P510/1
PHYSICS
Paper 1
July/ Aug: 2022
2 ½ hours

MATIGO MOCK EXAMINATIONS 2022
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 calculators may be used
Assume where necessary.

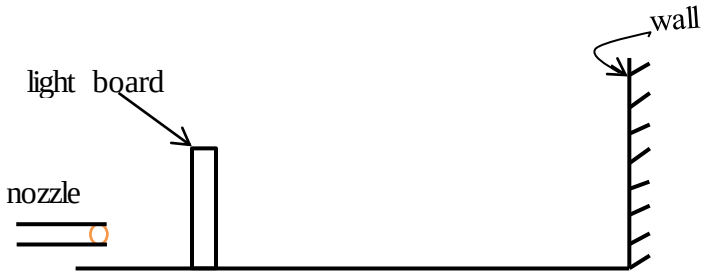
Acceleration due to gravity, g	$= 9.81 ms^{-2}$
Electronic charge, e	$=1.6\times 10^{-19} C$
Electron mass	$=9.11\times 10^{-31} kg$
Mass of the Earth	$= 5.97\times 10^{24} kg$
Planck's constant, h	$=6.6\times 10^{-34} Js$
Stefan's- Boltzmann's constant σ	$= 5.67\times 10^{-8} Wm^{-2}k^{-4}$
Radius of the Earth	$= 6.4\times 10^{6} m$
Radius of the sun	$= 7.0\times 10^{8} m$
Wien's displacement constant, K,	$=2.9\times 10^{-3} mK$
Radius of earth's orbit about the sun	$= 1.5\times 10^{11} m$
Speed of light in vacuum, c	$=3.0\times 10^{8} ms^{-1}$
Thermal conductivity of copper	$=390\ Wm^{-1}K^{-1}$
Thermal conductivity of aluminium	$= 210 Wm^{-1}K^{-1}$
Specific heat capacity of water	$= 4200 Jkg^{-1}K^{-1}$
Avogadro's constant, N_A	$= 6.02\times 10^{23} mol^{-1}$
Universal gravitational force constant, G,	$=6.67\times 10^{-11} Nm^{2}Kg^{-2}$
Density of water	$=1000 kgm^{-3}$
Gas constant, R	$=8.31 Jmol^{-1}K^{-1}$

SECTION A

1. a) i) State the **principle of conservation of linear momentum**. *(1 mark)*

ii) Using the Newton's laws of motion, deduce the principle stated in **a (i)** above. *(4 marks)*

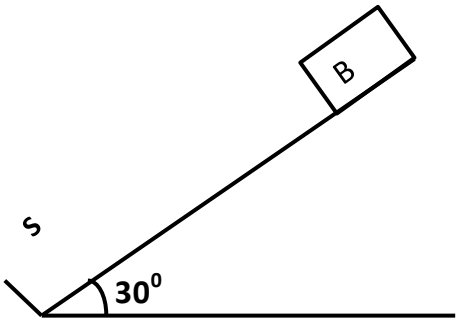
b) A light horizontal spring of force constant $512Nm^{-1}$ has one of its ends fixed in a vertical wall and its free end has a light vertical board fitted on it as shown.



When water from a horizontal nozzle of cross-sectional area $4cm^2$ strikes the light board, the spring compresses by 5cm. If the nozzle is coaxial with the spring, find the velocity with which the water jets off the nozzle. *(5 marks)*

c) Explain rocket propulsion. *(3 marks)*

d)



A block **B** of mass 1kg is released from rest and travels down a rough incline of 30^0 to the horizontal distance of 2m before striking a spring **S** of force constant $100Nm^{-1}$. The co-efficient of kinetic friction between the block and the plane is 0.1. Calculate the;

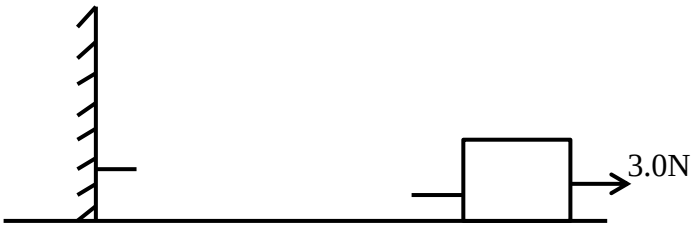
i) Velocity of **B** just before it strikes the spring. *(4 marks)*

ii) Maximum compression of the spring. *(3 marks)*

2. a) i) State the conditions necessary for an oscillatory motion to be considered simple harmonic. (2 *marks)*

ii) Sketch an acceleration time graph for an object describing simple harmonic motion. (2 *marks)*

b) A wooden block of mass 2kg is attached to a spring of natural length 25.0cm and placed on a horizontal surface. The face end of the spring is fixed to a rigid support as shown in the figure below.



