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

131/2

PHYSICS 2
(For Both School and Private Candidates)

Time: 2 Hours 30 Minutes ***Monday, March 21, 2005 a.m.***

Instructions

1. This paper consists of sections A, B and C.
2. Answer ***five (5)*** questions choosing at least ***one (1)*** question from each section .
3. Marks for each question or part thereof are given beside each question.
4. Cellular phones are ***not*** allowed in the examination room.
5. Write your ***Examination Number*** on every page of your answer booklet(s).
6. The following constants may be important.
   (a) Acceleration due to gravity, $g = 9.8\ m/s^2$.
   (b) Gravitational constant, $G = 6.7 \times 10^{11}\ Nm^{-1}\ Kg^{-2}$.
   (c) Stefan's constant, $\sigma = 5.67 \times 10^{8}\ Wm^{-2}\ K^{-4}$.
   (d) electronic charge, $e = 1.6 \times 10^{-19}\ C$.
   (e) Permeabity of free space, $\mu_o = 4\pi \times 10^{-7}\ Hm^{-1}$.
   (f) Planck's constant, $h = 6.62 \times 10^{-34}\ Js$
   (g) 1 kg mole $= 6.02 \times 10^{26}$ particles.

SECTION A

Answer at least **one (1)** question from this section.

1. (a) (i) What is meant by viscous drag? **(01mark)**

(ii) With the aid of dimensional analysis, derive an expression relating viscous drag to other relevant parameters leading to Stoke's law. **(05 marks)**

(b) (i) Compare the time taken by two small spheres of the same material to fall the same height through a liquid after reaching their terminal velocity. The diameter of one sphere is three times that of the other. **(04 marks)**

(ii) Deduce the terminal velocity of an oil drop of radius 3×10^{-6} m falling through air. Neglect the density of air. **(05 marks)**

(Take $\eta_{air} = 1.8 \times 10^{-5}$ Pa, density of oil $= 8 \times 10^{2}$ kg m^{-3})

(c) A tank is filled with water to a height H. A small hole is punched at a depth h below the water surface. Show that the distance x from the base of the tank to the point at which the resulting stream strikes the ground is given by $x = 2\sqrt{h(H-h)}$. **(05 marks)**

2. (a) (i) What is a centripetal force?

(ii) Why does a centripetal force not do any work in a circular orbit? **(02 marks)**

(iii) A conical pendulum is an example on which a force acts centripetally, show that the period T is given by $T = 2\pi\sqrt{\ell \cos\theta / g}$. **(05 marks)**

(b) (i) List **two (2)** ways of describing "g" as applied to gravitation. Give its appropriate units in each case. **(04 marks)**

Assuming the earth to be a uniform sphere of radius 6.4×10^{6} m and mass $M_e = 6 \times 10^{24}$ kg calculate the:

(ii) gravitational potential at a point 6×10^{5} m above the earth's surface. **(03 marks)**

(iii) work done in taking a 5.0 kg mass from the earth's surface to a point where the gravitational field of the earth is negligible. **(03 marks)**

(c) What is the binding energy of the earth – sun system? Neglecting the presence of other planets or satellites, calculate the binding energy of this system. **(03 marks)**

(Take mass of sun $M_s = 3.3 \times 10^{5} M_e$, mass of earth $M_e = 6 \times 10^{24}$ kg and radius of earth – sun orbit $r_{es} = 1.5 \times 10^{11}$ m).

3. (a) (i) Write down the Van der Waal's equation and define each term in its usual meaning. **(02 marks)**

(ii) State the assumptions upon which the equation you have written in 3.(a)(i) above is derived from the ideal gas equation. **(02 marks)**

(b) (i) On the basis of the kinetic theory of gases, show that two different gases at the same temperature, will have the same average value of the kinetic energy of the molecules. **(05 marks)**

(ii) Determine the rms speed of air molecules at stp, given that the density of air is 1.29 kg m^{-3}, density of mercury is 13600 kg m^{-3} and the barometric height at stp is 760 mm Hg. **(04 marks)**

(c) Define *mean free path*, λ of the molecules of a gas and state how it is affected by temperature. **(02 marks)**

(d) If the mean free path of molecules of air at 0 °C and 1.0 atmospheric pressure is 2×10^{-7} m, what will the mean free path be at 1.0 atmospheric pressure and 27 °C? **(05 marks)**

4. (a) (i) What is fundamental interval? How would you use it to establish a scale of temperature? **(02 marks)**

(ii) Explain how the Kelvin absolute thermodynamic scale of temperature is defined. **(03 marks)**

(b) (i) State three laws of black body radiation. **(03 marks)**

(ii) The roof which measures 20 m by 50 m is blackened. Find the solar energy incident onto the roof per minute if the temperature of the sun's surface is about 6000 K, given that half of the energy is absorbed while passing through the atmosphere, the roof being normal to the sun's rays. **(05 marks)**

(Radius of sun $R_s = 7.5 \times 10^8$ m, distance of sun – earth, $d = 1.5 \times 10^{11}$ m).

