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 Hours 30 Minutes **Monday 03 May 2004 p.m.**

Instructions

1. This paper consists of sections A, B and C.
2. Answer **four** questions from section A and **three** questions from each of sections B and C.
3. All questions carry equal marks.
4. Mathematical tables and unprogrammable 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(s)
7. The following information may be useful.

(a)	Acceleration due to gravity	g	=	$9.8\ ms^{-2}$
(b)	Mass of electron	m_e	=	9.1×10^{-31} kg.
(c)	Charge of electron	e	=	1.6×10^{-19} C
(d)	Plancks constant	h	=	6.62×10^{-34} Js
(e)	Speed of light in vacuo	c	=	$3.0 \times 10^{8}\ ms^{-1}$
(f)	Avogadro's constant	N_A	=	6.02×10^{23}
(g)	Unified atomic mass unit	u	=	931 MeV.

This paper consists of 7 printed pages.

SECTION A (40 marks)

Answer four (4) questions from this section.

1. (a) (i) What is meant by the term "dimensions of a physical quantity?" (01 mark)

(ii) Give two uses of dimensional analysis. (01 mark)

(iii) Use the method of dimensions to obtain the relationship between the lift force per unit wingspan on an aircraft wing of width L moving with velocity v through air of density ρ on the parameters L, v and ρ. (03 marks)

(b) (i) Distinguish between systematic and random errors in the measurement of a physical quantity. (01 mark)

(ii) In an experiment to determine the Young's Modulus for steel, a student recorded the following measurements.

length ℓ, of the wire = 3.25 ± 0.005 m
diameter d of the wire = 0.63 ± 0.02 mm
force F on the wire = 26.5 ± 0.1 N
extension, e, produced = 1.40 ± 0.05 mm.

Calculate the Young's modulus of the wire from these measurements, and its corresponding error. (04 marks)

2. (a) (i) Give two examples of projectiles and describe their trajectories in a cartesian coordinate system. (02 marks)

(ii) Show that the maximum range of a projectile of fixed initial speed μ is obtained when it is launched at an angle of 45° to the horizontal (ignoring the effects of air resistance). (03 marks)

(b) A stone is projected horizontally with velocity 3.0 cm^3 from the top of a vertical cliff 200 m high. Calculate:

(i) the time it takes to reach the ground. (02 marks)

(ii) its distance from the foot of the cliff. (01 mark)

(iii) its vertical and horizontal components of velocity when it hits the ground. (02 marks)

3. (a) Define surface tension in a liquid and state its SI unit. (01½ marks)

(b) Explain the following phenomena with reference to surface tension and capillarity:

(i) When raindrops fall on a greasy glass surface, the water drops bounce off without wetting the surface. (01½ marks)

(ii) Soap solution is sometimes used in gardener's solution for spraying the leaves of plants in order to increase the wetting nature of the solution. (01 mark)

(c) (i) Discuss how the rise of water in a capillary tube is used to determine the surface tension of water. (02½ marks)

(ii) A column of mercury with a length L = 20 cm is in the middle of a horizontal capillary tube evacuated and soldered at both ends. If the capillary tube is placed vertically, the mercury column shifts through a distance ΔL = 10 cm. Determine the pressure at which the capillary tube was evacuated.
[assume the length of the tube L = 1 m] (03½ marks)

4. (a) (i) Define simple harmonic motion (shm) and describe the terms amplitude, period and frequency as applied to shm. **(02½ marks)**

(ii) Explain what is responsible for the continual interchange of p.e. and k.e. in a mechanical oscillation. At what points in shm is the acceleration greatest? Where is it least? **(02 marks)**

(b) A small mass of 200 g is attached to one end of a helical spring and produces an extension of 15 mm. The mass is now set into oscillation of amplitude 10 mm. Calculate the

(i) period of oscillation. **(01 mark)**

(ii) velocity of the system as it passes the equilibrium point. **(02 marks)**

(iii) maximum k.e. of the system. **(01 mark)**

(iv) potential energy of the spring when the mass is 5 mm below the centre of oscillation. **(01½ marks)**

5. (a) (i) What is the difference between the Kelvin temperature scale and the celcius temperature scale? **(01 mark)**

(ii) A copper – constantan thermocouple with its cold junction at ice point had an emf of 4.28 mV with its other junction at 100° C. The emf became 9.29 mV when the temperature difference was 200° C. Find the values of A and B in the equation $E = A\theta + B\theta^2$ where E is the emf and θ the temperature difference. **(04 marks)**

(b) (i) What is meant by temperature gradient? **(0½ mark)**

(ii) The ends of a straight uniform metal rod are maintained at temperatures of 100°C and 20° C, the room temperature being below 20° C. Draw sketch-graphs of the variation of the temperatures of the rod along its length when the surface of the rod is

- lagged
- coated with soot
- polished **(04½ marks)**

Give a qualitative explanation of the form of the graphs.

