



Instructions to candidates

Duration: One (01) hour

Number of questions: Two (02) questions

Number of questions to be answered: Two (02) questions

Mark allocation: 100

All symbols carry their usual meaning.

- 1.
- a. Describe the following terms with one practical example for each term.
Thermodynamic system, surrounding, boundary, isolated system, open system, closed system, adiabatic and diathermic boundary,
(16 marks)
- b. i. What is a thermodynamic process?
ii. Explain a "reversible process".
(4 marks)
- c. i. State the Zeroth law of thermodynamics.
(5 marks)
ii. An important concept about the *state of matter* is introduced by this law. What is this concept? Explain it with an aid of a diagram.
(10 marks)
- d. i. Write the *equation of state* in the more general form including pressure, volume and temperature.
(5 marks)
ii. For a paramagnetic substance, the exact form of the *equation of state* is given by
$$M = \kappa B / T, \text{ where } M \text{ is the magnetization, } B \text{ is the magnetic flux and } T \text{ is the absolute temperature. } \kappa \text{ is a constant. Show that}$$

$$\left(\frac{\partial M}{\partial B}\right)_T \left(\frac{\partial B}{\partial T}\right)_M \left(\frac{\partial T}{\partial M}\right)_B = -1$$

(10 marks)

(Total 50 marks)

2. a. What is "internal energy" of a thermodynamic system?
(10 marks)
- b. In thermodynamics, only processes that can change the internal energy of a system are considered important. Describe processes that can be used to change the internal energy of a system.
(15 marks)
- c. i. For a diffusively interacting system, write the first law of thermodynamics defining all the terms in the equation.
(10 marks)
- ii. 1 kg of water is boiled under a pressure of 2 atm at 120 °C. If the volumes occupied by water and steam under given conditions are respectively 10^{-3} m^3 and 0.824 m^3 . Calculate the work done (dW) and the increase in internal energy (dU). Given the latent heat of vaporization of water, *i.e.*, $L = 2.20 \times 10^6 \text{ J kg}^{-1}$, and $1 \text{ atm} = 1.013 \times 10^5 \text{ Nm}^{-2}$.
(10 marks)
- iii. In a cyclic process, there are two exothermic and two endothermic stages. The heat transfer in each stage are, + 17.4 kJ, -52.2 kJ, -5.36 kJ and +31.5 kJ. Identify endothermic and exothermic stages in the process and calculate the net work done in this cyclic process.
(5 marks)

(Total 50 marks)