

P510/1
PHYSICS
Paper1
August
2 ½ Hours



ELITE EXAMINATION BUREAU MOCK 2019

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 scientific calculators may be used.

Assume where necessary,

Acceleration due to gravity, g	=	9.81 ms^{-2}
Electronic Charge, e	=	$1.6 \times 10^{-19} \text{ C}$
Electron mass	=	$9.11 \times 10^{-31} \text{ kg}$
Mass of the earth	=	$5.97 \times 10^{24} \text{ kg}$
Planck's constant h	=	$6.6 \times 10^{-34} \text{ Js}$
Stefan's – Boltzmann's constant, σ	=	$5.67 \times 10^{-8} \text{ Wm}^{-2} \text{ K}^{-4}$
Radius of the earth	=	$6.4 \times 10^6 \text{ m}$
Radius of the sun	=	$7 \times 10^8 \text{ m}$
Radius of earth's orbit about the sun	=	$1.5 \times 10^{11} \text{ m}$
Speed of light in vacuum, c	=	$3.0 \times 10^8 \text{ ms}^{-1}$
Specific heat capacity of copper	=	$400 \text{ Jkg}^{-1} \text{ K}^{-1}$
Universal gravitational constant, G	=	$6.67 \times 10^{-11} \text{ Nm}^2 \text{ Kg}^{-1}$
Avogadro's number, N_A	=	$6.02 \times 10^{23} \text{ mol}^{-1}$
Density of water	=	1000 kgm^{-3}
Gas constant, R	=	$8.31 \text{ J}^{-1} \text{ mol}^{-1} \text{ K}^{-1}$
Change to mass ratio, e/m	=	$1.8 \times 10^{11} \text{ CKg}^{-1}$
The Constant, $\frac{1}{4\pi\epsilon_0}$	=	$9.0 \times 10^9 \text{ F}^{-1} \text{ m}$
Specific heat capacity of water	=	$4200 \text{ Jkg}^{-1} \text{ K}^{-1}$

SECTION A

1.
 - a) Define the following terms
 - (i) uniform acceleration (1mark)
 - (ii) angular velocity (1mark)
 - b(i) What is meant by banking of a track? (1mark)
 - (ii) Derive an expression for the angle of banking, θ for a car of mass, m , moving at speed, v , round a banked track of radius, r (4marks)
 - c) A bob of mass m is tied to an inelastic thread of length, l , and whirled with constant speed in a vertical circle.
 - (i) With the aid of a sketch diagram, explain the variation of tension in the string along the circle. (5marks)
 - (ii) If the string breaks at one point along the circle, state the most likely position and explain the subsequent motion of the bob. (2marks)
 - d) A body of mass 15kg is moved from the earth's surface to a point $1.8 \times 10^6\text{m}$ above the earth. If the radius of the earth is $6.4 \times 10^6\text{m}$ and its mass is $6.0 \times 10^{24}\text{Kg}$, calculate the work done in taking the body to that point. (6marks)

2.
 - a(i) State Archimedes principle. (1mark)
 - (ii) A solid weighs 237.5g in air and 12.5g when totally immersed in a fluid of density 900Kg m^{-3} . Calculate the density of the liquid in which the solid would float with one fifth of its volume exposed above the liquid surface. (8marks)
 - b(i) What is meant by fluid element and flow line as applied to fluid flow? (2marks)
 - (ii) Explain why some fluids flow more easily than others (3marks)
 - c(i) What is meant by viscosity? (1mark)
 - (ii) Explain the effect of temperature on the viscosity of a liquid. (1mark)
 - d) Describe an experiment to measure coefficient of static friction between a rectangular block of wood and plane surface. (4marks)

3.
 - a) What is meant by simple harmonic motion? (1mark)
 - b) A cylindrical vessel of cross-sectional area, A , contains air of volume V , at pressure, P , trapped by frictionless air tight piston of mass, M . The piston is pushed down and released.
 - (i) If the piston oscillates with simple harmonic motion, show that its frequency, f , is given by

$$f = \frac{A}{2\pi} \sqrt{\frac{P}{MV}}$$
 - (ii) Show that the expression for f , in b(i) is dimensionally correct. (3marks)
 - c) A particle executing simple harmonic motion vibrates in a straight line. Given that the speeds of the particle are 4ms^{-1} and 2ms^{-1} when the particle is 3cm and 6cm respectively from the equilibrium. Calculate the

- (i) Amplitude of oscillation (3marks)
 - (ii) frequency of the particle (3marks)
 - d) If the moon moves round the earth in a circular orbit of radius $4.0 \times 10^8 \text{ m}$ and takes exactly 27.3 days to go round once. Calculate the value of acceleration due to gravity, g , at the earth's surface. (4marks)
4. a(i) Describe the terms tensile stress and tensile strain as applied to a stretched wire. (2marks)
- (ii) Distinguish between elastic limit and proportional limit. (2marks)
- (b) With the aid of a labelled diagram, describe an experiment to investigate the relationship between tensile stress and tensile strain of a steel wire. (7marks)
- c(i) A load of 60N is applied to a steel wire of length 2.5m and cross-sectional area of 0.22 mm^2 . If Young's modulus for steel is 210GPa, find the expansion produced. (3marks)
- (ii) If the temperature rise of 1K causes a fractional increase of 0.001%, find the change in length of a steel wire of length 2.5m when temperature increases by 4K
- d) The velocity, v of a wave in a material of Young's Modulus, E , and density, ρ , given by $v = \sqrt{\frac{E}{\rho}}$. show that the relationship is dimensionally correct. (3marks)

