"Affordable Quality Assessment"

WAKISO-KAMPALA TEACHERS' ASSOCIATION (WAKATA)

WAKATA MOCK EXAMINATIONS 2023

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) State the **work – energy theorem.** *(01 mark)*

(ii) Show that work done by a resultant force on a body is equal to the change in the kinetic energy of the body. *(04 marks)*

(b) (i) A tennis ball is projected with a velocity, u at a height, H, vertically upwards. Explain how its kinetic energy varies with height above the ground. *(04 marks)*

(ii) Sketch a graph to show the relationship in b(i) above. *(02 marks)*

(c) Distinguish between **dissipative** and **non – dissipative forces**. Give **two** examples of each. *(04 marks)*

(d) A pump draws $3.6m^3$ of water from a well 5m below the ground every minute and pushes it at ground level through a pipe of cross – sectional area 400 cm^2. Find the rate at which the pump is working. *(05 marks)*

2. (a) Define **Young's Modulus of elasticity, E** and derive its dimensions. *(04 marks)*

(b) State the measurements necessary in the determination of Young's Modulus of a metal wire. *(02 marks)*

(c) A light rigid rod is suspended horizontally from **two** vertical wires one made of steel and the other made of brass as shown in figure 1.

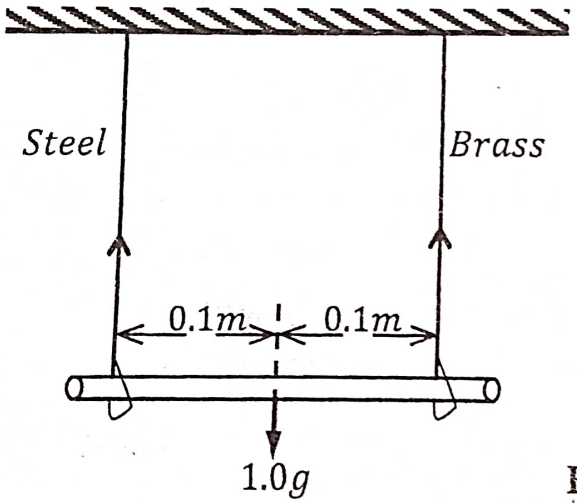

Fig. 1

Each wire is 2m long. The diameter of steel wire is 0.6mm, and the length of the light rigid rod is 0.2m. When a mass of 10kg is suspended from the centre of the light rod, the rod remains horizontal. If Young's Modulus of elasticity for steel, $E_s = 2 \times 10^{11} Pa$, Calculate the;

(i) energy stored in the steel wire *(05 marks)*

(ii) diameter of the brass wire. *(03 marks)*

(d) Explain the process of work hardening of metals. *(05 marks)*

3. (a) Define the term **surface tension** in terms of surface energy and derive the relationship between them. *(04 marks)*

(b) Describe a simple experiment to show the effect of temperature on surface tension of a liquid. *(04 marks)*

(c) A liquid drop of diameter 0.5cm breaks into 27 tiny droplets all of the same size. If the surface tension of the liquid is $0.07 Nm^{-1}$, calculate the resulting change in energy. *(05 marks)*

(d) Two soap bubbles A and B of radii r_1 and r_2 combine and coalesce to form a single bubble with a common interface of radius, r. Show that the excess pressure inside the resulting soap bubble is $\frac{4\gamma}{\sqrt{r_1^2 + r_2^2}}$, where γ is the surface tension of the soap solution. *(03 marks)*

(e) Explain why small mercury droplets are spherical while large ones flatten out. *(04 marks)*

4. (a) State **Newton's law of viscosity** and use it to derive the formula for coefficient of viscosity. *(04 marks)*

(b) Explain why a viscous liquid flows faster when heated. *(03 marks)*

(c) (i) Distinguish between **streamline flow** and **turbulent flow** as applied to fluid flow. *(02 marks)*

(ii) Describe an experiment to demonstrate the types of fluid flow in c(i) above. *(05 marks)*

(d) A particular air craft design calls for a dynamic lift of $2.4 \times 10^4 N$ on each square metre of the wing when the speed of the air craft through the air is $80 ms^{-1}$. Assuming that the air flows past the wings with streamline flow and that the flow past the lower surface is equal to the speed of the air craft, what is the required speed of the air over the upper surface of the wing? *(04 marks)*
(Assume that density of air is $1.29 kgm^{-3}$).

