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 **Thursday, 04th May, 2017 p.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, $g = 9.8\,ms^{-2}$
   (b) Density of air $\rho_a = 1.29\,kg\,m^{-3}$
   (c) Density of water , $\rho_w = 10^3\,kg\,m^{-3}$
   (d) Density of mercury $\rho_m = 13.6\times10^3\,kg\,m^{-3}$
   (e) Speed of sound in air, $v = 340\,ms^{-1}$
   (f) Plank's constant, $h = 6.63\times10^{-34}\,Js$
   (g) Young modulus of copper $= 1.1\times10^{11}\,Pa$,
   (h) Young modulus of steel $= 2.0\times10^{11}\,Pa$
   (i) Linear expansivity of steel $= 1.6\times10^{-7}\,^0C^{-1}$
   (j) Surface tension of mercury, $\gamma = 0.472\,k\,gs^{-2}$
   (k) Density of steel $= 10^4\,kg\,m^{-3}$
   (l) Pie, $\pi = 3.14$
   (m) Permittivity of free space, $\varepsilon_0 = 8.854\times10^{12}\,N\,m^{-2}\,kg^{-2}$
   (n) 1a.m.u = 931MeV
   (o) Mass of $^2_1H = 1.00782$ a.m.u and Mass of $^3_1H = 1.00782$ a.m.u
   (p) Mass of $^0_1n = 1.00865$ a.m.u
   (q) Electronic charge, $e = 1.6\times10^{-19}C$
   (r) Mass of electron, $9.1\times10^{-31}\,kg$
   (s) Permeability of free space, $\mu_0 = 4\pi\times10^{-7}\,H\,m^{-1}$.

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SECTION A

1. (a) (i) State Bernoulli's theorem for the horizontal flow. **(01 mark)**

(ii) On which principle does the Bernoulli's theorem based. **(01 mark)**

(iii) A pipe is running full of water. At a certain point A, it tapers from 30 cm diameter to 10 cm diameter at B, the pressure difference between point A and B is 100 cm of water column. Find the rate of flow of water through the pipe. **(05 marks)**

(b) (i) What is the terminal velocity? **(01 mark)**

(ii) Derive an expression for the terminal velocity of a spherical body falling from rest through a viscous fluid. **(06 marks)**

(c) Two capillaries of the same length and radii in the ratio of 1 : 2 are connected in series and the liquid flow through the system under stream line conditions. If the pressure across the two extreme ends of the combination is 1 m of water, what is the pressure difference across the first capillary? **(06 marks)**

2. (a) A cyclist and a railway train are approaching each other with a speed of 10 ms^{-1} and 20 ms^{-1} respectively. If the engine driver sounds a warning siren at a frequency of 480 Hz, calculate the frequency of the note heard by the cyclist ;

(i) Before the train has passed. **(04 marks)**

(ii) After the train has passed. **(04 marks)**

(b) (i) The equation $y = a\sin(\omega t - k x)$ represents a plane wave travelling in a medium along the x - direction, y being the displacement at the point x at time t . Deduce whether the wave is travelling in the positive x - direction or in the negative x - direction. **(01 mark)**

(ii) If $a = 1.1\times10^{-7}$ m, $\omega = 6.5\times10^{3} s^{-1}$, $k = 19\ m^{-1}$; determine the speed of the wave. **(06 marks)**

(c) (i) Briefly explain why diffraction is common in sound but not in light.

(01 mark)

(ii) A 40 cm long wire is in unison with a tuning fork of frequency 256 Hz, when stretched by a load of density 9 g m^{-3} hanging vertically. The load is then immersed in water. By how much the length of the wire should be reduced to bring it again in unison with the same tuning fork.

(04 marks)

3. (a) In a Young's double – slit experiment a total of 23 bright fringes occupying a total distance of 3.9 mm were visible in travelling microscope, which was focused on a plane being at a distance of 31 cm from the double slit. If the wavelength of light being used was 5.5×10^{-7} m; determine the separation of the double slit.

