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: 2:30 Hours **Friday, 15th February 2013 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. Each question carries **twenty (20)** marks.
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 booklet (s).
7. The following information may be useful:
   (a) Acceleration due to gravity $g = 9.8\ m/s^2$
   (b) Pie $\pi = 3.14$
   (c) Density of water $\rho_{water} = 1000\ Kgm^{-3}$
   (d) Density of lead $\rho_{Pb} = 11.4 \times 10^3\ Kgm^{-3}$
   (e) Electrochemical equivalent of Copper $= 3294 \times 10^{-7}\ gc^{-1}$
   (f) Electrochemical equivalent of Silver $= 1118 \times 10^{-6}\ gc^{-1}$
   (g) Molecular weight of Helium $M_{He} = 4$
   (h) Universal gas constant $R = 8.3\ J/mol$
   (i) Monatomic gas $\frac{C_p}{C_v}$ ratio $\gamma = 1.5$
   (j) Specific heat of an ideal monatomic gas at constant volume $c_v = \frac{3R}{2}$
   (k) Permeability of free space $\mu_o = 4\pi \times 10^{-7}\ Hm^{-1}$
   (l) Avogadro's number $N_A = 6.02 \times 10^{23}\ mol^{-1}$
   (m) Plank's constant $h = 6.62 \times 10^{-34}\ Js$
   (n) Velocity of light in vacuum $c = 3.8 \times 10^8\ ms^{-1}$
   (o) Electronic charge $e = 1.6 \times 10^{-19}\ C$
   (p) Young's modulus for rubber $= 5.0 \times 10^8\ Pa$.
   (q) $1\ a.m.u = 1.66 \times 10^{-27} kg$.

SECTION A

1. (a) (i) Write down the Poiseuille's equation for a viscous fluid flowing through a tube defining all the symbols. **(2 marks)**

(ii) What assumptions are used to develop the equation in (a) (i) above. **(4 marks)**

(iii) What is meant by Newtonian fluid? **(1 mark)**

(b) A submarine model is situated in a part of a tube with diameter 5.1 cm where water moves at 2.4 ms^{-1}. Determine the:

(i) velocity of flow in the water supply pipe of diameter 25.4 cm. **(3 marks)**

(ii) pressure difference between the narrow and the wide tube. **(3 marks)**

(c) (i) Define compressibility of a gas in terms of the elasticity of gases. **(2 marks)**

(ii) The bulk modulus of elasticity for lead is 8×10^9 N/m^2. Find the density of lead if the pressure applied is 2×10^8 Nm^{-2}. **(5 marks)**

2. (a) (i) Define the terms: proportional limit, elastic limit, yield point and elasticity. **(4 marks)**

(ii) Use a sketch graph to show how the extension of the wire varies with the applied force and mark the elastic limit and yield point on it. Explain how the magnitude of the Young's modulus is obtained from the graph. **(5 marks)**

(b) A block of metal weighing 20 N with a volume of 8×10^{-4} m^3 is completely immersed in oil of density 700 kgm^{-3} then attached to one end of a vertical wire of length 4.0 m and diameter of 0.6 mm whose other end is fixed. If the length of the wire is increased by 1.0 mm. find the;

(i) young's modulus of the wire. **(4 marks)**

(ii) energy stored in the wire. **(2 marks)**

(c) A rubber cord of a Y – shaped object has a cross sectional area of 4×10^{-6} m^2 and relaxation length of 100 mm. If the arms of the catapult are 70 mm apart, calculate the:

(i) tension in the rubber. **(2 marks)**

(ii) force required to stretch it when the rubber cord is pulled back until its length doubles. **(3 marks)**

3. (a) Briefly give comments on the following observations:

(i) Polyatomic and diatomic gases have larger molar heat capacities than monatomic gases. **(2.5 marks)**

(ii) Cubical container is used for the derivation of pressure of an ideal gas. **(2.5 marks)**

