P510/1

PHYSICS

Paper 1

DECEMBER, 2020

2½ hours

JINJA JOINT EXAMINATIONS BOARD

UgandaAdvanced Certificate of Education

MOCKEXAMINATIONS – DECEMBER, 2020

PHYSICS

Paper 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Attempt not more thanfive questions including at least one but not more than two from each ofthe sectionsA, B and C.

Any additional question(s) answered will not be marked

Where necessary, assume the following constants:

Acceleration due to gravity, g = 9.81 m s – 2

Electronic charge, e = 1.6 x 10-19C

Electronic mass = 9.11 x 10-31kg

Avogadro’s number, NA = 6.02 × 10 23mol– 1

Mass on earth = 5.97 x 1024kg

Charge to mass ratio of an election =

One electron volt, eV = 1.6 × 10 – 19 J

Planck’s constant, h = 6.6 × 10 – 34 J s

Radius of the earth = 6.4 x 106m

Specific heat capacity of water = 4.2 × 10 3 J kg – 1 K– 1

Specific latent heat of fusion of ice = 3.36 x 103JKg-1K-1

Stefan’s – Boltzmann’s constant, δ = 5.67 × 10– 8 W m– 2 K – 4

Speed of light in Vacuum, c = 3.0 × 10 8 m s – 1

Unified mass unit, U = 1.66 × 10– 27 kg

Universal gravitationalconstant, G = 6.67 x 10-11NM2Kg-2

Gas constant, R = 8.31Jmol-1K-1

Permittivity of free space, o = 8.8510-12Fm-1

SECTION A

1. (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** and

(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 100Nm-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)

2. (a) Define the following terms :

(i) **Simple harmonic motion**  (01 mark)

(ii) Amplitude (01 mark)

(b) Derive an expression for **total energy** of a simple harmonic oscillator.

(03 marks)

(c) A test tube of mass 6g and external diameter 2cm is floated vertically in water by adding 100g of mercury at the bottom of the tube. The tube is depressed a small distance and released.

(i) Show that resulting motion of the tube is simple harmonic motion and determine the frequency of its oscillation. (06 marks)

(ii) Explain why the test tube ultimately comes to rest. (02 marks)

(d) What is meant by **critically damped** and **over damped oscillations**? (02 marks)

(e) Describe an experiment to determine the acceleration due to gravity, using a spiral spring, stop clock, a point and a set of masses. (5 marks)

1. (a) (i) What is meant by **dimensions** of a physical quantity (01 mark)

(ii) A sphere rolling down an incline of angle, θ to the horizontal has an acceleration, a given by the equation a = where

M is the mass of the sphere, g is the acceleration due to gravity, I is the moment of inertia of the sphere and r its radius. Find the dimensions of I.

(06 marks)

(b)(i) Define **vector** and **scalar quantities** and give an example of each.

(03 marks)

(ii)

**y**

**0.002N**

**110o**

**74o**

**45o**

**2.004N**

Figure 1

Figure 1 above shows a body of mass 2g which is acted upon by forces of 2.004N, 3.600N and 0.002N, determine the body’s acceleration. (06 marks)

(c) (i) Define **uniform acceleration** . (01 mark)

(ii) Suppose a body moving with a uniform acceleration, **a** increases its velocity steadily from **U** to **V** over a distance, **S**. derive an expression relating **a**, **U,** **V** and **S**.

(03 marks)

1. (a) A piece of cork of density, σ and diameter , d is released from the bottom of a liquid of density, ρ and coefficient of viscosity, η, if ρ > σ
2. Write an equation for the initial acceleration of the cone. (02 marks)
3. Derive an expression for the terminal velocity of the cork. (04 marks)

(b) Describe an experiment to measure relative density of a liquid using Archimedes principle and the principle of moments. (06 marks)

(c) State **Archimedes principle** and **the law of floatation**  (01 mark)

(d) (i) Define **density** of a substance. (01 mark)

(ii) A cork cylinder of cross sectional area 20cm2 and length 30cm is covered at one end with a layer of brass 2cm thick. If the composite floats in water with brass below the cork and the axis of the cylinder being vertical, determine the length of cork that projects above the water surface. (Density of cork = 250kgm-3, density of water = 1000kgm-3.)

