P510/1
PHYSICS
Paper 1
JULY/ AUGUST, 2017
2 ½ HOURS

OSPINA SUNIOR'S PRODUCTS.

BUSOGA REGION JOINT EXAMINATION BOARD

Uganda Advanced Certificate of Education

MOCK EXAMINATION 2017

PHYSICS

Paper 1

2 hours 30 minutes

MONDAY: 14TH/08/2017 **MORNING: 9:00AM – 11:30AM**

INSTRUCTIONS TO CANDIDATES

- Attempt any **five** questions, including at least one question from each of the sections A, B and C but **NOT** more than **two** questions from each section.
- Silent non-programmable scientific electronic calculators may be used.
- Where necessary assume:

Acceleration due to gravity (g)	=	$9.81 ms^{-2}$
Electronic mass (M_e)	=	$9.11 \times 10^{-31} kg$
One electron volt (ev)	=	$1.6 \times 10^{-19} J$
Planck's constant (h)	=	$6.63 \times 10^{-34} Js$
Radius of the earth	=	$6.4 \times 10^{6} m$
Radius of the sum	=	$6.96 \times 10^{8} m$
Speed of light in a vacuum (c)	=	$3.0 \times 10^{8} m$
Stefan's constant, σ	=	$5.67 \times 10^{-8} W m^{-2} K^{-4}$
Charge to mass ratio $(\frac{e}{m})$	=	$1.8 \times 10^{11} Ckg^{-1}$
Universal gravitational constant (G)	=	$6.67 \times 10^{-11} Nm^2 kg^{-2}$
Avogadro's number (N_A)	=	$6.02 \times 10^{23} mol^{-1}$
1 ev	=	$931 MeV$
Molar gas constant (R)	=	$8.31 JK^{-1} mol^{-1}$
Specific heat capacity of copper	=	$3.70 \times 10^{2} Jkg^{-1} k^{-1}$
Unified mass unit (1U)	=	$1.66 \times 10^{-27} kg$
Specific heat capacity of water	=	$4200 Jkg^{-1} K^{-1}$
Radius of earth's orbit about the sun	=	$1.47 \times 10^{11} m$

SECTION A:

1. a) Define the following terms as applied to oscillatory motion.

   i. Amplitude (01mk)

   ii. Period (01mk)

   b) State four characteristics of simple harmonic motion (02mks)

   c) A mass, M is suspended from a rigid support by a string of length, l. The mass is pulled a side so that the string makes an angle, θ with the vertical and then released.

   i) Show that the mass execute simple harmonic motion with a period,

   $$T = 2\pi\sqrt{\frac{l}{g}}$$ (05mks)

   ii) Explain why this mass comes to a stop after a short time. (02mks)

   d) A piston in a car engine performs a simple harmonic motion of frequency 12.5Hz. If the mass of the piston is 0.50kg and its amplitude of vibration is 45mm, find the maximum force on the piston (3mks)

   e) Describe an experiment to determine the acceleration due to gravity, g using a spiral spring of known force constant. (06mks)

2. a) Define viscosity of a fluid (01mk)

   b) (i) Derive an expression for terminal velocity attained by a sphere of density δ, and radius, a falling through a fluid of density ρ and coefficient of viscosity η.

   ii) Explain the variation of viscosity of a liquid with temperature (02mks)

   c) i) State the laws of solid friction (02mks)

   ii) With the aid of a well labeled diagram, describe an experiment to determine the coefficient of kinetic function between two surfaces. (05mks)

d) A body slides down a rough plane inclined at 30^0 to the horizontal. If the coefficient of kinetic friction between the body and the plane is 0.4, find the velocity after it has travelled 6m along the plane. (01mk)

3. a)Define gravitational potential at a point

b) (i) Describe the energy changes that occur as a space-craft falls towards the earth well away from the earth's atmosphere. (05mks)

ii) Calculate the minimum energy required to project a space craft of mass 2.0×10^6kg from the surface of the earth so that it escapes completely from the influence of the earth's gravitational field. (04mks)

(Radius of the earth = 6400km, Mass of the earth = 6.0×10^{24}kg)

i. State Newton's law of gravitation and give the units of the gravitational constant. (02mks)

ii. Briefly describe an experiment to determine the universal gravitational constant. (06mks)

iii. Explain why the moon has no atmosphere (02mks)

4. a) i) Define Young's modulus and strain of an elastic material (02mks)

ii) Derive an expression for the energy stored per unit volume of a stretched wire in terms of Young's modulus and strain. (03mks)

b) Describe an experiment with the aid of a labeled diagram, to investigate the relationship between tensile stress and tensile strain of a steal wire (07mks)

c) A steel wire in a guitar has a length of 0.75m and mass per unit length of 8.0×10^{-4}kgm^{-1}. Its tension is adjusted so that it vibrates at a fundamental frequency of 256Hz when plucked.

i) Calculate the value of the tension in the wire (03mks)

ii) Calculate the energy stored per unit volume in the stretched wire if it has a cross-sectional area 1.0×10^{-7}m^2 (02mks)

iii) The wire snaps at one of the bridges. Find the total energy stored in the wire and hence estimate the initial speed of the wire. (Young's modulus of steel = 2.0×10 "Pa) (03mks)

SECTION B:

5. a) (i) Define thermal radiation (01mk)

ii) Describe how infra-red radiations can be detected (4mks)

b) i) Explain the mechanism of heat transfer in insulators (03mks)

ii) Describe how the thermal conductivity of rubber can be determined (07mks)

a) A rain drop of mass m falls to the ground at its terminal velocity V. The specific heat capacity of water is C and the acceleration of free fall is g. Given that 25% of the energy is retained when it strikes the ground, derive an expression for the temperature rise of the rain drop.

