P510/1
PHYSICS
(Principal subject)
Paper 1
AUGUST 2019
2 ½ HOURS

MASAKA DIOCESAN EXAMINATIONS BOARD

Uganda Advanced Certificate of Education
JOINT MOCK EXAMINATION 2019
PHYSICS
(Principal Subject)
PAPER 1
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INSTRUCTIONS TO CANDIDATES:

Attempt **five** *questions, including* **one** *but not more than* **two** *from each of the sections,* **A**, **B** *and* **C**. ***Any additional question(s) attempted will not be marked***.
Non-programmable scientific electronic 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	=	$9.11 \times 10^{-31} kg$
Mass of earth	=	$5.97 \times 10^{24} kg$.
Planck's constant, h	=	$6.6 \times 10^{-34} Js$.
Stefan's – Boltzmann's constant, σ	=	$5.7 \times 10^{-8} Wm^{-2}K^{-4}$
Radius of Earth	=	$6.4 \times 10^{6} m$.
Radius of the sun	=	$7 \times 10^{8} m$.
Radius of earth's orbit about the sun	=	$1.5 \times 10^{11} m$
Speed of light in a vacuum, c	=	$3 \times 10^{8} ms^{-1}$
Thermal conductivity of copper	=	$390 Wm^{-1}K^{-1}$
Thermal conductivity of aluminium	=	$210 Wm^{-1}K^{-1}$
Specific heat capacity of water	=	$4200 Jkg^{-1}K^{-1}$
Universal Gravitational constant, G	=	$6.67 \times 10^{-11} Nm^{2}kg^{-2}$
Avogadro's number N_A	=	$6.02 \times 10^{23} mol^{-1}$.
Density of water	=	$1000 kgm^{-3}$
Gas constant, R	=	$8.31 Jmol^{-1}K^{-1}$
Charge to mass ratio, e/m	=	$1.8 \times 10^{11} Ckg^{-1}$
The constant $\frac{1}{4\pi\varepsilon_o}$	=	$9.0 \times 10^{9} F^{-1}m$
Faradays constant, F	=	$9.65 \times 10^{4} Cmol^{-1}$

SECTION A

1. (a) Define the term.
   (i) work (1 mark)
   (ii) Friction (1 mark)

   (b) (i) Distinguish between a conservative force and non-conservative force. (2 marks)
   (ii) Give one example of each type of force. (1 mark)

   (c) (i) State the laws of static friction. (3 marks)
   (ii) Using molecular theory explain the laws of solid friction. (5 marks)
   (iii) Describe an experiment to determine the coefficient of kinetic friction between two solid surfaces. (4 marks)

   (d) A car of mass 1.2×10^3kg increases its speed from $10ms^{-1}$ to $20ms^{-1}$ while moving up an incline of inclination 1 in 20. The car moves through 500m against a constant resistance to motion of 300N. Calculate the driving force exerted by the engine. (3 marks)

2. (a) Define the terms:
   (i) surface tension (1 mark)
   ii) angle of contact (1 mark)

   (b) (i) Explain the effect of increase in temperature on the surface tension of a liquid. (3 marks)
   (ii) Describe an experiment to determine the surface tension of a liquid using capillary rise method. (6 marks)

   (c) (i) Distinguish between laminar flow and turbulent flow. (2 marks)
   (ii) State Bernoulli's principle. (1 mark)

   (d) A tank contains a liquid of density $1.2 \times 10^3 kgm^{-3}$. A body of volume $5.0 \times 10^{-3}m^3$ and density $9.0 \times 10^2 kgm^{-3}$ is totally immersed in the liquid and is attached by a thread to the bottom of the tank. Calculate the
   (i) Upthrust on the body (3 marks)
   (ii) tension in the thread (3 marks)

3. (a) Define the following:
   (i) angular velocity (1 mark)
   (ii) frequency (1 mark)

(b) A body of mass, m moves round a circle of radius, r at a uniform speed, v. Derive the expression for the centripetal force, F on the body. (3 marks)

(c) (i) State Newton's law of gravitation. (1 mark)
(ii) Describe an experiment to determine the universal gravitational constant, G. (6 marks)
(iii) Sketch a graph showing variation of acceleration due to gravity with distance from the centre of the earth. (2 marks)

(d) A satellite of mass 200kg is launched in a circular orbit of radius 7.2×10^3km about the earth.
(i) Calculate the kinetic energy of the satellite. (3 marks)
(ii) Explain the effect of air resistance on such a satellite. (3 marks)

4. (a) Define the terms:
(i) stress (1 mark)
(ii) work hardening (1 mark)

(b) (i) Distinguish between elastic deformation and plastic deformation. (2 marks)
(ii) Describe an experiment to determine the young's modulus of steel wire. (6 marks)

(c) Two wires of lengths L_1 and L_2, cross-sectional areas A_1 and A_2 and Young's moduli γ_1 and γ_2 respectively are joined in series. Show that the force, F exerted on the wire to produce total extension, e is given by:

$$F = \frac{(A_1 A_2 \gamma_1 \gamma_2)}{A_1\gamma_2 L_1 + A_2\gamma_2 L_1} e$$ (4 marks)

(d) (i) Distinguish between stable equilibrium and unstable equilibrium. (2 marks)
(ii) A uniform ladder 5.0m long and of mass 40kg rests with its upper end against a smooth vertical wall and its lower end 3.0m from the wall on a rough ground. Calculate the force at the foot of ladder. (4 marks)

