P510/1

PHYSICS

PAPER 1

July/August 2019

2½ hours

MWALIMU EXAMINATIONS BUREAU

UACE RESOURCE MOCK EXAMINATIONS 2019

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 sections A, B and C.

These values of physical quantities may be useful to you.

Acceleration due to gravity, *g*	=	$9.81\ ms^{-2}$
Specific heat capacity of water	=	$4200\ J\ kg^{-1}\ K^{-1}$
Specific heat capacity of copper	=	$400\ J\ kg^{-1}\ K^{-1}$
Density of water	=	$1000\ kgm^{-3}$
Speed of sound in air	=	$340\ m\ s^{-1}$
Electron charge, *e*	=	$1.6 \times 10^{-19}\ C$
Plank's constant, *h*	=	$6.6 \times 10^{-34}\ J\ s$
Mass of an electron	=	$9.11 \times 10^{-31}\ kg$
Gas constant, *R*	=	$8.31\ J\ mol^{-1}\ K^{-1}$
Radius of the earth	=	$6.4 \times 10^{6}\ m$
Speed of light *c*	=	$3.0 \times 10^{8}\ ms^{-1}$
Avogadro number	=	6.02×10^{23}
Universal gravitational constant, *G*	=	$6.67 \times 10^{-11}\ Nm^{-2}\ kg^{-2}$
Radius of the earth	=	$6.4 \times 10^{6}\ m$
Mass of earth	=	$5.97 \times 10^{24}\ kg$

SECTION A

1. a) (i) Explain what is meant by free fall and terminal velocity. (3 marks)
(ii) The weight of a body is measured using a spring balance which is suspended from the roof of a lift. Explain the weight obtained when the lift is accelerating downwards and when it is accelerating upward. (4 marks)

b) (i) Derive an expression relating the distance S, the initial velocity U, the time t and the acceleration. (2 marks)
(ii) Show that expression in b) (i) is dimensionally correct. (1 mark)

c) A bomb is dropped from an aeroplane when it is directly above a target at a height of 1402.5m. The aeroplane is moving horizontally with a speed 500Kmh^{-1}, by how much distance will the bomb miss the target? (4 marks)

d) (i) Distinguish between a perfectly elastic and a perfectly inelastic collision. (2 marks)
(ii) A bullet of mass 10.0g is fired at close range into a block of mass 4.99 kg suspended from a rigid support by an inelastic string and becomes embedded in the block. The block rises through a height of 2.50 cm before coming to rest. Calculate the initial speed of the bullet. (4 marks)

2. a) (i) Define surface tension and state its dimensions. (2 marks)
(ii) Explain the occurrence of surface tension using the molecular theory. (3 marks)
(iii) State two cases where surface tension applies. (1 mark)

b) (i) Show that the excess pressure inside a soap bubble of radius *r* is given by $P = \frac{4\gamma}{r}$ where γ is the surface tension of the soap solution. (4 marks)

(ii) Two soap bubble of radius 2.0cm and 3.0cm respectively coalesce under isothermal conditions. If the surface tension of the soap solution is 2.6 x 10^{-2} Nm^{-1}. Calculate the excess pressure inside the resulting soap bubble. (5 marks)

c) Describe the action of a venturi meter in determining the velocity of a boat in still water. (5 marks)

3. a) (i) Define the terms tensile stress and tensile strain as applied to a stretched wire. (2 marks)
(ii) Distinguish between elastic limit and proportional limit. (2 marks)

b) With the aid a labeled diagram, describe an experiment to investigate the relationship between tensile stress and tensile strain of a steel wire. (7 marks)

c) (i) A load of 60N is applied to a steel wire of length 2.5m and cross sectional area of 0.22mm^2. If Young's modulus for steel is 2x10^{11} Nm^{-2} find the expansion produced. (3 marks)
(ii) If the temperature rise of 1K causes a fraction increase of 0.001%, find the change in length of steel wire of length 2.5m when temperature increases by 4K. (3 marks)

d) The velocity, **V** of a wave in a material of Young's modulus E and density $\boldsymbol{\gamma}$ is given by

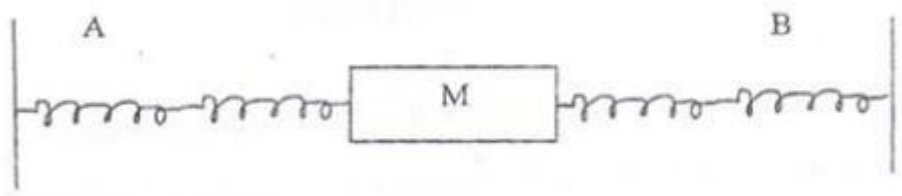
$$V = \sqrt{\frac{E}{\gamma}}$$

Show that the equation is dimensionally correct. (3 marks)

4. (a) (i) What is meant by simple harmonic motion? (1 mark)

(ii) A particle of mass m executes simple harmonic motion between two point A and B about equilibrium position O. Sketch a graph of the restoring force acting on the particle as a function of distance r from O, moved by the particle. (2 marks)

(b)



Two springs A and B of spring constant KA and KB respectively are connected to a mass m as shown. The surface on which the mass slides is frictionless.

