P510/1
PHYSICS
Paper 1
July/August 2017
2½ hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

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**.*
- *Any additional question(s) answered will **not** be marked.*
- *Non programmable silent 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		=	$9.11 \times 10^{-31}\ kg$
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	=	$5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$
Radius of the earth		=	$6.4 \times 10^{6} m$
Radius of the sun		=	$7.0 \times 10^{8} m$
Radius of earth's orbit about the sun		=	$1.5 \times 10^{11} m$
Speed of light in a vacuum		=	$3.0 \times 10^{8} m$
Specific heat capacity of water		=	$4.02 \times 10^{3}\ Jkg^{-1}K^{-1}$
Universal gravitational constant,	G	=	$6.67 \times 10^{-11} Nm^{2}kg^{-2}$
Avogadro's number	N_A	=	$6.02 \times 10^{23}\ mol$
Density of mercury		=	$13.4 \times 10^{3} kgm^{-3}$
Charge to mass ratio,	e/m	=	$1.81 \times 10^{11}\ Ckg^{-1}$
The constant $1/4\pi\varepsilon_0$		=	$9.0 \times 10^{9}\ F^{-1}m$

Turn Over

SECTION A

1. (a) What is meant by the following?
   (i) Derived quantities. (01 mark)
   (ii) Dimensions. (01 marks)

   (b) The volume per second V of a liquid flowing through a horizontal pipe is given by $V = \frac{Kr^4P}{\eta}$, where **r** is the radius of the pipe, **η** is coefficient of viscosity of the liquid and **K** is a constant.
   If the dimensions of **η** are $ML^{-1}T^{-1}$, show that **K** is dimensionless. (03 marks)

   (c) (i) State the principle of **conservation of linear momentum.** (01 marks)
   (ii) Use Newton's second law of motion to derive the expression relating force to mass and acceleration of a body. (03 marks)
   (iii) Use the derived expression in (c) (ii) above to define the unit of force. (01 marks)
   (iv) Water from a horse pipe issues horizontally at a velocity of $15ms^{-1}$ and strikes a vertical wall. If the cross-sectional area of the pipe is $4.5cm^2$, find the force exerted on the wall by the water if the water does not rebound on hitting the wall. (04 marks)

   (d) (i) What is meant by **projectile motion?** (01 mark)
   (ii) Derive an expression for maximum range for a particle projected at an initial velocity u at angle Θ to the vertical. (03 marks)

   (e) Explain why a balloon filled with air darts around when released with its neck open. (02 marks)

2. (a) (i) State **Kepler's laws of planetary motion.** (03 marks)
   (ii) Estimate the mass of the sun, if the orbit of the earth around the sun is circular. (04 marks)

   (b) (i) Define the term **gravitational potential.** (01 mark)
   (ii) Explain why the speed of a satellite increases when it encounters resistance to its motion in its orbit. (03 marks)

   (c) A satellite is launched into its parking orbit. Calculate its height above the earth's orbit. (04 marks)

   (d) (i) What is meant by **angular velocity?** (01 mark)
   (ii) Explain why a racing car travels faster on a banked road than on a flat unbanked road of the same radius of curvature. (04 marks)

3. (a) Distinguish between the following terms:
(i) **Elastic limit** and **proportional limit.** (02 marks)
(ii) **Ductile** and the **brittle materials.** (02 marks)

(b) (i) Sketch the stress - strain graph for cast iron. (02 marks)
(ii) Explain the features of the graph in (b) (i) above. (02 marks)

(c) A mass of 8.0kg is suspended at one end of a steel wire of length 2.0m and cross-sectional area $0.2mm^2$.
Calculate
(i) extension produced in the steel wire. (03 marks)
(ii) the change in length of the wire if a temperature rise of 1.5K produces a fractional increase in length of 0.04%. (03 marks)
Take Young's modulus for steel to be 2.1×10^{11} Pa.

(d) Explain the precautions taken in an experiment to determine Young's modulus of a material. (06 marks)

4. (a) (i) Define **pressure.** (01 mark)
(ii) Derive an expression for the pressure at a point inside a liquid in terms of the density ρ of the liquid and the depth h of the point below the liquid surface. (03 marks)

(b) (i) State the **law of flotation.** (01 mark)
(ii) A cylindrical piece of cork of cross-sectional area $15cm^2$ and length 20cm is covered at one end with a layer of brass 2cm thick. If the cork floats in water with the brass all submerged below the water surface and with part of the cork above the surface. Show that the height h above the water surface is given by
$h = 20(1 - \rho_c) + 2(1 - \rho_b)$
where ρ_c and ρ_b are the densities of cork and brass respectively and density of water is $1.0gcm^{-3}$ (05 marks)

(c) (i) Define **surface tension.** (01 marks)
(ii) Explain the origin of surface tension. (03 marks)
(iii) Give two instances that illustrate existence of surface tension. (02 marks)

(d) Mercury is poured into a U-glass tube with vertical limbs of diameters 2mm and 14mm respectively.
If the angle of contact between mercury and glass is 140° and surface tension of mercury is $0.52Nm^{-1}$,
(i) Calculate the difference in the levels of mercury. (03 marks)
(ii) Draw the diagram of the U – tube showing the mercury levels in (d) above. (01 mark)

SECTION B

5. (a) Define the following terms.
(i) **Specific heat capacity** (01 mark)
(ii) **Cooling correction** (01 mark)

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(b) (i) State two reasons why the mechanical method of determining specific heat capacity of substance may not be accurate. (02 marks)

