Teacher's copy

P510/1
PHYSICS
Paper 1
2 Hours 30 Minutes
August 2019

TORORO ARCHDIOCESE EXAMINATIONS BOARD
Uganda Advanced Certificate of Education
MOCK EXAMINATIONS
PHYSICS
Paper 1
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**.
Non – programmable scientific calculators may be used.
Assume where necessary;

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Acceleration due to gravity	g	=	9.81 ms^{-2}
Electron charge	e	=	1.60×10^{-19} C
Electron mass	m	=	9.11×10^{-31} kg
Mass of the earth		=	5.97×10^{24} kg
Plank's constant	h	=	6.6×10^{-34} Js
Stefan Boltzmann's constant	σ	=	$5.67 \times 10^{-8} Wm^{-2}k^{-4}$
Radius of the earth		=	6.4×10^{6}m
Speed of light in a vacuum	c	=	$3.0 \times 108 ms^{-1}$
Surface tension of water	γ	=	7.0×10^{-2} Nm^{-1}
Charge to mass ratio	$\frac{e}{m}$	=	$1.8 \times 10^{11} Ckg^{-1}$
Universal gravitational constant G		=	6.67×10^{-11} Nm^2kg^{-2}
Specific heat capacity of water		=	4200 $Jkg^{-1}K^{-1}$
Avogadro's number	N	=	6.02×10^{23} mol^{-1}
Gas constant	R	=	8.31 $Jmol^{-1}K^{-1}$
Specific heat capacity of ice		=	3.30×10^{5} $Jkg^{-1}K^{-1}$
The constant	$\frac{1}{4\pi\varepsilon_0}$	=	9.0×10^{9} $F^{-1}m$

SECTION A

1 (a) Define the following terms as applied to the motion of projectiles;

(i) **Range** [01 mark]

(ii) **Time of flight** [01 mark]

(b) A ball is thrown vertically upwards, moves to the maximum height and returns to the level of projection.

(i) Sketch a speed -, time graph for the motion of the ball [01 mark]

(ii) Explain the motion of the ball throughout [02 marks]

(c) (i) What is meant by the term **acceleration due to gravity**? [01 mark]

(ii) Explain why the acceleration due to gravity at the equator is less than that at the poles. [02 marks]

(d) State the following;

(i) **Work – energy theorem** [01 mark]

(ii) **Newton's laws of motion** [03 mark]

(e) A car of mass 2000 kg, travelling at $10ms^{-1}$ on a horizontal surface is brought to rest in a distance of 12.5m by the action of the brakes

Calculate the;-.

(i) Average retarding force [04 marks]

(ii) Power that must be developed by the engine to take the car up the incline of 1 in 10 at a constant speed of 10 ms^{-1} against friction resistance of 200 N [04 marks]

2 (a) (i) State the **principle of conservation of linear momentum** [01 mark]

(ii) Distinguish between **perfectly elastic** and **perfectly inelastic** collision [02 marks]

(b) A bullet of mass 20 g is fired horizontally into a suspended stationary block of wood of mass 500 g with a velocity of 200 ms^{-1}

(i) State the factors upon which the angle of swing θdepends [01 mark]

(ii) Calculate the common velocity of the bullet and the block if the bullet is embedded in the block. [03 marks]

(c) (i) What is meant by the term **friction** [01 mark]

(ii) Using molecular theory, explain the origin of solid friction [03 marks]

(iii) Describe an experiment to determine the coefficient of kinetic friction [04 marks]

(d) (i) Distinguish between **elastic** and **plastic deformation** [02 marks]

(ii) Derive an expression for the energy stored per unit volume of a stretched wire in terms of stress and strain [03 marks]

3 (a) State **Kepler's laws** of planetary motion [03 marks]

(b) (i) A satellite moves in a circular orbit of radius **R** about a planet of mass **M** with a period **T**. show that, $\mathbf{R^3} = \frac{GMT^2}{4\pi^2}$.

