Physicsaholics

DPP – 4

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Q 1. The specific heat of hydrogen gas at constant pressure is $C_P = 3.4 \times 10^3$ cal/kg°C and at constant volume is $C_v = 2.4 \times 10^3$ cal/kg°C. If one-kilogram hydrogen gas is heated from 10°C to 20°C at constant pressure, the external work done on the gas to maintain it at constant pressure is

(a) 10^5 cal (b) 10^4 cal
(c) 10^3 cal (d) 5×10^3 cal

Q 2. Calculate the change in internal energy when 5g of air is heated from 0°C to 2°C. Specific heat of air at constant volume is 0.172 cal/g-°C

(a) 7.2 J (b) 3.6 J
(c) 11.4 J (d) 36 J

Q 3. When heat energy of 1500 Joules, is supplied to a gas at constant pressure 2.1×10^5 N/m^2, there was an increase in its volume equal to 2.5×10^{-3} m^3. The increase in internal energy of the gas in Joules is

(a) 450 (b) 525
(c) 975 (d) 2025

Q 4. A system is given 400 calories of heat and 1000 Joule of work is done by the system, then the change in internal energy of the system will be

(a) 680 Joule (b) 680 erg
(c) 860 Joule (d) – 860 Joule

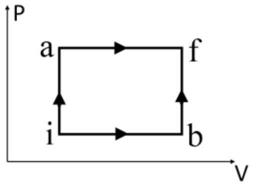
Q 5. A gas is compressed from 10 m^3 volume to 4 m^3 volume at constant pressure of 50 N/m^2. Then the gas is heated by giving it 100 Joules of energy. The internal energy of the gas will-

(a) Increase by 100 Joule
(b) increase by 200 Joule
(c) increases by 400 Joule
(d) decrease by 200 Joule.

Q 6. The amount of heat required to raise the temperature of a diatomic gas by 1°C at constant pressure is Qp and at constant volume is Qv. The amount of heat which goes as internal energy of the gas in the two cases is nearly -

(a) Qp & Qv (b) 0.71 Qp & 0.71 Qv
(c) 0.71 Qp & Qv (d) 0.7 Qp & 0.9 Qv

Q 7. When a system is taken from state i to state f along the path iaf, it is found that Q = 50 cal and W = 20 cal. Along the path ibf Q= 36 cal. W along the path ibf is-

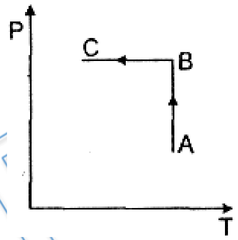


(a) 6 cal (b) 16 cal
(c) 66 cal (d) 14 cal

Q 8. 140 calories of heat is required to raise the temperature of 2 moles of an ideal gas at constant pressure from 40°C to 50°C (R = 2 cal/mol-°C). The gas may be:
(a) H_2 (b) He (c) CO_2 (d) NH_3

Q 9. The pressure of given mass of a gas in a thermodynamic system is changed in such a way that 20 joule of heat is released from the gas and 8 joule of work is done on the gas. If the initial internal energy of the gas was 30 joule then final internal energy will be
(a) 2 Joule (b) 42 Joule
(c) 18 Joule (d) 58 Joule

Q 10. Ideal gas is taken through the process shown in the figure , mark the wrong statement:



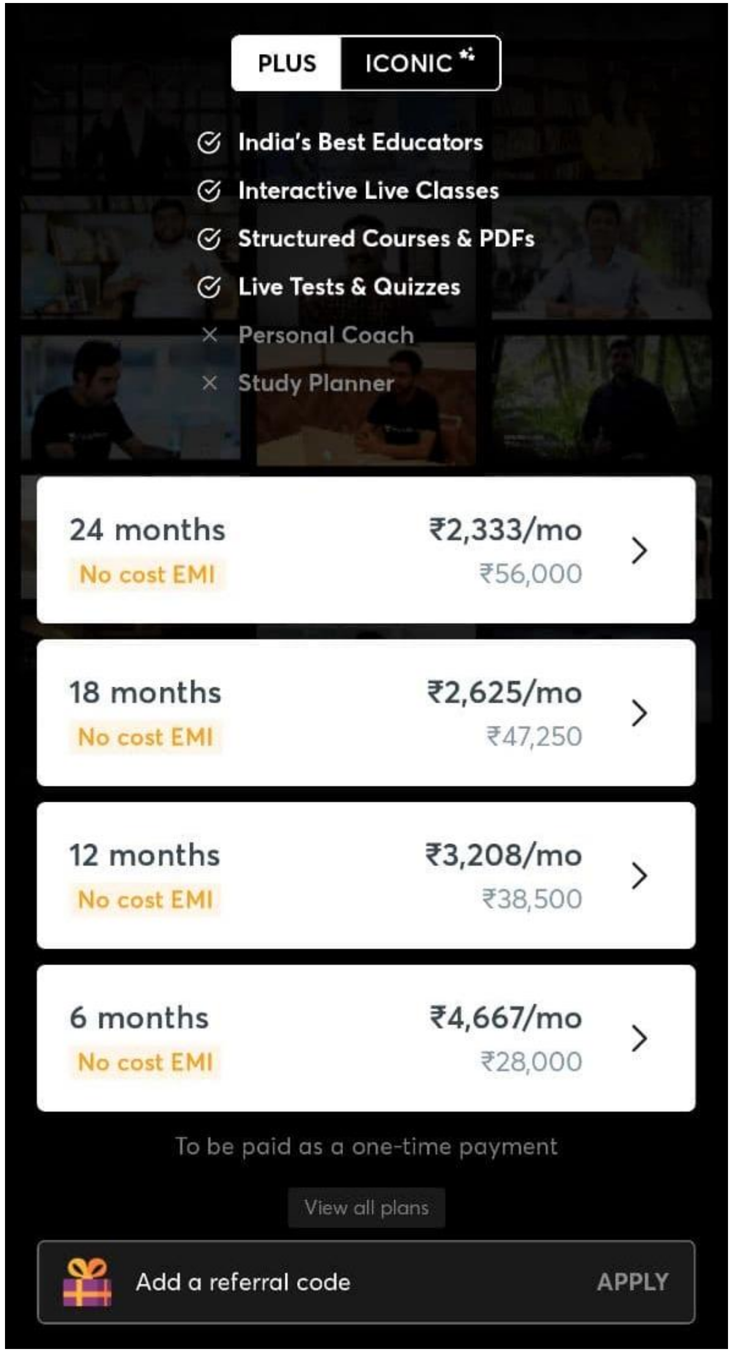
(a) In process AB, work done by system is positive.
(b) In process AB, heat is rejected.
(c) In process AB, internal energy increases.
(d) in process AB internal energy decreases and in process BC, internal energy increases.

Q 11. A given quantity of gas can be taken from a state A to a state B by two different processes. Let ΔQ and W represent the heat supplied to the gas and the work done by the gas respectively. Which of the following must be a constant for both processes?
(a) $\Delta Q + W$ (b) ΔQ
(c) W (d) $\Delta Q - W$

Q 12. A system absorbs 100 calories of heat and the system does 1675 Joule work. The internal energy of the system increases by 2515 Joule. The value of J is -
(a) 4.18 Cal/Joule (b) 420 Joule/cal
(c) 42 Joule/cal (d) 4.19 Joule/cal

Answer Key

Q.1 b	**Q.2 a**	**Q.3 c**	**Q.4 a**	**Q.5 c**
Q.6 c	**Q.7 a**	**Q.8 a**	**Q.9 c**	**Q.10 d**
Q.11 d	**Q.12 d**			



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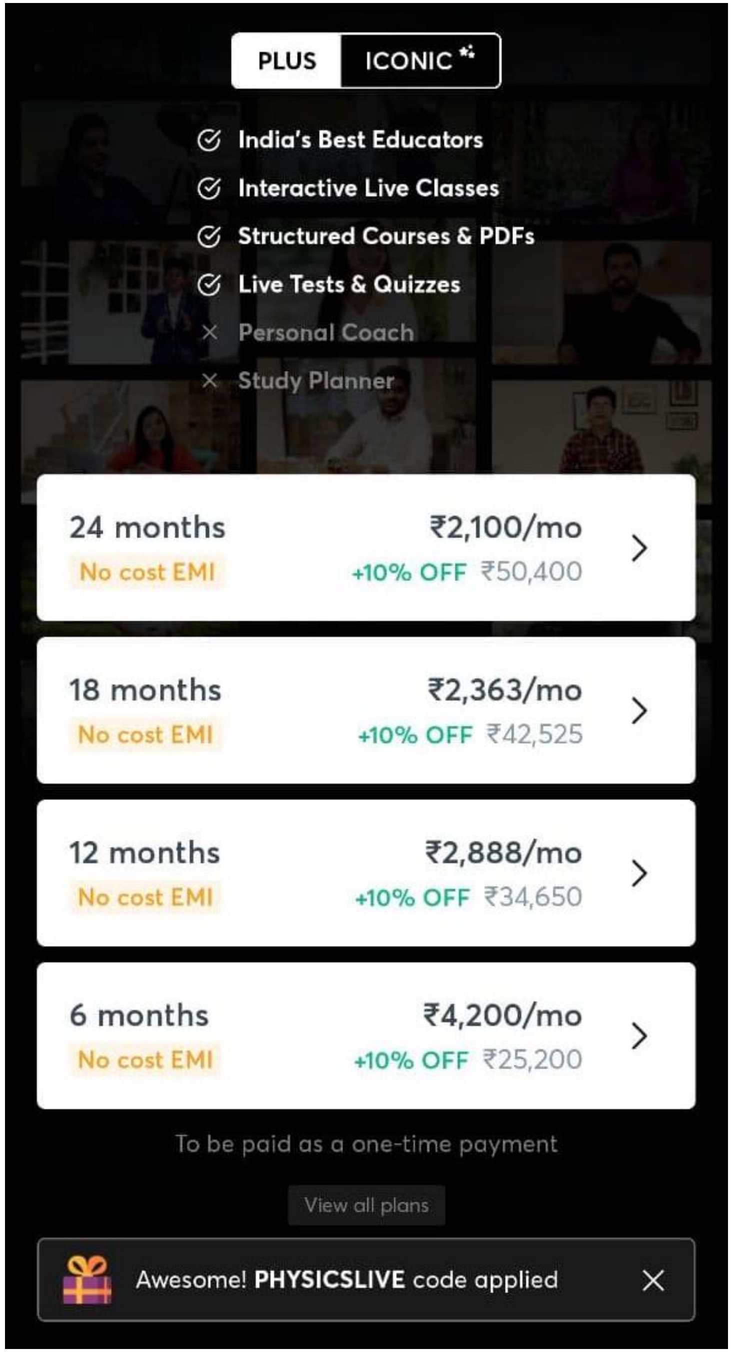