(i) Derive an expression for the frequency f of oscillation when the mass is slightly displaced. (4 marks)

(ii) If the two springs above are identical such that KA = KB = 55.0Nm-1 and mass m = 50g, calculate the period of oscillation. (3 marks)

(c) (i) With the aid of a diagram, describe an experiment to determine the universal gravitational constant, G. (6 marks)

(ii) If the moon moves round the earth in circular orbit of radius = 4.0 x 108 m and takes exactly 27.3 days to go round once, calculate the value of acceleration due to gravity g at the earth's surface. (4 marks)

SECTION B

5. (a) Define *thermal conductivity.* (1 mark)

(b) (i) Explain the mechanism of thermal conduction in non-metallic solids. (3 marks)

(ii) Why are metals better thermal conductors than non-metallic solids? (2 marks)

(c) With the aid of a labelled diagram, describe an experiment to determine the thermal conductivity of a poor conductor. (6 marks)

(d) (i) What is meant by a black body? (1 mark)

(ii) Sketch curves showing the spectral distribution of energy radiated by a black body at three different temperatures. (2 marks)

(iii) Describe the main features of the curves you have drawn in (d) (ii). (2 marks)

(e) A small blackened solid copper sphere of radius 2 cm is placed in an evacuated enclosure whose walls are kept at 100 ºC. Find the rate at which energy must be supplied to the sphere to keep its temperature constant at 127 ºC. (3 marks)

6. (a) (i) State Boyle's law. (1 mark)

(ii) Describe an experiment that can be used to verify Boyle's law. (6 marks)

(b) Explain the following observations using kinetic theory.

(i) A gas fills any container in which it is placed, and exerts a pressure on its walls. (3 marks)

(ii) The pressure of a fixed mass of gas rises when its temperature is increased at constant volume. (2 marks)

(c) (i) What is meant by a reversible process? (1 mark)

(ii) State the conditions necessary for isothermal and adiabatic processes to occur. (4 marks)

(d) A mass of an ideal gas of volume 200 cm^3 at 144 K expands adiabatically when its temperature is raised to 137 K. calculate its new volume.
(Take γ = 1.40) (3 marks)

7. (a) (i) What is meant by cooling correction? (1 mark)
(ii) Explain how the cooling correction may be estimated in the determination of the heat capacity of poor conductors of heat by the method of mixtures. (5 marks)
(b) (i) Define the term specific heat capacity of a substance. (1 mark)
(ii) An electrical heater rated 500 W is immersed in a liquid of mass 2.0 kg contained in a large thermos flask of heat capacity 840 J K^{-1} at 28 ^{0}C. Electrical power is supplied to the heater for 10 minutes. If the specific heat capacity of the liquid 2.5×10^3 J $kg^{-1}K^{-1}$, its specific latent heat of vaporization is 8.54×10^3 Jkg^{-1} and its boiling point is 78 ^{0}C, estimate the amount of liquid which boils off, stating any assumptions made. (7 marks)
(c) (i) With reference to an electrical thermometer, describe the steps involved in setting up a kelvin scale of temperature. (3 marks)
(ii) The resistance of the element of a platinum resistance thermometer is 4.00 Ω at the ice point and 5.46 Ω at the steam point. What temperature on the platinum resistance scale would correspond to a resistance of 9.84Ω? (3 marks)

SECTION C

8. (a) (i) With the aid of a labelled diagram, describe how an *X* – rays are produced. (5 marks)
(ii) How do *X* – rays differ from beta particles? (2 marks)
(iii) Distinguish between *X* – ray production and the photo electric effect. (2 marks)
(b) A beam of cathode rays is directed midway between two parallel metal plates of length 4.0 cm and separation 1.0 cm. The beam is deflected through 10.0 cm on a fluorescent screen placed 20.0 cm beyond the nearest edge of the plates when a potential difference of 200 V is applied across the plates. If this deflection is annulled by a magnetic field of flux density 1.14×10^{-3} T applied normally to the electric field between the plates, find the charge to mass ratio of cathode rays. (6 marks)
(c) With the aid of a labelled diagram, describe and give the theory of a mass spectrometer for measuring the charge to mass ratio of positive ions. (5 marks)

9. (a) (i) What is meant by the term Binding energy of a nucleus? (1 mark)
(ii) Calculate the binding energy per nucleon of an alpha particle, expressing your result in MeV.

Mass of a proton	=	1.0080 u
Mass of a neutron	=	1.0087 u
Mass of an α – particle	=	4.0026 u
1 u =	931 MeV	

(4 marks)

(iii) Sketch a graph of binding energy per nucleon against mass number and use it to explain liberation of energy by nuclear fusion and nuclear fission. (6 marks)
(b) Derive an expression relating the half life of a radioactive material, $T_{½}$ and the decay constant, λ. (3 marks)

(c) When $^{238}_{92}U$ decays, the end product is $^{206}_{82}Pb$. The half life is 1.4×10^{17} s. Suppose a rock sample contains $^{206}_{82}Pb$ and $^{238}_{92}U$ in the ratio 1 : 5 by weight, calculate;

(i) the number of $^{206}_{82}Pb$ atoms in 5.0 g of rock sample. (3 marks)

(ii) the age of the rock. (3 marks)

Assume decay law $N=N_0e^{-\lambda t}$

10. (a) State the laws of photoelectric effect. (4 marks)

(b) Describe an experiment to determine the stopping potential of a metal surface. (5 marks)

(c) A 100 mW beam of light of wavelength 4.0×10^{-7} m falls on caesium surface of a photocell.

(i) How many photons strike the caesium surface per second? (3 marks)

(ii) If 16% of the photons emit photoelectrons,, find the resulting photocurrent. (3 marks)

(iii) Calculate the kinetic energy of each photon if the work function of caesium is 2.20 eV. (3 marks)

(d) Distinguish between continuous and line spectra in X-ray tube. (2 marks)

END