SECTION B

5. (a) Define the following:
(i) isothermal change (1 mark)
(ii) Critical temperature (1 mark)

(b) The equation of state for one mole of real gas of volume, V and pressure, P at temperature, T is given by $\left(P + \frac{a}{V^2}\right)(V - b) = RT$, where a and b are constants. Explain the significance of the terms $\frac{a}{V^2}$ and b. (2 marks)

(c) (i) State the kinetic theory of matter. (1 mark)
(ii) Describe briefly an experiment to demonstrate the kinetic theory of matter. (3 marks)
(iii) A gas of density, $\rho$with molecules moving at mean square speed, $\overline{c^2}$ is contained in a cube of side, l. Show that the pressure exerted by the gas is $P = \frac{1}{3}\rho\overline{c^2}$ (4 marks)

(d) (i) Distinguish between saturated vapour pressure and partial pressure. (2 marks)
(ii) Explain the effect of increase in temperature on the saturated vapour pressure of a liquid. (3 marks)

(e) An ideal gas at a pressure of 1.0 x 10^5Pa and temperature of 27^{o}C is compressed isothermally to half its volume. The gas then expands adiabatically to its original volume. Taking γ = 1.4, calculate the final temperature of the gas. (3 marks)

6. (a) Define the following:
(i) conduction (1 mark)
(ii) thermal conductivity (1 mark)

(b) Explain how convection takes place in a liquid. (3 marks)

(c) (i) With the aid of a labelled diagram, describe an experiment to detect thermal radiation by use of a bolometer. (5 marks)
(ii) Explain the flow of heat along a fully lagged metal bar. (3 marks)

(d) (i) What is meant by a black body? (1 mark)
(ii) State the laws of black body radiation. (2 marks)

(e) An iron pan containing water boiling steadily at 100^{o}C stands on a hot plate and heat conducted through the base of the pan evaporates 90g of water per minute. If the base of the pan has an area of 0.05m^2 and of uniform thickness 2mm, calculate the surface temperature of the underside of pan. (4 marks)

7. (a) Define the following:
(i) thermometric property (1 mark)
(ii) triple point of water (1 mark)

(b) (i) With the aid of a labelled diagram, describe the operation of a constant – volume gas thermometer. (6 marks)
(ii) List three corrections necessary in the constant – volume thermometer. (3 marks)

(c) (i) State Newton's law of cooling. (1 mark)
(ii) Explain why a small body cools faster than a large one of the same material. (3 marks)

(d) A heating coil is immersed in 180g of paraffin contained in a copper calorimeter of mass 100g. A current of 2.5A flowing through the coil causes a temperature rise of 10^0C in the paraffin in 100 seconds. Calculate the:
(i) total heat absorbed by the system. (3 marks)
(ii) reading of voltmeter connected across the coil. (3 marks)

SECTION C

8. (a) Define the terms:
(i) Mass number (1 mark)
(ii) decay constant (1 mark)

(b) Derive the relation between half-life, $T_{½}$ and decay constant, λ. (3 marks)

(c) With the aid of a labelled diagram describe the operation of a cloud chamber in detecting radiation. (6 marks)

(d) (i) What is meant by binding energy of a nucleus? (1 mark)
(ii) Distinguish between nuclear fusion and nuclear fission. (2 marks)
(iii) State the significance of each of the process in (ii) above. (1 mark

(d) The radioactive nuclei $^{210}_{84}Po$ emit alpha particles and the product nuclei are of $^{206}_{82}Pb$. Taking the mass of:
$^{210}_{84}Po$ = 209.937u, $^{206}_{82}Pb$= 205.929u, =$^{4}_{2}He$ 4.002u and 1u = 931MeV.
(i) Calculate the energy released in each disintegration. (4 marks)
(ii) Explain why not all the energy does not appear as the kinetic energy of the alpha particle. (1 mark)

9. (a) Define the following:
(i) photoelectric emission (1 mark)
(ii) threshold frequency (1 mark)

(b) Explain using quantum theory the laws of photoelectric emission. (5 marks)

(c) With the aid of a labelled diagram, describe an experiment to determine the stopping potential of a given metal surface. (5 marks)

(d) An alpha particle of mass, M moving at velocity, V collides head-on with a gold atom of atomic number, Z and is deflected through 180^0. Derive the expression for the distance of closest approach, r between the gold nucleus and the alpha particle. (3 marks)

(e) The energy levels of mercury atom are -5.5eV, -3.7eV and -1.6eV.
(i) Distinguish between ionization energy and excitation energy. (2 marks)
(ii) Calculate the speed of an electron that can ionize the mercury atom. (3 marks)

10. (a) Define the following:
(i) positive rays (1 mark)
(ii) thermionic emission. (1 mark)

(b) With the aid of a labelled diagram, describe an experiment to determine the charge to mass ratio of ions using the Bainbridge mass spectrometer. (7 marks)

(c) Explain the motion of electrons when directed mid-way between two parallel metal plates across which a potential difference is applied. (3 marks)

(d) An electron is accelerated by a p.d of 4KV and directed into a region of uniform magnetic field of flux density 0.12T. Calculate the:
(i) speed acquired by each electron before entering the magnetic field. (2 marks)
(ii) radius of the circle described. (3 marks)

(e) (i) Explain the function of the time base in a cathode ray oscilloscope. (1 mark)
(ii) State two advantages of the CRO when used to measure voltage. (2 marks)

END