P510/1
Physics
Paper 1
July/August 2018
2 ½ hours

MOCK EXAMINATIONS 2018

UGANDA ADVANCED CERTIFICATE OF EDUCTION

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 electronic calculators may be used.
- Assume where necessary:

Acceleration due to gravity	g = 9.81 ms^{-2}
Electronic charge	e = 1.6 x 10^{-19} C
Mass of the earth	= 5.97 x 10^{24}kg
Plank's constant	h = 6.6 x 10^{-34}Js
Stefan's Boltzman's constant	□ = 5.67 x 10^{-8} $wm^{-2}K^{-4}$
Radius of the earth	= 6.4 x 10^{6}m
Radius of the sun	= 7 x 10^{8}m
Universal gravitational constant	G = 6.67 10^{-4} Nm^{2} Kg^{-2}
Avogadro's number	N_A = 6.02 x 10^{23} mol^{-1}
Surface tension of water	= 7.0 x 10^{-2} Nm^{-1}
Gas constant	R = 8.31 $Jmol^{-1}K^{-1}$
The constant $\frac{1}{4\pi\varepsilon_o}$	$= 9.0 \times 10^{9} F^{-1} m$

SECTION A:

1. (a) (i) State the work energy theorem (01 mark)
   (ii) State Newton's laws of motion (03 marks)

(b) A bullet of mass 20g travelling at 100ms $^{-1}$ embeds itself in the centre of the wooden block of mass 1kg suspended by light vertical string 1m in length.

(i) State the factor upon which the angle of swing depends (01 mark)

(ii) Calculate the maximum inclination of the string to the vertical (05 marks)

(c) Explain the terms: time **of flight** and **range** as applied to the projection motion (04 marks)

(d) A particle is projected at an angle of 20 ^{0} to the horizontal and just clears a wall which is 10m high and 30m from the point of projection.

Calculate the;

(i) Speed of projection (03 marks)

(ii) Angle which the particle makes with the horizontal as it passes through the wall (03 marks)

2. (a) (i) Define coefficient of surface tension (01 mark)
   (ii) Use the molecular theory of matter to explain the existence of surface tension (03 marks)

(b) (i) A clean glass capillary tube is of internal diameter 0.04cm is held vertically with its lower end below the surface of clean water in a clean beaker and with 10cm of the tube above the surface of the water. Show that the height to which the water rises in the tube is given by $h = \frac{2\gamma}{r\rho g}$ where γ is the coefficient of surface tension of water, r radius of the tube, ρ density of water and g is the acceleration of gravity. (3 marks)

(ii) Given that coefficient of surface tension of water is 7.2 x 10 $^{-2}$ Nm $^{-1}$ Calculate the height to which water will rise in the tube in (i) above (2 marks)

(c) (i) Explain what will happen if the tube is then depressed until its length above the water surface is only 5cm. (3 marks)

(ii) Describe an experiment to determine the surface tension of water using capillary tube method. (5 marks)

(d) A soap bubble whose radius is 12mm becomes attached to another of radius 20mm. Calculate the radius of the common interface. (03 marks)

3. (a) (i) Define the terms tensile stress and tensile strain as applied to a stretched wire (02 marks) (ii) Distinguish between elastic limit and proportional limit (02 marks)

(b) With the aid of a labeled diagram, describe an experiment to investigate the relationship between tensile stress and tensile strain of a steel wire (07 marks)

(c) (i) A load of 60N is applied to a steel wire of length 2.5m and cross-sectional area of $0.22mm^2$. If Young's modus for steel is 2×10^{11} Nm^{-2}, find the extension produced. (03 marks)

(ii) If the temperature rise of 1K causes a fractional increase of 0.001%, find the change in length of steel wire of length 2.5m when the temperature increases by 4K (03 marks)

(d) The velocity ,V of a wave in a material of Young's modulus E and density γ is given by $V = \sqrt{\frac{E}{\gamma}}$ show that the equation is dimensionally correct (03 marks)

4. (a) (i) Distinguish between uniform velocity and uniform acceleration (02 marks) (ii) A body travelling with a velocity, u is uniformly accelerated with an acceleration ***a*** to a velocity, v over distance, s. Derive an expression relating u,v ,***a*** and s. (04 marks)

(b) A body started from rest, travels for 6s with a uniform acceleration of $2ms^{-2}$, it then maintains this speed until it is brought to rest with a uniform retardation of $3ms^{-2}$. If the total distance travelled is 180m.

(i) Calculate the time taken for the journey (07 marks)

(ii) Sketch a velocity time graph for the motion of the body. (02 marks)

(c) You are provided with a stop clock, a metre rule, a spiral spring with a pointer, a set of masses, a retort stand and a clamp. Describe how you would use the set of apparatus
to determine acceleration due to gravity. (05 marks)

SECTION B:

5. (a) (i) State the assumptions made in the derivation of the Kinetic theory expression for the pressure of an ideal gas (2 marks)
   (ii) Which assumptions made above have to be modified for real gases? (2 marks)
   (iii) The equation of state of one mole of a real gas is given by the expression $(\rho + \frac{9}{v2})(v - b) = RT$

   Account for the terms $\frac{9_2}{v}$ and b. (03 marks)

   (b) Calculate the root mean square speed of the molecules of an ideal gas at 147°C given that the density of the gas at a pressure 1.01 x 10^5 Nm^{-2} at a temperature of 0°C is 1.5kgm^{-3} (05 marks)