A horizontal force of 3.0N acts on the block and causes the spring to extend by 10.0cm and the force is then removed.

i) Show that the motion is **simple harmonic**. *(3 marks)*
ii) What is the velocity of the block when it is 5.0cm from its equilibrium position? (3*marks)*
iii) Calculate the total energy of the vibrating system. *(3 marks)*

c) i) State the **principle of moments** . *(1 mark)*

ii) With aid of a diagram, describe how to estimate **density of a liquid** using **Archimedes principle** and the **principle of moments**. (6 *marks)*

3. a) i) Distinguish between **velocity gradient** and **pressure gradient**. (2 *marks)*
ii) Derive an expression for volume of liquid flowing per second through a pipe in terms of co-efficient of viscosity (ƞ), radius of pipe (a) and pressure gradient. *(5 marks)*

b) Describe an experiment to demonstrate the difference between **laminar flow** and **turbulent flow**. *(5 marks)*

c) i) Define **free surface energy**. *(1 mark)*
ii) Explain the effect of temperature on surface tension of water. *(3 marks)*

d) A glass U – tube is such that the diameter of one limb is 6.0mm and that of the other is 12.0mm. The tube inverted vertically with the open ends below the surface of water in a beaker. If the angle of contact of water is zero, calculate the difference between the heights to which water rises in the two limbs. *(4 marks)*

4. a) i) What is meant by **potential energy**? *(1 mark)*
ii) Derive an expression for the potential energy due to earth at any point outside the earth. *(3 marks)*
iii) Sketch a graph to show how the potential energy varies with the distance from the center of the earth from the point of the earth. (*2 marks)*

b) i) Explain why the maximum speed of a car on a banked road is higher than that on unbanked road. *(3 marks)*

ii) Show that the angle of inclination to the horizontal necessary for a bicycle rider moving round a circular track of radius, **r** with skidding at a speed, **V** is given by tan $\theta \frac{rg}{V^2}$. *(3 marks)*

c) A pendulum bob of mass 0.15kg is suspended from a fixed point by a thread of fixed length. The bob is given a push so that it marks a long a circular path of radius 1.82m in a horizontal plane at a steady speed, taking 18seconds to make 10 complete revolutions.

Calculate the;

i) Speed of the bob. *(2 marks)*

ii) Centripetal force acting on the bob. *(3 marks)*

iii) Tension in the string. *(3 marks)*

SECTION B

5. a) Define the following.

i) **Heat capacity at constant volume.** *(1 mark)*

ii) **Isothermal change.** *(1 mark)*

b) i) State the **kinetic theory of matter**. *(1 mark)*

ii) Describe an experiment to demonstrate the kinetic theory of matter. *(5 marks)*

iii) Distinguish between **ideal gas** and **real gas**. *(3 marks)*

c) Explain the effect of temperature on the saturated vapour pressure of a liquid. *(4 marks)*

d) When air saturated with water vapour in a rigid cylinder, at 100^0C and pressure 2.0×10^5pa is cooled at 20^0C, the pressure drops to 7.98×10^4pa. Neglecting the expansivity of the cylinder. Calculate the saturated vapour pressure of water at 20^0C. *(Atmospheric pressure* $=1.03 \times 10^5$pa). *(5 marks)*

6. a) With the aid of a diagram, describe the action of an ether thermoscope used to detect infra – red radiation in a beam of sun light. *(5 marks)*

b) i) What is meant by a **black body radiation**? *(1 mark)*

ii) Sketch curves to show how energy is distributed among the various wave lengths of black body radiation for three different temperatures. *(3 marks)*

iii) Explain the why cavities in a fire look brighter than the rest of the fire. *(2 marks)*

iv) The intensity of radiant energy from a black body is a maximum at a wave length of 1.5×10^{-6}m.

