THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

TABORA HIGH SCHOOLS EXAMINATION ASSOCIATION (TAHISEA)

FORM SIX PRE NATIONAL EXAMINATION

131/2 **PHYSICS 2**

TIME: 3 Hours **Friday 7th March 2025**

Instructions

1. This paper consists of **six (06)** questions
2. Answer any **five (05)** questions
3. Each question carries **Twenty (20)** marks
4. Cellular phones and any unauthorized materials are not allowed in the examination room
5. Mathematical and non-programmable calculator may be used
6. Write your number on every page of your answer sheet(s)
7. Where necessary the following information may be useful
   - i. Acceleration due to gravity, $g = 9.8 m/s^2$
   - ii. Charge of an electron, $e = 1.6 \times 10^{-19} C$
   - iii. Coefficient of linear expansion of copper $= 8 \times 10^{-6} {}^{\circ}C^{-1}$
   - iv. Density of water $= 1000 kg/m^3$
   - v. Electrostatic force constant $= 9 \times 10^{9} NM^2C^{-1}$
   - vi. Refractive index of water = 4/3
   - vii. Specific gravity of petrol = 0.8
   - viii. Speed of light $= 3 \times 10^{8} m/s$
   - ix. Surface tension of soap solution $= 2.5 \times 10^{-2} N/M$
   - x. Universal gas constant $= 8.314 Jmol^{-1}K^{-1}$
   - xi. Viscosity of water $= 0.801 \times 10^{-3} Pas$
   - xii. Young's modulus of steel $2.0 \times 10^{11} Pa$
   - xiii. Permeability in free space $= 4\pi x 10^{-7} Hm^{-1}$
   - xiv. Avogadro's number $= 6.02 \times 10^{23} mo^{-1}$
   - xv. Plank's constant $= 6.63 \times 10^{-34} Js$

1. (a) (i) Water flows faster than honey. Use Poiseuille's formula to explain **(02marks)**

(ii) A large bottle is fitted with a siphon made of capillary glass tubing. Compare the coefficient of viscosity of water and petrol if the time taken to empty the bottle in the two cases is in the ratio 2:5 **(04marks)**

(b) (i) Approximately what volume of water per second can flow through a pipe 2.0cm in diameter before turbulent flow will occur? The critical of Reynold's number is 2000 **(04marks)**

(ii) Water flowing through the horizontal pipe having different cross-sections at points A and B. The diameters of the pipe at A and B are 0.6m and 0.2m respectively. The pressure difference between point A and B is 1m column of water. Calculate the volume of water flowing per second **(06marks)**

(c) In Milikani's oil drop experiment, what is the terminal speed of an uncharged drop of radius 2.0×10^{-5}m and density 1.2×10^{3}kgm^{-3}. Take the viscosity of air at the temperature of the experiment to be 1.8×10^{-5}Pas. How much is the viscous force on the drop at that speed? Neglect the buoyancy of the drop due to air **(04marks)**

2. (a) (i) Describe three types of wave fronts by using diagrams only **(03marks)**

(ii) State Brewster's law and hence derive its equation **(04marks)**

(iii) A beam of light travelling in water strikes a glass plate which is also immersed in water. When the angle of incidence is 51°, the reflected beam is found to be plane-polarized. Calculate the refractive index of glass **(03marks)**

(b) A parallel beam of sodium light is incident normally on a diffraction grating. The angle between the first order spectra on either side of the normal is 27°42'. Assuming that the wavelength of light is 5.893×10^{-7}m. Calculate;

(i) Number of rulings per mm on the grating **(03marks)**
(ii) Greatest number of bright images obtained **(03marks)**

(c) In Young's double slit experiment a light of wavelength 5.893×10^{-7}m was illuminated on the slits which were 0.40mm apart. If the slits from the screen was 1.2m, Calculate the;

(i)Separation of fringes at the slits **(02marks)**

(ii) Angle (in radian) subtended by a central pair of bright fringes at the slits **(02marks)**

3. (a) (i) Define the term strain energy **(01mark)**

(ii) Show that the stain energy per unit volume in a deformed body is equal to one half the product of the stress and strain. In which type of strain is the expression applicable? **(05marks)**

