PHYSICS – CLASS XI

Chapter 11 : Thermodynamics

PRACTICE PAPER (Chapter-wise Test)

Time : 1½ Hours **Max. Marks : 35**

General Instructions

(a) All questions are compulsory.

(b) There are 17 questions in total. Section A: Q. 1 to 8 carry 1 mark each. Section B: Q. 9 to 12 carry 2 marks each. Section C: Q. 13 to 15 carry 3 marks each. Section D: Q. 16 and 17 carry 5 marks each.

(c) There is no overall choice. An internal choice is given in one 2-mark question (Q. 11), one 3-mark question (Q. 14) and both 5-mark questions (Q. 16, Q. 17). Attempt only one of the given choices.

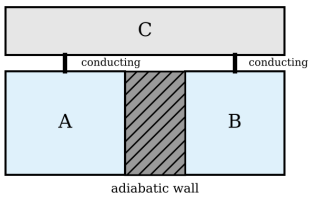
(d) Use of calculators is not permitted. Take $R = 8.3$ J mol^{-1} K^{-1} and T (K) = t (°C) + 273 unless a different value is given in the question. Sign convention: ΔQ is positive when heat is supplied to the system and ΔW is positive when the system does work.

(e) Figures are schematic and not drawn to scale. Write the unit with every numerical answer.

SECTION A

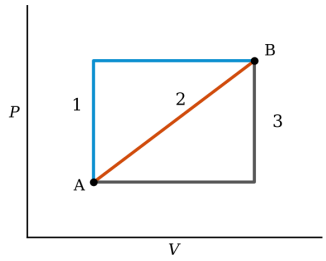
Questions 1 to 8 carry 1 mark each.

1. Systems A and B are separated by an adiabatic wall, and each is in thermal equilibrium with a third system C through a conducting wall (figure). The adiabatic wall between A and B is now replaced by a conducting wall, and C is insulated from A and B. Then **(1)**



(a) heat flows from A to B
(b) heat flows from B to A
(c) no heat flows between A and B, since they are in thermal equilibrium
(d) nothing can be said about A and B

2. A gas is taken from state A to state B along three different paths 1, 2 and 3 (figure). The change in internal energy of the gas is **(1)**

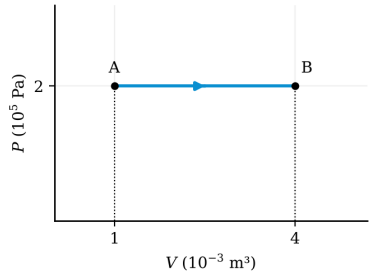


(a) greatest along path 1
(b) greatest along path 2
(c) the same along all three paths
(d) least along path 3

3. Which one of the following is **not** a state variable of a thermodynamic system? **(1)**
(a) Internal energy
(b) Pressure
(c) Temperature
(d) Work done

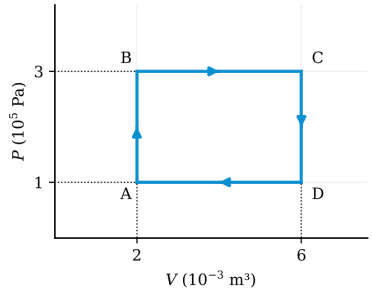
4. **Assertion (A):** The efficiency of a Carnot engine can never be 100%. **(1)**
Reason (R): The temperature of the sink of an engine cannot be absolute zero.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

5. A gas expands at a constant pressure from state A to state B (figure). Find the work done by the gas. **(1)**



6. A gas is supplied with 500 J of heat and, in expanding, it does 200 J of work. Find the change in its internal energy. **(1)**

7. An ideal gas is taken through the cycle ABCDA shown in the figure. Find the net work done by the gas in one cycle. **(1)**

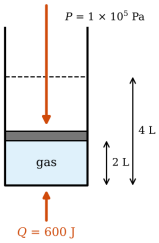


8. Find the efficiency of a Carnot engine working between a source at 727 °C and a sink at 27 °C. **(1)**

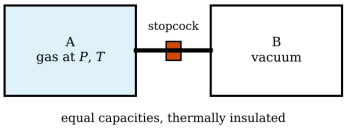
SECTION B

Questions 9 to 12 carry 2 marks each.

