P510/1
PHYSICS
Paper 1
July/August 2017
2½ hours

MWALIMU EXAMINATIONS BUREAU

UACE RESOURCE MOCK EXAMINATIONS 2017

P510/1 PHYSICS

Paper 1

2 hours 30 minutes

INSTRUCTION TO CANDIDATES

*Answer any **five** questions, including at least **one** from each section, but **not** more than **two** from each of the sections A, B and C.*

Mathematics tables and squared papers will be provided.

Non-programmable scientific calculators may be used.

Where necessary assume the following constants:

Acceleration due to gravity	= $9.8ms^{-2}$
Avogadro's number, N_A	= $6.02x10^{23}$ mol^{-1}
Density of water	= 1000kgm^{-3}
Electron charge, e	= $1.6x10^{-19}$C
Electron mass	= $9.1x10^{-31}$kg
Gas constant, R	= 8.31Jmol-1K-1
Mass of the earth	=$5.97x10^{24}$kg
Planck's constant, h	= 6.63 $x10^{-34}$Js
Radius of the earth	= 6.4 $x10^{6}$m
Radius of the earth's orbit about the sun	= 1.5 $x10^{11}$m
Radius of the sun	= 7 $x10^{8}$m
Stefan's constant, σ	= $5.7x10^{-8}$ $Wm^{-2}K^{-4}$
Speed of light in a vacuum, c	=$3.0x108ms^{-1}$
Specific heat capacity of water	= $4.2x10^{3}JKg^{-1}K^{-1}$
Surface tension of water	= $7.0x10^{-2}$ Nm^{-1}
Thermal conductivity of aluminium	= $210Wm^{-1}K^{-1}$
Thermal conductivity of copper	= 390 $Wm^{-1}K^{-1}$
Universal gravitational constant, G	= $6.6x10^{-11}Nm^{2}kg^{-2}$

SECTION A

1\. a) (i) What is a conservative force? Give two examples. (2mark)

(ii) State the principle of conservation of mechanical energy (1mark)

(iii) Show that mechanical energy is conserved when a ball is kicked vertically upwards from the ground, which is a point of reference. (4 marks)

b) Explain the term weightlessness as applied to a body in a lift. (3marks)

c) (i) Sate the principle of conservation of linear momentum (1mark)

(ii) A truck of mass 10 Kg moving at $45Kmh^{-1}$ rams into a truck of mass $4x10^{+3}$ Kg which is stationary. The trucks stick together and skid to a stop along a horizontal surface.

Calculate the distance through which the trucks skid if the coefficient of kinetic friction is 0.25 (4 marks)

d) (i) Distinguish between scalar and vector quantities. Give two examples of each. (2marks)

(ii) Define the terms time of flight and range as applied to projectile motion. (1 mark)

(iii) A projectile is fired in air with a speed U at an angle of 30^0 to the horizontal. Find the time of flight. (2marks)

2\. a) (i) Define the terms tensile stress and tensile strain as applied to a stretched wire. (2marks)

(ii) Distinguish between elastic limit and proportional limit. (2marks)

b) With the aid of 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 2.5 m and cross-sectional area of $0.22mm^2$. If Young's modulus for steel is $2x10^{11}$ Nm^{-2}, find the expansion produced. (3marks)

(ii) If the temperature rise of 1K causes a fractional increase of 0.001% , find the change in length of steel wire of length 2.5 m when temperature increases by 4 K. (3 marks)

d) The velocity, V of a wave in a material of Young's modulus E and density γ is given by

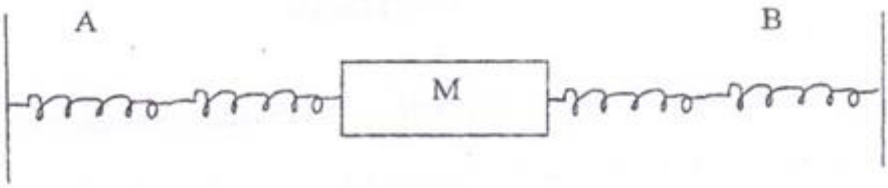
$$V = \sqrt{\frac{E}{\gamma}}$$

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

3. a) (i) Define simple harmonic motion. (1mark)

(ii) A particle of mass m executes simple harmonic motion between two points 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 constants K_A and K_B 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 $K_A = K_B = 5\ 5.0Nm^{-1}$ and mass m= 50g, calculate the period of oscillation. (3marks)

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

(ii) If the moon moves round the earth in a circular orbit of radius = 4.0×10^8 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. (4marks)

4. a) (i) Define surface tension and state its dimensions (2marks)

(ii) Use the molecular kinetic theory of matter to explain the occurrence of surface tensions. (3marks)

(iii) State two cases where surface tension applies (1mark)

