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: 3 Hours **Friday, 06th May 2016 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 answer booklet(s).
7. The following information may be useful:
   (a) Acceleration due to gravity g =9.8m/s^2
   (b) Pie π =3.14
   (c) Density of steel = 7800kg/m^3
   (d) Speed of light, c =3×10^{8}m/s.
   (e) Surface tension of soap film is 0.08Nm^{-1}.
   (f) $\frac{1}{4\pi\varepsilon_0} = 9\times10^9 Nm^2C^{-2}$
   (g) Charge of electron =1.6×10^{-19}C.
   (h) Charge-mass ratio of electron, $\frac{e}{m_e} = 1.8\times10^{11} Ckg^{-1}$
   (i) Permeability of free space, $\mu_0 = 4\pi\times10^{-7} Hm^{-1}$
   (j) Rydberg constant, R =1.0974×10^{7}m^{-1}
   (k) Permittivity of the free space = 8.85×10^{-12}Fm^{-1}.

SECTION A

1. (a) (i) Distinguish between static pressure, dynamic pressure and total pressure when applied to streamline or laminar fluid flow and write down expressions at a point in the fluid in terms of the fluid velocity v, the fluid density ρ, pressure P and the height h, of the point with respect to a datum. **(2.5 marks)**

(ii) The static pressure in a horizontal pipeline is 4.3×10^{4}Pa, the total pressure is 4.7×10^{4}Pa and the area of cross-section is $20cm^{2}$. The fluid may be considered to be incompressible and non-viscous and has a density of $1000kg/m^{3}$. Calculate the flow velocity and the volume flow rate in the pipeline. **(4 marks)**

(b) (i) State Newton's law of viscosity and hence deduce the dimensions of the coefficient of viscosity. **(2 marks)**

(ii) In an experiment to determine the coefficient of viscosity of motor oil, the following measurements are made:

- Mass of glass sphere $=1.2\times10^{-4}$kg.
- Diameter of sphere $=4.0\times10^{-3}$m.
- Terminal velocity of sphere $=5.4\times10^{-2}ms^{-1}$.
- Density of oil $=860kgm^{-3}$.

Calculate the coefficient of viscosity of the oil. **(3.5 marks)**

(c) (i) Briefly explain the carburetor of a car as applied to Bernoulli's theorem.

(2 marks)

(ii) Three capillaries of the same length but with internal radii 3R, 4R and 5R are connected in series and a liquid flows through them under streamline conditions. If the pressure across the third capillary is 8.1mm of liquid, find the pressure across the first capillary. **(3 marks)**

(d) Give reasons for the following observations as applied in fluid dynamics:

(i) A flag flutter when strong winds are blowing on a certain day. **(1 mark)**
(ii) A parachute is used while jumping from an airplane. **(1 mark)**
(iii) Hotter liquids flow faster than cold ones. **(1 mark)**

2. (a) Define the following terms:

(i) Intensity of sound **(1 mark)**
(ii) Beats **(1 mark)**
(iii) Ultrasonic **(1 mark)**
(iv) Overtones. **(1 mark)**

(b) A steel wire hangs vertically from a fixed point, supporting a weight of 80N at its lower end. The length of the wire from the fixed point to the weight is 1.5m. Calculate the fundamental frequency emitted by the wire when it is plucked if its diameter is 0.5mm. **(4 marks)**

(c) (i) Give any two applications of ultrasonic as applied to sound waves. **(2 marks)**

(ii) Ultrasound of frequency 4.0MHz is incident at an angle of 30° to a blood vessel of diameter 1.6mm. If a Doppler shift of 3.2 kHz is observed, calculate the blood flow velocity and the volume rate of blood flow. Assume that the speed of ultrasound is $1.5kms^{-1}$. **(4 marks)**

(d) The absorption spectrum of a faint galaxy is measured and the wavelength of one of the lines identified as the calcium H line is found to be 478nm. The same line has a wavelength of 397nm when measured in a laboratory.

(i) Is the galaxy moving towards or away from the observer on the earth? **(1 mark)**

(ii) Determine the speed of the galaxy relative to observer on the Earth. **(5 marks)**

3. (a) State the principle of;

(i) Superposition of waves. **(1 mark)**

(ii) Huygens construction of wave fronts. **(1 mark)**

(b) The incident parallel light is a monochromatic beam of wavelength 450nm. The two slits A and B have their centres a distance of 0.3mm apart. The screen is situated a distance of 2.0m from the slits.

