P510/1
PHYSICS
(Theory)
Paper 1
Jul./Aug. 2022
2 ½ hours

WAKISO-KAMPALA TEACHERS' ASSOCIATION (WAKATA)

WAKATA MOCK EXAMINATIONS 2022

Uganda Advanced Certificate of Education

PHYSICS

(Theory)

Paper 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **five** *questions including at least* **one**, *but* **not** *more than* **two** *from each of the sections;* **A**, **B** *and* **C**.
Any additional question(s) answered will **not** *be marked.*
Non – programmable scientific calculators may be used.
Assume where necessary:

Acceleration due to gravity, g	$= 9.81 ms^{-2}$.
Electron charge, e	$= 1.6 \times 10^{-19}$ C.
Electron mass	$= 9.11 \times 10^{-31}$ kg.
Mass of the earth	$= 5.97 \times 10^{24}$ kg.
Plank's constant, h	$= 6.6 \times 10^{-34}$ J s.
Stefan's Boltzmann's constant, σ	$= 5.67 \times 10^{-8}$ W m^{-2} K^{-4}.
Radius of the earth	$= 6.4 \times 10^{6}$ m.
Radius of the sun	$= 7 \times 10^{8}$ m.
Radius of the earth's orbit about the sun	$= 1.5 \times 10^{11}$ m.
Speed of light in a vacuum, c	$= 3.0 \times 10^{8} ms^{-1}$.
Thermal conductivity of copper	$= 390 Wm^{-1}K^{-1}$.
Thermal conductivity of aluminium	$= 210 Wm^{-1}K^{-1}$.
Specific heat capacity of water	$= 4200$ J $kg^{-1}K^{-1}$.
Universal gravitational constant, G	$= 6.67 \times 10^{-11} Nm^2 Kg^{-2}$.
Avogadro's number, N_A	$= 6.02 \times 10^{23} mol^{-1}$.
Surface tension of water	$= 7.0 \times 10^{-2} Nm^{-1}$.
Density of water	$= 1000 Kgm^{-3}$.
Gas constant, R	$= 8.31$J mol^{-1} K^{-1}.
Charge to mass ratio, e/m	$= 1.8 \times 10^{11}$ C kg^{-1}.
The constant $\frac{1}{4\pi\varepsilon_0}$	$= 9.0 \times 10^{9}$ $F^{-1}m$.
Faraday constant, F	$= 9.65 \times 10^{4}$C mol^{-1}.

SECTION A

1. (a) (i) Distinguish between **uniform acceleration** and **instantaneous acceleration**. *(02 marks)*

(ii) Draw a velocity – time graph for a body moving with uniform velocity (with $u \neq 0$) and use it to derive the second equation of motion. *(04 marks)*

(b) (i) What is **projectile motion**? *(01 mark)*

(ii) Figure **1** shows a ball with speed, u at angle of 55^0 to the horizontal, a point 2.0m above the ground. The ball passes through a horizontal ring with a velocity of $5ms^{-1}$ at an angle of 60^0 to the axis of the ring.