6. (a) (i) What is a black body? **(1 mark)**

(ii) State Wien's Law and Stefan's law for black body radiation. **(02 marks)**

(iii) If the radiated power per nanometer wavelength from the sun peaks at 490 nm, estimate the temperature of the sun's surface assuming the sun to radiate as a black body and that Wiens' constant is 2.93×10^{-3} mK. **(02 marks)**

(b) What is Prevost's theory of heat exchanges? **(01 mark)**

(c) A cube of side 0.01 m has a surface which gives 50% of the emission of a black body at the same temperature. If the temperature of the cube is 700° C,

(i) Calculate the power radiated by the cube. **(2 marks)**

(ii) If the same power in 6(c) (i) above is given by a black body sphere at 300° C, what would its diameter be? **(2 marks)**
(Take Stefans constant to be 5.7×10^{-8} w/m²/T⁴)

SECTION B (30 marks)

Answer three (3) questions from this section.

7. (a) (i) Distinguish between longitudinal and transverse wave motion and give an example of each. **(03 marks)**

A plane wave traveling in a medium along the x – direction is described by the equation y = a sin (wt – kx) where y is the displacement at a time and t a distance x from the origin.

(ii) Write the equation of an identical wave traveling in the opposite direction. **(0½ mark)**

(iii) If $a = 1.5 \times 10^{-6}$ m, $w = 600\ s^{-1}$ and $k = 6 \times 10^{-3}$ m, find the frequency, the amplitude and the wave speed. **(02½ marks)**

(b) (i) How is it possible to hear a sounding flute or a vibrating string of a musical instrument? **(0½ mark)**

(ii) A sonometer wire is stretched by hanging a metal cylinder of density 8000 kgm^{-3} at the end of the wire. A fundamental note of frequency 256 is sounded when the wire is plucked. Calculate the frequency of vibration of the same length of wire when a vessel of water is placed such that the metal cylinder is totally immersed in water. **(03½ marks)**

8. (a) (i) Differentiate between an ohmic conductor and a non-ohmic conductor giving an example for each. **(02 marks)**

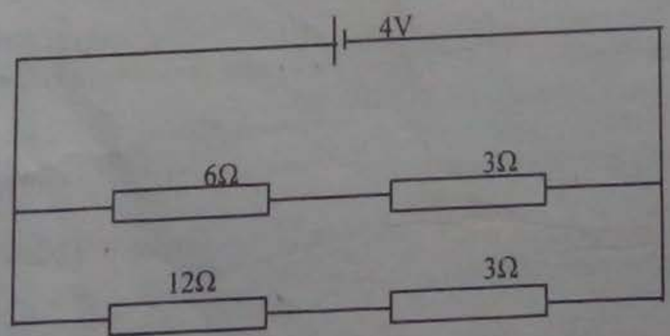
(ii) Define the terms "resistivity" and "conductivity" for a conductor. **(01½ marks)**

(b) A resistance wire of length 20 m has a diameter of 0.62 mm and a resistance of 12 Ω. Calculate:

(i) its resistivity and its conductivity, **(02½ marks)**

(ii) the length of another wire of the same diameter and material which when joined in parallel will give a total resistance of 8 Ω. **(02 marks)**

(c) In the circuit shown below, what is the current through the 6 Ω resistor? **(02 marks)**



9\. (a) (i) Define magnetic flux and state its SI unit. **(01½ marks)**

(ii) Describe how a permanent magnet and a current in a conductor can be used to demostrate electromagnetic induction (in both cases explain the production of an induced emf in terms of flux linkage). **(02 marks)**

(b) (i) State the laws of electromagnetic induction. **(02 marks)**

(ii) Calculate the maximum emf induced in a coil of 500 turns each with an area 4.0 cm^2 which makes 50 revolutions per second in a uniform magnetic field of flux density 0.04 T. **(03 marks)**

(c) What is the total magnetic flux in the middle of a long solenoid of cross sectional area 7.0 cm^2 having 15 turns per cm carrying a current of 4.0 A. **(01½ marks)**

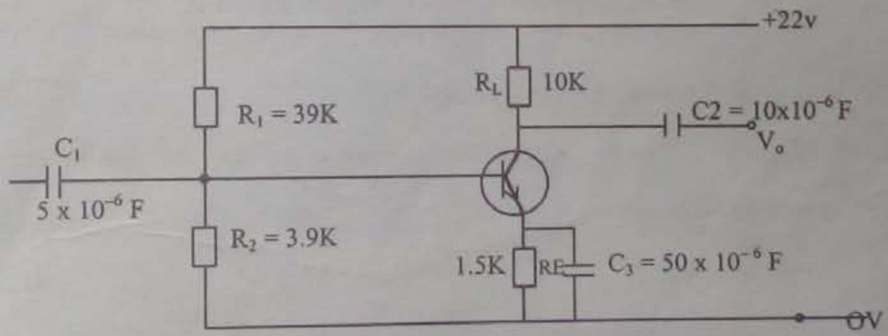
[The magnetic permeability of free space $\mu_o = 4\pi \times 10^{-7}\ Hm^{-1}$]

