P510/1
Physics
Paper 1
July 2017
2 ½ Hours

ACEITEKA JOINT MOCK EXAMINATIONS 2017

UGANDA ADVANCED CERTIFICATE OF EDUCATION

PHYSICS

PAPER 1

TIME: 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.

Non programmable scientific calculators may be used.

Assume where necessary;

Acceleration due to gravity, g	$= 9.81 ms^{-2}$
Electron charge, e	$= 1.6 \times 10^{-19} C$
Electron mass	$= 9.11 \times 10^{-34} Kg$
Plank's constant	$= 6.6 \times 10^{-34} Js$
Avogadro's constant, N_A	$= 6.02 \times 10^{23} mol^{-1}$
Charge to mass ratio e/m	$= 1.8 \times 10^{11} Ckg^{-1}$

SECTION A:

1. (a) (i) Define vector and scalar quantities and give one example of each. (03 marks)
(ii) State the principle of moments. (01 mark)
(iii) Give two conditions for the equilibrium of a rigid body under the action of coplanar forces. (01 mark)

(b)

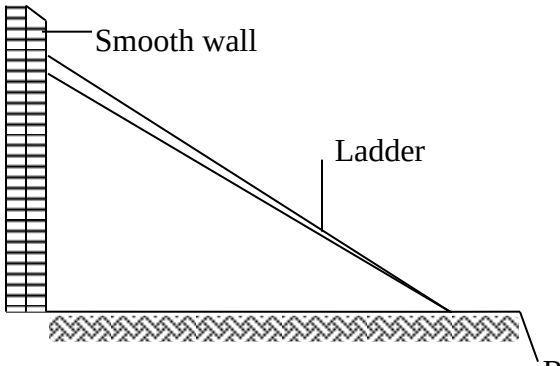

Fig 1:

Fig 1 above shows a uniform ladder, **10m** long and weight **100N** leaning against a smooth vertical wall. The bottom of the ladder is **6m** from the base of the wall. A man whose weight is **700N** stands on the ladder at a point **6m** above the ground. Calculate the forces acting on the ladder. (07 marks)

(c) (i) Define the term velocity. (01 mark)
(ii) A ball is thrown vertically upwards with a velocity of **40ms $^{-1}$** from a point **16m** above the ground. Find the velocity with which it hits the ground. (04 marks)
(ii) State the energy transformations in (c) (ii) above. (03 marks)

2. (a) (i) Define the terms, **tensile stress**, **tensile strain** and **Young's modulus**. (03 marks)
(ii) Describe an experiment to determine Young's modulus of a wire. (05 marks)

(b) Show that the work done per unit volume of a wire is equal to **½ x stress x strain**. (03 marks)

(c) The ends of a uniform wire of length **2m** are fixed the points **A** and **B** which are **2m** apart in the same horizontal line. When a **5kg** mass is attached to the midpoint of the wire, the equilibrium position of the midpoint is **7.5cm** below the line **AB**. Given that the Young's modulus for the material of the wire is **2 x 10^{11} Pa.** Calculate the energy stored in the wire. (06 marks)

(d) Given that the linear expansivity of the material of the wire is **$1.7 \times 10^{-5}\ K^{-1}$,** Calculate the temperature change required to produce an extension as in (c) above. (3 marks)

3. (a) (i) State the laws of solid friction. (03 marks)
   (ii) Explain the above laws using the molecular theory of matter (03 marks)

   (b) Describe an experiment to measure the coefficient of kinetic friction between two solid surfaces. (03 marks)
   (c) What is meant by the following terms?
   (i) Coefficient of surface tension
   (ii) Streamline flow
   (iii) Viscous drag (03 marks)

   (d) Explain the origin of surface tension. (03 marks)

   (e) A wooden block of mass **3.98kg** rests on a rough horizontal surface. The block is attached to a light spring of force constant **$100 Nm^{-1}$,** whose other end is fixed. A bullet of mass **20g** fired into the block embeds itself there and the spring is compressed by **40cm**. If the coefficient of kinetic friction between the block and the surface is **0.3,** find the velocity of the bullet just before it hits the block. (05 marks)

4. (a) (i) State **Newton's law of gravitation**. (01 mark)
   (ii) Derive an expression for the period of a planet moving in a circular orbit about the sun in terms of the radius of the orbit. (04 marks)

   (b) A small bob of mass **0.2kg** is attached to an inextensible string of length **0.80m**. The bob rotates in a horizontal circle of radius **0.40m**. Find the

   (i) Linear speed of the bob. (03 marks)
   (ii) Tension in the string. (02 marks)
   (iii)Periodic time. (02 marks)

   (c) Explain with clear illustrations what is meant by

   (i) An amplitude (02 marks)
   (ii) Period (02 marks)
   in connection with simple harmonic motion