SECTION B

5. a(i) Define specific heat capacity of a substance. (1mark)
- ii) Explain why the specific heat capacity of a body in solid state is lower than its specific heat capacity in a liquid state. (3marks)
- b(i) With the aid of a labelled diagram, describe how the method of mixtures is used to determine the specific heat capacity of a solid. (6marks)
- (ii) State two advantages of the continuous flow method over the method of mixtures in the determination of specific heat capacity. (2marks)
- (iii) In a continuous flow calorimeter experiment, water flows at a rate of 5.0 g s^{-1} and a liquid Y must flow at 8.0 g s^{-1} to maintain the same temperature difference and power supply as in the case of water. Find the specific heat capacity of liquid Y. (3marks)
- c(i) Explain why the temperature of a liquid does not change when the liquid is boiling. (2marks)
- (ii) Explain how a kelvin scale of temperatures can be established. (4marks)

6. a(i) What is meant by boiling point? (1mark)
 (ii) Explain why boiling point of a liquid increases with increase in the external pressure. (4marks)
 b) Explain how the pressure of a fixed mass of a gas can be increased at;
 i) constant temperature (3 marks)
 ii) constant volume (3 marks)
 c(i) Sketch a pressure versus volume curve for a real gas undergoing compression (2 marks)
 ii) Explain the main features of the curve in c(i) above. (3 marks)
 d(i) The cylinder of an exhaust pump has a volume of 25cm^3 , if it is connected through a valve to a flask of volume 225cm^3 containing air at a pressure of 75cmHg , calculate the pressure of the air in the flask after two strokes of the pump, assuming that the temperature of the air remains constant. (4marks)
7. a(i) What is meant by kinetic theory of gases? (3marks)
 (ii) Define an ideal gas (1mark)
 (iii) State and explain the conditions under which real gases behave as ideal gases. (4marks)
 b) The temperature of one mole of helium gas at a pressure of $1.0 \times 10^5\text{Pa}$ increases from 20°C to 100°C when the gas is compressed adiabatically. Find the final pressure of the gas. (take $\gamma = 1.67$) (4 marks)
 c) With the aid of a P-V diagram, explain what happens when a real gas is compressed at different temperatures. (4 marks)
 d) The root mean square speed of the molecules of a gas is 44.72ms^{-1} . Find the temperature of the gas if density is $9.0 \times 10^{-2}\text{Kgm}^{-3}$ and the volume is 42.0m^3 (4marks)

SECTION C

8. a(i) Define Avogadro's constant and Faraday's constant. (2marks)
 (ii) Show that the charge carried by a monovalent ion is $1.6 \times 10^{-19}\text{C}$. (2marks)
 b) With the use of a labelled diagram, describe Millikan's oil drop experiment for the determination of the charge of an electron. (7marks)
 c) A beam of positive ions moving with velocity $\vec{v}$ enters a region of a uniform magnetic field of density $\vec{B}$ with the velocity at right angles to the field $\vec{B}$. By use of a diagram, describe the motion of the ions. (3marks)
 d) A charged oil drop of density 880Kgm^{-3} is held stationary between two parallel plates 6.0mm apart held at a potential difference of 103V . When

the electric field is switched off, the drop is observed to fall a distance of 2.0mm in 35.7s (Viscosity of air = $1.8 \times 10^{-5} \text{ Nsm}^{-2}$, density of air = 1.29 Kgm^{-3})

- (i) Calculate the radius of the drop (3marks)
- (ii) Estimate the number of excess electrons on the drop (3marks)

9. a) The figure below shows some of the energy levels of a hydrogen atom.

Principal quantum Number, n	energy, eV
6	-0.38
5	-0.54
4	-0.85
3	-1.51
2	-3.39
1	-13.60

- (i) Why are the energies for the different energy levels negative? (1mark)
- (ii) Calculate the wave length of the line arising from a transition from the third to the second energy level. (3marks)
- (iii) Calculate the ionization energy in Joules of hydrogen (2marks)
- b) Explain the physical processes in an X-ray tube that account for. (3marks)
 - i) Cut off wavelength (4marks)
 - ii) characteristic lines
- c) Calculate the maximum frequency of radiation emitted by an X-ray tube using an accelerating voltage of 33.0KV. (3marks)
- d) Derive Bragg's law of X-ray diffraction in crystals. (4marks)

10. a) Define half-life and decay constant as used in the study of radioactive decay. (2marks)
- b) ^{238}U has a half-life of 4.5×10^9 years. It is believed that the earth solidified 4.0×10^9 years ago. What percentage of ^{238}U found on the earth remains undecayed today. (4marks)
- c(i) With aid of a diagram, describe the structure and action of a Geiger-Mullertube. (3marks)
- (ii) Sketch the count rate-voltage characteristics of the Geiger-Muller tube and explain its main features (3marks)
- (iii) Identify, giving reasons the suitable range in c(ii) of operation of the tube. (2marks)
- d) Briefly explain the use of radio carbon in determining the age of organic archeological objects. (3marks)

END