(e) Explain **one** application of Bernoulli's principle. *(03 marks)*

Turn Over

SECTION B

5. (a) Define **coefficient of thermo conductivity** and state its units. *(02 marks)*

(b) Explain why temperature fall is not uniformly distributed along un lagged body. *(03 marks)*

(c) A window of height 1.5m and width 2.0m contains a double glazed unit consisting of two single glass planes each of thickness 4.4mm, separated by an air gap of 2.2mm. Calculate the rate at which heat is conducted through the window if the temperature of the external surfaces of glass are 25° C and 33° C respectively. *(thermal conductivities of glass and air are $0.72 Wm^{-1}K^{-1}$ and $0.025 Wm^{-1}K^{-1}$ respectively).* *(07 marks)*

(d) (i) What is meant by **a black body**? *(01 mark)*
(ii) Describe how an approximate black body can be realized in practice. *(02 marks)*

(e) (i) State **Stefan's** law. *(01 mark)*
(ii) A blackened solid copper sphere of radius 3cm is placed in an evacuated enclosure whose walls are kept at 98° C. Find the rate at which energy must be supplied to the sphere to keep its temperature constant at 117° C. *(04 marks)*

6. (a) Define the following:
(i) adiabatic expansion of a gas. *(01 mark)*
(ii) a reversible isothermal change. *(01 mark)*

(b) State **three** conditions of achieving a reversible isothermal change. *(03 marks)*

(c) A fixed mass of a gas in the state (P_1, V_1) undergoes an isothermal expansion to the state (P_2, V_2) at temperature, T. Derive the expression $W = nRTIn\frac{V_2}{V_1}$, where W is the work done by the gas, n is the number of moles of the gas and R is the gas constant. *(05 marks)*

(d) An ideal gas at a pressure of 4.0×10^6Pa occupies a volume of $4.0 \times 10^{-3} m^3$ at 49°C. The gas expands adiabatically to a final pressure of 1.2×10^7Pa.

Given that $\frac{C_p}{C_v} = 1.4$, calculate

(i) the number of moles of the gas. *(03 marks)*
(ii) the final temperature of the gas. *(03 marks)*

(e) (i) State **Boyle's law**. *(01 mark)*
(ii) Using Boyle's law, explain how humans breathe and exhale. *(03 marks)*

7. (a) Define the following:
   (i) cooling correction. *(01 mark)*
   (ii) specific heat capacity. *(01 mark)*

   (b) Describe an experiment to determine the specific heat capacity of rubber using cooling correction method. *(03 marks)*

   (c) Explain why:
   (i) a small body cools faster than a larger one of the same material. *(02 marks)*
   (ii) at night it is much colder in valley than on top of hills. *(02marks)*

   (d) A copper cylinder of mass 0.25kg is mounted along the axis of a wooden pulley of diameter 0.30 cm. The pulley rubs against the cylinder when it turns. When a steady force of 49N is applied tangentially to the pulley the temperature of the cylinder rises by 9°C after the pulley has turned through 20 revolutions.
   (i) Calculate the specific heat capacity of the copper cylinder. *(04 marks)*
   (ii) How can you estimate the temperature difference in this experiment? *(02 marks)*
   (iii) State **one** disadvantage of this method in determining the specific heat capacity of copper. *(01 mark)*

SECTION C

8. (a) Define the following:
   (i) rectification *(01 mark)*
   (ii) space charge *(01 mark)*

   (b) With the aid of a labelled diagram, explain how a triode can be used as a voltage amplifier. *(07 marks)*

   (c) A sinusoidal voltage of amplitude $0.3V$ is applied to the grid of a triode of amplification factor 10. If the anode resistance of the triode is 10kΩ, what voltage will appear across a load of 5kΩ? *(03 marks)*

   (d) Sketch the current – potential difference characteristics of a thermionic diode for two different operating temperatures and explain their main features. *(06 marks)*

   (e) State **two** disadvantages of a transistor as an amplifier over a triode. *(02 marks)*

9. (a) Define the following:
   (i) photo electric emission *(01 mark)*
   (ii) work function of a metal *(01 mark)*

   (b) Describe an experiment to determine the stopping potential of a metal surface. *(02marks)*

   (c) Explain why the wave theory of light fails to account for the photoelectric effect. *(06 marks)*

   (d) When light of wave length $7.0 \times 10^{-7} m$ is incident on zinc metal, electrons of maximum kinetic energy $2.0 \times 10^{-20} J$ are emitted. Calculate the work function of the zinc metal. *(07 marks)*

   (e) (i) What are **cathode rays**? *(01 mark)*
   (ii) State **three** differences between X – rays and cathode rays. *(03 marks)*

10. (a) Define the following:
   (i) radioactivity *(01 mark)*
   (ii) decay constant *(01 mark)*

   (b) (i) Draw the current – voltage characteristic of a Geiger Muller Tube. *(02 marks)*
   (ii) Identify giving reasons the part of the characteristic over which the Geiger Muller Tube is normally operated. *(02marks)*

   (c) The activity of a sample of dead wood is 20 counts per minute while activity for a living plant is 30 counts per minute. If the half-life of carbon – 14 is 5600 years, find the age of the wood sample. *(03 marks)*

   (d) Show that when an alpha particle collides head on with an atom of atomic number, Z the closest distance of approach to the nucleus, r_o is given by

$$r_o = \frac{ze^2}{\pi\varepsilon_o m v^2},$$

   Where, e is the electron charge, ε_o is the permittivity of free space, m is the mass of the alpha particle and V is the initial velocity of the particle. *(07 marks)*

   (e) State **three** uses of radioactive isotopes. *(03 marks)*

END