(i) Calculate the spacing between fringes observed on the screen. **(4 marks)**

(ii) How would you expect the pattern to change when the slits A and B are each made wider? **(2 marks)**

(c) Describe the formation of interference patterns by using Newton's rings experiment. **(5 marks)**

(d) Calculate the radius of curvature of a Plano-convex lens used to produce Newton's rings with a flat glass plate if the diameter of the tenth dark ring is 4.48mm, viewed by normally reflected light of wavelength 5.00×10^{-7}m. What is the diameter of the twentieth bright ring? **(7 marks)**

SECTION B

4. (a) Define the following terms:

(i) Free surface energy **(1 mark)**

(ii) Capillary action **(1 mark)**

(iii) Angle of contact. **(1 mark)**

(b) Briefly explain the following observations.

(i) Soap solution is a better cleansing agent than ordinary water. **(1 mark)**

(ii) When a piece of chalk is put into water, it emits bubbles in all directions. **(1 mark)**

(c) (i) Two spherical soap bubbles are combined. If V is the change in volume of the contained air, A is the change in total surface area, show that $3P_aV + 4AT = 0$, where T is the surface tension and P_a is the atmospheric pressure. **(3 marks)**

(ii) There is a soap bubble of radius 3.6×10^{-4}m in air cylinder which is originally at a pressure of 10^5N/m^2. The air in the cylinder is now compressed isothermally until the radius of the bubble is halved. Calculate the pressure of air in the cylinder. **(4 marks)**

(d) What is strain energy? **(1 mark)**

A piece of rod 1.05m long whose weight is negligible is supported at its ends by wires Q and P of equal lengths as shown in Figure 1.

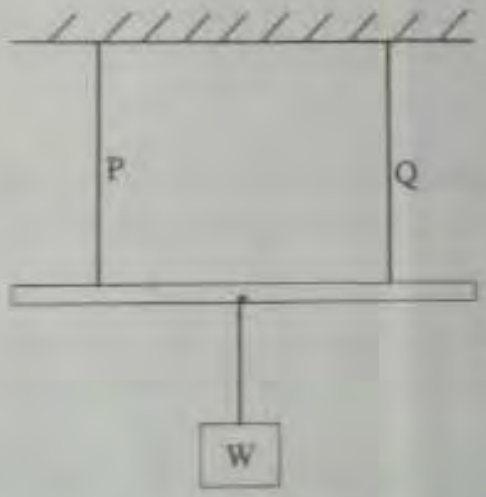

Figure 1

The cross-sectional area of P is 1mm^2 and that of Q is 2mm^2. At what point along the bar should the weight be suspended in order to produce,

(i) Equal stress of P and Q. **(3.5 marks)**

(ii) Equal strain of P and Q. **(3.5 marks)**

(Given: Young's modulus of wire P $=2.4\times10^{11}$Nm^{-2} and that of wire Q $=1.6\times10^{11}$Nm^{-2}).

5. (a) (i) State coulomb's law of electrostatics. **(1 mark)**

(ii) Define electric field strength, E at any point. **(1 mark)**

(iii) Mention two common properties of electric field lines. **(2 marks)**

(b) Two identical balls each of mass 0.8kg carry identical charge and they are separated by thread of equal length. At equilibrium they positioned themselves at a distance of 1.2cm as shown in Figure 2. Calculate the charge in either ball. **(5 marks)**

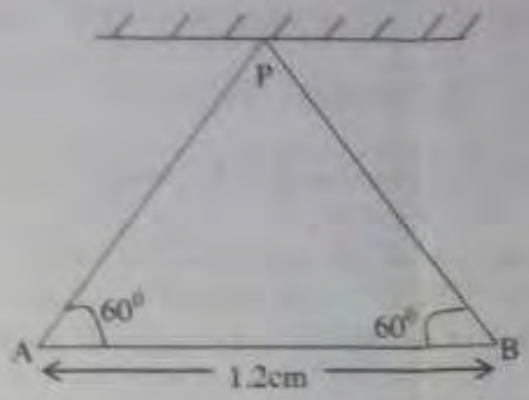

Figure 2

(c) Two capacitors C_1 and C_2 each of area $36cm^2$ separated by 4cm have capacitances of $6\mu C$ and $8\mu C$ respectively. The capacitor C_1 is charged to a potential difference of 110V whereas the capacitor C_2 is charged to a potential difference of 140V. The capacitors are now joined with plates of like charges connected together.