   (d) Explain what is meant by **damped and forced oscillations**. (04 marks)

SECTION B:

5. (a) (i) What is meant by the term fixed points in thermometry? (01 mark)
(ii) Give three examples of such points (02 marks)
(iii) How is temperature on a thermodynamic scale defined using a constant volume gas thermometer? (02 marks)

(b) (i) Describe, with the aid of a diagram, the structure and mode of operation of the total radiation pyrometer. (06 marks)
(ii) State one advantage and one disadvantage of the thermometer in (b) (i) above (01 mark)

(c) What are the molecular differences between a real gas and an ideal gas? (03 marks)
(d) The cylinder of an exhaust pump has a volume of **25cm^3**. It is connected through a valve to a flask of volume **225cm^3** containing air at a pressure of **75cmHg.** Calculate the pressure of the air in the flask after two strokes of the pump assuming that the temperature of the air remains constant. (05 marks)

6. (a) (i) What is **coefficient of thermal conductivity**? (01 mark)
(ii) Describe **Searle's method** of determination of coefficient of thermal conductivity. (07 marks)
(b) The external walls of a house consists of two layers of brick separated by an air cavity. The outer face is at a temperature of **45^{o}C** while the inside of the house is at **20^{o}C.** If the thickness of each brick layer is **15cm** and of air cavity is **5cm**, calculate the temperatures of the walls in contact with the air in the cavity.
(Conductivity of brick = 0.6Wm^{-1}K^{-1} and of air = 0.02Wm^{-1}K^{-1}) (06 marks)

(c) (i) State two factors which determine the rate of heat transfer in a material. (02 marks)
(ii) Explain the mechanism of heat transfer in metals. (04 marks)

7. (a) (i) State the first law of thermodynamics. (01 mark)
(ii) Use the above law to distinguish between an isothermal change and an adiabatic change. (03 marks)
(b) Derive the expression for work done during an adiabatic expansion from state **P_1, V_1** to **P_2, V_2** for a gas whose ratio of the principle heat capacities is **γ** (04 marks)

(c) A vessel contains **2.5 x 10^{-3} m^3** of an ideal gas at a pressure of **8.5 x 10^4 Pa** and a temperature of **45^{o}C**. The gas is compressed isothermally to a volume of **1.25 x 10^{-3} m^3**. It is then allowed to expand adiabatically to the original volume. Calculate the

(i) Final temperature and pressure of the gas (04 marks)
(ii) Total work done during the two processes. (04 marks)
(d) (i) State Dalton's law of partial pressures. (01 mark)
(ii) Deduce Avogadro's hypothesis from the Kinetic theory of gases. (03 marks)

SECTION C

8. (a) (i) State Bohr's postulates of the hydrogen atom. (02 marks)
(ii) Use Bohr's postulates to derive an expression for the radius of the n^{th} Orbit of a hydrogen atom. (6 marks)
(b) (i) Define a line spectrum. (01 mark)
(ii) Explain how a line spectrum is produced in a gas (04 marks)
(c) (i) Explain briefly, why in Millikan's experiment how vapour pressure oil is used (02 marks)
(ii) In a Millilkan's experiment, a charged oil drop of radius 9.2 **x 10 $^{-7}$m** and density **800kgm $^{-3}$** is held stationary in an electric field of intensity **4.0 x 10^{4}Vm $^{-1}$**. How many electron charges are on the drop? (05 marks)

9. (a) (i) State the laws of photoelectric emission. (04 marks)
(ii) Explain why the wave theory of light fails to account for the photoelectric effect. (05 marks)
(b) A freshly clean zinc plate is placed on the cap of a positively charged gold leaf electroscope. Ultraviolent is directed on the zinc plate.
(i) State what is observed. (01 mark)
(ii) Explain the observation in (b) (i) above (03 marks)
(c) (i) Define work function and stopping potential. (02 marks)
(ii) Calculate the wavelength of the electrons that have been accelerated from rest through a p.d. of **100V** (05 marks)

10. (a) (i) Define the terms **radioactivity**, **half life** and **decay constant**. (03 marks)
(ii) Derive the relationship between half life and decay constant (03 marks)
(b) Describe the structure and action of a **Geiger – Muller** tube. (05 marks)
(c) Explain the following terms with respect to a **Geiger-Muller** tube.
(i) Dead time (02 marks)
(ii) A quenching agent (02 marks)
(d) (i) Define the terms unified atomic mass unit and binding energy peer nucleon. (02 marks)
(ii) Calculate the binding energy per nucleon for $^{202}_{80}Hg$ given the following information

Mass of $^{202}_{80}Hg$ $= 201971U$

Mass of a neutron = 1.009U
Mass of hydrogen = 1.008U

Mass of electron = 5.454×10^{-4} U
1U = 931 MeV (03 marks)

END