

ST. MARYS' KITENDE
Uganda Advanced Certificate of Education
RESOURCEFUL MOCK EXAMINATION 2020
PHYSICS
PAPER 1
2 HOURS 30 MINUTES

Instructions:

- Answer five questions, including at least one from each of the sections A, B and C.
- Any additional question(s) answered will not be marked.
- Mathematical tables and squared paper will be provided.
- Non-programmable scientific electronic calculators may be used.

Where necessary, assume the following constants;

Acceleration due to gravity, g	$= 9.81 \text{ ms}^{-2}$
Electron charge, e	$= 1.6 \times 10^{-19} \text{ C}$
Electronic mass	$= 9.11 \times 10^{-31} \text{ kg}$
Mass of earth	$= 5.97 \times 10^{24} \text{ kg}$
Plank's constant, h	$= 6.6 \times 10^{-34} \text{ Js}$
Stefan's – Boltzmann's constant, δ	$= 5.67 \times 10^{-8} \text{ Wm}^{-2} \text{ K}^{-4}$
Radius of earth	$= 6.4 \times 10^6 \text{ m}$
Radius of the sun	$= 7 \times 10^8 \text{ m}$
Radius of earth's orbit round the sun	$= 1.5 \times 10^{11} \text{ m}$
Speed of light in vacuum (c)	$= 3.0 \times 10^8 \text{ ms}^{-1}$
Specific heat capacity of water	$= 4200 \text{ Jkg}^{-1} \text{ K}^{-1}$
Specific heat capacity of copper	$= 400 \text{ Jkg}^{-1} \text{ K}^{-1}$
Young's modulus of steel	$= 2.0 \times 10^{11} \text{ Nm}^{-2}$
Young's modulus of copper	$= 1.2 \times 10^{11} \text{ Nm}^{-2}$
Avogadro's number, N_A	$= 6.02 \times 10^{23} \text{ mol}^{-1}$
Gas constant, R ,	$= 8.31 \text{ Jmol}^{-1} \text{ K}^{-1}$
The constant $\frac{1}{4\pi\epsilon_0}$	$= 9.0 \times 10^9 \text{ F}^{-1} \text{ m}$

SECTION A

1. Define the following
 - i) Centre of gravity (1 mark)
 - ii) Moment of force (1 mark)
- b) Explain briefly how to locate the Centre of gravity of an irregular lamina. (4 marks)
- c) i) Define the term Pressure. (1 mark)
ii) Derive the expression $p = h\rho g$ for pressure at a point in a fluid of density, ρ , and at a depth, h below the surface. (3 marks)
- d) i) State Archimede's principle. (1 mark)
ii) Using a solid cylinder of cross-sectional area, A and height, h , completely immersed in a fluid of density, ρ , verify Archimede's principle. (4 marks)
- e) A block of wood floats in a liquid with four-fifth of its volume submerged. Given the relative density of wood is 0.80, calculate the density of the liquid. (5 marks)
2. a) Define the following;
 - i) gravitational potential (1 mark)
 - ii) escape velocity (1 mark)
- b) i) State Kepler's law of planetary motion. (3 marks)
ii) A satellite of mass, m , is in a circular orbit around the earth at a distance, r , from the Centre of the earth. Show that r is given by;
$$r = \left(\frac{gT^2 R^2}{4\pi^2} \right)^{\frac{1}{3}}$$
 where R is the radius of the earth and T is period of satellite. (3 marks)
- c) i) Distinguish between free oscillations and damped oscillations. (2 marks)
ii) Describe an experiment to determine the acceleration due to gravity using a simple pendulum. (5 marks)
ii) A spring of force constant 1200Nm^{-1} is mounted on a horizontal frictionless table. One end of the spring is fixed and to the other end is attached a mass of 3.0 kg. The mass is pulled sideways to a distance of 2.0cm and released. Given the mass of the spring is negligible, calculate the;
 - i) speed of the mass when the spring is compressed by 1.0cm. (3 marks)
 - ii) total energy of the oscillation. (2 marks)
3. a) Define the terms;

