P510/1
PHYSICS
Paper 1
July/August, 2022
3 Hours

ASSHU BUNYORO REGION EXAMINATION BOARD (ABREB)

Uganda Advanced Certificate of Education
MOCK EXAMINATION, 2022
PHYSICS
Paper 1
3 hours

Instructions to the 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
-Non-programmable calculators may be used
-Assume where necessary

Acceleration due to gravity,	$g = 9.81ms^{-2}$
Radius of the Earth	$r_e = 6400km$
The universal gravitational constant,	$G = 6.67 \times 10^{-11}Nm^2kg^{-?}$
The specific latent heat of vaporization of liquid	$= 8.54x10^3\ Jkg^{-1}$
The specific heat capacity of liquid	$= 2.5x\ 10^3Jkg^{-1}K^{-1}$
Specific heat capacity of a gas at constant pressure	$C_p =$ `950Jkg^{-1}K^{-1}
The Unified Atomic mass Unit	U = 931MeV
Specific heat capacity of liquid,	$C_w = 4200\ Jkg^{-1}K^{-1}$
Plank's constant,	$h = 6.6 \times 10^{-34}Js^{-1}$
Charge of electron,	$e = 1.6 \times 10^{-19}C$
Mass of electron	$m = 9.11 \times 10^{-31}kg$
Thermal conductivity of metal of flask	$\alpha_m = 65Wm^{-1}K^{-18}$
Thermal conductivity of air	$\alpha_a = 0.02Wm^{-1}K^{-1}$

SECTION A:

MECHANICS

1. (a)(i) Explain why momentum is a vector quantity. *(01 mark)*

(ii) The equation for real gases is $(P + a)(V - \frac{b}{V}) = nRT$. Express a and b dimensionally *(04 marks)*

(b)(i) Define centripetal acceleration. *(01 mark)*

(ii) Explain why a cyclist negotiating a circular track leans through an angle from the vertical towards the center of the track. *(03 marks)*

(c)(i) Show that when a cyclist bends through an angle towards the centre of a circular track, the velocity, v of the cyclist is $v = (rgtan\,\theta)^{\frac{1}{2}}$ *(04 marks)*

(ii) A conical pendulum has a period of 0.5 seconds. Find the radius of the circular path of the pendulum bob if the string is inclined at an angle 60^0 to the vertical. *(04 marks)*

(d) By considering the motion of a known planet round the sun, use its orbital radius and period to determine the mass of the sun. *(03 marks)*

2. (a) What is meant by work hardening as applied to materials? *(01 mark)*

(b) (i) Differentiate between tensile stress and tensile strain *(02 marks)*

(ii) A copper rod of given length, Young's modulus, E, cross-section area, A and linear expansivity, $\propto$ is heated though a temperature rise of θ^0C. Deduce the expression for the force, due to expansion, exerted at its ends. *(05 marks)*

(c)(i) What is meant by streamlined flow? *(01 marks)*

(ii) Explain why an aero plane has to slant in air in order to turn along a bent horizontal path. *(03 marks)*

(d)(i) Define simple harmonic motion. *(01 mark)*

(ii) Sketch a velocity-time graph for a simple harmonic motion *(03 marks)*

(iii) A car of width 170cm goes round a horizontal bend of radius 200cm. If its centre of gravity is 50cm above the ground, calculate the maximum safe speed for the car not to topple. *(04 marks)*

3. (a) (i)State Bernoulli's principle *(01 mark)*

(ii) Use kinetic theory to explain the effect of temperature on viscosity of a liquid. *(04 marks)*

(b) Water enters a house through a pipe with an inside diameter of 2.0cm at a pressure of $4.ox10^5 Nm^{-2}$. The pipe leading to the second floor bedroom 5.0 m above is 10cm in diameter. When the flow velocity at the inlet pipe is $4.0ms^{-1}$, calculate

(i) flow velocity in the bedroom *(03 marks)*
(ii) the pressure in the bedroom. *(04 marks)*

(c)(i) State Hooke's law *(01 marks)*
(ii) Outline four measurements carried out in determining Young's modulus. *(02 marks)*

(iii) State two limitations in verifying Hooke's law. *(02 marks)*

(d) A wire of length 4.0m and cross-section area of $10^{-6}m^2$ is stretched 2mm by a force of 20N in the elastic region. Calculate the energy density. *(03 marks)*

4. (a) Define **angular velocity** *(01 marks)*

(b)(i) Consider a body describing a circle. Show that its centripetal acceleration, a, is given by $a = \frac{v^2}{r}$ *(05 marks)*

(c)(i) What is meant by parking orbit and gravitational potential? *(02 marks)*
(ii) With the aid of a diagram, describe an experiment to determine the gravitational constant, G. *(06 marks)*

(d) A satellite of mass 300kg is in stationed in an orbit about the Earth at a height of $3.6\ x\ 10^7 m$ above the Earth's surface. Calculate

(i) the mechanical energy *(03 marks)*

(ii) the period of the satellite *(03 marks)*

SECTION B

HEAT

5. (a) (i) What is meant by molar heat capacity of a gas at constant pressure?

(01 mark)

(ii) Derive the relationship $\boldsymbol{C_p - C_v = R}$ where the letters have their usual meaning

(04 marks)

(b) (i) State Dalton's Law of partial pressure *(01 mark)*

(ii) Two containers A and B each of volume $3x10^3$ cm^3 and $6x10^3$cm^3 respectively contain Helium gas at a pressure $1.0x10^3$Pa and temperature 27^0C. A is then heated to 100^0C while B is cooled to 0^0C. Calculate the final pressure of the gas.