10\. (a) (i) In the context of semiconductors, what is meant by p-type and n-type materials. What conduction processes occur in such materials when a potential difference is applied across them? **(02 marks)**

(ii) If α is a fraction of charge carriers which are to flow from the emitter to the collector, show that the current gain β (h_{FE}) is

$$\beta = \frac{\alpha}{1-\alpha}$$ **(02 marks)**

(b) Study figure below showing a circuit connection and answer the questions below:



(i) Calculate the p.d. across R_1 and R_2.

(ii) Calculate the value of dc bias voltage V_{CE} and the collector current given that $V_{BE} = 0.7$ V $h_{f_e} = 140$.

(iii) What are the functions of C_1, C_2 and R_E in the circuit? **(06 marks)**

SECTION C (30 marks)

Answer three (3) questions from this section.

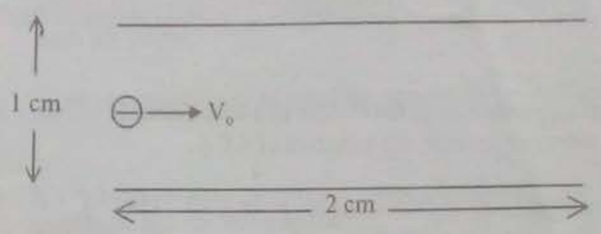
11\. (a) (i) State Coulomb's law, **(01 mark)**

(ii) Two point charges, A and B, are situated 90 mm apart. If A has a charge of +2q and B a charge of –4q, where should a point charge of –2q be placed so that it experiences no resultant electrostatic force? **(03 marks)**

(b) (i) Define electric field strength and state its units. **(01 mark)**

(ii) How is the direction of the field strength specified? **(0½ mark)**

(iii) An electron is projected with an initial velocity $V_o = 10^7 \, ms^{-1}$ into a uniform field between parallel plates as shown below. The direction of the field is vertically downwards if the electron just misses the upper plate as it emerges from the field. Find the magnitude of the field. **(03marks)**



(c) Two small balls are suspended by insulating threads from a common point. Each ball has a mass of 0.20 g and the suspension threads are 1.0 m long. When the balls are given equal positive charge each suspension thread is found to make an angle of 7° with the vertical. What are the charges carried by the two balls? **(01½ marks)**

12. (a) (i) State any four basic properties of X-rays. **(02 marks)**

(ii) Electrons are accelerated from rest through a potential difference of 10,000 V in an X-ray tube.
Calculate:-
- the wavelength of the associated electrons. **(01 mark)**
- the maximum energy of X – radiation generated. **(01 mark)**
- the minimum wavelength of the X – radiation generated **(01 mark)**

(b) State and explain Einstein's photoelectric equation. **(01 mark)**

(c) If a photoemissive surface has a threshold wavelength of 0.65 μm, calculate the

(i) threshold frequency. **(01 mark)**

(ii) work function in eV. **(01½ marks)**

(iii) maximum speed of the electron emitted by violet light of wavelength 0.4 μm. **(01½ marks)**

13. (a) (i) Define the terms '**activity**' and '**half-life**'. **(02marks)**

(ii) the half-life of $_{92}U^{238}$ against alpha decay is 4.5×10^9 years. How many disintegrations per second occur in 1 g of $_{92}U^{235}$? **(02marks)**

(b) Explain the meaning of the following terms:

(i) nuclear fussion,

(ii) nuclear fission,

(iii) chain reaction and

(iv) critical mass. **(02marks)**

If the mass of the deuterium nucleus is 2.015 u, that of one isotope of helium is 3.017 u and that of the neutron is 1.009 u. Calculate the energy released by the fusion of 1 kg of deuterium. Suppose 50% of this energy was used to produce 1MW of electricity continuously, for how many days would the station be able to function? **(04 marks)**

14. (a) (i) Explain the terms epicentre and focus as applied to earthquake. **(02 marks)**

(ii) State any four (4) indicators that may predict the occurrence of an earthquake. **(02 marks)**

(iii) State and explain two types of variations of the earth's magnetic field. **(02 marks)**

(iv) State one necessary precaution to be taken by people living in a region with a high risk of occurrence of earthquakes. **(01mark)**

(b) Explain the following:

(i) Solar wind. **(01mark)**

(ii) Magnetopause. **(01mark)**

(iii) Ionosphere. **(01mark)**