Where **G** is the universal gravitational constant [04 marks]

(ii) Explain why any resistance to the forward motion of the satellite causes an increase its speed [03 marks]

(c) (i) Describe an experiment to measure the universal gravitational Constant **G** [06 marks]

(ii) A communication satellite revolves with a period of 8.65×10^4 s a round the earth surface. Calculate the height above the earth that the satellite maintains to keep the period of revolution constant. [04 marks]

4 (a) Define the following terms;

(i) **Terminal velocity** [01 mark]

(ii) **Coefficient of viscosity** [01 mark]

(b) (i) A ball of density σ and radius **r** is released to fall through a liquid of Density ρ and viscosity η. Derive an expression for the terminal velocity of the ball. [03 marks]

(ii) Explain using molecular theory why the viscosity of the gas increases with increase in temperature while that of a liquid decrease with increase temperature. [04 marks]

(c) (i) State **Archimedes principle** [01 mark]

(ii) Describe an experiment to determine the density of a liquid using Archimedes principle [05 marks]

(d) A block of mass 120 g is suspended from a spring balance and when fully immersed in water, the balance reads 0.63N and reads 0.75N when fully immersed in oil. Calculate the;-

(i) Density of the block [03 marks]

(ii) Density of oil [02 marks]

SECTION B

5 (a) (i) Define **specific latent heat of vaporisation** [01 mark]

(ii) Describe an electrical method for determination of the specific latent heat of vaporization of water [05 marks]

(iii) State **two** advantages of using the method in (a) (ii) above. [02 mark]

(b) Explain why the specific latent heat of fusion and specific latent heat of vaporisation of a substance at the same pressure are different [04 marks]

(c) When water was passed through a continuous flow calorimeter, the rise in temperature was from 16.0^0C to 20.0^0C, the mass of water flowing was 100 g in one minute, the potential difference across the heating coil was 20.0V and the current was 1.5A. Another liquid at 16.0^0C was then passed through the calorimeter and got the same change in temperature and potential difference was 13.0V, the current was 1.2A and the rate of flow of 120 g in one minute. Calculate the specific heat capacity of the liquid. [05 marks]

(d) Using the expression for the kinetic pressure of an ideal gas, deduce the ideal gas equation if $\frac{1}{2}mc^{-2} = \frac{3}{2}k_B\ T$ [03 marks]

6 (a) (i) Define **Thermal conductivity** [01 mark]

(ii) Explain the mechanism of heat transfer in metals [03 marks]

(b) A copper kettle containing 1.00 kg of water has a base of thickness 2.0 mm and area $3.0 \times 10^{-2}m^2$. Calculate the;-

(i) Steady temperature difference between the inner and outer and outer surfaces of the base which must be maintained so that the temperature of the water rises at a rate of $0.25Ks^{-1}$ [03 marks]

(ii) Specific latent heat of vaporization of water, if its allowed to boil under the same conditions for 120s and the mass of water remaining is 0.94 Kg [03 marks]

(c) (i) Describe an experiment to determine the thermal conductivity of a piece of rubber. [06 marks]

(ii) Define **a perfect black body** [01 mark]

(d) Using the same axes, sketch graphs to show the distribution of energy in the spectrum of radiation from a black body at three different temperatures

[03 marks]

7 (a) Distinguish between **saturated vapour** and **unsaturated vapour** [02 marks]

(b) (i) With the aid of a labelled diagram, describe an experiment to determine the saturated vapour pressure of a liquid at a particular temperature. [05 marks]

(ii) Explain the effect of increasing temperature on the pressure of the gas [03 marks]

(c) (i) Derive an expression for the difference in molar heat capacities of an ideal gas [04 marks]

(ii) Account for the difference in the molar heat capacities for a fixed mass of gas [02 marks]

(d) A gas of volume 2 litres at a temperature of 300K and a pressure of 1.5×10^5 Pa is heated to a temperature of 325K at a constant pressure until its volume doubles. It is the cooled at constant volume back to its original temperature before finally being compressed isothermally to its original volume.

