P510/1

PHYSICS 1

$2^1/_2$hours

UGANDA ADVANCED CERTIFICATE OF EDUCATION

RESOURCEFUL EXAMS 2022

PHYSICS 1

2 hours 30 minutes

Instructions to candidates:

- Attempt any **five** questions, including at least **one** but not more than **two** from each of the sections A,B and C .
- Where necessary assume;

Acceleration due to gravity, (g) $= 9.81ms^{-2}$

Electronic charge, (e) $= 1.6x10^{-19}C$

Electron mass $= 9.11x10^{-31}kg$

Mass of the earth, $= 5.97x10^{24}kg$

Plank's constant, (h) $= 6.6x10^{-34}Js$

Stefan's-Boltzmann's constant, (σ) $= 5.67x10^{-8}Wm^{-2}K^{-4}$

Radius of earth $= 6.4x10^{6}m$

Radius of the sun $= 7.0x10^{8}m$

Radius of earth 's orbit about the sun $= 1.5x10^{11}m$

Speed of light in a vacuum (C) $= 3.0x10^{8}ms^{-1}$

Universal Gravitation constant, (G) $= 6.67x10^{-11}\ Nm^{2}kg^{-2}$

Avogadro's number, (N_A) $= 6.02x10^{23}mol^{-1}$

Density of water, (ρ) $= 1000kgm^{-3}$

Gas constant , R $= 8.31\ Jmol^{-1}K^{-1}$

Thermal conductivity of aluminium $= 40\ Wm^{-1}K^{-1}$

Specific latent of vaporization of water $= 2.26x10^{6}Jkg^{-1}$

Specific heat capacity of water (c) $= 4200Jkg^{-1}K^{-1}$

Specific heat capacity of Aluminium $= 400Jkg^{-1}K^{-1}$

Section A

1. (a) (i) What is **a projectile motion?** (01mark)

(ii) Define the terms **range** and **time of flight** as used in projectile motion? (02marks)

(b) A bullet of mass 0.5 kg is fired from a gun on top of a cliff 200m above the ground. The bullet leaves the gun at a speed of 700ms^{-1}. If the bullet takes 40 seconds to hit the ground below, find

(i) The angle between the horizontal and the speed of projection of the bullet. (04marks)

(ii) The horizontal distance covered by the bullet (02marks)

(iii) The kinetic energy of the bullet as it hits the ground (04marks)

(c) A footballer X standing 100m away from footballer Y kicks a ball towards Y and the ball leaves the ground with a speed of 20.0ms^{-1} at an angle of 45^{0} to the horizontal. Find;

(i) The time the ball takes to hit the ground. (02marks)

(ii) The speed at which footballer Y must run so as to get the ball just before it hits the ground, if he starts running at the same time the ball is kicked (04marks)

2. (a) (i) State the characteristics of Simple Harmonic Motion (02marks)

(ii) On the same axes, sketch graphs of Kinetic energy and potential energy against displacement for a body executing Simple Harmonic Motion. (02marks)

(iii) Give two practical example of simple harmonic motion (01marks)

(b) A small mass of 20g is suspended from a vertical helical spring of force constant 100Nm^{-1}. The mass is slightly displaced through a vertical distance x of 3cm and then released.

(i) Show that the mass executes simple harmonic motion (02marks)

(ii) Derive the expression for the frequency of this motion (02marks)

(iii) Calculate the speed of the mass when it is a distance of 0.5cm from its equilibrium position (03marks)

(c) A conical pendulum has a frequency of 0.5 Hz and its string makes an angle of 60^{0} with the vertical at the point of suspension. Calculate;

(i) The length of the pendulum string (04marks)

(ii) The speed of the mass attached to the string (02marks)

(d) An aero plane is flying at a speed of 800kmh^{-1}. At what angle should the pilot bank its wings in order to make a circular curve of radius 7.0 km in space?. (03marks)

3. (a) State **Kepler's laws** of planetary motion (03 marks)

(b) Show that Kepler's third law is consistent with Newton's law of gravitation (03marks)

(c) (i) Define the term **escape Velocity** (01 mark)

(ii) Explain why the escape velocity of the moon is smaller than that of the earth. (03marks)

(d) Titan is a moon orbiting the planet Saturn at a mean orbital radius of $1.22 \times 10^9 m$. The orbital period of Titan is 15.95 days. Hyperion orbits Saturn at a mean radius of $148 \times 10^9 m$. Calculate the orbital period of Hyperion in days. (03marks)

(e) A satellite of mass 200kg is launched into the parking orbit round the earth.

(i) Calculate the height of the parking orbit above the earth's surface (03marks)

(ii) Find the mechanical energy of the satellite (03marks)

(iii) State any one application of an artificial satellite. (01mark)

4. (a) (i) What is meant by an elastic material? (01mark)

(ii) Define Young's modulus and state its units (02marks)

(iii) Sketch a graph of Stress against Strain for a ductile material and on it indicate the, proportionality limit, yield point, elastic limit and the breaking stress (03 marks)

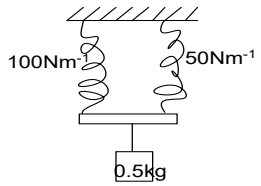
(b) A load of 60N is applied to a steel wire of length 2.5m and cross-sectional area of 0.22mm^2.

(i) Find the extension produced. (3marks)

(ii) If the steel wire is cooled from 60^{o}C to 20^{o}C, find the resulting strain in it. (3 marks)

(Coefficient of linear expansion of steel is$= 1.1x10^{-5}K^{-1}$ and young's modulus for steel as $2.1x10^{11}P$))

(c) A mass of 0.5kg is suspended from the free ends of two springs of force constant 100Nm^{-1} and 50Nm^{-1} respectively as shown in the figure below.