(c) (i) Define *thermal conductivity* of a material and state its units. **(02 marks)**

(ii) What is the rate of flow of heat through a plaster ceiling of dimensions 5 m x 3 m x 15 mm with a 45 mm thick layer of an insulating fibre glass if the inside and outside are at the surrounding air temperatures of 15 °C and 5 °C respectively? **(05 marks)**

SECTION B

Answer at least **one (1)** question from this section.

5. (a) (i) What is the meaning of the terms "coherent waves" and "wave front"? **(02 marks)**

(ii) State three basic differences between interference and diffraction. **(03 marks)**

(iii) Can white light produce interference? **(01 mark)**

(iv) If your answer to 5.(a)(iii) is yes, what will be the outcome? **(01 mark)**

(b) (i) What is polarization? **(01 mark)**

(ii) Explain why light can be polarized but sound can not. **(02 marks)**

(iii) List **three (3)** uses of polaroids and state **three (3)** ways in which light can be polarized. **(02 marks)**

(c) (i) Define the term *diffraction.*

(ii) A diffraction grating has 500 lines per mm when used with monochromatic light of $\lambda = 6 \times 10^{-7}$ m at normal incidence. At what angles will bright diffraction images be observed? (08 marks)

6. (a) (i) Define and give the units of the terms electrochemical equivalent (e.c.e.) and Faraday as applied in electrolysis. (03 marks)

(ii) List **six (6)** important applications of electrolysis. (03 marks)

(b) (i) State Faraday's laws of electrolysis. (02 marks)

(ii) A circuit consists of a solution of a silver salt and a coil of wire of resistance 20 Ω immersed in an oil bath in series. A constant current flows for 10 seconds and deposits 0.0279 g of silver. If the e.c.e. of silver is 1.11×10^{-6} kg C^{-1}, calculate the heat energy developed in the oil bath. (06 marks)

(c) (i) Discuss the back e.m.f. (polarization potential) in a water voltameter with platinum electrodes.

(ii) Calculate the minimum potential difference required for the electrolysis of water, if 3800 J are required to decompose 1.0 g of water.

Take e.c.e. of hydrogen = 1045×10^{-8} g C^{-1}

e.c.e. of oxygen = 8293×10^{-8} g C^{-1}

(iii) Can a Daniel cell or a single Lenclanche's cell electrolyse water? (06 marks)

7. (a) (i) Define *root mean square current* hence show that it is represented by an equation $I_r = 0.7071\, I_o$ with I_r and I_o in their usual meaning. (03 marks)

(ii) If the effective current in a 50 Hz AC circuit is 50A, calculate the value of the current $\frac{1}{300}$ sec after it was zero. (04 marks)

(b) An a.c. generator of negligible internal impedance whose output voltage is 100 rms is connected in series with a resister of 100 Ω and an inductor of 2H. Calculate the:

(i) frequency of the generator

(ii) power dissipated in the resistor when the current is half its value. (05 marks)

(c) (i) Define the terms *capacitance* and *inductance.* (02 marks)

(ii) A radio can tune over the frequency range of a portion of a MW broadcast band (800 Hz to 1200 Hz). If its LC circuit has an effective inductance of 200μH, what must be the range of its variable capacitor? (06 marks)

SECTION C

Answer at least **one (1)** question from this section.

8. (a) (i) State Ampere's circuital law. **(01 mark)**

(ii) A long straight wire is carrying a current of 100 mA. An electron is moving at 10^7 ms^{-1} in a direction parallel to the wire. What is the magnitude of the force on the electron when it is 10 cm from the wire? **(03 marks)**

(b) (i) Define *Ampere*. **(01 mark)**

(ii) Explain the characteristics of the flux density and force for parallel conductors when like currents flow through them in the same direction. Give their magnitudes.

What will happen when a current is sent through a vertical spring from whose lower end a weight is attached? **(07 marks)**

(c) (i) Distinguish between geographical meridian and magnetic meridian and define the angle of dip. **(03 marks)**

(ii) A magnet suspended at 30° with the magnetic meridian makes an angle of 45° with the horizontal. What is the actual value of the angle of dip? **(05 marks)**

9. (a) What is meant by:

(i) Fusion **(01 mark)**

(ii) Fission? **(01 mark)**

(b) State the similarity between the two terms in 9(a) above. **(01 mark)**

(c) A deutron strikes $_8O^{16}$ nucleus with the subsequent emission of an α – particle. Find the atomic number, mass number and the chemical name of the element produced. **(03 marks)**

(d) (i) A parent radioactive substance with a very long half-life has a daughter with a very short half-life. Describe what happens to a freshly purified sample of the parent substance. **(02 marks)**

(ii) K^{40} has a half life of 1.27×10^9 years. Its isotopic abundance in natural potassium makes about 0.3 % of the human body weight. How many disintegrations per sec of K^{40} will occur in a 100-kg man? **(05 marks)**

(e) (i) Light is both a wave and a particle. Comment on the statement by using examples.