(i) Draw P-V diagram to describe the whole cycle [02 marks]

(ii) Calculate the pressure of the gas after cooling at constant volume to its original temperature [02 marks]

SECTION C

8 (a) Define the following;

(i) **Nuclide** [01 mark]

(ii) **Nucleons** [01 mark]

(b) (i) Distinguish between **nuclear fission** and **nuclear fission** [02 marks]

(ii) State the conditions necessary for nuclear fusion to take place [02 mark]

(c) Sketch the graph of binding energy per nucleon against mass number and indicate the position of the most stable nuclide [04 marks]

(d) The deuterium – trillium fusion reaction that can take place in a thermonuclear fusion reactor is as shown

$$^{2}_{1}H + {}^{3}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n + \text{energy.}$$

Taking;

Mass of $^{2}_{1}H$ = 2.0141 U

Mass of $^{3}_{1}H$ = 3.0161 U

Mass of $^{4}_{2}He$ = 4.0026 U

Mass of $^{1}_{0}n$ = 1.0087 U

1 U = 931 MeV

Calculate the;-

(i) Amount of energy released in the reaction [05 marks]

(ii) Kinetic energy needed to overcome coulomb's repulsion, assume radius of deuterium and trillium to be 1.50×10^{-15} m each [05 marks]

9 (a) Define the following;

(i) **Photoelectric emission** [01 mark]

(ii) **Threshold frequency** [01 mark]

(b) (i) With the aid of a diagram, describe an experiment to demonstrate photoelectric emission [04 marks]

(ii) Describe an experiment to measure the stopping potential of a given surface [05 marks]

(c) (i) What is meant by **a photon**? [01 mark]

(ii) State the **laws of photoelectric emission** [04marks]

(d) (i) What is meant by **line spectrum**? [02 marks]

(ii) Distinguish between **ionisation energy** and **excitation energy** [02 marks]

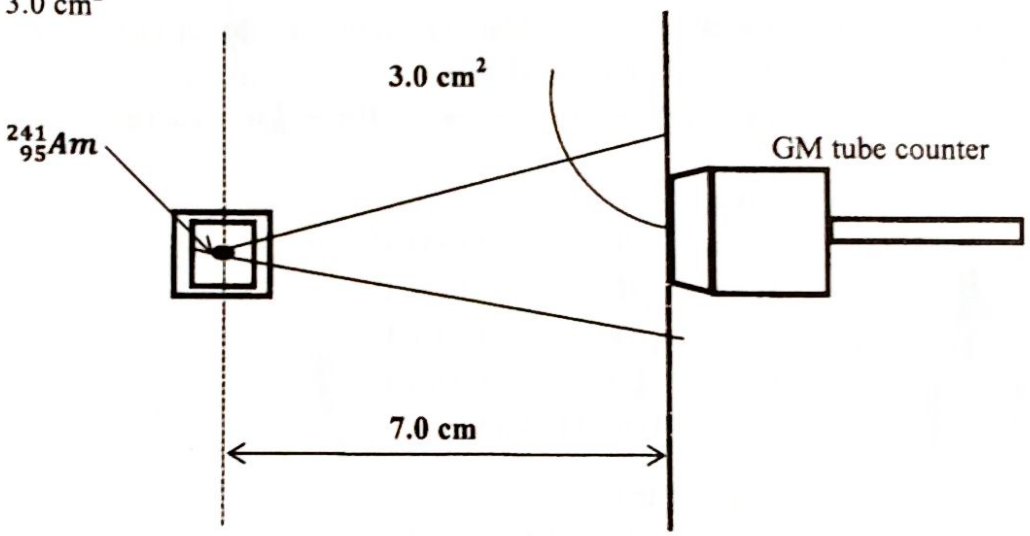
10 (a) (i) What is meant by **radioactivityand decay constant?** [02 mark]

(ii) Define the **unified mass unit** [01 mark]

(b) (i) With the aid of a diagram, describe the structure and operation of an ionisation chamber [06 marks]

(ii) Sketch a graph of ionisation current verses operatingP.D and explain the features of the graph [04 marks]

(c) Figure 1 shows a point source of alpha particles as a tiny mass of the nuclide $^{241}_{95}Am$ Mounted 7.0 cm in front of a GM tube whose mica window has a reception area of 3.0 cm^2



The counter linked to the GM tube records 5.40 x 10^4 counts per minute.
Calculate the;-

(i) Number of disintegrations per second with in the source [04 marks]

(ii) Number of $^{241}_{95}Am$ atoms with the source [03 marks]

[The decay constant **λ**, for $^{241}_{95}Am$ **= 4.80** x 10^{-11} per second]

END