   (c) The density of an ideal gas is 1.60kgm^{-3} at 27°C and 1.01 x 10^5 Nm^{-2} pressure and its specific heat capacity at constant volume, c_v is 312 Jkg^{-1} K^{-1}. Find the ratio of the specific heat capacity at constant pressure ,c_p to that at constant volume. (04 marks)

   (d) Explain with the aid of a volume against temperature sketch graph, what happens to a gas cooled at constant pressure from room temperature to zero Kelvin. (04 marks)

6. (a) Define the following terms as applied to heat
   (i) specific heat capacity (01 mark)
   (ii) internal energy of a substance (01 mark)

   (b) (i) Describe an experiment to determine the specific heat capacity of a liquid using the continuous flow method (05 marks)

(ii) Outline the advantages the continuous flow method has over the method of mixtures when determining specific heat capacity of a liquid. (03 marks)

(c) State Newton's law of cooling (01 mark)

(d) In an experiment to determine the specific heat capacity of aluminium a cylindrical 1kg block of aluminium, suspended in a room at 20°C was heated electrically by a 17.3W immersion heater inserted into a hole in the centre of the block. The temperature of the block at first rose steadily and at 25°C, Its rate of rise was 10K in 10 minutes, then more slowly, finally stabilizing at 85°C.

Calculate

(i) the rate of heat loss from the block at 25°C (04 marks)

(ii) the specific heat capacity of aluminium (03 marks)

(e) Explain why temperature remains constant during change of phase from solid to liquid (02 marks)

7. (a) (i) Explain why the amount of energy required to raise the temperature of 1 mole of a gas at constant pressure through a temperature of 1K is different from that required to raise its temperature by 1K but at constant volume. (03 marks)

(ii) Derive the expression for the difference in the values of heat in (a) (i) above (04 marks)

(b)State the relationship between pressure P and volume V of a fixed mass of an ideal for

(i) A reversible isothermal process (1 mark)

(ii) A reversible adiabatic process (2 marks)

(c) State any two differences between ideal and real gases (2 marks)

(d) An ideal gas at a pressure of 2.0×10^6Pa occupies a volume of 2.0×10^{-3} m^3 at 47.5°C. The gas expands adiabatically to a final pressure of 1.1×10^5 Pa. The ratio of specific heat capacity at constant pressure to that at constant volume is 1.4

Calculate the

(i) Number of moles of the gas (02 marks)

(ii) Final volume of the gas (03 marks)

(iii) Work done by the gas (03 marks)

(Gas constant , R = 8.31 $Jmol^{-1} K^{-1}$)

SECTION C:

8. (a) (i) With the aid of a diagram, describe how cathode rays are produced (04 marks)
(ii) Explain how the sign of the charge of cathode rays may be determined (02 marks)

(b) An electron is projected with a speed of 3.0 x 107ms^{-1} in the direction of a uniform electric field. After travelling a distance of 40cm the electron reverses its direction.
(i) Why does the electron reverse its direction? (01 mark)
(ii) calculate the magnitude of the electric field (04 marks)

(c) With the aid of a labeled diagram, describe the operation of the Bainbridge mass spectrometer in the measurement of specific charge of positive ions. (06 marks)

(d) A beam of positive ions is accelerated through a potential difference of 1 x 10^3V into a region of uniform magnetic field of flux density 0.2T while in the magnetic field it moves in a circle of radius 2.3cm.Calculate the charge to mass ratio of these ions. (03 marks)

9. (a) (i) Write down Einstein's equation for the Kinetic energy of electrons due to photoelectric emission (01 mark)
(ii) Explain briefly how the Kinetic energy of the electrons emitted from a metal surface depends on frequency of the incident radiation. (03 marks)

(b) (i) Sketch , using the same axes, graphs showing the variation of maximum Kinetic energy of photo electrons emitted by two metals having different work functions, with frequency of incident radiation (03 marks)
(ii) Explain briefly how Planks constant can be obtained from the above graphs (02 marks)
(iii) When sodium of work function of 2.0eV is illuminated by a radiation of wavelength 149nm, electrons are emitted. Calculate the speed of the emitted electrons. (03 marks)

(c) (i) State Bragg's law of X-ray diffraction (01 mark)

(ii) When a monochromatic beam of x-rays is incident on a certain crystal at 0^oC first order diffraction is observed at a glancing angle of 30^o. When the temperature of the crystal is raised to 300^oC again first order diffraction is observed at an angle 28^o. Calculate the mean value of the coefficient of linear expansion of the crystal for the temperature range 0^oC to 300^oC. (05 marks)

(d) State one medical use and one industrial use of x-rays. (02 marks)

10. (i) What is meant by the term 'binding energy of a nucleus?' (01 mark)

(ii) Calculate the binding energy per nucleon of an $\square - particle$ expressing your answer in MeV

Mass of proton = 1.0080U

Mass of a neutron = 1.0087U

Mass of an □ - particle = 4.0026U

1U = 931 MeV (04 marks)

(iii) Sketch a graph of binding energy per nucleon against mass number and use it to explain liberation of energy by nuclear fusion and nuclear fission. (05 marks)

(b) Derive an expression relating the half life of a radioactive material T½ and the decay constant □ (03 marks)

(c) When $^{238}_{98}U$ decays, the end product is $^{206}_{82}Pb$. The half life is 1.4 x 10^{17} s suppose a rock sample contains $^{206}_{82}Pb$ and $^{238}_{98}U$ in the ratio 1:5 by weight.

Calculate the

(i) number of ^{206}Pb atoms in 5.0g of the rock sample. (3 marks) 82

(ii) age of the rock (04 marks)

END