(b) (i) What is meant by a gas constant. **(1 mark)**

(ii) Helium gas occupies a volume of 4×10^{-2} m^3 at a pressure of 2×10^5 Pa and temperature of 300 K. Calculate the mass of helium and the r.m.s speed of its molecules. **(4 marks)**

(c) (i) When a gas expand adiabatically it does work on its surroundings although there is no heat input to the gas. Explain where this energy is coming from. **(3 marks)**

(ii) An ideal gas at 17 °C and 750 mmHg is compressed isothermally until its volume is reached to ¾ of its initial value. If it then allowed to expand adiabatically to a volume of 20% greater than its original value, calculate the final temperature and pressure of the gas. **(7 marks)**

4. (a) How does the first law of thermodynamics change under isothermal and adiabatic processes? **(2 marks)**

(b) (i) Show that the specific heat capacities of an ideal gas are related by the relation $C_p = C_v + n R$. **(6 marks)**

(ii) Explain the meaning of all the symbols used in the equation (b) (i) above. **(2 marks)**

(c) One mole of an ideal monatomic gas is heated at constant volume from the temperature of 300 K to 600 K. Calculate the:

(i) amount of heat added **(2 marks)**

(ii) work done by the gas **(1 mark)**

(iii) change in its internal energy. **(2 marks)**

(d) The piston of a bicycle pump at room temperature of 290 K is slowly moved in until the volume of air enclosed is one – fifth of the total volume of the pump. The outlet is then sealed and the piston suddenly drawn out to full extension. If no air passes the piston, find the temperature of the air in the pump immediately after withdrawing the piston, assuming that air is an ideal gas with cryoscopic constant, $\gamma = 1.4$. **(5 marks)**

SECTION B

5. (a) (i) What is meant by crossed polaroids? **(1.5 marks)**

(ii) Briefly describe the appearance of fringes produced by monochromatic light. **(2.5 marks)**

(b) (i) Give two difference between diffracting grating spectra and prism spectra. **(4 marks)**

(ii) A diffraction grating used at normal incidence gives a yellow line, $\lambda = 5750$ Å in a certain spectral order superimposed on a blue line, $\lambda = 4600$ Å of the next higher order. If the angle of diffraction is 30°, what is the spacing between the grating lines? **(5 marks)**

(c) (i) State Huygens principle of wave construction. **(2 marks)**

(ii) A thin wedge of air of small angle is enclosed by two thin glass plates. When the plates are illuminated by a parallel beam of monochromatic light of wavelength 589 nm, the distance apart of the fringes is 0.8 mm. Calculate the angle of the wedge. **(5 marks)**

6. (a) (i) Explain why it is better to use a small current for a long time to plate a metal with a given thickness of silver than using a larger current for a short time? **(2 marks)**

(ii) Give four difference between the passage of electricity through metals and ionized solution. **(4 marks)**

(b) (i) Define electric discharge and give one example. **(2 marks)**

(ii) A milliameter connected in series with a hydrogen discharge tube indicates a current of 1.0×10^{-3} A. If the number of electrons passing the cross section of the tube at a particular point is 4.0×10^{15} per second, find the number of protons that pass the same cross section per second. **(6 marks)**

(c) A silver and copper voltammeter are connected in parallel across a 6 V battery of negligible internal resistance. In half an hour 1.0 g of copper and 2.0 g of silver are deposited. Calculate the rate at which the energy is supplied by the battery. **(6 marks)**

7. (a) (i) State Lenz's law of electromagnetic induction. **(2 marks)**

(ii) An aircraft is flying horizontally at 200 ms^{-1} through the region where the vertical component of the earth magnetic field is 4.0×10^{-5} T. If the air craft has a wing span of 40 m, what will be the potential difference (p.d) produced between the wing tips? **(3 marks)**

(b) A toroid of inner radius 25 cm and an outer radius of 28 cm has 4500 turns of wound around it which passes a current of 12 A. What will be the induction of the magnetic flux;