(i) What will be the loss of energy transferred to heat in the connecting wires? **(8 marks)**

(ii) What will be the loss of energy per unit volume transferred to heat in the connecting wires? **(3 marks)**

6. (a) Define the following terms:

(i) Capacitance **(1 mark)**

(ii) Charge density **(1 mark)**

(iii) Equipotential surface. **(1 mark)**

(b) By using the coulomb's law of electrostatics, derive an expression for the electric field strength E, due to a point charge if the material is surrounded by a material of permittivity ε, and hence show how it relates with charge density σ. **(4 marks)**

(c) Describe the structure and the mode of action of a simplified version of the Van de Graaff generator. **(5 marks)**

(d) (i) Identify any three factors on which the capacitance of parallel plate capacitor depends. **(1.5 marks)**

(ii) A proton of mass 16.7×10^{-28}kg falls through a distance of 2.5cm in a uniform electric field of magnitude 2.65×10^{4}V/m. Determine the time of fall if the air resistance and the acceleration due to gravity, g are neglected. **(3.5 marks)**

(iii) A parallel plate capacitor is made of a paper 40mm wider and 3.0×10^{-2}mm thick. Determine the length of the paper sheet required to construct a capacitance of $15\mu F$, if its relative permittivity is 2.5. **(3 marks)**

SECTION C

(a) (i) State any three magnetic components of the earth's magnetic field. **(1.5 marks)**

(ii) The horizontal and vertical components of the earth's magnetic field at a certain location are 2.7×10^{-5}T and 2.0×10^{-5}T respectively. Determine the earth's magnetic field at the location and its angle of inclination I. **(2.5 marks)**

(b) State the following laws or theorems as applied in magnetism.

(i) Biot-Savart law **(1 mark)**

(ii) Ampere's theorem. **(1 mark)**

(c) (i) Draw hysteresis loops diagram for soft iron and hard steel and use them to discuss permanent magnets. **(3 marks)**

(ii) Define permeability constant. **(1 mark)**

(iii) Derive an expression for the magnetic flux density B at the centre of the circular coil of radius r and N turns placed in air carrying a current I. **(4 marks)**

(d) The diameter of a 40 turn circular coil is 16cm and it has a current of 5A. Calculate:

(i) The magnetic induction at the centre of the coil. **(2 marks)**

(ii) The magnetic moment of the coil. **(2 marks)**

(iii) The torque acting on the coil if it is suspended in a uniform magnetic field of 0.76T such that its plane is parallel to the field. **(2 marks)**

(a) (i) Briefly explain the production of X-rays. **(1.5 marks)**

(ii) List down any three uses of X-rays. **(1.5 marks)**

(iii) How are the intensity and penetrating power of an X-ray beam controlled? **(1 mark)**

(b) An X-ray tube, operated at a d.c potential difference of 60kV, produces heat at the target at the rate of 840W. Assuming 0.65% of the energy of the incident electrons is converted into X-radiation, calculate:

(i) The number of electrons per second striking the target. **(3 marks)**

(ii) The velocity of the incident electrons. **(2 marks)**

(iii) The energy of incident electrons. **(2 marks)**

(c) (i) Show that the possible energy levels (in joules) for the hydrogen atom are given by the formula: $E_n = -k^2 \frac{2\pi^2 me^4}{h^2} \frac{1}{n^2}$. **(4 marks)**

Where m is the mass of electron, e is the electronic charge, h is the Planck's constant, $k = \frac{1}{4\pi\epsilon_0}$ and ϵ_0 is the permittivity constant of vacuum.

(ii) What does the negative sign signify in the formula for E_n in (c) (i) above? **(1 mark)**

(iii) The first member of Balmer series of hydrogen spectrum has wavelength of 6563×10^{-10}m. Calculate the wavelength of its second member. **(4 marks)**

(a) (i) Differentiate natural radioactivity from artificial radioactivity. **(2 marks)**

(ii) Name three applications of radioisotopes in medicine. **(3 marks)**

(iii) State two conditions for stability of nuclides referring to light nuclides and heavy nuclides. **(2 marks)**

(b) (i) Derive an expression for the half-life using the radioactive decay law. **(4 marks)**

(ii) What is carbon -14? Explain its production and how it is used in the dating process. **(3 marks)**

(c) Living wood has an activity of 16.0 counts per minute per gram of carbon. A certain sample of dead wood is found to have an activity of 18.4 counts per minute for 4.0 grams. Calculate the age of the sample of dead wood. Assume the half-life of carbon-14 is 5568 years. **(6 marks)**