(07 marks)

(b) When a grating with 300 lines per millimeters is illuminated normally with parallel beam of monochromatic light a second order principal maximum is observed at 18.9^0 to the straight through direction. Find the wavelength of the light.

(6.5 marks)

(c) A white light fall on a slit of width 'a'; for what value of 'a' will be the first minimum of light falling at the angle of 30^0 when the wavelength of light is 6500 nm?

(6.5 marks)

SECTION B

4. (a) A steel rod of length 0.60 m and cross-sectional area $2.5\times10^{-5}\,m^2$ at a temperature of $100^0\,C$ is clamped so that when it cools was unable to contract. Find the tension in the rod when it has cooled to $20^0\,C$. **(06 marks)**

(b) A spring 60 cm long is stretched by 2 cm for the application of load of 200 g. What will be the length when a load of 500 g is applied? **(06 marks)**

(c) Calculate the percentage increase in length of a wire of diameter 2.2 mm stretched by a load of 100 kg. (Young's modulus of wire is $12.5\times10^{10}\,Nm^{-2}$). **(08 marks)**

5. (a) (i) Define the terms capacitance and electric potential. **(02 marks)**

(ii) The capacitance C of a capacitor is full charged by a 200 V battery. It is then discharged through a small coil of resistance wire embedded in a thermally insulated block of specific heat capacity $2.5\times10^2\,Jkg^{-1}K^{-1}$ and of mass of 0.1 kg. If the temperature of the block rises by 0.4 K, what is the value of C?

(06 marks)

(b) A parallel plate capacitor has plates each of area $0.24\,m^2$ separated by a small distance 0.50 mm. If the capacitor is full charged by a battery of electromotive force of 24 V, Calculate;

(i) the capacitance of the capacitor. **(03 marks)**

(ii) the energy stored in the capacitor. **(03 marks)**

(c) (i) Comment on the assertion that, the safest way of protecting yourself from lightning is to be inside a car. **(02 marks)**

(ii) Find the total potential energy of the system of point charges shown in Figure 1.

(04 marks)

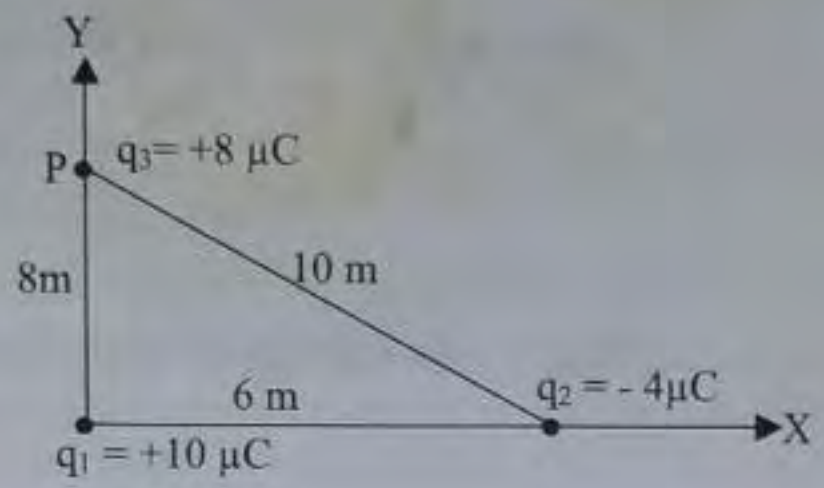


Figure 1

6. (a)(i) Define tensile stress and tensile strain. **(02 marks)**

(ii) Calculate the work done in a stretching copper wire of 100 cm long and 0.03 cm^2 cross – sectional area when a load of 120 N is applied. **(04 marks)**

(b) (i) Mention any two factors on which modulus of elasticity of a material depends? **(02 marks)**