Calculate the temperature of the black body. *(3 marks)*

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

ii) A strip of platinum foil coated black is placed on the ground. The area of the strip exposed to the radiation from the sun is $10^{-2}m^2$. The radiation from the sun falls normally on the strip to obtain a certain temperature rise. The strip is then shielded from the radiation and a current of 1.4A is maintained through the foil at a potential difference of 4V to obtain the same temperature rise. If only 40% of the intensity of radiation incident on the earth's atmosphere reaches the earth's surface, estimate the surface temperature of the sun. *(5 marks)*

7. a) i) Define **conduction.** *(1 mark)*

ii) Explain the **mechanism of heat conduction** in gases. *(3 marks)*

b) i) With aid of a labeled diagram, describe an experiment to determine the co –efficient of thermal conductivity of steel. *(7 marks)*

ii) State **two** advantages of the apparatus used in b (i) above. *(2 marks)*

c) i) A circular disc of glass 3mm thick and 110mm diameter is placed between two brass slabs **X** and **Y**. The temperature of the lower slab becomes constant at 92^0C while the temperature of **X** is 96^0C. **Y** is warmed above 92^0C when insulated on top and its cooling pattern studied. The rate of cooling at 92^0C is found to be $0.042Ks^{-1}$. Calculate the thermal conductivity of the glass, if the mass of **Y** is 0.94kg and its specific heat capacity is $400Jkg^{-1}K^{-1}$. *(5 marks)*

ii) Explain why in determining the thermal conductivity of a poor conductor, the specimen is made in form of a thin disc and of large diameter. *(2 marks)*

SECTION C

8. a) Define the following.

i) **Mass number.** *(1 mark)*

ii) **Radio isotopes.** *(1 mark)*

b) i) State the **radioactive decay law**. *(1 mark)*

ii) Write down the expression for the decay law and use it to show that the decay constant, $\lambda = \frac{0.693}{T_{\frac{1}{2}}}$ where $\frac{T_1}{2}$ – is half life. *(4 marks)*

c) i) With the aid of a labeled diagram, describe the operation of diffusion cloud chamber. *(5 marks)*

ii) In relation to a Geiger Muller tube, distinguish between **quenching process** and **gas amplification**. *(2 marks)*

d) A fission reaction is given by the equation

$$^{235}_{92}U + ^{1}_{0}\cap \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3\ ^{1}_{0}\cap$$

Given mass of $^{235}_{92}U$ = 235.0439u

$^{141}_{56}Ba$ = 140.913 u

$^{92}_{36}Kr$ = 91.8973 u

$^{1}_{0}\cap$ =1.0087 u

1u = 931MeV

i)Calculate the energy released by fission of 1.5g of Uranium. *(4 marks)*

ii) State the significance of the above equation. *(1 mark)*

iii) List **two** dangers of radio isotopes. *(1 mark)*

9. a) i) Distinguish between X-rays and cathode rays. *(2 marks)*

ii) In an X –ray tube, explain the features adopted for the structure and materials of the anode. *(4 marks)*

b) i) State **Bragg's law**. *(1 mark)*

ii) What is the condition for obtaining many orders of X –ray diffraction? *(1 mark)*

iii) A mono chromatic beam of X – rays of wave length $\boldsymbol{\lambda}$ is incident on a set of cubic planes of potassium chloride crystals. First order diffraction maxima are observed at a glancing angle of **θ,**
show that,

$$\rho = \frac{4msin^3\theta}{\lambda^3 N_A}$$

Where ρ - density of potassium chloride, m – molecular mass N_A- Avogadro's number. *(4 marks)*

c) i) What is meant by the term **photo electric effect**. *(1 mark)*

ii) Define the terms work function and threshold frequency. *(2 marks)*

iii) When light of wave length 450nm falls on a certain metal surface. It ejects photo electrons with maximum velocity of $6.0\times10^{5}ms^{-1}$. Calculate the work function and the threshold frequency for the metal surface. *(5 marks)*

10. a) i) Sketch the I –V characteristics for gaseous conduction. *(2 marks)*

ii) Explain the main features of the curve in **a (i)** above. *(3 marks)*

b) i) What is meant by **thermionic emission?** *(1 mark)*

ii) Describe an experiment to show that cathode rays carry a negative charge *(4 marks)*

c) A horizontal beam of electrons moving with a uniform speed, enters a uniform electric field between two horizontal parallel charged plates, show that the path between the plates is a parabola. *(5 marks)*

d) In a Millikan oil – drop experiment, a single negatively charge drop of radius 6×10^{-6}m was found to fall freely at a terminal velocity of $4 \times 10^{-3} cms^{-1}$ with electric fields off and to rise at $1.2 \times 10^{-2} cms^{-1}$ when a field of $2 \times 10^{5} Vm^{-1}$ was suitably applied given that the viscosity of $2.122 \times 10^{-5} Nsm^{-2}$.
Determine the number of electrons on the drop. *(5 marks)*

END