

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Faculty of Science Education

Department of Mathematics and Science Education

MAR 2024

Diploma in Science-Physics

DP003/PH002

Thermal Physics

Duration: Three (3) Hours

INTSRUCTIONS

- Answer ALL questions in Section A and any THREE questions from Section B. Section A carries 40 marks and each question of Section B carries 20 marks.
- Show ALL formulae and substitutions in ALL calculations.
- Leave your answers correct to 2 decimal places

You may not start to read the questions printed on the subsequent pages until instructed to do so by the Invigilator.

SECTION A (20 MARKS)

(Answer ALL questions in this section)

QUESTION 1 (40 MARKS)

- a) Distinguish between '*intensive*' and '*extensive*' properties. (2)
- b) Define the term '**thermometric property**'. State the thermometric property that defines the temperature scale in a liquid-in-glass thermometer. (3)
- c) Volume of a fixed mass of liquid.

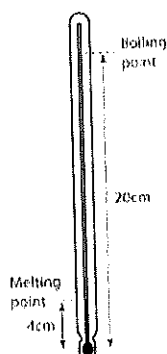
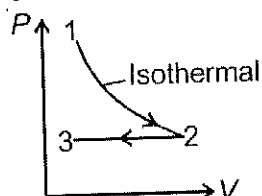


Figure above shows the length of the mercury thread of a thermometer at melting point and boiling point of water. What is the length of the mercury thread when the thermometer is dipped into a hot liquid of temperature 70°C ? (6)

- d) Calculate the efficiency of a power plant if the efficiencies of the boiler, turbine and generator are 88, 40 and 98%, respectively. (4)
- e) One mole of a monoatomic gas undergoes the process 1 - 2 and 2 - 3 as shown.



Sketch the corresponding graph of pressure against temperature. Briefly explain how you arrived at your answer. (5)

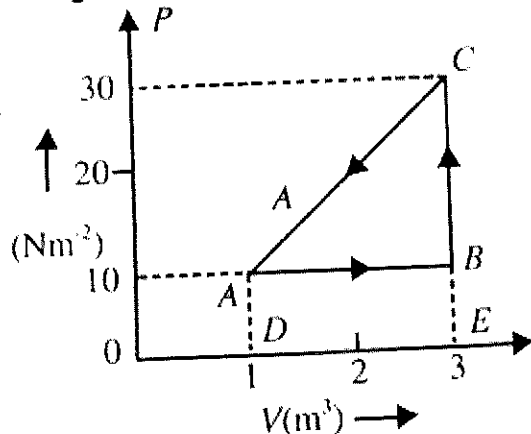
- f) Using the kinetic model of gases, explain why the pressure exerted by a fixed mass of gas increases when its volume is reduced at constant temperature. (6)
- g) With the aid of a labeled diagram, briefly describe how a thermocouple works. (5)
- h) How long will it take a 50 W heater to melt 2 kg of ice at 0°C ? (5)
- i) Why is a burn from 100 degrees C steam more severe than a burn from water at 100 degrees C? (4)

SECTION B (60 MARKS)

(Answer ANY THREE (3) questions in this section.)

QUESTION 2 (20 MARKS)

An ideal gas is taken round a cyclic thermodynamic process ABCA as shown below;



If the internal energy of the gas at point A is assumed zero while at B it is 50 J. The heat absorbed by the gas in the process BC is 90 J.

- What is the internal energy of the gas at point C? (5)
- How much heat energy is absorbed by the gas in the process AB? (5)
- Find the heat energy rejected or absorbed by the gas in the process CA. (5)
- What is the net work done by the gas in the complete cycle ABCA? (5)

QUESTION 3 (20 MARKS)

Answer the following; (20 MARKS)

- Give the entropy statement of the second law of thermodynamics and show that heat flow from a higher temperature isotherm to a lower temperature isotherm is in accordance with this law. (4)
- State and prove Carnot's theorems. (10)
- An inventor claims to have designed a heat engine with the following specifications:

Power developed	50 kW
Fuel burned per hour	3 kg
Heating value of the fuel	75 MJ kg ⁻¹
Temperature limits	627 °C and 27 °C

Examine the feasibility of these claims.

(6)

QUESTION 4 (20 MARKS)

With the aid of a clearly labeled diagram, briefly discuss the greenhouse effect and how it can be used to explain global warming. State the effects and suggest possible solutions to global warming.

QUESTION 5 (20 MARKS)

Use the Laws of thermodynamics to show that $C_p = C_v + nR$ for an ideal gas.

THE END

Some useful information

Constant	Value
Boltzmann constant	$1.38 \times 10^{-23} \text{ m}^2 \text{ kg s}^{-2} \text{ K}^{-1}$
Planck's constant	$6.63 \times 10^{-34} \text{ m}^2 \text{ kg / s}$
Speed of light in a vacuum	$3 \times 10^8 \text{ ms}^{-1}$

Data

Specific heat capacity of aluminium = $910 \text{ J kg}^{-1} \text{ K}^{-1}$.

Specific heat capacity of water = $4200 \text{ J kg}^{-1} \text{ K}^{-1}$

Specific latent heat of fusion of ice = $335\,000 \text{ J kg}^{-1}$

Specific latent heat of evaporation of water 2.26 MJ kg^{-1}