(ii) A 45 kg traffic light is suspended with two steel wires of equal lengths and radii of 0.5 cm. If the wires make an angle of 15^0 with the horizontal, what is the fractional increase in their length due to the weight of the light? **(04 marks)**

(c) (i) Define free surface energy in relation to the liquid surface. **(01 mark)**

(ii) Explain what will happen if two bubbles of unequal radii are joined by a tube without bursting. **(01 mark)**

(iii) A spherical drop of mercury of radius 5 mm falls on the ground and breaks into 1000 droplets. Calculate the work done in breaking the drop. **(06 marks)**

SECTION C

7. (a) What is meant by the following?

(i) Atomic mass unit (a.m.u)

(ii) Binding energy. **(03 marks)**

(iii) Mass defect.

(b) Calculate the binding energy per nucleon for phosphorus $^{31}_{15}P$ given that, $^{31}_{15}P = 30.97376$ a. m .u and $^{1}_{1}H = 1.00782$ a. m .u. **(04 marks)**

(c) It is observed that thorium nucleus $^{226}_{90}Th$ originally at rest decays to form a radium nucleus $^{222}_{88}Ra$, α – particle and γ – rays.

(i) Write down the equation for the disintegration. **(02 marks)**

(ii) Determine the energy of the $\gamma-$ray, if the $\alpha-$particle is emitted with energy of 2.38 MeV. Given that rest mass of $^{226}_{90}\text{Th} = 226.0249$ a.m.u, $^{222}_{88}\text{Ra} = 222.0154$ a.m.u and $\alpha-$particle $= 4.0026$ a.m.u. **(06 marks)**

(d) When a nucleus of deuterium (hydrogen-2) fuses with a nucleus of tritium (hydrogen-3) to helium nucleus and a neutron, 2.88×10^{-12} J of energy is released. The equation for the reaction is represented as $^{2}_{1}\text{H}+^{3}_{1}\text{H}\rightarrow^{4}_{2}\text{He}+^{1}_{0}\text{n}$. Calculate the mass of helium nucleus produced. **(05 marks)**

8. (a) State the law of force acting on a conductor of length l, carrying an electric current in a magnetic field. **(02 marks)**

(b) (i) Draw the diagram of the solenoid with certain number of turns placed in the magnetic field and indicate any suitable directions of the flow of current in it. **(02 marks)**

(ii) Write down the formulae for the magnetic field induced at the centre of solenoid. **(01 mark)**

(c) It is desired to design a solenoid that produces a magnetic field of 0.1 T at the centre. If the radius of solenoid is 5 cm, its length is 50 cm and carries a current of 10A; Calculate:

(i) The number of turns per unit length of the solenoid. **(3.5 marks)**

(ii) The total length of a wire required. **(3.5 marks)**

(d) (i) State the Biot-Savart law. **(02 marks)**

(ii) In a hydrogen atom, an electron keeps moving around its nucleus with a constant speed of $2.18\times10^{6}\,ms^{-1}$. Assuming that the orbit is a circular of radius $5.3\times10^{-11}\,m$, determine the magnetic flux density produced at the site of the proton in the nucleus. **(06 marks)**

9. (a) Use the Rydberg constant, $\text{R}_{\text{H}} = 1.0974\times10^{7}\,\text{m}^{-1}$ to calculate the shortest wavelength of the Balmer series. **(04 marks)**

(b) Use the Bohr's theory for hydrogen atom to determine the:

(i) Radius of the first orbit of the hydrogen atom in $\overset{0}{\text{A}}$ units. **(04 marks)**

(ii) Velocity of the electron in the first orbit. **(03 marks)**

(c) (i) What is ionization potential of an atom? **(01 mark)**

(ii) Show that the ionization potential of hydrogen is 13.6 eV. **(05 marks)**

(iii) How can you account for the chemical behaviour of atoms on the basis of the atomic electrons and shells? **(03 marks)**