(05 marks)

(c)(i) Sketch a p-v curve for a gas undergoing compression below it critical temperature and explain the main feature of the curve. *(04 marks)*

(ii) A beam of $2X10^{22}$ Nitrogen atoms each of mass $2.32x10^{-26}$kg is incident normally on the wall of a cubical container of edges 5.0cm^3. The beam is reflected through 180^0. If the mean speed of the atoms is 500ms^{-1}, find the pressure exerted by the gas. State any assumption made. *(05 marks)*

6. (a)(i) State Newtons' Law of cooling. *(01 mark)*

(ii) Sketch a well labeled cooling curve for steam at 100^0C losing heat to -10^0C.

(04 marks)

(b)(i) What is meant by thermal conductivity? *(01 mark)*

(ii) Describe, with the aid of a diagram, how the thermal conductivity of a cork disc can be obtained. *(07 marks)*

(c)(i) Use kinetic theory to explain melting. *(2 marks)*

(ii) An electric heater rate 500W is immersed in a liquid of mass 2.0kg contained in a large thermos flask of heat capacity $840JK^{-1}$ at 28^0C. Electric power is supplied to the liquid by the heater for 10 minutes. If the boiling point of the liquid is 78^0C, estimate the mass of the liquid boiled off. *(05 marks)*

7(a)(i) What is meant by a black body? *(01 mark)*

(ii) With the aid of a diagram, briefly explain how an approximate black body can be achieved in practice. *(04 marks)*

(b)(i) State Stefan's law of black body radiation. *(01 mark)*

(ii) Describe how thermal radiations are detected by the infrared spectrometer. *(04 marks)*

(iii) A tungsten filament lamp rate 10W at a temperature of 217°C and effective surface area of $0.64cm^2$ radiates energy at a rate equivalent to 49% of that radiated by a black body. Calculate Stefan's constant. *(03 marks)*

(c)(i) What is meant by reversible isothermal process? *(01 marks)*

(ii) Mention two examples of an adiabatic process. *(01 marks)*

(iii) A vessel contains $2.5\times10^{-3}m^3$ of an ideal gas at a pressure of $3.5\times10^4N/m^2$ and a temperature of 35°C. The gas is compressed isothermally to a volume of $1.0\times10^{-3}m^3$. It is then allowed to expand adiabatically to its original volume $(\gamma=1.4)$. Find the final temperature of the gas and the work done during the isothermal compression. *(05 marks)*

SECTION C:

MODERN PHYSICS

1. (a)(i) What is meant by **decay constant**? *(01 mark)*

(ii) With the aid of a diagram, describe the structure and mood of operation of a Geiger Muller tube. *(05 marks)*

(iii) The activity of a sample of dead wood is 10 counts per minute; while for a living plant is 19 counts per minute. If the half-life of ^{14}C is 5500 years, find the age of the wood sample. *(03 marks)*

(b)(i) Define the terms **thermionic emission** and **work function** *(02 marks)*

(c) Describe a laboratory experiment to determine the Plank's constant. (05 marks)

(d) Electromagnetic radiation of frequency 8.8×10^{14}Hz falls onto the surface of a metal of work function 2.5eV. Estimate the speed at which the photoelectrons are released for the surface of the metal. *(04 marks)*

2. (a)(i) State Bohr's postulates of the hydrogen atom. *(02 marks)*

(ii) Define the **Unified atomic mass**. *(01 marks)*

(b)(i) Sketch a graph of biding energy per nucleon against mass number and use it to account for nuclear fusion and nuclear fission. *(05 marks)*

(ii) Given the following information.

$$Mass\ of\ iron\ {}^{59}_{26}Fe, nucleus = 156.93488U$$
$$Mass\ of\ proton = 1.00728U$$
$$Mass\ of\ neutron = 1.00867U$$
$$Mass\ of\ electron = 0{,}00018U$$

Calculate the binding energy of Iron ${}^{59}_{26}Fe$ *(04 marks)*

(c)(i) An Alpha particle of mass m is incident with a velocity v towards the nucleus of an

atom of atomic number Z. Show that the distance r of closest approach is given by $r = \frac{Ze^2}{\pi\epsilon_0 mv^2}$, where the letters have their usual meaning. *(04 marks)*

(ii) Outline the necessary steps in determining the charge of an electro using Millikan's oil drop method. *(04 marks)*

10. (a) Differentiate between positive rays and cathode rays. *(02 marks)*

(b)(i) State Bragg's Law if X-ray diffraction *(01 mark)*

(ii) Describe the operation of a modern x-ray tube. *(05 marks)*

(iii) A beam of positive ions is accelerated through a p.d of 2x 103V so as to enter a region of uniform magnetic field of flux density 0.2T. The magnetic field deflects the beam into a circular path of radius 2.5cm. Calculate the charge to mass ration of the ions. *(04 marks)*

(c) The lowest energy level in a helium atom is -24.6eV. There are a number of other energy levels, one of which is -21,4eV,

(i) Explain the significance of the negative sign in the energy value quoted? *(02 marks)*

(ii) What is the energy, in joules, of the photon emitted when an electron returns from the energy level -21.4 eV to the ground state? *(04 marks)*

(e) Explain briefly how the concept of energy levels account for the characteristic emission of line spectrum of an electron. *(02 marks)*

END