UACE EXTERNAL MOCK 2019

PHYSICS PAPER P510/1

Time: 2 hours 30 minutes

Attempt **FIVE** questions with at least **ONE** but not more than **TWO** questions from each of the sections **A**, **B** and **C**.

Assume where necessary;

Acceleration due to gravity	=	$9.81ms^{-2}$
Electron charge, *e*	=	$1.6 \times 10^{-19}C$
Electron mass	=	9.11×10^{-31} kg
Gas constant R	=	$8.31Jmol^{-1}K^{-1}$
Density of water	=	1000 kg m^{-3}
Density of the moon	=	900 kg m^{-3}
Radius of the earth	=	$6.4\times10^{6}m$
Radius of the sun	=	$7.0\times10^{8}m$
Radius of earth's orbit about the sun	=	$1.5\times10^{11}m$
Mass of the earth	=	5.97×10^{24} kg
Universal gravitational constant, G	=	$6.67\times10^{-11}Nm^{2}kg^{-2}$
Specific heat capacity of water	=	$4200Jkg^{-1}K^{-1}$
Specific latent heat of vaporization of water	=	$2.26\times10^{6}Jkg^{-1}$
Speed of light in vacuum	=	$3.0\times10^{8}ms^{-1}$
Avogadro's number N_A	=	$6.02\times10^{23}mol^{-1}$

SECTION A

1. (a) (i) State the characteristics of simple harmonic motion. [2]

(ii) With use of diagrams distinguish between damped and free oscillations. [4]

(b) A simple pendulum of length, ***L***, has a small mass ***m***, attached to its lower end. The string is displaced through a small angle and then released.

(i) Show that it performs simple harmonic motion. [4]

(ii) Derive the expression for the frequency of the oscillation. [2]

(c) A mass of 0.1 kg suspended from a spring of force constant 24.5 Nm^{-1} is pulled vertically downwards through a distance of 5.0 cm and released. Find the:

(i) Period of oscillation [2]

(ii) Position of the mass 0.3 seconds after release. [4]

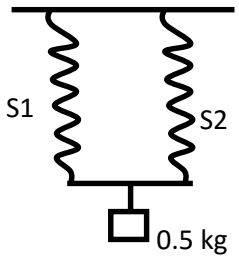
(iii) Sketch the graph of kinetic energy against displacement for the mass. [2]

2. (a) (i) What is meant by an elastic material? [1]

(ii) Define Young's modulus and state its units. [2]

(iii) Sketch a graph Stress against strain for a ductile material and on it indicate the, ***proportional limit, yield point, elastic limit*** and ***the breaking point.*** [3]

(b)



Two springs S1 and S2 of force constants $100Nm^{-1}$ and $50Nm^{-1}$ respectively are suspended from a rigid support and a mass of 0.5kg hanged on them as shown in the figure above. Calculate;

(i) The extension caused by the 0.5 kg mass. [3]

(ii) The total energy stored in the system. [2]

(iii) The period of oscillation if the mass is given a small vertical displacement and then released. [3]

(c) With the aid of a diagram, describe an experiment to determine the acceleration due to gravity. [6]

3. (a) (i) State Newton's law of gravitation [1]

(ii) Define the following; gravitational potential, gravitational field intensity and escape velocity. [3]

(b) With a labelled diagram describe an experiment to determine the **universal gravitational constant** G. [5]

(c) (i) Given that the acceleration due to gravity on the surface of the moon is $1.7\ ms^{-2}$, calculate the radius of the moon stating any assumption made. [4]

(ii) Explain why there is no atmosphere on the moon's surface. [2]

(d) (i) Define centripetal acceleration. [1]

(ii) A car travels round a bend banked at an angle of 22.6^0. If the radius of curvature of the bend is 62.5m and the coefficient of friction between the tyres of the car and the road surface is 0.3, calculate the minimum speed at which the car negotiates the bend without skidding. [5]

4. (a) (i) State Bernoulli's principle. [1]

(ii) Explain why it is dangerous to stand close to a railway line on which a fast moving train is passing. [3]

(b) (i) Explain the temperature dependence of viscosity of a liquid. [3]

(ii) Water of negligible viscosity flows steadily through a horizontal pipe of varying cross-sectional area. At a point A of cross-sectional area $10cm^2$, the velocity is $0.2ms^{-1}$. What is the pressure difference between A and B if the cross section area of point B is $2.5cm^2$? (Given that the density of water = 10^3kgm^{-3}) [4]

(c) (i) Explain the origin of surface tension. [4]
(iii) Describe an experiment to measure the surface tension of a liquid by the capillary tube method. [5]

SECTION B

5. (a) State any two ways in which real gases differ from an ideal gas. [2]

(b) Using the same axes, sketch pressure versus volume graphs for a real gas;

(i) **above** the critical temperature, **at the** critical temperature and **below** the critical temperature. [3]

(ii) Indicate in your sketch in (i) above, the different phases of the gas. [2]

(c) An ideal gas at a pressure of 2.0×10^5 Pa occupies a volume of 3.0×10^{-3} Pa at 50.2˚C. The gas expands adiabatically to a final pressure of 1.5×10^7 Pa. The ratio of the specific heat capacity at constant pressure to that at constant volume is 1.40.