9. A gas in a cylinder is supplied with 600 J of heat. It expands at a constant pressure of 1 × 10^5 Pa from a volume of 2 × 10^{-3} m^3 to 4 × 10^{-3} m^3 (figure). Find (i) the work done by the gas and (ii) the change in its internal energy. **(2)**



10. Two cylinders A and B of equal capacity are joined by a stopcock. A contains a gas at pressure P and temperature T, and B is evacuated. The whole system is thermally insulated and the stopcock is suddenly opened (figure). Find (i) the change in internal energy and the change in temperature of the gas, and (ii) the final pressure of the gas. **(2)**

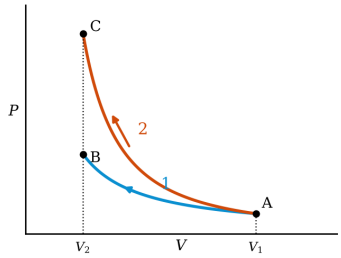


11. Using the first law of thermodynamics, show that $C_p - C_v = R$ for one mole of an ideal gas. **(2)**

OR

State the Kelvin–Planck statement and the Clausius statement of the second law of thermodynamics.

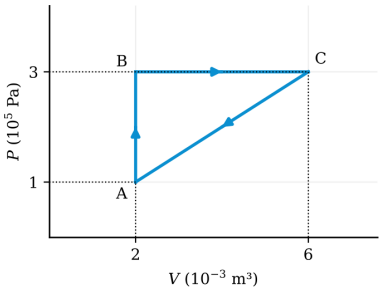
12. An ideal gas is compressed from the same initial state A to the same final volume V_2 along two curves, an isothermal and an adiabatic (figure). (i) Which curve, 1 or 2, represents the adiabatic compression? (ii) Give a reason for your answer. **(2)**



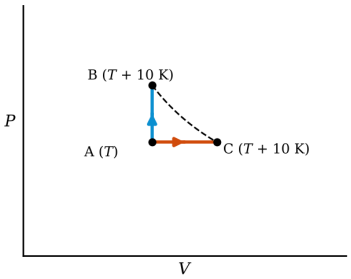
SECTION C

Questions 13 to 15 carry 3 marks each.

13. A heat engine takes an ideal gas through the cycle ABCA shown in the figure and absorbs 1600 J of heat from the source in each cycle. Find (i) the net work done by the gas in one cycle, (ii) the efficiency of the engine and (iii) the heat rejected to the sink per cycle. **(3)**

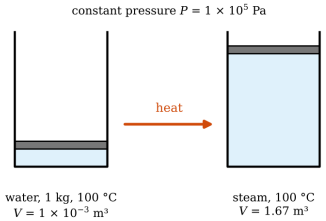


14. 2 mol of a monatomic ideal gas are heated through a temperature rise of 10 K, first at constant volume (A → B) and then, from the same initial state, at constant pressure (A → C) (figure). For a monatomic gas $C_v = 3R/2$ and $C_p = 5R/2$. Find (i) the heat absorbed in A → B, (ii) the heat absorbed in A → C and (iii) the work done by the gas in A → C. **(3)**

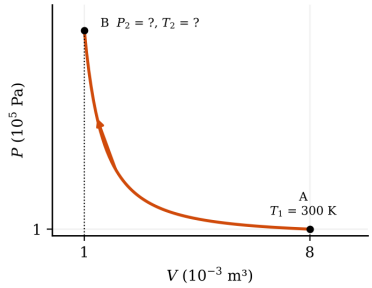


OR

1 kg of water at 100 °C is converted into steam at 100 °C at a constant pressure of 1.0×10^5 Pa (figure). The latent heat of vaporisation is 2.25×10^6 J kg^{-1}. The volume of 1 kg of water is 1×10^{-3} m^3 and that of 1 kg of steam is 1.67 m^3. Find (i) the heat supplied, (ii) the work done by the system against the atmosphere and (iii) the increase in internal energy.



