# MOCK EXAMINATIONSSET ONE 2019

## Uganda Advanced Certificate of Education

**Physics P510/1**

**Paper 1**

**2 Hours 30 Minutes**

**Instructionsto Candidates**

- *Answer five questions, including atleast 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 | = | $9.81 ms^{-2}$ |
| Speed of light in vacuum, c | = | $3.0 \times 10^{8} ms^{-1}$ |
| Speed of sound in air v | = | $340 ms^{-1}$ |
| Electronic Charge, e | = | $1.6 \times 10^{-19} C$ |
| Electronic mass, $m_e$ | = | $9.1 \times 10^{-31} kg$ |
| Mass of the earth | = | $5.97 \times 10^{-31} kg$ |
| Radius of the sun | = | $7 \times 10^{8} m$ |
| Radius of earth's orbit about the sun | = | 1.5 x 1011m |
| Thermal conductivity of copper | = | $390 Wm^{-1}K^{-1}$ |
| Thermal conductivity of aluminum | = | $210 Wm^{-1}K^{-1}$ |
| Universal gravitational constant, G | = | $6.67 \times 10^{-11} Nm^2 Kg^{-1}$ |
| Avogadro's number, $N_A$ | = | $6.02 \times 10^{23} mol^{-1}$ |
| Surface tension of water | = | $7.0 \times 10^{-2} Nm^{-1}$ |
| Density of water | = | $1000 kgm^{-3}$ |
| Gas constant, R | = | $8.314 J^{-1}K^{-1}$ |
| Change to mass ratio, $e/m$ | = | $1.8 \times 10^{11} CKg^{-1}$ |
| Faraday constant, F | = | $9.65 \times 10^{4} Cmol^{-1}$ |
| Permeability of free space, $\mu_0$ | = | $4.0\pi \times 10^{-7} Hm^{-1}$ |
| Permittivity of free space, $\varepsilon_0$ | = | $8.85 \times 10^{-12}$ C |
| The Constant, $\frac{1}{4\pi\varepsilon_0}$ | = | $9.0 \times 10^{9} F^{-1}m$ |
| Radius of the earth | = | $6.4 \times 10^{6} m$ |
| Specific heart capacity of water | = | $4200 Jkg^{-1}K^{-1}$ |
| Electron charge, e | = | $1.6 \times 10^{-19} C$ |
| Planck's constant *h* | = | $6.6 \times 10^{-34} J$ |
| Velocity of light *C* | = | $3.0 \times 10^{8} ms^{-1}$ |
| Stefan's constant | = | $5.7 \times 10^{-8} Wm^{-2}K^{-4}$ |
| Wien's constant | = | $2.9 \times 10^{-3} mk$ |
| 1 electron volt *eV* | = | $1.6 \times 10^{-19} J$ |
| Electron Mass | = | $9.1 \times 10^{-31} kg$ |
| Unified mass (IU) | = | $1.66 \times 10^{-27} kg$ |

## SECTION A

**1.** a(i) State kepler's laws of planetary motion. (3marks)
(ii) Show that Newton's laws of gravitation is consistent with Kepler's third law. (5marks)
b) If the moon moves around the earth in a circular orbit of radius $4.0 \times 10^8$m and takes exactly 27.3days to go round once, calculate the value of the acceleration due to gravity, g at the earth's surface. (4marks)
c) Explain briefly how satelites are used in worldwide radio or television communication. (4marks)
d) Explain why tyres of a car moving on a hard surfaced road may burst. (4marks)

2. a(i) State the conditions for a body to be in equilibrium under action of coplanar forces. (2 marks).
(ii) Briefly explain the three states of equilibrium. (3marks)

b) Describe an experiment to determine the centre of gravity of a plane sheet of material having an irregular shape. (4marks)
c) Explain the following;
i) Damped oscillations (2marks)
ii) Forced oscillations (2marks)
d) What is meant by simple harmonic motion? (1marks)
e) A horizontal spring of force constant $200Nm^{-1}$ fixed at one end has a mass of 2kg attached to the free end and resting on a smooth horizontal surface. The mass is pulled through a distance of 4.0cm and released. Calculate the,
i) angular speed (2marks)
ii) maximum velocity attained by the vibrating body. (2marks)
iii) Acceleration when the body is half way towards the centre from its initial position. (2marks)

3. a) Explain what is meant by centripetal force. (2marks)

b(i) Derive an expression for the centripetal force acting on a body of mass, m moving in a circular path of radius, r (6marks)
(ii) A body moving in a circular path of radius 0.5m makes 40 revolutions per second. Find the centripetal force if the mass is 1kg. (3marks)

c) Explain the following
i) A mass attached to a string rotating at a constant speed in a horizontal circle will fly off at a tangent if the string breaks.
ii) A cosmonaut in a satellite which is in a free circular orbit around the earth experiences the sensation of weightlessness even though there is influence of gravitational field of the earth. (3marks)

d(i) Derive an expression for the maximum horizontal distance travelled by a projectile interms of the initial speed, u and the angle of projection, θ to the horizontal.
(2marks)
(ii) Sketch a graph to show the relationship between kinetic energy and height above the ground in a projectile. (2marks)