(ii) Compute the de Broglie wavelength of a 50 g rock with a speed of 40 ms^{-1}. **(07 marks)**

10. (a) (i) Define the terms *logic gates* and *digital signal*. **(02 marks)**

(ii) State one practical application of an OR gate. **(01 mark)**

(iii) Using a well labelled circuit diagram of an inverting amplifier, derive the closed-loop gain A. What would the value of A be when the input resistor equals the feedback resistor? Name the circuit. **(07 marks)**

(b) The diagram below (figure 1) shows a differential op-amp circuit.

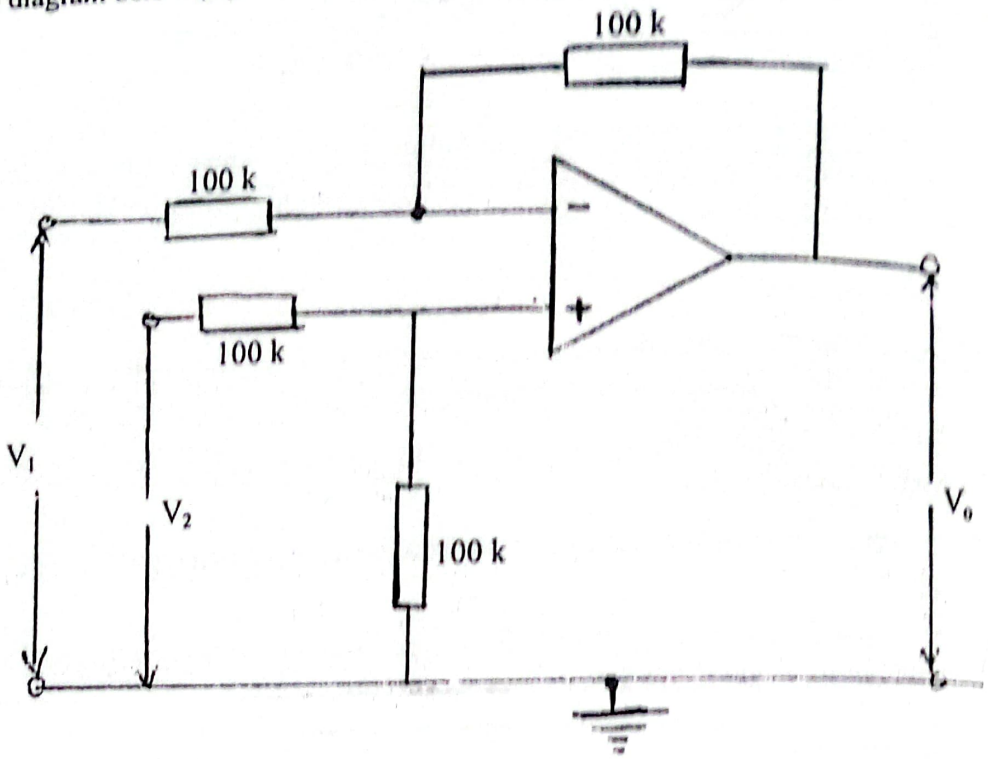


Fig. 1

(i) Write down the relationship between the output voltage V_o and the input voltages V_1 and V_2 as applicable. **(03 marks)**

(ii) What will be the output voltage Vo when $V_1 = 0.5$ V and $V_2 = 2.0$ V? **(01 mark)**

(c) Draw a truth table for the circuit below. (Figure 2) **(06 marks)**

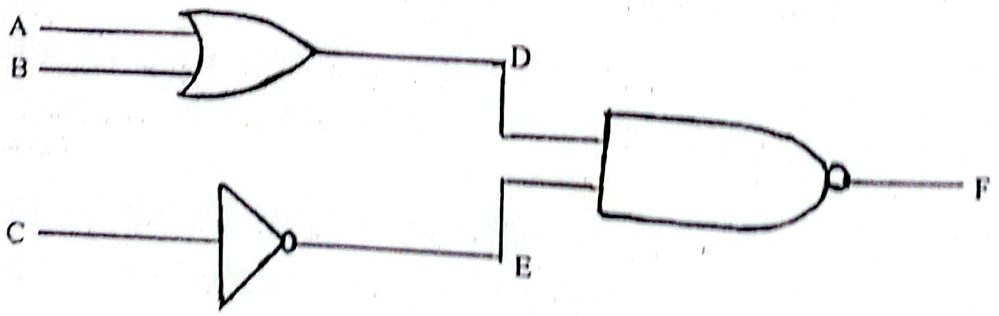


Fig. 2