P510/1
PHYSICS
Paper 1
July/Aug. 2022
2 ½ hours

ASK INTERGRATED TEACHERS' MOCK EXAMINATIONS BURREAU

AITEL JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

PHYSICS

Paper 1

2 Hours 30 Minutes

INSTRUCTIONS TO CANDIDATES:

Attempt **FIVE** *questions, including atleast* **one** *from each sections* **A, B** *and* **C**.

Assume where necessary:

Acceleration due to gravity, ***g***	=	$9.81 ms^{-2}$
Electron charge, ***e***	=	1.6×10^{-19} C
Electron mass	=	9.11×10^{-31}kg
Mass of the earth	=	5.97×10^{24}kg
Plank's constant, ***h***	=	6.6×10^{-34}Js
Stefan's – Boltzmann's constant, σ	=	$5.67 \times 10^{-8} Wm^{-2}K^{-4}$
Radius of the earth	=	6.4×10^{6}m
Radius of the sun	=	7×10^{8}m
Radius of earth's orbit about the sun	=	1.5×10^{11}m
Speed of light in a vacuum, ***c***	=	$3.0 \times 10^{8} ms^{-1}$
Thermal conductivity of copper	=	$390 W^{-1} K^{-1}$
Thermal conductivity of aluminium	=	210Wm–1 K–1
Specific heat capacity of water	=	$4{,}200 Jkg^{-1}K^{-1}$
Universal gravitational constant, G	=	$6.67 \times 10^{-11} Nm^{2}kg^{-2}$
Avogadro's number, NA	=	$6.02 \times 10^{23} mol^{-1}$
Surface tension of water	=	$7.0 \times 10^{-2} Nm^{-1}$
Density of water	=	$1000 kgm^{-3}$
Gas constant, R	=	$8.31 J mol^{-1} K^{-1}$
Charge to mass ratio e/m	=	$1.8 \times 10^{11} Ckg^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9} F^{-1} m$
Faraday constant, F	=	$9.65 \times 10^{4} Cmol^{-1}$

SECTION A

1. a) (i) State the laws of static friction. (3 marks)

(ii) Use molecular theory to explain the laws mentioned in (i) above. (6 marks)

b) Describe how you can measure the limiting friction between a wooden block and plane surface. (4 marks)

c) A block of wood of mass 950g rests on a horizontal table of height 3.0m at a distance of 2m from the edge of the table. A bullet of mass5og moving with a horizontal velocity $750ms^{-1}$ hits and get embedded in the block. If the coefficient of friction between the block and the tables 0.2. Find;

(i) The initial velocity of the block and the bullet.

(ii) The horizontal distance from the table to the point where the block hits the ground.

2. a) (i) Define simple harmonic motion. (1 mark)

(ii) Explain why the oscillations in simple harmonic motion ultimately die out. (3 marks)

b) (i) Show that a small mass attached to the tree and of suspended inelastic string, executes simple harmonic motion when displaced through a small angle and then released. (5 marks)

(ii) Explain briefly how you can use the experimental arrangement in b(i) above to determine acceleration due to gravity. (5 marks)

c) A particle of mass 0.1kg is executing s.h.m of amplitude 3.6×10^{-2}m between two points A and B about point O as the centre of oscillation. The maximum restoring force on a particle is 3.52N. Calculate;

(i) The period of oscillation. (2 marks)

(ii) The kinetic energy of the particle in the path of motion a distance 4.5×10^{-2} m from A. (3 marks)

(iii) The total energy of a particle. (2 marks)

3. a) State Kepler's laws of planetary motion (3 marks)

b) (i) Define a parking orbit. (1 mark)

(ii) Derive an expression for the period of a satellite in a circular orbit of radius R About the earth in terms of the mass of the earth, gravitational constant G and R. (4 marks)

c) A satellite of mass 200kg is in a circular orbit at a height of 3.59×10^7 m above the earth's surface. Find;

(i) The mechanism energy of the satellite. (4 marks)

(ii) State what will happen to the satellite if its mechanical energy was reduced. (2 marks)

d) (i) Define young's modulus and derive its dimensions. (3 marks)

(ii) Draw a stress strain curve for metal wire. (2 marks)

(iii) Explain briefly the main features of the curve in (ii) above. (3 marks)

4. a) (i)Define surface tension. (1 mark)

(ii) Use the molecular theory to account for the surface tension of a liquid. (4 marks)

b) Describe an experiment to determine surface tension of a liquid by capillary tube methods. (6 marks)

c) Derive an expression for the excess pressure in an air bubble formed inside a liquid. (3 mark)

d) A soap bubble of diameter 1 cm is is formed at the top of a capillary tube of diameter 1 mm dipping into a beaker of water. It the surface tension of water and soap solutions is 7.0×10^{-2} $Nm^{-1}$and 3.0×10^{-2} Nm^{-1} respectively. Calculate the height of the water in the capillary tube above the water in the beaker and state any assumptions you have made. (6 marks)