(ii) A copper cylinder is mounted along the axis of a wooden pulley of radius 12.5cm. The pulley rubs against the cylinder when it turns. When a steady force of 100N is applied tangentially to the pulley, the temperature of the cylinder rises by 8°C after the pulley has been turned through 40 revolutions. If the mass of the copper cylinder is 250g, calculate the specific heat capacity of copper. (04 marks)

(c) (i) Define **thermometric property.** (01 mark)
(ii) Describe the steps taken to set up a Celsius scale of temperature. (03 marks)
(iii) State why a thermocouple can measure rapidly changing temperatures. (01 marks)

(d) The resistance of an electrical resistance thermometer is 3.0Ω at 50°C and 3.2Ω at 55°C.
Calculate the minimum detectable change in temperature, given that the least change in resistance of the thermometer that can be detected is 0.02Ω. (05 marks)

(e) State two advantages of the electrical resistance thermometer. (02 marks)

6. (a) (i) State **Charles' law.** (01 mark)
(ii) Describe an experiment to verify Charles' law. (05 marks)
(iv) Explain why the pressure of a fixed mass of a gas increases when heated. (03 marks)

(b) The pressure **P** of an ideal gas is given by $P = \frac{1}{3}\rho c^{\overline{2}}$, where ρ is the density of the gas and $C^{\overline{2}}$ is its mean square speed.
(i) What is meant by an ideal gas? (01 marks)
(ii) Show clearly the steps taken to derive the above expression (06 marks)

(c) A gas of density $8.0 \times 10^{-2}kgm^{-3}$ has a volume $50m^3$. If the root mean square speed of its molecules is $45.0ms^{-1}$, find the temperature of the gas. (04 marks)

7. (a) (i) Define **thermal conductivity** as applied to heat. (01 mark)
(ii) Compare the mechanisms of thermal conduction in glass and metals. (05 marks)
(iii) State and explain the precautions taken in an experiment to determine the thermal conductivity of a poor conductor. (03 marks)

(b) A cooking saucepan of thickness 2.0mm is coated with a thin layer of soot of average thickness 0.5mm on its bottom surface. Boiling water in the saucepan is evaporated at a rate of 0.48kg for every minute. If the base area of the saucepan is $0.04m^2$ and the temperatures of the boiling water and that of the underside of the soot nearest the heat source are 100°C and 160°C respectively,

Calculate:-

(i) the rate of transmission of heat through the saucepan. (03 marks)

(ii) the thermal conductivity of the soot. (03 marks)

(c) (i) State **laws of black body radiation.** (02 marks)

(ii) Sketch the spectral distribution of black body radiation for two different temperatures and describe their main features. (03 marks)

SECTION C

8. (a) (i) What is meant by **half-life** of a radioactive material? (01 mark)

(ii) From the radioactive law of exponential decay, derive the relation between decay constant λ and half – life $t_{½}$. (03 marks)

(b) The radioisotope $^{90}_{38}Sr$ decays by beta emission. If the half – life of the radio isotope is 28.8 years, determine the activity of 1g of the isotope. (05 marks)

(c) (i) What is meant by **binding energy per nucleon?** (01 mark)

(ii) Account for the fact that $^{56}_{26}Fe$ has the most stable nucleus. (02 marks)

(d) A typical nuclear reaction is given by:

$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{95}_{42}Mo + {}^{139}_{57}La + 2^{1}_{0}n + 7^{0}_{-1}e$.

Calculate the:

(i) binding energy is joules. (03 marks)

(ii) energy released by 2g of uranium. (03 marks)

Take mass of : $^{1}_{0}n = 1.009U$, $^{0}_{-1}e = 0.00055U$,

$^{95}_{42}Mo = 94.906U$, $^{139}_{57}La = 138.906U$.,

$^{235}_{92}U = 235.044U, 1U = 1.66\times10^{-27}kg$.

(e) Explain the condition necessary for nuclear fusion to occur. (02 marks)

9. (a) (i) What are **cathode rays?** (01 marks)

(ii) State four properties of cathode rays. (02 marks)

(b) Show that the path of an electron in between two horizontal metal plates is parabolic when a p.d is applied between them. (04 marks)

(c) A beam of electrons is accelerated through a p.d. of 2kV and is directed mid-way between two horizontal plates of length 4.0cm.
If the p.d. between the plates is 90V and the plate separation is 2.5cm, Calculate the velocity of the electrons as they emerge from the region between the plates. (05 marks)

(d) (i) Give an account of the stages observed when an electric discharge passes through a gas at pressures varying from atmospheric to about 0.01mmHg as air is pumped out when the p.d across the tube is maintained at a very high voltage. (05 marks)

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(ii) State two disadvantages of discharge tubes when used to study cathode rays. (02 marks)

(e) Give two applications of discharge tubes. (01 mark)

10. (a) (i) What is meant by **photoelectric emission?** (01 mark)
(ii) Explain the mechanism of photoelectric emission (03 marks)
(iii) Explain, using quantum theory, the experimental observation that photocurrent is proportional to the intensity of incident radiation. (03 marks)

(b) When light of wavelength 440nm falls on a certain metal surface, electrons of maximum kinetic energy 0.75eV are emitted. Calculate the minimum frequency of the radiation required for emission of electrons to occur. (04 marks)

(c) In the production of X-rays in an X-ray tube,

(i) describe the energy changes which occur when the tube is in operation. (02 marks)
(ii) explain how the quality of the X -rays can be increased. (02 marks)
(iii) explain the occurrence of the characteristic spectrum. (03 marks)

(d) If the shortest wavelength of an X -ray beam is 0.25nm, Calculate the operating voltage of the X -rays tube. (02 marks)

END