(b) (i) Four identical hollow cylindrical columns of mid-steel support a big structure of mass 50000kg. The inner and outer radii of each column are 30cm and 60cm respectively. Assuming the load distribution to be uniform, Calculate the compressional strain of each column. **(05marks)**

(ii) Calculate the pressure required to stop the increase in volume of copper block when it is heated from 50°C to 70°C. Bulk modulus of elasticity is $3.6x10^{11}N/M^2$. **(04marks**

(c) (i) An electric fan is switched on in a closed room. Will the air in the room be heated or cooled? Explain **(02marks)**

(ii) At what temperature is the root mean square speed of an atom in an argon gas cylinder equals to the root mean square speed of Helium gas atom at -20°C? (Atomic masses; Ar=39.9u, He=4.0u) **(03marks)**

4. (a) Explain why when you run comb through hair, it attracts bits of paper? What would you expect if the hair is wet or if is a rainy day? **(03marks)**

(b) The diameter of a hollow metallic sphere is 60cm and the sphere carries a charge of 500μC. Find the electric field intensity at;

(i) A distance of 100cm from the centre of the sphere **(02marks)**

(ii) The surface of the sphere **(02marks)**

(c) The capacitance of a parallel plate capacitor is 50pF and the distance between the plates is 4mm. It is charged to 200V and the charging battery is removed. Now a dielectric slab (k=4) of thickness 2mm is introduced between the plates. Calculate the;

(i) Final charge on each plate **(02marks)**

(ii) Potential difference between the plates **(02marks)**

(iii) Final energy in the capacitor **(02marks)**

(iv) Energy loss **(02marks)**

(d) (i) State Gauss's law **(01mark)**

(ii) The electric field in a region is radially outward and varies with distance r as $E=250rVm^{-1}$. Calculate the charge contained in a sphere of radius 0.2m centered at the origin **(04marks)**

5. (a) (i) State Biot-Savart law and use it to derive the expression for the magnetic field at the center of a current carrying circular coil **(04marks)**

(ii) The electron of hydrogen atom moves along a circular path of radius 0.5nm with a uniform speed of $4x10^6m/s$. Calculate the magnetic field produced by the electron at the center **(04marks)**

(b) (i) Differentiate paramagnetic, ferromagnetic and diamagnetic materials in term of magnetic susceptibility **(03marks)**

(ii) Find the current through a loop needed to create a maximum torque of 11.8Nm. The loop has 100 square turns, each of length 22cm and is placed in a uniform magnetic field of 0.96T. **(04marks)**

(c) (i) Explain the meaning of magnetic flux **(01mark)**

(ii) The current through a solenoid of length 60cm and radius 1.5cm with 1500 turns per meter is changing at the rate of 2A/s. A small circular coil of radius 0.5cm consisting of 30 turns is placed inside the solenoid in such a way that the plane of the coil is perpendicular to the central axis of the solenoid. Calculate the magnitude of induced emf **(04marks)**

6. (a) (i) Explain the term activity as applied in nuclear physics **(02marks)**

(ii) Deduce an expression for the activity constant in terms of half life **(03marks)**

(b) (i) Explain the meaning of negative energy of an orbiting electron **(02marks)**

(ii) Differentiate between Rutherford's model and Bohr' mode of an atom. Give two points **(02marks)**

(c) An X-ray unit operating at 100kV produces a current of 20mA. Calculate

(i) The number of electrons per second striking the target **(01mark)**

(ii) The speed of electrons incident on the target **(01mark)**

(iii) The lowest wavelength of the continuous X-ray spectrum **(01mark)**

(d) (i) How do you account for the stability of the nucleus? **(02marks)**

(ii) It is proposed to use nuclear fusion; ${}_1^2H + {}_2^4He$ in a nuclear reactor of 200MW rating. If the energy from the above reactions is used with 25% efficiency in the reactor, how many grams of deuterium fuel will be needed per day? Some atomic and particle masses may be used; ${}_2^4He = 4.0026 a.m.u$ *and* ${}_1^2H = 2.0141 a.m.u$ **(06marks)**