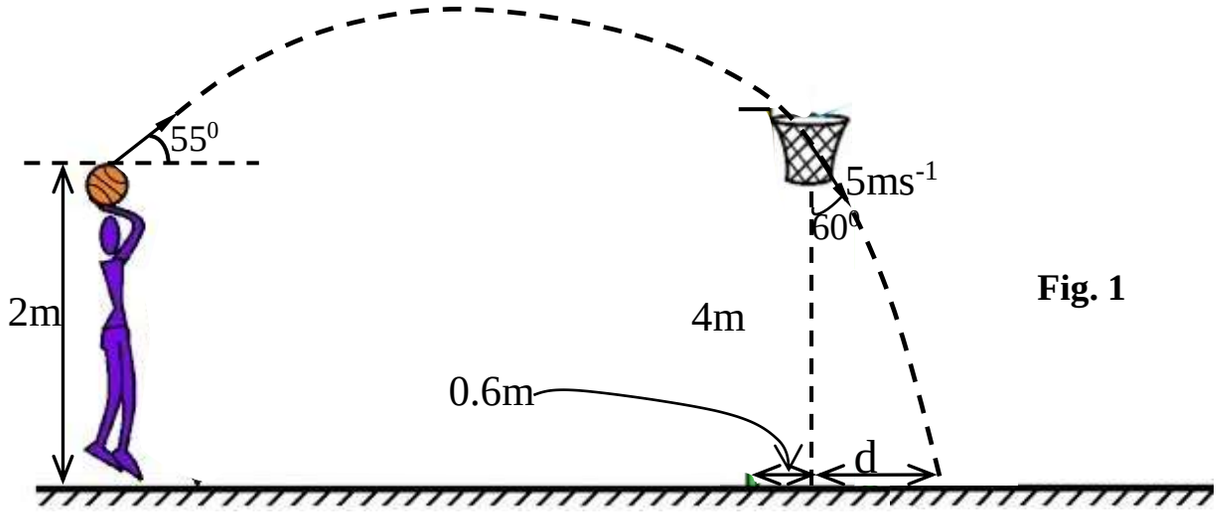

Fig. 1

If the axis of the ring is 0.6m from the pole and that the height of the ring is 4m, calculate the distance, d between the pole and the point where the ball hits the ground. *(05 marks)*

(c) (i) Define **Angular velocity**. *(01 mark)*

(ii) A car moves around a circular path of radius 60m, which is banked at $tan^{-1}\frac{7}{15}$ to the horizontal. At what speed should the car be driven if it is to have no tendency to slip? *(04 marks)*

(iii) Explain why it is necessary for a bicycle rider moving around a circular path to lean towards the centre of the path. *(03 marks)*

2. (a) Define **elastic limit** as applied to a stretched wire. *(01 mark)*

(b) A force, F stretches a wire of force constant, k to a distance, x.
sketch a graph of F against x and use it to derive an expression for the energy stored in the wire. *(07 marks)*

(c) A uniform wire of un – stretched length 3m is attached to two rigid supports, **P** and ***Q*** which are 2.6m apart and in the same horizontal line. When a 8kg mass is attached to the mid - point, **T**, of the wire, the equilibrium position of **T** is 0.6m below the line ***PQ***. Calculate the energy stored in the wire and state any assumptions made. *(07 marks)*

(d) Explain the energy changes which occur during plastic deformation. *(05 marks)*

3. (a) (i) What is meant by **coefficient of viscosity of a fluid**? *(01 mark)*

(ii) Explain the effect of temperature on viscosity of a liquid. *(03 marks)*

(b) (i) Write down Poisseulle's formula of fluid flow. *(02 marks)*

(ii) Describe an experiment based on Poisseulle's formula to determine the coefficient of viscosity of a liquid. *(07 marks)*

(c) 25 spherical rain drops of the same mass and radius are falling down with a terminal velocity of $20cms^{-1}$. The rain drops coalese to form a big drop. Calculate the terminal velocity of a big drop.
(Neglect the buoyancy due to air) *(04 marks)*

(d) (i) Define **surface tension**. *(01 mark)*

(ii) Explain the dependency of surface tension of a liquid on temperature. *(02 marks)*

4. (a) (i) Define **Simple Harmonic Motion (SHM)**. *(01 mark)*

(ii) State **four** characteristics of a Simple Harmonic Motion. *(02 marks)*

(b) Derive an expression for mechanical energy of an oscillating bob of a simple pendulum. *(06 marks)*

(c) (i) What is meant by a **spring constant**? *(01 mark)*

(ii) Describe an experiment to determine the value of the spring constant. *(06 marks)*

(d) When a mass of 600g is suspended from a helical spring, it causes a displacement of 6cm in the spring. Find the displacement produced when a mass of 100g is dropped from a height of 15cm onto a light pan attached on the spring. *(04 marks)*

SECTION B

5. (a) Define the term **triple point of water**. *(01 mark)*

(b) Describe with the aid of a diagram, how you would calibrate a thermocouple thermometer. *(06 marks)*

(c) (i) State **Newton's law of cooling**. *(01 mark)*

(ii) Figure **2** shows a temperature against time graph for a cooling piece of rubber.