- i) Impulse (1 mark)
 ii) Power (1 mark)
- b) i) State Newton's law of motion (3 marks)
 ii) Explain how the law of conservation of energy applies to a simple pendulum pulled to one side and released. (3 marks)
- c) i) Distinguish between static friction and kinetic friction. (2 marks)
 ii) Describe briefly an experiment to determine the coefficient of static friction between a wooden block and a flat table. (4 marks)
 iii) List two ways by which the friction between the surfaces can be reduced. (2 marks)
- d) A vehicle of mass 2000kg travelling at 10ms^{-1} along a horizontal surface is brought to rest in a distance of 12.5m against a constant retarding force. Calculate the;
 i) retardation on the vehicle (2 marks)
 ii) power the engine must develop to take the vehicle up an incline of 1 in 10 at a constant speed of 10ms^{-1} of given the frictional resistance to motion is 200N. (2 marks)
4. a) Define the terms;
 i) Young's modulus (1 mark)
 ii) elasticity (1 mark)
- b) i) State Hooke's law. (1 mark)
 ii) Sketch a graph of stress against for a ductile material and rubber on the same axes. (2 marks)
 iii) Explain the features of the curve for rubber. (2 marks)
- c) i) With the aid of a labeled diagram, describe an experiment to determine the Young's modulus of steel wire. (6 marks)
 ii) State four precautions necessary in the experiment in (i) to ensure accuracy. (2 marks)
- d) A copper wire and steel wire, each of length 1.5m and diameter 2mm are joined end – to-end to form a composite wire of length 3m. The wire is loaded and its length becomes 3.003m. Calculate the;
 i) strain in each of the wires (3 marks)
 ii) force applied (2 marks)

SECTION B

5. 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 temperature scale based on the platinum resistance thermometer. (3 marks)

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

c) i) With the aid of a labeled diagram, describe an experiment to determine the specific latent heat of vaporization of a liquid by the method of mixtures. (6 marks)

ii) A block of metal of mass 200g is heated to 150°C and dropped in a copper calorimeter of mass 250g containing 150g of water at 27°C . After stirring the final temperature is 40°C . Calculate the specific heat capacity of the metal. (4 marks)

6. a) Define the following;

- i) adiabatic 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 the heat capacity at constant pressure, C_p , heat capacity at constant volume, C_v and the gas constant, R . (3 marks)

d) Explain the following;

- i) effect of increase in temperature on the pressure of a gas. (2 marks)
- ii) effect of decrease in 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°C is compressed adiabatically to half its original volume. Given $\gamma = 1.4$, calculate the final temperature. (3 marks)

7. a) Define the following;

- i) convection (1 mark)
- ii) thermal conductivity (1 mark)

b) Explain clearly the mechanism of heat transfer in a solid. (3 marks)

c) With the aid of a labeled diagram, describe the experiment to determine the thermal conductivity of copper. (6 marks)

- d) i) What is meant by a black body? (1 mark)
 ii) State Stefan's law of black body radiation. (1 mark)
 iii) Explain briefly how a black body can be realized in practice. (3 marks)
- e) The tungsten filament of an electric lamp has a length of 25cm with a diameter of 0.06mm and its power rating is 100W. Given the emissivity of the filament is 0.8, calculate the steady temperature of the filament. (4 marks)

SECTION C

8. a) Define the following;
 i) mass defect (1 mark)
 ii) isotopes (1 mark)
- b) i) Sketch a graph of binding energy per nucleon against mass number. (2 marks)
 ii) Explain how energy is released during nuclear fusion and nuclear fission. (2 marks)
- c) i) With the aid of a labeled diagram, describe the operation of a Geiger Muller (GM) tube. (6 marks)
 ii) What is meant by background count rate? (1 mark)
 iii) State two sources of background count rate. (1 mark)
- d) The half-life of the Th-230 against alpha decay is 7600years. Calculate the number of disintegrations per second that occur in 1g of $^{230}_{90}\text{Th}$. (4 marks)
9. a) Define the following;
 i) Work function (1 mark)
 ii) Stopping potential (1 mark)
- b) State the laws of photoelectric emission. (4 marks)
- c) i) With the aid of a labeled diagram, describe how X – rays are produced in an X-ray tube. (5 marks)
 ii) Derive Bragg's law X-ray diffraction. (4 marks)
- d) An Alpha particle of mass 6.65×10^{-27} kg travelling at $2.0 \times 10^7 \text{ ms}^{-1}$ head on towards a gold atom of atomic number 79 is repelled back. Calculate the distance of closest approach between the alpha particle and the nucleus. (3 marks)

10. a) Define the following;

i) specific charge

(1 mark)

ii) Faraday's constant

(1 mark)

b) Explain the motion of an electron beam in a region of uniform magnetic field.

(3 marks)

c) i) With the aid of a labeled diagram, describe how to determine the charge on an oil drop by Millikan's oil drop experiment.

(6 marks)

ii) Explain why in experiment in (i) above the temperature of the enclosure is kept constant.

(2 marks)

iii) Distinguish between Cathode rays and positive rays.

(2 marks)

d) The deflecting plates in a Thomson's set up are 5cm long and 1.5cm apart. The plates are maintained at a p.d of 240V. Electrons accelerated to energy 2KeV enter from one edge of the plates midway in the direction parallel to the plates. Calculate the vertical deflection on a screen placed 30cm away from the other end of the plates.

END