b) A well lagged copper bar having a uniform cross-sectional area of $2.0 \times 10^{-4}m^2$ is heated at one end and is cooled by a flow of water at the other end. The temperature gradient along the bar is $2.1Kcm^{-1}$ when the rate of water flow is $1.0gs^{-1}$. If the heat taken up by the water raises its temperature by 4.0K, calculate the thermal conductivity of copper (specific heat capacity of water is $4.2KJkg^{-1}K^{-1}$. (03mks)

6. a) (i) Define the term specific heat capacity, internal energy and state their units. (03mks)

(ii) Why is the distinction between specific heat capacity at constant pressure and that at constant volume important for gases, but less important for solids and liquids? (04mks)

b) Explain why the temperature of a liquid does not change when the liquid is boiling? (02mks)

c) One kilogram of water is converted to steam at a temperature of 100^0C and a pressure of 1.0×10^5Pa. If the density of steam is $0.58kgm^{-3}$ and the specific latent heat of vaporization of water is $2.3 \times 10^6Jkg^{-1}$. Calculate the

i) external work done (04mks)

ii) internal energy (03mks)

a) Explain why the specific latent heat of fusion and specific latent heat of vaporization of a substance at the same pressure are different. (04mks)

7. a) (i) Distinguish between isothermal and adiabatic changes (02mks)

(ii) State the condition under which an adiabatic change can take place (02mks)

(iii) Explain why the passage of sound waves through air is considered as an adiabatic process. (03mks)

b) A fixed mass of an ideal gas whose ratio Cp: Cv is 5:3 has a temperature of 27^{0}C, volume of 6.4 x $10^{-2}m^3$ and pressure 243Nm^{-2}. It undergoes a reversible adiabatic compression to a volume of 2.7 x $10^{-2}m^3$. The gas is then expanded isothermally to the original volume.

i) Show an indicator diagram in the above process (02mks)

ii) Calculate the pressure at the end of the compression (03mks)

c) (i) What is meant by the thermometric property? (01mk)

(ii) List four thermometric properties which are used in thermometry (01mk)

iii) The resistance of a thermistor over a limited range of temperature is given by the equation; $R = \frac{C}{T - 203}$, where C is a constant and T is the absolute temperature. T = 310K. (05mks)

SECTION C

8. a) (i) What is meant by mass defect? (01mk)

ii) Sketch a graph showing how binding energy per nucleon varies with mass number and explain its main features (03mks)

iii) Find the binding energy per nucleon of $^{56}_{26}Fe$ given that

mass of 1 proton = 1.007825u

mass of 1 neutron = 1.008665u (03mks)

$[1u = 931\ MeV]$

b) (i) Show that when an alpha particle collides head – on with an atom of atomic number Z, the closest distance of approach to the nucleus, X_0 is given by $X_0 = \frac{Ze^2}{\Pi\Sigma_0 mV^2}$

Where: e is electronic change

Σ_0 is permittivity of free space

m is mass of alpha particle

v is initial speed of the alpha particle. (4mks)

ii) In a head-on collision between an alpha particle and a gold nucleus, the minimum distance of approach is 5×10^{-14}m. Calculate the energy of the alpha particle (in MeV). (03mks)

(Atomic number of gold = 79).

c) With the aid of a diagram, explain how an ionization chamber works. (06mks)

9. (a) Define the following terms as used in photoelectric emission (01mk)

i. Threshold frequency (01mk)

ii. A photon

b) Describe an experiment you would use to determine plank's constant, h. (06mks)

c) Light of wave length 6.0×10^2nm and intensify 1×10^{-5}Wm^{-2} falls on a photo-sensitive surface of area 2.0cm^2 and work function 1.9eV. If 80% of the photons can cause electron emission, find the; (02mks)

i. Photon energy for this light (04mks)

ii. Photon current that results

d) i) Explain how the line spectra in an x-ray tube is produced (03mks)

ii) Electrons in an x-ray tube are accelerated through a pd of 14kv. Calculate the minimum wave length of the x-rays that can be produced. (03mks)

10. a) Show that the total energy of an electron in an orbit is given by $\frac{-e^2}{8\Pi\Sigma_0 r}$

(05mks)

b) The energy levels shown in figure 1 below are of an atom of a certain element X.

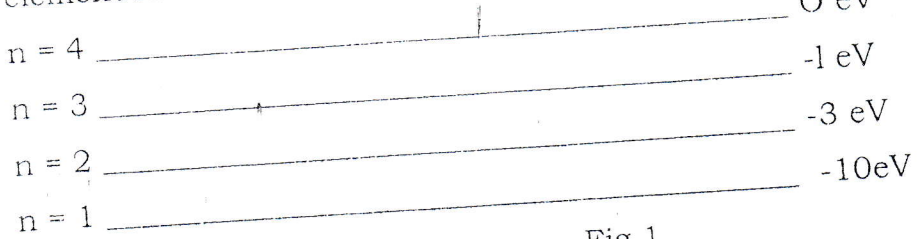

Fig 1

i. What is the shortest wave length of radiation that can be emitted by X? (03mks)

ii. What region of the electromagnetic spectrum do you find the radiation emitted in (i) above? (01mk)

c) (i) What are positive rays? (01mk)

(ii) Describe an experiment to determine the specific charge of positive rays. (05mks)

a) An oil drop of mass 3.25×10^{-15}kg falls vertically with uniform velocity between two vertical parallel plates which are 2.0cm apart. When a p.d of 1000V is applied between the plates, the drop moves towards the negative plate, its path being inclined at 45^0 to the vertical.

i. Explain why the vertical component of the velocity remains unchanged. (01mk)

ii. Calculate the charge on the drop. (04mks)

END