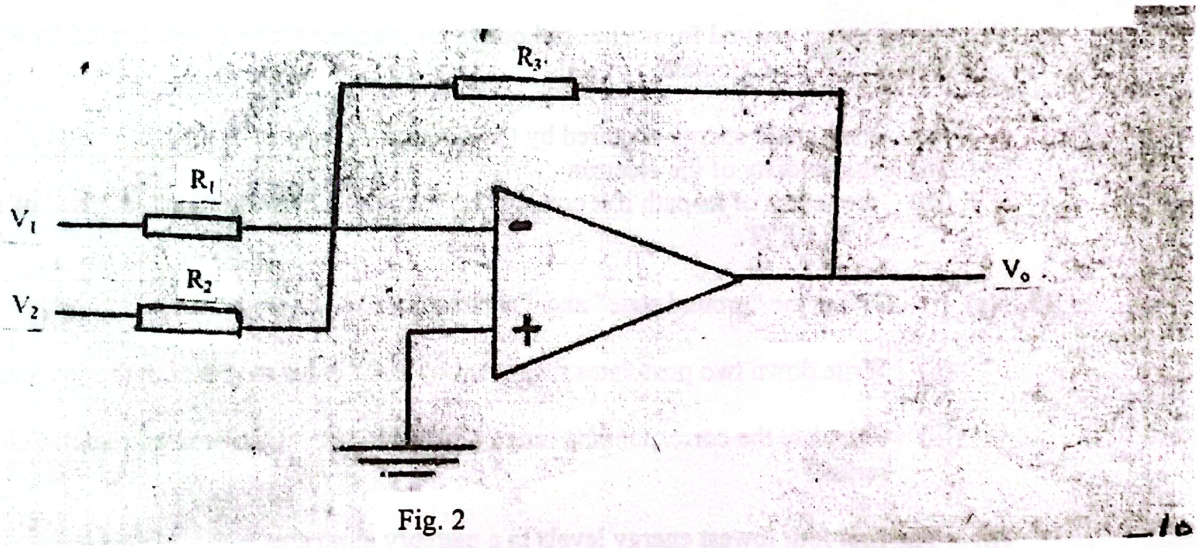

Fig. 2

(i) Determine the output voltage Vo if the input voltages $V_1 = 3.0$ V and $V_2 = 5.0$ V. (04 marks)

(ii) Name the practical use of such a circuit. (01 mark)

SECTION C (30 Marks)

Answer THREE (3) questions from this section.

11. (a) Write down an expression for the variation of charge with time t in a capacitor during the charging process through resistor R" and define its terms. (02 marks)

(b) A 5.0 μF capacitor is charged by a 12 V supply and then discharged through a 2.0 MΩ resistor.

(i) Find the charge on the capacitor at the start of the discharge. (02 marks)

If the time used was 5.0 seconds after the discharge process calculate:

(ii) the charge on the capacitor (02 marks)
(iii) the p.d. across the capacitor (02 marks)
(iv) the current in the circuit. (02 marks)

12. (a) Show that the path followed by an electron of charge e and mass m moving horizontally at a speed v at right angles to an electric field E is a parabola. . (05 marks)

(b) An electron emitted from a hot cathode in an evacuated tube is accelerated by a p.d. of 1.0×10^3 V. Calculate:

(i) the kinetic energy acquired by the electron (01 mark)
(ii) the velocity of the electron (02 marks)
(iii) the radius of its path if it enters at right angles a uniform magnetic field of flux density 1×10^{-3} T. (02 marks)

13. (a) (i) Define the "ground state" and "excited state" of an atom. (01 mark)

(ii) Write down two postulates suggested by Bohr in his model of hydrogen atom. (02 marks)

(iii) Calculate the corresponding range of frequencies for the emitted radiation in the Lyman series. (03 marks)

(b) The first four lowest energy levels in a mercury atom are:

–10.4 eV; –5.5 eV ; –3.7 eV and –1.6 eV

Calculate the ionization energy of mercury.

(c) What is likely to happen if a mercury atom in the ground state is bombarded with an electron of energy

(i) 4.4 eV
(ii) 6.7 eV
(iii) 11.2 eV?

(03 marks)

14. (a) (i) What is the importance of ionosphere to mankind? (02 marks)

(ii) Explain why transmission of radio waves is better at night than at day time. (03 marks)

(b) (i) What is an earthquake? (01 mark)
(ii) Explain briefly any four (4) causes of earthquake. (04 marks)