P510/1
Physics
Paper 1
July - August 2023
2 ½ Hours

UGANDA MUSLIM TEACHERS' ASSOCIATION

UMTA JOINT MOCK EXAMINATIONS - 2023

UGANDA ADVANCED CERTIFICATE OF EDUCATION

Physics
Paper 1
2 Hours 30 Minutes

INSTRUCTIONS TO CANDIDATES

- *Answer five questions including at least one, but not more than two from each of the Sections **A**, **B** and **C**.*
- *Any additional question(s) answered will not be marked.*

Assume where necessary

• *Universal gravitational constant, G*	=	$6.67 \times 10^{-11}\ Nm^3\ Kg^{-2}$
• *Stefan's — Boltzmann's constant, σ*	=	$5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$
• *Speed of light in vacuum, C*	=	$3.0 \times 10^{8} ms^{-1}$
• *Specific heat capacity of water*	=	$4200 Jkg^{-1}k^{-1}$
• *Radius of earth*	=	$6.4 \times 10^{6} m$
• *Radius of sun*	=	$7 \times 10^{8} m$
• *Radius of earth's orbit about the sun*	=	$1.5 \times 10^{11} m$
• *Planck's constant, h*	=	$6.6 \times 10^{-34} Js$
• *Gas constant, R*	=	$8.31\ Jmol^{-1}K^{-1}$
• *Electron mass*	=	$9.11 \times 10^{-31}\ Kg$
• *Electron charge, e*	=	$1.6 \times 10^{-19} C$
• *Density of water*	=	$1000\ Kgm^{-3}$
• *Density of Mercury*	=	$13600\ Kg\ m^{-3}$
• *Specific latent heat of vaporization of water*	=	$2.26 \times 10^{6} JKg^{-1}$
• *Viscosity of air*	=	$1.8 \times 10^{-5} Ns^{-1}m^{-1}$
• *Avogadro's number, NA*	=	$6.02 \times 10^{23}\ mol^{-1}$
• *Acceleration due to gravity, g*	=	$9.81\ ms^{-2}$
• *Mass of sun*	=	$2.0 \times 10^{30} Kg$
• *Mass of earth*	=	$6.0 \times 10^{24} Kg$
• *Temperature of sun*	=	$6000K$
• *Specific latent heat of fusion of ice*	=	$3.4 \times 10^{5} JKg^{-1}$
• *Thermal conductivity of brick*	=	$8.0 \times 10^{-1} Wm^{-1}K^{-1}$
• *Thermal conductivity of air*	=	$2.4 \times 10^{-2} Wm^{-1}K^{-1}$
• *Density of Oil*	=	$900 Kgm^{-3}$

SECTION A

1. (a) (i) State the principle of conservation of Mechanical energy (1 mark)

(ii) Give two types of forces in which the principle in a (i) is obeyed. (1 mark)

(b) A particle is thrown vertically upwards with speed **U** from the top of a tower of height, **H**. The time taken by the particle to hit the ground is n-times that taken to reach the highest point of its path.

(i) Sketch its displacement -time and velocity -time graphs for the particle. (2marks)

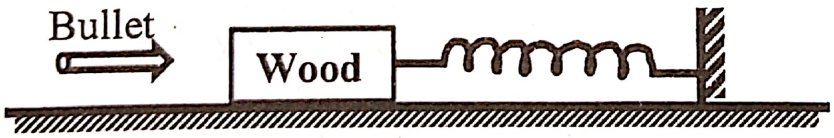
(ii) Show that: $2gH = n(n-2)u^2$. (4 marks)

(c) (i) Use molecular theory to explain the origin of frictional force between two surfaces in contact (3 marks)

(ii) Describe an experiment to determine the coefficient of kinetic friction.