4. a) Define terminal velocity (1marks)

b) Explain laminar flow and turbulent flow (3marks)

c) Describe an experiment to measure the coefficient of viscosity of water using poiseulle's formula. (7marks)

d(i) state Bernoulli's principle. (1mark)
(ii) Explain why a person standing near a railway line is sucked towards the railway line when a fast moving train passes. (3marks)

e) A horizontal pipe of cross sectional area $0.4m^2$, tapes to a cross sectional area of $0.2m^2$. The pressure at the large section of the pipe is $8.0 \times 10^4 Nm^{-2}$ and the velocity of water through the pipe is $1.2ms^{-1}$. If atmospheric pressure is $1.01 \times 10^5 Nm^{-2}$, find the pressure at the small section of the pipe. (5marks)

## SECTION B

5. a) Define the following
i) Absolute zero (1mark)
ii) Cooling correction (1mark)

b(i) State Dalton's law of partial pressures (1mark)
(ii) The kinetic theory expression for the pressure, p, of an ideal gas of density ℓ, and mean square speed, $\bar{c}^2$is $= \frac{1}{3}\ell\bar{c}^2$ . Use the expression to deduce Dalton's law. (5marks)

c) Explain clearly the steps taken to determine the cooling correction when measuring the specific heat capacity of a poor conductor by the method of mixtures. (7marks)

d) The density of air at $0^oC$ and pressure of 101KPa is $1.29kgm^{-3}$. Calculate pressure of 200KPa is $1.29Kgm^{-3}$. Calculate pressure of 200KPa. (5marks)

6. a(i) What is meant by a black body? (1marsk)
(ii) Sketch the spectral curve of relative intensity against wavelength of a black body at three different temperatures and state main features of the curves. (5marks)

b(i) State Stefan's law of black body radiation. (1mark)

(ii) The sun is a black body of surface temperature 6000K. If the radius of the earth's orbit about the sun is 1.5 x $10^{11}$m, estimate the equilibrium temperature of the earth (5marks)

c) Define thermal conductivity of a material and state its units. (2marks)

d) A double glazed window has two glass sheets of the thickness 3.0m. They are separated by a layer of air of thickness 1.0cm, if the two inner air glass surfaces have steady temperature of 20$^{o}$C and 4$^{o}$C respectively. Find the
(i) temperature of the outer air glass surface. (3marks)
Amount of heat that flows across a 2m$^2$ cross sectional area in 2hours. (Conductivity of glass = 0.72Wm$^{-1}$K$^{-1}$ and that of air = 0.025Wm$^{-1}$K$^{-1}$)

7. a(i) State Boyle's law (1mark)
(ii) Describe an experiment that can be used to verify Boyle's law (6marks)

b) Explain the following observations using the kinetic theory
i) A gas fills any container in which it is placed and exerts a pressure on its walls. (3marks)
(ii) The pressure of a fixed mass of a gas rises when its temperature increased at constant volume (2marks)

c(i) What is meant by a reversible process? (1mark)
(ii) Sate the conditions necessary for isothermal and adiabatic processes to occur. (4marks)

d) A mass of an ideal gas of volume 200cm3 at 14 expands a adiabatically to a temperature of 137K. Calculate its new volume (take $\gamma = 1.40$) (3marks)

## SECTION C

8. a(i) State Bragg's law of X-ray diffraction (1mark)
(ii) Derive Bragg's equation (4marks)
b) Draw a well labelled diagram of an X-ray tube and use it to explain how the intensity of the X-rays produced can be varied. (5marks)

c) During the production of X-rays in an X-ray tube, X-rays of minimum wave length 2.5 x $10^{-10}$m were produced. If the tube current was 30mA, find
i) the number of electrons that strike the target per second? (2marks)
ii) the voltage used (2marks)
iii) The velocity with which the electrons hit the target (2marks)

d) X-rays of wavelength 1.12 x $10^{-10}$m are diffracted by a sodium chloride crystal and second order diffracted beam is observed at a glancing angle of 23.2$^{o}$. If the molecular mass of sodium chloride is 58.5. Find the
i) Atomic spacing of sodium chloride (2marks)
ii) Density of sodium chloride (2marks)

9. a(i) What are cathode rays. (1mark)
(ii) With the aid of a diagram, describe an experiment to show that cathode rays travel in straight lines. (4marks)

b) A beam of electrons is accelerated through a potential difference of 500V, the beam enters midway between two similar parallel plates of length 10cm and are 3cm apart. If the potential difference a cross the plates is 600V, find the velocity of an electron as it leaves the region between the plates. (8marks)

10. (i) What is meant by the terms; radioactive decay, half-life and decay constant? (3marks)
(ii) Show that the half-life $t_{\frac{1}{2}}$ of a radio isotope is given by $t_{\frac{1}{2}} = \frac{0.693}{\lambda}$ where λ is the decay constant. (5marks)

b) With the aid of a labelled diagram, describe the structure and action of a cloud chamber. (5marks)

c) A radioactive isotope $^{99}_{43}X$ decays by emission of a gamma ray. The half-life of the isotope is 360 minutes. What is the activity of 1mg of the isotopes? (6marks)

d) Explain the term avalanche as applied to an ionization chamber. (3marks)

**END**