SECTION B

5. a) (i) Define the coefficient of thermal conductivity of a material. (1 mark)

(ii) Explain the mechanism of heat transfer in good and poor solid conductors. (5 marks)

b) With the aid of a well labeled diagram, describe an experiment to determine the thermal conductivity of a piece of wood. (6 marks)

c) (i)Define a black body and state the laws of black body radiation. (3 marks)

(ii) The total power output of the son is 4.4×10^{26} w. if the density of the sun is $1.4 \times 10^{3} kg / m^{3}$ and its mass is 2.0×10^{30} kg. Calculate the surface temperature of the sun

6. a) define the following

(i) absolute zero (1 mark)

(ii) thermometric property (1 mark)

b) (i) explain briefly the steps taken to set up the absolute scale on platinum resistance thermometer. (5 marks)

c) (i) With the aid of a well labeled diagram, describe an experiment to determine the specific latent heat of vaporization of water by the method of mixtures. (7 marks)

(ii) Distinguish between heat capacity and latent heat. (2 marks)

(iii) A block of metal of mass 200g is heated to $150^{0}C$ and dropped into a copper calorimeter of mass 250g containing 150g of water at $27^{0}C$. After stirring the final temperature is $40^{0}C$ the final temperature is $40^{0}C$. calculate the specific heat capacity of the metal. (2 marks)

7. a) Define the following

(i) A diabetic change (1 mark)

(ii) Vapour (1 mark)

b) State four conditions necessary for a reversible isothermal change to take place. (2 marks)

c) (i) State the first law of thermodynamics. (2 marks)

(ii) Derive the expression relating heat capacity at constant pressure Cp and heat capacity at constant volume Cv and gas constant R. (3 marks)

d) Explain the following;

(i) Effect of increase in temperature on the pressure of a gas at a constant volume. (2 marks)

(ii) Effect of decrease in a volume of container on the pressure of a gas. (2 marks)

e) (i) describe an experiment to determine the saturated vapour pressure of water. (5 marks)

(ii) one mole of air at 27^0C is compressed adiabatically to half its original volume. Given that $\propto = 1.4$. Calculate the final pressure. (2 marks)

SECTION C

8. a) Define the following;

(i) Work friction (1 mark)

(ii) Stopping potential (1 mark)

b) Explain how photo electric effect provides evidence for the quantum theory of light. (5 marks)

c) Derive the Bragg's law of x-ray diffraction. (5 marks)

d) a source emits monochromatic light of frequency 5.5×10^{14}Hz at a rate of 0.1W of the photons given out 15% fall on the cathode which gives current of 6.0Na in an external circuit. Calculate the;

(i) Energy of a photon (2 marks)

(ii) Number of photons leaving the source per second (3 marks)

(iii) Percentage of photons falling on the cattode which produces photon electrons

9. a) Define the terms

(i) Decay constant (1 mark)

(ii) Half-life (1 mark)

b) (i) Derive the relationship between half time and decay constant.

(3 marks)

(ii) The half time of polonium – 30 is 2.5 minutes. Calcite the mass of polonium- 30 which has an activity of 1.0 x 10^{15}disintegrations per second. (4 marks)

c) (i) What is meant by binding energy nucleon. (1 mark)

(ii) Sketch a graph of binding energy per nucleon against mass number and use it to explain liberation of energy by nuclear fusion and nuclear fission.

(6 marks)

d) (i) What are radioisotopes? (1 mark)

(ii) State two industrial uses of radioisotopes. (2 marks)

(iii) Mention any two safety measures taken when handling radioactive substances. (2 marks)

10. a) Describe Bohr's model of an atom. (3 marks)

b) (i) Explain the observations made in Rutherford's alpha particles scattering experiment. (4 marks)

(ii) State why this experiment is carried out in a vacuum. (1 mark)

c) Distinguish between excitation and ionization energies of an atom.

(2 marks)

d) In a simple model the hydrogen atom an electron of mass, m, and charge e, moves in a circular orbit about the nucleus. Given that the angular momentum of the electron is $\frac{nh}{2\pi}$ show that the total energy of the electron is given by

E = $\frac{me^4}{8\varepsilon_0^2 h^2 n^2}$ where h is the plank's constant and ε_0 is permittivity of free space. (6 marks)

e) The diagram below shows some energy levels of the mercury atoms in eV.

OeV …….. n = ∞

-2.71eV…….. n = 6

-3.74eV ……..... n = 5

-4.98Ev …….. n =4

- 5.55eV…….. n = 3

- 5.77eV……... n = 2

-10.44eV……..... n = 1

Calculate the speed of the electron which just ionizes the atom.

(4 marks)

END