(4 marks)

(d) A bullet of mass 20g is fired at close range into a wooden block of mass 980g connected to a spring of force constant $150Nm^{-1}$ fixed at one end and resting on a rough horizontal surface of coefficient of friction 0.37. After collision, the bullet gets embedded into the wood and the spring is compressed through a distance of 2.4cm. Calculate the initial speed of the bullet before impact with the block (5 marks)

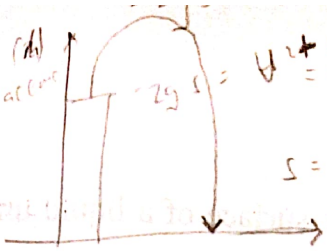


2. (a)(i) What is meant by

(i) an incompressible fluid? (1 mark)

(ii) Pressure energy? (1 mark)

(b) Explain why velocity of a liquid at a wide part of a tube is less than that at a narrow part. (2marks)



(c) (i) State the law of floatation (1 mark)

(ii) Show that the weight of fluid displaced by an object is equal to the up thrust on the object. (4 marks)

(iii) A 500kg wooden block is floating with 0.25 of its volume above the water level, what is the volume of a metal of density 9.0×10^2 Kgm^{-3} which must be attached to the under side of the block to completely submerge it. (5 marks)

(d) Describe, stating the necessary precautions an experiment to measure the coefficient of viscosity of engine oil (6 marks)

3. (a) (i) What is meant by a parking orbit? (1 mark)

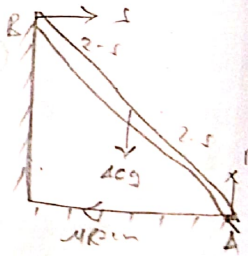
(ii) Calculate the height above the earth's surface for a parking orbit. (4 marks)

(b) (i) With aid of a diagram, describe a laboratory method of determining the universal gravitational constant,G (6 marks)

(ii) State any precautions taken in b(i) above (1 mark)

(c) State the conditions for mechanical equilibrium of a system of coplanar forces. (2 marks)

(d) A uniform ladder of mass 40kg and length 5.0m rests with its upper end against a smooth vertical wall and with its lower end at 3.0m from the wall on a rough ground. Find the



(i) Least coefficient of friction between the ladder and the ground. (3 marks)

(ii) Force exerted at the bottom of the ladder. (3 marks)

4. (a) (i) What is meant by surface tension and angle of contact? (2 marks)

(ii) With aid of a diagram, describe the capillary rise method of determining surface tension of water (5 marks)

(b) A U-tube is made up of capillary tubes of diameters 1.0mm and 3.2mm respectively. The tube is held vertically and partially filled with a liquid of surface tension $0.075Nm^{-1}$ and zero angle of contact. If the difference in the levels of the meniscus is 1.25cm, Calculate the density of the liquid. (4 marks)

(c) (i) Explain why the free surface of a liquid under no external forces is spherical. (3 marks)

(ii) An air bubble of diameter 10.0mm is formed at a depth of 50.0cm inside a container of soap solution of relative density 1.20. By what amount is the pressure inside the bubble greater than the atmospheric pressure? (3 marks)

(d) If number of little droplets of water of surface tension γ, all of the same radius, **r** combine to form a single drop of radius, **R**, show that the energy released is

$$4\pi R^3 \gamma \left(\frac{1}{r} - \frac{1}{R}\right)$$ (3 marks)

SECTION B

5. (a) What is meant by

(i) triple point of water? (1 mark)

(ii) Cooling correction? (1 mark)

(b) Explain clearly the steps taken to determine the cooling correction when measuring the specific heat capacity of a poor conductor of heat by the method of mixtures (6 marks)

(c) 10g of dry steam is added to a copper calorimeter of heat capacity $80Jk^{-1}$ containing 50g of ice and 120g of water at 0°C .Calculate the final temperature after all the ice has melted. (5 marks)

(ii) Explain why systems based on circulation of steam are more efficient in warming a room than those based on circulation of boiling water. (2 marks)

(d) (i) Give two advantages of gas thermometers over those of mercury thermometers. (2 marks)

(ii) The resistance of a platinum thermometer is 1.510Ω at ice point, 2.160Ω at steam point and 1.878Ω at 50°C on the gas scale. What is the difference between the values of the latter temperature on the two scales. (3 marks)

6. (a) (i) What is meant by kinetic theory of gases? (1 mark)

