P510/1
PHYSICS
PAPER 1
2 ½ HOURS

UGANDA ADVANCED CERTIFICATE OF EDUCATION

SHACK PRE-MOCK EXAMINATIONS 2016

P510/1: PHYSICS
PAPER 1

TIME: 2 hours 30 minutes

S.6

INSTRUCTIONS TO CANDIDATES:

Attempt **five** questions, including at least one, but not more than **two** from each of the Sections **A, B** and **C**.

Assume where necessary:

Acceleration due to gravity	g	=	$9.81\ ms^{-2}$
Electron charge	e	=	$1.6 \times 10^{-19}\ C$
Electron mass		=	$9.11 \times 10^{-21}\ Kg$
Planck's constant	h	=	$6.6 \times 10^{-34}\ Js$
Speed of light in Vacuum,	c	=	$3.0 \times 10^{8}\ ms^{-1}$
Stefan's constant,	J	=	$5.67 \times 10^{-8} Wm^{-2}K^{-4}$
Wien's displacement constant		=	$2.90 \times 10^{-3}\ m\ K$
Specific heat capacity of water		=	$4.2 \times 10^{3}\ J\ kg^{-1}\ K^{-1}$
Avogadro's number	N_A	=	$6.02 \times 10^{-23}\ mol^{-1}$
Radius of the earth		=	$6.4 \times 10^{6}\ m.$

SECTION A

1. **GRAVITATION**

(a) (i) State Newton's law of universal gravitation.

(ii) Show that this law is consistent with Kepler's third law.

(iii) Two alternative units for gravitational field strength are Nkg^{-1} and ms^{-1}. Use the method of dimensions to show that the two units are equivalent.

(b) (i) Derive an expression for the speed of a body moving uniformly in a circular path.

(ii) Explain why a force is necessary to maintain a body moving with constant speed in a circular path.

(c) A small mass attached to a string suspended from a fixed point moves in a circular path at constant speed in a horizontal plane.

(i) Draw a diagram showing the forces acting on the mass.

(ii) Derive any equation showing how the angle of inclination of the string depends on the speed of the mass and the radius of the circular path.

2. **SOLID FRICTION**

(a) State the laws of friction. (4 marks)

(b) A block of mass 5.0 kg resting on the floor is given a horizontal velocity of $5.0ms^{-1}$ and comes to rest in a distance of 7.0m.

Find the coefficient of kinetic friction between the block and the floor.

(4 marks)

(c) State Newton's laws of motion. (3 marks)

(d) A body of mass m_1 and m_2 moving with velocity U_1 and U_2. After collision, the bodies move with velocities V_1 and V_2 respectively.

Use Newton's laws of motion to show that the total linear momentum is conserved in the collision.
(4 marks)

(e) A bullet of mass 300kg travelling horizontally at a speed of $8ms^{-1}$ hits a body of mass 450g moving in the same direction as the bullet at 1.5 ms^{-1}. The bullet and body move together after collision.
Find the loss in kinetic energy. (5 marks)

PROJECTILES

3. (a) Explain the terms "**time of flight**" and "range" as applied to projectile motion.

(b) A stone projected at an angle 20^{o} to the horizontal and just clears a wall which is 10m high and 30m away from the point of projection.
Find:

(i) The speed of projection.
(ii) Angle which the stone makes with the horizontal as it clears the wall. (3 marks)

(c) (i) What is meant by "simple harmonic motion'?

(ii) A particle of mass, m executes simple harmonic motion, between two paints **A** and **B** about equilibrium position **O**.

Sketch a graph of the restoring force acting on the body as a function of the distance, *r*, moved by the particle. (2 marks)

(iii)

Two springs A and B of spring constant k_A and k_B respectively are connected to a mass, m as shown.

The surface on which the mass slides is frictionless surface tension

(i) Show that when the mass is displaced slightly, it oscillates with simple harmonic motion of frequency, ***f***, green by

$$f = \frac{2}{2\pi}\sqrt{\frac{k_A + k_B}{m}}$$ (4 marks)

(ii) If the two springs are 'Identical' such that

$k_A = k_B = 5.0\ Nm^{-1}$ and mass M = 50g, calculate the period of the oscillation.
(3 marks)

SURFACE TENSION:

4. (a) What is meant by the following terms:

(i) velocity gradient?

(ii) coefficient of viscosity?

(...marks)

(b) Derive an experiment for the terminal velocity of a steel ball-bearing of radius ***r*** and density ***p***, falling through a liquid of density and coefficient of viscosity η .

(c) (i) Define surface tension.
(ii) Explain the origin of surface tension.

(iii) Describe an experiment to measure the surface tension of a liquid by the capillarity method.

(d) Explain, with and of a diagram why air-flow over the wings of an aircraft at take-off causes a lift.

5. ELASTICITY

(a) State Hooke's law.

(b) A A copper wire is stretched until it breaks.

(i) Sketch a stress-strain graph for the wire and explain the main features of the graph.

(ii) Explain what happens to the energy used to stretch the wire at each stage.

(iii) Derive the expression for the work done to stretch a spring of force constant, k by a distance e.

(c) (i) Define Young's Modulus.

(ii) Two identical steel bars A and B of radius 2.0 mm are suspended from the ceiling. A mass of 2.0 kg is attached to the free end of bar A. Calculate the temperature to which B should be raised so that the bars are again of equal length.

(Young's Modulus of steel = 1.0×10^{11} Nm^{-2})
(Linear expansivity of steel = 1.2×10^{-5} k^{-1})

(d) Describe the terms tensile stress and tensile strain as applied to a stretched wire.

Describe and experiment to investigate the relationship between the two above.