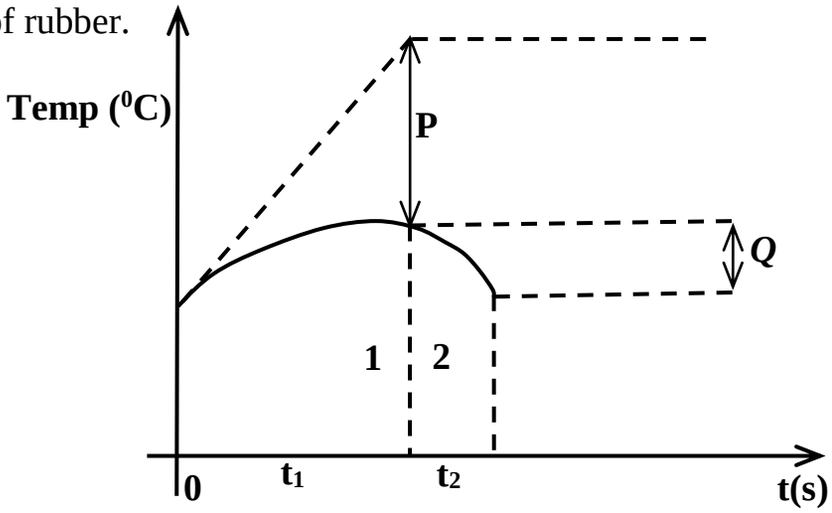

Fig. 2

Use Newton's law of cooling to show that the cooling correction, **P** is given by

Turn Over

$P = \left(\frac{t_1}{t_2 - t_1}\right) Q$, *where* ***Q*** *is the quantity of heat lost by rubber*.

(06 marks)

(d) (i) Define **specific heat latent heat of fusion of ice**. *(01 mark)*

(ii) 15g of dry ice was added to 100g of water at 25^0C in polystyrene beaker of negligible heat capacity. When all ice had melted the temperature of water fell to 10^0C. Calculate the specific latent heat of fusion of ice. *(05 marks)*

6. (a) (i) Distinguish between **saturated vapour** and **saturation vapour pressure.**

(02 marks)

(ii) Describe with the aid of a diagram, how saturated vapour pressure varies with temperature. *(07 marks)*

(b) The total pressure in a closed vessel containing air and saturated vapour at 36^0C is 1.01×10^5 Pa. If the saturation vapour pressure at 36^0C and 90^0C are 4×10^3 Pa and 8×10^4 Pa respectively. Calculate the total pressure in the vessel at 90^0C assuming the air remains saturated. *(04 marks)*

(c) Using kinetic theory, explain why saturated vapour pressure is independent of an increase in volume. *(03 marks)*

(d) (i) Define **partial pressure**. *(01 mark)*

(ii) State **three** differences between an ideal gas and a real gas. *(03 marks)*

7. (a) (i) State the difference between **isothermal** and **adiabatic expansion of a gas**.

(02 marks)

(ii) Show that the work, W, done by a gas which expands reversibly from V_0 to V_1 is given by

$$W = \int_{V_0}^{V_1} P dV$$

. *(04 marks)*

(b) (i) Define **thermal conductivity**. *(01 mark)*

(ii) Why are metals better thermal conductors than non – metallic solids?

