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

131/2

PHYSICS 2

(For Both School and Private Candidates)

Time: 3 Hours **Monday, 14th May 2018 a.m.**

Instructions

1. This paper consists of sections A, B and C with a total of **nine (9)** questions.
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 and any unauthorized materials 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 mercury = 13.6×10^{3}kg/m^3
   (d) Density of water = 10^{3}kg/m^3
   (e) Charge of electron =1.6×10^{-19}C.
   (f) Speed of light c, is 3.0×10^{8}ms^{-1}
   (g) Planck constant h, is 6.63×10^{-34}Js
   (h) 1u = 931MeV
   (i) Permeability of free space, $\mu_0 = 4\pi \times 10^{-7}\, Hm^{-1}$
   (j) Rydberg constant, R =1.0974×10^{7}m^{-1}
   (k) Mass of electron=9.1×10^{-31}kg
   (l) Permittivity of free space, $\varepsilon_0 = 8.85 \times 10^{-12}\, Fm^{-1}$.
   (m) The refractive index of glass, $\mu_g = 1.52$

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SECTION A

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

1. (a) Given the Bernoulli's equation: $p + \rho g h + \frac{1}{2}\rho v^2 =$ constant where all the symbols carry their usual meaning.

(i) What quantity does each expression on the left hand side of the equation represent? **(2 marks)**

(ii) Mention any three conditions which make the equation to be valid. **(3 marks)**

(b) Water is supplied to a house at ground level through a pipe of inner diameter 1.5 cm at an absolute pressure of 6.5×10^5Pa and velocity of 5 m/s. The pipe line leading to the second floor bath room 8 m above has an inner diameter of 0.75 cm. Find the flow velocity and pressure at the pipe outlet in the second floor bathroom. **(6 marks)**

(c) Define the following terms when applied to fluid flow:

(i) Non-viscous fluid **(1 mark)**

(ii) Steady flow **(1 mark)**

(iii) Line of flow **(1 mark)**

(iv) Turbulent flow. **(1 mark)**

(d) A horizontal pipeline increases uniformly from 0.080 m diameter to 0.160 m diameter in the direction of flow of water. When 96 litres of water is flowing per second, a pressure gauge at the 0.080 m diameter section reads 3.5×10^5Pa. What should be the reading of the gauge at the 0.160 m diameter section neglecting any loss? **(5 marks)**

2. (a) What do you understand by the terms:

(i) Progressive wave **(1 mark)**

(ii) Refraction of waves **(1 mark)**

(iii) Diffraction of waves **(1 mark)**

(iv) Standing wave. **(1 mark)**

(b) Two progressive waves travelling in the opposite direction in the medium are represented by $Y_1 = 5\sin\left(\omega t + \frac{\pi}{3}\right)$ and $Y_2 = 5\sin\left(\omega t - \frac{\pi}{3}\right)$. If the two progressive waves form a standing wave, determine the resultant amplitude and the phase angle formed. **(6 marks)**

(c) The shortest length of the resonance tube closed at one end which resounds to fork of frequency 256 Hz is 31.6 cm. The corresponding length for a fork of frequency 384 Hz is 20.5 cm. Determine the end correction for the tube and the velocity of sound in air. **(5 marks)**

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(d) (i) What do you understand by the term interference of waves? **(1 mark)**

(ii) A viewing screen is separated from a double-slit source by 1.2 m. The distance between the two slits is 0.030 mm. The second order bright fringe (m = 2) is 4.5 cm from the centre line. Determine the wavelength of the light and the distance between adjacent bright fringes. **(4 marks)**

3. (a) Define the term coherent sources of light. **(2 marks)**

(b) (i) Interference patterns are formed when using Young's double slit experiment. Mention other three methods that can be used to form interference patterns. **(3 marks)**

(ii) Giving reasons, explain whether either transverse or longitudinal waves could exist, if the vibratory motion causing them were not simple harmonic motion. **(2 marks)**

(c) A beam of monochromatic light of wavelength 680 nm in air passes into glass. Calculate:

(i) The speed of light in glass **(2 marks)**

(ii) The frequency of light **(2 marks)**

(iii) The wavelength of light in glass. **(2 marks)**

(d) Light of wavelength 644 nm is incident on a grating with a spacing of 2.00×10^{-6} m.