15. A monatomic ideal gas ($\gamma = 5/3$) at 300 K and a pressure of 1×10^5 Pa has a volume of 8×10^{-3} m³. It is compressed adiabatically to a volume of 1×10^{-3} m³ (figure). Take $8^{2/3} = 4$ and $8^{5/3} = 32$. Find (i) the final pressure, (ii) the final temperature and (iii) the work done on the gas. **(3)**



SECTION D

Questions 16 and 17 carry 5 marks each.

16. A Carnot engine uses an ideal gas as the working substance and works between a source at 600 K and a sink at 300 K, absorbing 1200 J of heat from the source in each cycle (figure). **(5)**

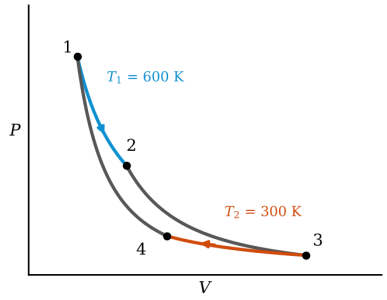
(a) Name the four steps 1 → 2, 2 → 3, 3 → 4 and 4 → 1 of the cycle. (1)

(b) Find the efficiency of the engine. (1)

(c) Find the work done per cycle. (1)

(d) Find the heat rejected to the sink per cycle. (1)

(e) The sink temperature is lowered to 150 K. Find the new efficiency and state whether it can ever become 100%. (1)



OR

A reversible refrigerator (a Carnot engine run backwards) works between a cold chamber at 250 K and a room at 300 K. The work done on it in each cycle is 200 J (figure).

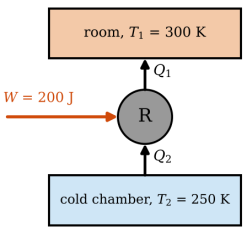
(a) State the Clausius statement of the second law. (1)

(b) Find the ratio Q_1/Q_2. (1)

(c) Find the heat Q_2 extracted from the cold chamber per cycle. (1)

(d) Find the heat Q_1 rejected to the room per cycle. (1)

(e) Find the coefficient of performance Q_2/W. (1)



17. A gas is taken from state A to state B by two different paths: path 1 (A → C → B) and path 2 (A → D → B) as shown (figure). The change in internal energy of the gas from A to B is 1000 J. **(5)**

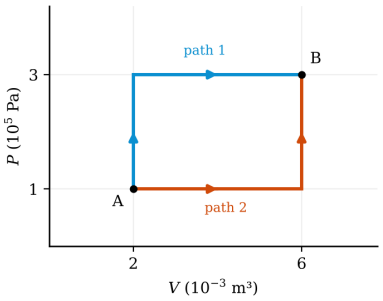
(a) Why is the change in internal energy the same for both paths? (1)

(b) Find the work done by the gas along path 1. (1)

(c) Find the work done by the gas along path 2. (1)

(d) Find the heat absorbed along path 1. (1)

(e) Find the heat absorbed along path 2. (1)



OR

A gas is enclosed in a cylinder with a movable piston, and heat ΔQ is supplied to it while it does work ΔW (figure).

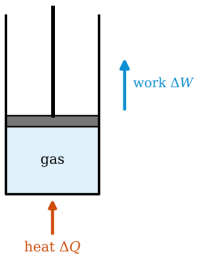
(a) Write the first law of thermodynamics and name the symbols. (1)

(b) A gas absorbs 500 J of heat and expands doing 300 J of work. Find the change in its internal energy. (1)

(c) The gas is compressed: 300 J of work is done on it and it gives out 100 J of heat to the surroundings. Find the change in its internal energy. (1)

(d) What is the relation between ΔQ and ΔW in an isothermal expansion of an ideal gas? (1)

(e) Why are heat and work not state variables? (1)



— END OF QUESTION PAPER —