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

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

SECTION B

5 a) Define the coefficient of thermal conductivity of a substance and state its S.1 Unit (2 marks)

b) Sketch graphs, of the temperature distribution along a lagged and unlagged metal rod. (2 marks)

c) Water in an aluminum saucepan, of diameter 16cm and thickness 4mm, is kept boiling at 100^0c on a hot stove. The water boils off at a rate of $2.28 \times 10^{-4}\ Kgs^{-1}$. Calculate the temperature of the underside of the saucepan, assuming it is uniformly heated and neglecting heat losses from the sides.
(Thermal conductivity of aluminum = $2.06 \times 10^2\ Wm^{-1}K^{-1}$ latent heat of vaporization of water = $2.26 \times 10^6\ JKg^{-1}$) (4marks)

d) Describe an experiment to compare the energy radiated by two different surfaces (3marks)

e) Explain the characteristic features of the relative intensity distribution curves for a black body. (4marks)

f) Given that the temperature of the sun is 6000k and that its in radiation equilibrium with the earth. Find the temperature of the earth (assume distances of earth from sun = 1.5×10^{11}m) (5marks)

6. a) (i) Define the term specific latent heat (1mark)

(ii) Use the kinetic theory of matter to explain latent heat of vapourization. (2marks)

b) (i) With the aid of a labeled diagram, describe an accurate method of measuring the specific latent heat of vapourisation of a liquid. (5marks)

(ii) Explain using kinetic theory why the specific latent heat of vapourization is much higher than the specific latent heat of fusion of the same substance. (2marks)

c) State the conditions for:

(i) An adiabatic change (2marks)

(ii) An isothermal change (2marks)

d) One litre of a gas at a pressure of 1.0×10^{5} Pa and a temperature of $17^{0}C$ is compressed isothermally to half its original volume. It is then allowed to expand adiabatically to its original volume.

(i) Sketch a p-v graph to show the above processes. (2marks)

(ii) Calculate the final temperature (take $\gamma = 1.40$) (4 marks)

7. a) The standard thermometric fixed point is the triple point of water, to which is assigned the value 273.16K.

(i) What is meant by a thermometric fixed point (1mark)

(ii) Define the triple point of water (1 mark)

(iii) The value of a thermometric property X of a certain substance is

$$X_t = X_0 + 0.50t + (2.0 \times 10^{-4})t^2$$

Where t is the temperature in ^{0}C measured on a gas thermometer scale. What would be the Celsius temperature defined by the property X which corresponds to a temperature of $50^{0}C$ on this gas thermometer scale? (4marks)

(iv) Account for the differences in the readings of the two thermometers in (iii) above (2marks)

b) (i) Distinguish between a real and an ideal gas (2marks)

(ii) Derive the expression

$P = \frac{1}{3}\rho \overline{C^2}$ for the pressure of an ideal gas of density, ρ and mean square speed $\overline{C^2}$. (6marks)

c) (i) Calculate the root mean–square speed of molecules of an ideal gas at 130^0C given that the density of the gas at a pressure of $1.0 \times 10^5\ Nm^{-2}$ and a temperature of 0^0C is $1.43\ Kgm^{-3}$ (3marks)

(ii) Explain why when pumping a bicycle tyre, the pump barrel gets warm. (1mark)

SECTION C

8 a) (i) What are cathode rays? (1mark)

(ii) An electron gun operating at $3 \times 10^3 V$ is used to project electrons into the space between two oppositely charged parallel plates of length 10 cm and separation 5cm. calculate the deflection of the electrons as they emerge from the region between the charged plates when the potential difference is 1.0×10^3 V (5marks)

b) (i) Describe a simple experiment to demonstrate photoelectric emission. (4 marks)

(ii) Explain why the wave theory of light fails to account for the photoelectric emission of light. (4 marks)

(iii) Describe an experiment to verify Einstein's equation for the photoelectric effect. Explain how Planck's constant may be obtained from the experiment. (6marks)

9 a) Define binding energy of a nuclide (1mark)

b) (i) Sketch a graph showing how binding energy per nucleon varies with mass number. (1mark)

(ii) Describe the main features of the graph in b(i) above. (3marks)

c) Distinguish between nuclear fission and nuclear fusion and account for energy released. (3marks)

d) With the aid of a labeled diagram, describe the working of an ionization chamber. (6marks)

e) (i) What is meant by half life and decay constant as applied to radioactivity? (2marks)

(ii) The radioisotope ^{60}Co decays by emission of a β- particle and a γ-ray. Its half life is 5.3 years. Find the activity of the source containing 1.10g of ^{60}Co. (4marks)

10. a) What is a line spectrum? (1mark)

b) Explain how line spectra accounts for the existence of discrete energy levels in atoms. (3 marks)

c) The energy levels in an atom are 10.4eV, -5.5eV, -3.7eV and -1.6eV

(i) Explain the significance of the negative signs in the values quoted. (2marks)

(ii) Find the ionization energy of the atom in Joules (2marks)

(iii) What is likely to happen if an atom in an unexcited state is bombarded with an electron of energy 4.0 eV and 11.0 eV? (3 marks)

d) Describe with the aid of a labeled diagram, the action of an X-ray tube. (5marks)

e) An X-ray tube is operated at 20KV with an electron current of 16mA in the tube. Estimate the;

(i) Number of electrons hitting the target per second. (2marks)

(ii) Rate of production of heat, assuming 99.5% of the kinetic energy of electron is converted to heat. ($e = 1.6 \times 10^{-19}$ C) (2marks)

END