Calculate

(i) The number of moles of the gas [2]
(ii) The final volume of the gas. [3]
(iii) The final temperature of the gas. [3]
(c) (i) State Dalton's law of partial pressures. [1]

(ii) Two metallic bulbs of volumes $3.0m^3$ and $8.0\ m^3$ respectively are joined together by a narrow tube of negligible volume. The bulbs contain air at a temperature 23˚C and pressure 1.01×10^5 Pa.

Calculate the resulting pressure in the bulbs when the temperature of the smaller bulb is raised to 100˚ C and that of the larger bulb lowered to 0˚ C. State any assumption made. [4]

6. (a) (i) State the thermometric property used in the constant-volume gas thermometer. [1]

(ii) Give two characteristics of a good thermometric property. [2]

(b) (i) Describe the steps taken to set up a Celsius scale of temperature for a mercury-in-glass thermometer. [4]

(ii) State four disadvantages of mercury-in-glass thermometer. [2]

(c) Describe with the aid of a labeled diagram the operation of an optical pyrometer. [6]

(d) The brake linings of the wheels of a car of mass 800 kg have a total mass of 4.8 kg and are made of a material of specific heat capacity 1200 J kg^{-1} K^{-1}. If the car is at 15 ms-1 and is brought to rest by applying the brakes, calculate the maximum possible temperature rise of the brake linings. [4]

7. (a) (i) Define specific latent heat of vaporization. [1]

(ii) With the aid of a well labelled diagram, describe the accurate method of determining the specific latent heat of vaporization of water. [5]

(b) Warm water and cold water flow are into a bath tab at the same time. Warm water flows at a rate of 3.5 kg min^{-1} at a temperature of 60ºC, while cold water flows out at a rate of 4.2 kg min^{-1}. When the water has been flowing for 40.0 seconds, the temperature of the water in the tab is found to be 35.0ºC. If the water in the tab loses heat at an average rate of 100W, find,

(i) The mass of water in the tab after 40.0 seconds. [2]

(ii) The temperature of the cold water. [4]

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

(d) A house has a concrete floor of area 40.0m^2 and thickness 10.0cm. The temperature inside the room is 25ºC while that just below the concrete is 20ºC. If 1.02×10^5 Joules of heat are lost through the concrete every minute, find;

(i) The conductivity of concrete. [3]

(ii) The thickness of extra concrete needed to reduce the rate of heat flow through the concrete by 40%. [3]

SECTION C

8. (a) State any four properties of Cathode rays. [2]

(b) (i) Define specific charge of an electron and state its units. [2]

(ii) With use of a labeled diagram, describe Thomson's experiment to determine the specific charge of an electron. [6]

(c) Electrons are 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 2.0cm on a screen placed 12.5cm beyond the plates when a potential difference of 960V is connected across the plates. Find

(i) The velocity of the electrons as they emerge from the region between the plates. [4]

(ii) the voltage used to accelerate the electrons before they enter the region between the plates. [2]

(d) In Millikan's oil drop experiment an oil drop of radius 6.2×10^{-6}m and density $880kgm^{-3}$ was observed to fall through a distance of $6.25\times10^{-1}cms^{-1}$, when no potential difference was put across the plates. When a potential difference of 690V was applied between the plates, the same drop was seen to rise steadily at a speed of $7.25\times10^{-2}cms^{-1}$. If the distance between the plates is 1.5cm and the coefficient of viscosity of air is $1.8\times10^{-7}Ns^{-1}kg^{2}$, find the charge on the oil drop. [4]

9. (a) Define a photon? [1]

(b) (i) With the aid of a diagram explain how X-rays are produced in an X-ray tube. [5]

(ii) State the energy changes that take place in the production of X-rays in an X-ray tube. [2]

(c) In an X-ray tube, the electrons strike the target with a velocity of $3.75\times10^{7}ms^{-1}$ after travelling a distance of 5.0cm from the cathode. If a current of 10mA flows through the tube, find the

(i) tube voltage. [2]

(ii) number of electrons striking the target per second. [2]

(iii) number of electrons within a space of 1 cm length between the anode and the cathode. [5]

(d) Briefly explain one medical application of X-rays. [3]

10. (a) Define the following terms as used in radioactivity.

(i) Isotopes (ii) Half-life, and (iii) Mass number. [3]

(b) With use of a labeled diagram describe how a Geiger Muller tube is used to detect radiation from a radioactive material. [6]

(c) The radioactive Strontium $^{90}_{38}Sr$ decays by emission of beta particles to form an element X .

(i) Write the equation representing the decay process above. [1]

(ii) If the half-life of $^{90}_{38}Sr$ is 28.8 years, determine the current activity of a sample of 2.5μg of $^{90}_{38}Sr$ obtained 15 years ago. [5]

(d) (i) State two industrial uses and two health hazards of radioactivity. [2]

(ii) Given the equation $N = N_o e^{-\lambda t}$, show that half-life $t_{\frac{1}{2}} = \frac{In2}{\lambda}$. [3]

END