Calculate;

(i) The extension produced (2 marks)

(ii) Tension in each spring (3 marks)

(iii) Energy stored in the system (3 marks)

Section B

5. (a) Define the term **Specific Latent heat of vaporization** and state its units. (02marks)

(b) With the use of a well labelled diagram, describe an accurate method to determine the specific latent heat of vaporization of water (05marks)

(c) 2.5 kg of water in an aluminium container of mass 1.0 kg, uniform thickness 3.0 mm and base area 0.1m^2 is heated by an electric fire and its temperature rise from 20^{o}C to 100^{o}C in 7 minutes 16 seconds. Assuming no heat is lost to the surrounding find;

(i) The power of the electric fire (03marks)

(ii) The rate at which water boils away (02 marks)

(iii) The temperature of the underside of the aluminium container (02marks)

(d) Explain the following observations

(i) A metal surface feels cooler to the touch than a wooden one at the same temperature (02marks)

(ii) The boiling temperature of a liquid is lower at high altitudes than that at lower altitude (04 marks)

6. (a) (i) What is meant by **a black body?.** (01mark)

(ii) State Stefan's law of black body radiation (01mark)

(b) The sun is a black body of surface temperature 6000K. If 15% of the radiant power from the sun is lost in the earth's atmosphere, calculate

(i) the amount of radiant power reaching the earth from the sun (04marks)

(ii) the equilibrium temperature of the earth (03marks)

(c) Describe, with the aid of a labelled diagram, how to measure high temperatures using an optical pyrometer (05marks)

(d) A thermocouple has its cold junction at $0°\text{C}$ and when the hot junction is at $\theta°\text{C}$, the thermos e.m.f is given by $E = (20\theta - 0.02\theta^2)\mu V$

(i) find the maximum temperature that can be measured by this thermocouple (03marks)

(ii) calculate the temperature of the hot junction if the thermo-emf produced is 6.5mV (03marks)

7. (a) (i) What is the difference between isothermal and an adiabatic process. (02marks)

(ii) State the conditions necessary for reversible adiabatic process to occur (02marks)

(b) (i) State any three difference between real and ideal gas (03marks)

(ii) Sketch the P-V isothermals for a real gas above and below the critical temperature. Mark on the curve, the liquid, saturated vapour and gaseous states (03marks)

(c) One mole of a gas occupies $2.24x10^{-2}m^3$ at pressure of $1.01x10^5Pa$ at 0°C. If the molar heat capacity at constant pressure is $28.5\ Jmol^{-1}K^{-1}$, calculate the molar heat capacity at constant volume (03marks)

(d) 20g of the gas in (c) at 27°C is heated at constant pressure 1.0×10^5Pa at pressure of and its volume increased from $0.250m^3$ to $0.375m^3$. Calculate;

(i) The external work done (02marks)

(ii) Increase in internal energy (05marks)

(relative molecular mass of the gas $= 2$)

Section C

8. (a) (i) What are cathode rays. (01mark)

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

(b) With the aid of a diagram, describe an experiment to show that cathode rays travel in a straight line (05marks)

(c) A beam of electrons is accelerated through a high potential difference and enter mid-way between two parallel plates with a velocity parallel to the plates. The plates are 15.0cm long and separated by 12.0mm. The electrons are deflected through 2.0 cm on a screen placed 12.5 cm beyond the plates when a potential difference of 960V is connected across the plates. Find;

(i) Calculate the speed of the electrons as they enter the region between the plates [05marks]

(ii) Voltage used to accelerate the electrons before they enter the region between the plates. (02mark)

(d) A beam of positive ions is accelerated through a $p.d$ of 1000V into a region of uniform magnetic field of flux density 0.2T. While in the magnetic field it moves in a circle of radius 2.3cm. Derive an expression for the charge to mass ratio of the ions and calculate its value (05marks)

9. (a) (i) State the laws of **photoelectric emission** (04marks)

(b) Define the following terms as applied to photo electric emission

(i) work function (01mark)

(ii) threshold wavelength (01mark)

(c) Sketch a graph showing the variation of photo current against voltage across a photo cell for;

(i) two different frequencies of incident radiation at the same intensity (02marks)

(ii) two different intensities of incident radiation at the same frequency (02marks)

(d) (i) What is meant by **nuclear binding energy** of a nucleon (01mark)

(ii) Sketch a graph showing the variation of binding energy per nucleon with mass number and use it to explain the nuclear fusion and fission reactions. (05marks)

(e) Given the following information, calculate the binding energy per nucleon of an alpha particle in joules

Mass of alpha particle $= 4.0028u,$

mass of neutron $= 1.0090u,$

mass of proton $= 1.0076u$

$$1u = 931MeV$$

(04marks)

10. (a) (i) What are **x-rays** (01mark)

(b) For a given source of X-rays, state how the following would be controlled

(i) Intensity of the X-ray beam (01mark)

(ii) The penetrating power of X-rays produced (01mark)

(iii) The exposure to the patients (01mark)

(c) An x-ray tube operated at anode potential of 150V, the target is made of the material of specific heat capacity $250Jkg^{-1}K^{-1}$ and has a mass of 0.25kg. one percent of the electrical power supplied is converted into x-ray and the rest is dissipated as heat in the target. If the temp of the target rises by $8Ks^{-1}$. Find

(i) The number of electrons which strike the target per second (04marks)

(ii) The shortest wavelength of x-rays produced (02marks)

(d) A beam of alpha particles of energy 5.0MeV is incident normally on a gold foil. Calculate the closest distance of approach by the alpha particle to the nucleus of the gold. Atomic number of gold=79) (04marks)

(e) With the aid of a labelled diagram describe Milikan's experiment to determine the charge of an electron. (06marks)