**SECTION B**

1. (a) (i) What is a thermometer? (01 mark)
2. With the aid of a well labeled diagram describe the structure and action of a constant volume gas thermometer. (05 marks)

(b) (i) What is a thermometric property? (01 mark)

(ii) Give four examples of thermometric properties (02 marks)

(c) (i) Define the Kelvin (01 mark)

(ii) With reference to the platinum resistance thermometer, describe how a Kelvin scale of temperature is established. (03 marks)

1. The pressure recorded by a constant volume gas thermometer at an absolute temperature, T is 4.8×104 Pa. calculate T if the pressure at the triple point is 4.2 ×104 Pa. (03 marks)

(d)(i) Define the boiling point of a liquid. (01 mark)

(ii) Explain how extra pressure increases boiling point. (03 marks)

1. (a)(i) Define the terms molar heat capacity at constant volume and molar heat capacity at constant pressure. (02 marks)
2. Derive the expression Cp – Cv = R for molar heat capacities. (04 marks)

(b) Define adiabatic and isothermal expansions. (02 marks)

(c) A mass of an ideal gas of volume 400cm3 at 15°C expands adiabatically and its temperature falls to 0°C. It is then compressed isothermally until the pressure returns to its original value. Given that the molar heat capacity at constant pressure is 28.6Jmol-1K-1.

(i) Sketch a P-V graph for the process. (01 mark)

(ii) Calculate the final volume after the isothermal compression. (04 marks)

(d) (i) define saturated vapour pressure. (01 mark)

(ii) Describe an experiment to show the variation of saturated vapour pressure of a liquid with temperature. (06 marks)

1. (a) What is meant by :
2. **Thermal conductivity** and (01 mark)
3. Coefficient of thermal resistance (01 mark)

(b) State two precautions that must be taken into account when measuring the thermal conductivity of a metal. (02 marks)

(c) Describe an experiment to determine the thermal conductivity of a poor conductor of heat. (06 marks)

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

(ii) Using the same axes, sketch graphs to show the distribution of energy in the spectrum of a black body radiation for two different temperatures.

(02 marks)

1. Use the graph in d (ii) above to explain why the radiation becomes more white as the temperature increases. (02 marks)

(e) A spherical body of radius 20mm emits 65% of the radiation emitted by a black body and is at a temperature of 27°C. Calculate the initial rate of fall of temperature of the body if the surrounding temperature is -20°C, specific heat capacity is 400JKg-1K-1 and its density is 8300kgm-3. (05 marks)

**SECTION C**

1. (a)(i) Define **binding energy** of a nuclide. (01 mark)
2. Sketch a graph to show how binding energy per nucleon varies with mass number and explain its main features. (04 marks)

(b) Distinguish between **nuclear fusion** and **nuclear fission**. (02 marks)

(c) Describe with a labeled diagram, the structure and mode of action of an ionization cloud chamber. (06 marks)

(d) In a fusion reaction, + calculate the energy in joules which is released. Given that:

Mass of = 3.345 × 10-27 kg

Mass of = 5.008 × 10-27kg

Mass of = 6.647 × 10-27kg

Mass of = 1.675× 10-27kg (04 marks)

(e) Explain the application of carbon-14 in **carbon dating**. (03 marks)

1. (a)(i) Explain briefly why **X-ray production** is referred to as the reverse of **photo electric emission**. (02 marks)
2. Describe with a labeled diagram how X-rays are produced in an X-ray tube.

(05 marks)

1. Give the use of a vacuum in X-ray production. (01 mark)

(b) (i) Give any two properties of cathode rays (01 mark)

(ii) Describe how the specific charge of an electron is determined using J.J Thompson’s method. (06 marks)

(c) An electron gun operating at 3.0×103V is used to project electrons into the space between two opposite charged parallel plates of length 10cm and separation 5cm, calculate the deflection of the electrons as they emerge from the region between the charged plates when the potential difference between the plates is 1.0×103V. (05 marks)

1. (a) (i) State **Bohr’s postulates** of the hydrogen atom (02 marks)
2. Use Bohr’s postulates to derive an expression for the radius of the nth orbit of a hydrogen atom. (06 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** low vapour pressure oil is used. (02 marks)

(ii) In a Millikan’s experiment, a charged oil drop of radius 9. 2× 10-7m and density 800kgm-3 is held stationary in an electric field of intensity 4.0×104 Vm-1. How many electronic charges are on the drop if the density of air is **1 kg m-1**? (05 marks)

***END***