SECTION B

6. (a) (i) What is meant by a scale of temperature? (1 mark)

(ii) Explain how a Kelvin temperature scale ie established. (4 marks)

(iii) A resistance thermometer has resistance of 25.40Ω at the ice-point, 27.30 Ω at the steam point, and 26.95Ω at the melting point of a certain solid. Calculate the temperature of the melting point on the Celsius scale of the thermometer. (3 marks)

(b) (i) Define specific latent heat of vaporization. (1 mark)

(ii) Describe how the specific latent heat of vaporisation of Water may be determined by an electrical method. (6 marks)

(iii) An electrical heater of 2 kW is used to heat 0.50 kg of Water in a kettle of heat capacity 400 JK^{-1}, initially at a temperature of 20^{o}C.

Calculate the time taken to bring the water to a boiling point and boil away 0.05 kg of water.
(5 marks)

7. (a) Explain briefly how the kinetic theory of matter accounts for:

(i) Evaporation. (2 marks)
(ii) Saturated vapours (2 marks)
(iii) Boiling (2 marks)

(b) (i) State Dalton's law of partial pressures. (1 mark)

(ii) A closed vessel; of fixed volume contains air and water. The pressures in the vessel at 20^{o}C and 75^{o}C are respectively 737.5mm and 1144mm of mercury, with some water

remaining at 75°C. If the SVP of water at 20°C is 17.5mm of mercury, find its value at 75°C. (4 marks)

(c) State the P—V relationships:

(i) An isothermal expansion. (1 mark)
(ii) An adiabatic expansion. (1 mark)

(d) Air initially at a pressure of 1.0×10^5 Pa is compressed adiabatically and reversibly to a pressure of 4.0×10^5 Pa and is then allowed to expand isothermally and reversibly to its original volume.
[Ratio of principal specific heats, $\gamma = 1.40$]

(i) Sketch on a P—V diagram for the two processes. (2 marks)
(ii) Find the final pressure. (5 marks)

8. (a) Describe briefly the mechanisms of heat conduction in metals. (4 marks)

(b) The brick wall of a house has thickness of 30cm and area $20m^2$. The inside surface of the wall is coated with a layer of plaster 10mm thick. The outside and inside temperatures are 5°C and 20°C respectively. [Thermal conductivities of brick and plaster are
$0.62 Wm^{-1} K^{-1}$ and $0.16 Wm^{-1} K^{-1}$]. Determine:

(i) the temperature of the interface between the brick and the plaster. (4 marks)
(ii) the rate of flow heat through the wall. (3 marks)

(c) (i) State **three** factors which determine the amount of heat radiated by a body. (3 marks)

(ii) Explain why a hollow sphere with a small pin-hole outlet approximates a black body. (3 marks)

(iii) A black body emits radiation with maximum energy emitted at a wavelength of 1250nm.

Calculate the temperature of the body. (3 marks)

ELECTRON MOTION

8. (a) (i) With the aid of a diagram, explain how cathode rays are produced in the cathode ray tube. (6 marks)

(ii) What is meant by a time base as applied to the CRO? (2 marks)

(iii) The gain control of a CRO is set an $8Vcm^{-1}$ and an alternating voltage produces a vertical line of 1.0 cm long, when the time a base is off. Find the r.m.s. value of the applied voltage.

(iv) State the advantages of CRO over moving coil voltmeter.(2 marks)

(b) (i) Describe thermson's experiment of determining the specific charge ratio of an electron.

(ii) Protons with a charge—mass ratio of $1.0 \times 10^{8} C\ kg^{-1}$ are rotated in a circular orbit or radius r, where they enter a uniform magnetic field of 0.5T. Show that the number of revolutions per second at ***f***, is independent of ***r***, and calculate ***f***.

RADIOACTIVITY

9. (a) What is meant by:

(i) half life.
(ii) Decay constant.

(b) (i) Derive the relationship between half life and decay constant of a radio active substance.

(ii) Sketch a characteristic curve of a GMT of count rate against Applied p.d. and explain main features.

(iii) What is meant by:
1. Dead time
2. Quenching agent.

(c) Describe how you would use a G.M.T. to determine the half life of
A radio active sample.

(d) A steel piston ring contains 15 g of a radioactive iron $^{54}_{26}Fe$.
The activity of $^{54}_{26}Fe$ is 3.75 x 10^5 disintegrations per second. After
100 days of continuous use, the crank case oil was found to have a total activity of 1.23 x 10^3 disintegrations per second.

Find:

(i) Half life of $^{54}_{26}Fe$
(ii) Average mass of iron warm off the ring per day assuming that all the metal removed from the ring accumulates in the oil.

PHOTELECTRIC EMISSIONJ

10. (a) (i) State the law of photo electric emission. (4 marks)

(ii) Using quantum theory, explain any two of the laws of photo electric emission. (4 marks)

(b) Describe an experiment that can be used to obtain the Plank's constant, *h*. (6 marks)

(c) Explain what is meant by stopping potential. (2 marks)

(e) Violet light of wavelength 0.4 μm is incident on a metal surface of threshold wavelength 0.65μm. Find the maximum speed of emitted electrons. (4 marks)

NUCLEUS

11. (a) Define binding energy of nuclide. (1 marks)

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

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

(c) Calculate the energy released during the decay of $^{220}_{86}Rn$ of Nucleus into $^{216}_{84}Po$ and an α—particle.

Mass of $^{216}_{84}Rn$ = 219.964176u

Mass of $^{220}_{86}Po$ = 215.955794u

Mass of $^{4}_{2}He$ = 4.001566u

(Iu = 931.5MeV)

(4 marks)