(i) What is the angle to the normal of a second order maximum? **(2 marks)**

(ii) What is the largest number of orders that can be visible? **(2 marks)**

(iii) Find the angular separation between the third and fourth order image. **(3 marks)**

SECTION B

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

4. (a) Mention any two factors which affect the surface tension of the liquid and in each case explain two typical examples. **(3 marks)**

(b) Why molecules on the surface of a liquid have more potential energy than those within the liquid? Briefly explain. **(2 marks)**

(c) (i) Derive an expression for excess pressure inside a soap bubble of radius R and surface tension γ when the pressures inside and outside the bubble are P_2 and P_1 respectively. **(5 marks)**

(ii) A soap bubble has a diameter of 5 mm. Calculate the pressure inside it if the atmospheric pressure is 10^5 Pa and the surface tension of a soap solution is 2.8×10^{-2} Nm^{-1}. **(4 marks)**

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(d) Water rises up in a glass capillary tube up to a height of 9.0 cm while mercury falls down by 3.4 cm in the same capillary. Assume angles of contact for water-glass and mercury-glass as 0^0 and 135^0 respectively. Determine the ratio of surface tensions of mercury and water. **(6 marks)**

5. (a) Briefly explain the following observations as applied to strengths of materials:

(i) Bridges are declared unsafe after long use. **(2 marks)**

(ii) Iron is more elastic than rubber. **(2 marks)**

(b) A composite wire of diameter 1 cm consists of copper and steel wires of lengths 2.2 m and 2 m respectively. Total extension of the wire when stretched by a force is 1.2 mm. Calculate the force, given that Young's modulus for copper is 1.1×10^{11} Pa and for steel is 2×10^{11} Pa. **(5 marks)**

(c) What do you understand by the following terms?

(i) A perfectly plastic material **(1 mark)**

(ii) The ultimate tensile strength **(1 mark)**

(iii) An elastic limit **(1 mark)**

(iv) Poisson's ratio. **(1 mark)**

(d) Two rods of different materials but of equal cross-sections and lengths 1.0 m each are joined to make a rod of length 2.0 m. The metal of one rod has coefficient of linear thermal expansion of $10^{-5}/\ ^0C$ and Young's Modulus $3x10^{10}N/m^2$. The other metal has the values $2\times10^{-5}/\ ^0C$ and $10^{10}N/\ m^2$ respectively. How much pressure must be applied to the ends of the composite rod to prevent its expansion when the temperature is raised by 100^0C? **(7 marks)**

6. (a) Briefly explain the effect of the dielectric material on the capacitance of a capacitor when the capacitor is:

(i) Isolated. **(2 marks)**

(ii) Connected to the battery. **(2 marks)**

(b) How are the electrolytic capacitors made? **(3 marks)**

(c) Two point charges of equal mass m and charge Q are suspended at a common point by two threads of negligible mass and length L. If the two point charges are at equilibrium, show that;

(i) The distance of separation $x = \left(\frac{Q^2L}{2\pi\varepsilon_o mg}\right)^{\frac{1}{3}}$ **(3 marks)**

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(ii) The angle of inclination $\beta = \sqrt[3]{\frac{Q^2}{16\pi\varepsilon_0 m g L^2}}$. **(3 marks)**

(d) Two point charges, $q_a = +3\ \mu C$ and $q_b = -3\ \mu C$, are located 0.2 m apart in vacuum. Find;

(i) the electric field at the midpoint of the line joining two charges. **(3 marks)**

(ii) the force experienced by the negative test charge of magnitude $1.5\times10^{-9}C$ placed at this point. **(4 marks)**

SECTION C

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

7. (a) (i) What is meant by the term Ballistic galvanometer? **(1 mark)**

(ii) State two conditions to be fulfilled for a galvanometer to be used as a ballistic galvanometer. **(2 marks)**

(iii) Consider a small flat coil which has N turns of area A and whose plane is perpendicular to a magnetic field of flux density B. If the search coil is connected to the ballistic galvanometer and the total resistance of the circuit is R, use the laws of electromagnetic induction to show that the charge delivered to the galvanometer does not depend on how long it takes to remove the search coil from the field. **(3 marks)**

(b) A circular coil of 300 turns has a radius of 10 cm and carries a current of 7.5 A. Calculate the magnetic field at:

(i) the centre of the coil. **(2 marks)**

(ii) a point which is at a distance of 5 cm from the centre of the coil. **(2 marks)**

(c) (i) Mention the three magnetic materials and briefly explain each one. **(3 marks)**

(ii) Give the differences between the magnetic materials mentioned in (c) (i) in terms of their magnetic susceptibility. **(3 marks)**

(d) Define the following terms:

(i) Ampere **(1 mark)**

(ii) Hysteresis. **(1 mark)**

(e) Two parallel conductors A and B are situated 0.16 m apart. Conductor A, carries a current of 4 A and conductor B, carries a current of 8 A. The directions of the currents are shown in Figure 1. Find the distance from A to a point where the magnetic fields due to A and B cancel each other (Ignore the effects of earth's magnetic field). **(2 marks)**