(02 marks)

(c) (i) What is a **black body**? *(01 mark)*

(ii) Describe how a black body can be approximated in practice. *(04 marks)*

(d) The total power output of the sun is $4.0 \times 10^{26} W$. Given that the mass of the sun is 1.97×10^3kg and its density is 1.4×10^3kgm^{-3}.
Calculate the temperature of the sun. State any assumptions made. *(06 marks)*

SECTION C

8. (a) (i) What is meant by **thermionic emission**? *(01 mark)*

(ii) Describe the mechanism of thermionic emission. *(03 marks)*

(b) (i) What are **X – rays**? *(01 mark)*

(ii) Draw a labelled diagram showing the main components of an X – ray tube. *(03 marks)*

(c) An X – ray tube is operated at 80kV and 45Ma. If 2% of the total energy supplied is emitted as X – radiation, calculate the:

(i) minimum wave length of emitted radiation; *(04 marks)*

(ii) rate at which heat must be removed from the target in order to keep it at a steady temperature. *(04 marks)*

(d) Derive Bragg's law of X – ray diffraction. *(04 marks)*

9. (a) (i) State Rutherford's model of an atom. *(02 marks)*

(ii) Explain **two** main failures of Rutherford's model of the atom. *(03 marks)*

(b) Show that the total energy, E_n of an electron in an atom is given by;

$$E_n = \frac{-me^4}{8{\varepsilon_o}^2 h^2 n^2},$$ where $m = electron\ mass$

$e = electron\ charge$

$n = an\ integer \geq 1$

$h = Plank's\ constant$

(07 marks)

(c) Calculate the wave length of the radiation that would be emitted when an electron makes a transition from $n = 3$ to $n = 2$. *(03 marks)*

(d) (i) What is meant by **binding energy of a nucleus**? *(02 marks)*

(ii) Sketch a graph showing how binding energy per nucleon varies with mass number and describe the features of the graph. *(04 marks)*

10. (a) Explain the term **space charge limitation** as applied to a vacuum diode. *(03 marks)*

(b) Sketch the **I – V** characteristic curve for a vacuum diode and explain its features. *(03 marks)*

(c) (i) With the aid of a labelled diagram, explain how a triode can be used as a voltage amplifier. *(06 marks)*

(ii) A sinusoidal voltage of amplitude 0.4V is applied to the grid of a triode of amplification factor 12. If the anode resistance of the triode is 20kΩ, what voltage will appear across a load of 20kΩ? *(05 marks)*

Turn Over

(d) Explain, with the help of suitable sketch diagrams the time – variation of the voltage across the resistor in the circuit in figure **3**. *(03 marks)*

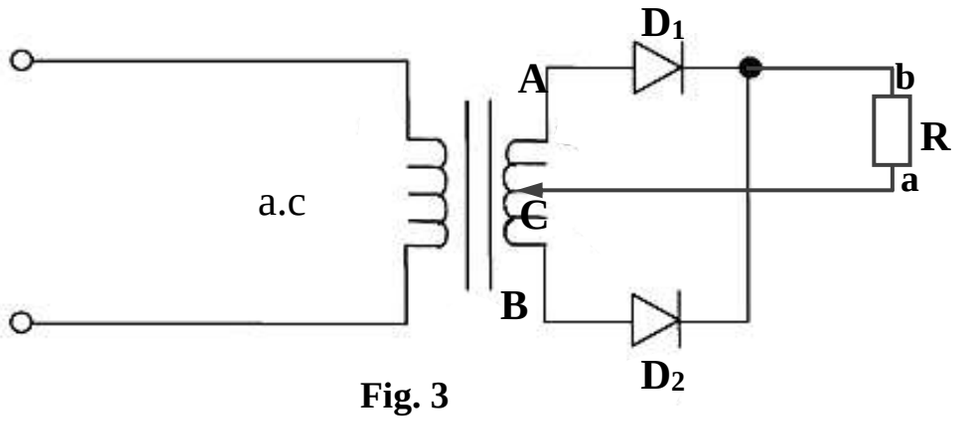

Fig. 3

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