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.

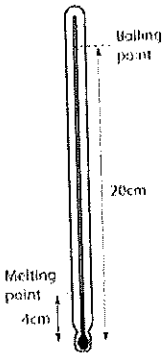
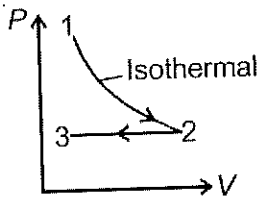


Figure above shows the length of the mercury thread of a thermometer at melting point and boiling point of water. What is the length of the mercury thread when the thermometer is dipped into a hot liquid of temperature 70° C? (6)

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)

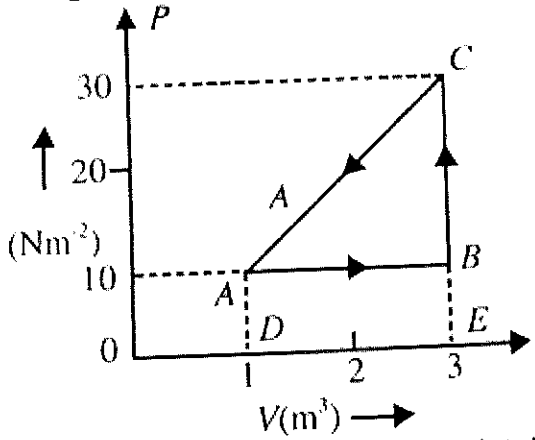
i) Why is a burn from 100 degrees C steam more severe than a burn from water at 100 degrees C? (4)

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.

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

QUESTION 3 (20 MARKS)

Answer the following; (20 MARKS)

a) 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)
b) State and prove Carnot's theorems. (10)
c) 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	$75\ MJkg^{-1}$
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	$1.38 \times 10^{-23}\ m^2 2\ kgs^{-2}K^{-1}$
Planck's constant	$6.63 \times 10^{-34} m^2 kg\ /\ s$
Speed of light in a vacuum	$3 \times 10^8 ms^{-1}$

Data

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

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

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

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