(i) outside the toroid. **(1 mark)**

(ii) inside the core of the toroid. **(3 marks)**

(iii) in an empty space surrounding the toroid. **(1 mark)**

(c) (i) Derive an expression for impedance of a series R – C circuit. **(4 marks)**

(ii) An alternating current (a.c) of 0.2 A r.m.s and frequency of $\frac{100}{2\pi}$ Hz flow in a circuit containing a series arrangement of a resistor R of resistance 20 Ω, an inductor L of 0.15 H and a capacitor C of capacitance 500 μF. Calculate the resultant potential difference (p.d) and the impedence of the circuit. **(6 marks)**

SECTION C

8. (a) (i) What is meant by transistor action? **(2 marks)**

(ii) Briefly explain why the collector of a transistor is made wider than the emitter and base? **(3 marks)**

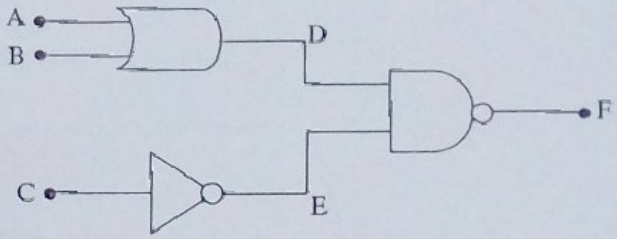
(b) (i) Draw a well labeled circuit diagram of an inverting amplifier. **(2 marks)**

(ii) Derive the closed – loop gain A of an inverting amplifier. If the input resistor is equal to the feedback resistor, what would be the value of the gain A. **(4 marks)**

(c) (i) Mention one application of LED. What type of a semiconductor is it?
(2 marks)

(ii) Write down two advantages of digital circuits over the analogue circuits.
(2 marks)

(iii) Create the truth table of the circuit below.



(5 marks)

9. (a) (i) Distinguish between white spectrum and line spectrum. **(2 marks)**

(ii) If the energy necessary to cause the ejection of an electron by photoelectric effect from the N – shell and K – shell of an atom is 10 eV and 20 eV respectively, calculate the maximum wavelength of radiation for each level.
(4 marks)

(b) (i) What is the significance of the binding energy per nucleon? **(1 mark)**

(ii) The nucleus of iron, $^{57}_{26}Fe$ with a mass of 56.935 a.m.u emits a γ – ray radiation of 14.4×10^3 eV. Calculate its recoil energy. **(5 marks)**

(c) Given that Rydberg's constant is approximately 1.1×10^7 m^{-1}. Calculate the corresponding range of frequency for emitted radiation in the:

(i) Lyman series. **(4 marks)**

(ii) Balmer series. **(4 marks)**

10. (a) A radioactive isotope of Thallium $^{207}_{81}Th$, emits β – particles with average energy of 1.5 MeV. If the half life of the isotope is 135 days and is brought to emit γ – radiation:

(i) Describe a simple test which could confirm the emission of β – particles and γ – radiation. **(3 marks)**

(ii) What will happen to the nucleus of the new isotope after the emission of γ-radiation? **(1 mark)**

(iii) Find the decay constant of the isotope. **(3 marks)**

(b) (i) Briefly explain why the β – particles emitted from a radioactive source differ from the electrons obtained by thermionic emission? **(03 marks)**

(ii) The mass of a particular radioisotope in a sample is initially 6.4×10^{-3}kg. After 42 days the isotope was separated from the sample and found to have a mass of 1.0×10^{-4}kg. Calculate the half- life of the isotope. **(03 marks)**

(c) (i) Define the activity of a nuclide. **(1 mark)**

(ii) A radioactive sample whose disintegration product is non – radioactive has an activity of 5×10^{-11} curie at a certain time. At this time an α – particle detector showed a count rate of $32\ s^{-1}$ but after 10 days the count rate dropped to $8\ s^{-1}$. Calculate the half-life and the number of nuclei which will remain after 100 days. **(6 marks)**