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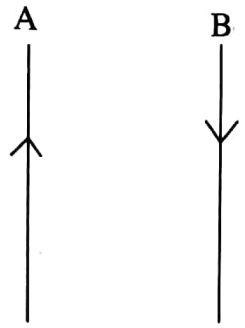


Figure 1

8. (a) (i) What do you understand by the term photon. **(0.5 mark)**

(ii) List down any three properties of a photon. **(1.5 marks)**

(iii) State any four laws of photoelectric emission. **(2 marks)**

(b) (i) Briefly explain what led de-Broglie to think that the material particles may also show wave nature and why the wave nature of matter not noticeable in our daily observations? **(3 marks)**

(ii) Prove that de-Broglie wavelength λ, of electrons of kinetic energy E is given by $\lambda = \frac{h}{\sqrt{2\,m\,e\,V}}$, where m is the mass of the electron, e is the charge of the electron, h is the Planck's constant and V is the accelerating potential difference. **(2 marks)**

(iii) Light of wavelength 488 nm is produced by an argon laser which is used in the photoelectric effect. When light from this spectral line is incident on the emitter, the stopping (cut-off) potential of photoelectrons is 0.38 V. Find the work function of the material from which the emitter is made. **(2 marks)**

(c) Use the concept of radioactive decay and nuclear reactions to define the following terms:

(i) Alpha decay

(ii) Beta decay

(iii) Gamma decay

(iv) Fission

(v) Fusion.

For each of the terms in (c) (i-v), give one suitable reaction equation. **(5 marks)**

(d) A freshly prepared sample of a radioactive isotope Y contains 10^{12} atoms. The half-life of the isotope is 15 hours. Calculate;

(i) the initial activity. **(2 marks)**

(ii) the number of radioactive atoms of Y remaining after 2 hours. **(2 marks)**

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(a) (i) Mention any four important features in the design of a nuclear reactor. **(2 marks)**

(ii) Differentiate binding energy from mass defect. **(1 mark)**

(iii) Calculate the binding energy per nucleon, in MeV and the packing fraction of an alpha particle.
Given: Mass of proton = 1.0080u, Mass of neutron = 1.0087u and Mass of alpha particle = 4.0026u. **(4 marks)**

(b) (i) State any three limitations of Bohr's model of the hydrogen atom. **(3 marks)**

(ii) In a hydrogen atom model, an electron of mass m and charge e revolves around the nucleus in a circular orbit of radius r. Develop an expression for the radius r of the orbit in terms of m, e, π, the quantum number n, Planck constant h and the permittivity of free space ε_0 and hence, use their values to find the Bohr's radius. **(4 marks)**

(c) (i) Distinguish between ionization energy and excitation energy. **(1 mark)**

(ii) Why hydrogen spectrum contains a larger number of spectral lines although its atom has only one electron? **(1.5 marks)**

(d) Figure 2 shows the energy level diagram of the hydrogen atom.

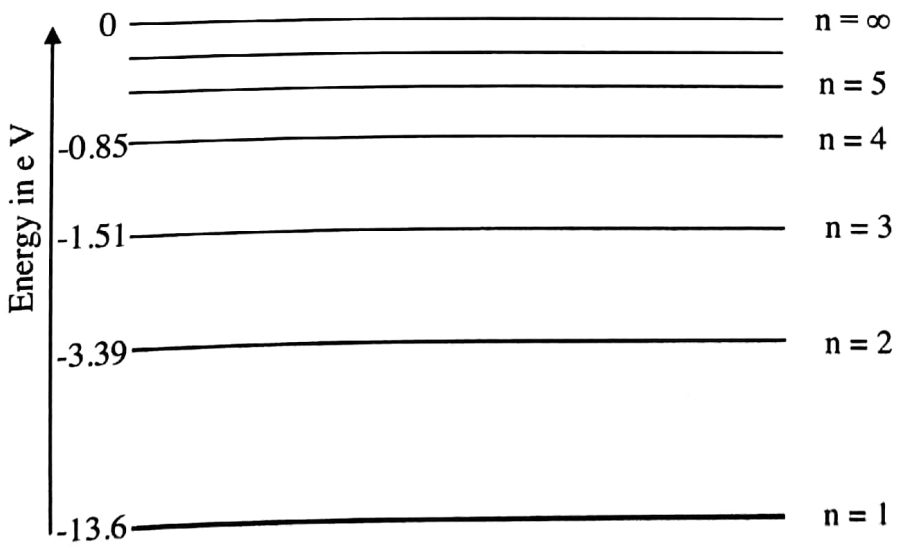


Figure 2

(i) Calculate the frequency and wavelength of the radiation emitted as a result of an electron transition from n = 4 to when an electron is in its ground state. **(2 marks)**

(ii) What is the energy at the level where n = 5? **(1.5 marks)**

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