(ii) Use the kinetic theory expression of pressure of an ideal gas to deduce Dalton's law of partial pressures. (4 marks)

(b) Explain why;

(i) the behaviour of real gases at very low pressures approximates to that of an Ideal gas. (2 marks)

(ii) air pressure inside a car tyre increases during driving (3 marks)

(c) (i) With aid of a diagram, describe an experiment to determine the temperature dependance of saturated vapour pressure of water. (6 marks)

(ii) A mixture of air and saturated alcohol vapour in presence of liquid alcohol exerts a pressure of 128mmHg at 20°C. When the mixture is heated at constant volume to the boiling point of alcohol at 78°C at standard pressure, the pressure becomes 860mmHg. Find the saturation vapour pressure of alcohol at 20°C. (4 marks)

7. .(a) Define the terms;

(i) Coefficient of the thermal conductivity (1 mark)

(ii) heat current (1 mark)

(b) (i) State Wien's displacement law (1 mark)

(ii) Explain why there is the word displacement in Wien's displacement law (2 marks)

(c) (i) With aid of a diagram. Describe Searle's method of determining thermal conductivity of a material of high conductivity (6 marks)

(ii) Why is the method in C(i) above best suited for a good conductor of heat? (2 marks)

(d) The external walls of a house consist of two layers of brick separated by an air cavity. The outer face of the wall is at a temperature of 20°C while the inside of the house is at 5°C .If the thickness of each brick layer is 10.0cm and of air cavity is 3.0cm

(i) Explain why in steady state, the rate of heat transfer must be the same. (1 mark)

(ii) Calculate the rate of heat flow per square metre through the wall. (6 marks)

SECTION C

8. (a) (i) What are positive rays? (1 mark)

(ii) State two differences between cathode rays and positive rays. (2 marks)

(b) With aid of a diagram, describe Millikan's experiment to determine the value of electronic charge. (6 marks)

(ii) Explain why the size of oil drops must be small in b(i) above (2 marks)

(c) In Millikan's apparatus the horizontal plates are 1.5cm apart. With the electric field switched off, an oil drop is observed to fall with a steady velocity of $2.5 \times 10^{-2}\ cms^{-1}$ .When the field is switched on, the drop just remains stationary when the P.d between the two plates is 1500V.

(i) Calculate the radius of the drop. (3 marks)

(ii) How many electronic charges does it carry? (3 marks)

(iii) If the P.d between the two plates remains unchanged, with what velocity will the drop move when it has collected two more electrons as a result of exposure to ionizing radiation? (3 marks)

9. (a) (i) What is meant by ionization potential? (1mark)

(ii) Explain how line spectra accounts for existence of discrete energy levels in atoms. (3 marks)

(b) The first excitation energy of a hydrogen atom is 10.4eV. Calculate the speed of the slowest electron that can excite a hydrogen atom. (3 marks)

(c) (i) With aid of a diagram, describe how x-rays are produced in an X-ray tube. (5 marks)

(ii) Under what conditions does X-ray diffraction occur? (2 marks)

(d) The closest spacing between planes of atoms in a crystal of NaCl is $2.82A°$ .First order diffraction maxima of a monochromatic beam of X-rays occurs at a glancing angle of $15^0\ 30^1$.

(i) How many orders of diffraction of these X-rays could be observed from these planes. (4 marks)

(ii) Find the density of $NaCl$ if its molecular weight is 59.5 (2 marks)

10. What is meant by

(i) Decay constant (1 mark)

(ii) Background count rate? (1 mark)

(b) (i) Describe the structure and operation of an expansion cloud chamber (5 marks)

(ii) Describe and explain the differences between the tracks formed in the chamber in b (i) above by alpha and beta particles (4 marks)

(c) (i) Explain the application of carbon -14 in carbon dating. (3 marks)

(ii) An element **X** has a stable isotope, 60_X and a radioactive isotope, 59_X of half-life 5.27 years whose atoms are 0.25% of those of the stable isotope. Estimate the rate of decay of 59_X with $5\mu g\ of\ 60_x$ after 10 years. (5marks)

(d) State one industrial use and one health hazard of radioactivity (1 mark)

END