NEET & JEE Main
Physics DPP- Solution

DPP- 4 Thermodynamics- Applying FLOT in different thermodynamic processes

By Physicsaholics Team

Solution 1:

$C_p = 3.4 \times 10^3$ cal/kg °C

$C_v = 2.4 \times 10^3$ cal/kg/°C

at constant Volume

$dW = 0$

$(dQ)_V = \Delta U + (dW)_V$

$(dQ)_V = \Delta U + 0$

$\Delta U = (dQ)_V$ — (1)

Now at constant Pressure

$(dQ)_P = \Delta U + (dW)_P$

$(dW)_P = (dQ)_P - \Delta U$

$(dW)_P = (dQ)_P - (dQ)_V$

$(dW)_P = mC_p\Delta T - mC_v\Delta T$

$= m\Delta T (C_p - C_v)$

$= 1 \times 10 \times (3.4 - 2.4) \times 10^3$

$= 10 \times 1 \times 10^3$

$(dW)_P = 10^4$ cal Ans

Ans. b

Solution 2:

air is heated at constant volume

$\Delta V = 0$

$\Rightarrow dW = 0$

$\Rightarrow dQ = \Delta U + dW$ (dW → 0)

$\Delta U = dQ = n C_V \Delta T$

or

$m C_V \Delta T$

$\Delta U = (5\ gm)(0.172\ cal/gm\text{-}^\circ C)(2^\circ C)$

$= 5 \times 0.172 \times 2\ cal$

$= 10 \times 0.172\ cal$

$= 1.72\ cal$

$\boxed{\Delta U = 1.72\ cal}$

as; $1\ cal = 4.2\ J$

$\therefore \Delta U = 1.72 \times 4.2$

$\boxed{\Delta U = 7.2\ J}$ Ans.

Ans. a

Solution 3:

$dQ = \Delta U + dW$

and given; $P = 2.1 \times 10^5$ N/m² (constant)

So; For Isobaric Process

$W = P\Delta V = 2.1 \times 10^5 \times 2.5 \times 10^{-3}$

$W = 2.1 \times 2.5 \times 10^2 = 21 \times 25$

$\boxed{W = 525 \text{ J}}$

And, Heat supplied to gas $Q = 1500$ J (given)

$\therefore \Delta U = dQ - dW = 1500 - 525$

$\boxed{\Delta U = 975 \text{ J}}$ Ans.

Ans. c

Solution 4:

$$\Delta Q = 400\ Cal = 400 \times 4.2\ J = 1680\ J$$

$$W_{gas} = 1000\ J$$

$$\Delta Q = \Delta U + W_{gas}$$

$$1680 = \Delta U + 1000$$

$$\Delta U = 680\ J$$

ANS (a)

Solution 5:

$$W_{gas} = P\Delta V = 50(4-10) = -300\,J$$

$$\Delta Q = 100\,J$$

$$\Delta Q = \Delta U + W_{gas}$$

$$100 = \Delta U - 300$$

$$\Delta U = 400\,J$$

$\Rightarrow$ Internal energy increased by 400 J

Ans. c

Solution 6:

for diatomic gas $\frac{C_p}{C_v} = \gamma = 1 + \frac{2}{f} = 1 + \frac{2}{5} = \frac{7}{5}$

$\Delta Q = n C \Delta T$

$\Rightarrow Q_p = n C_p \Delta T$ & $Q_v = n C_v \Delta T$

$\Rightarrow \frac{Q_p}{Q_v} = \frac{C_p}{C_v} = \frac{7}{5}$

in any process, $\Delta U = n C_v \Delta T$

$= n C_v \Delta T = Q_v = \frac{5}{7} Q_p = .71 Q_p$

ΔU in each case is Q_v or $.71 Q_p$

Ans (c)

Solution 7:

both paths are moving from same initial state to same final state

$$\Rightarrow \quad \Delta U_{iaf} = \Delta U_{ibf}$$

$$\Rightarrow \quad \Delta Q_{iaf} - W_{iaf} = \Delta Q_{ibf} - W_{ibf}$$

$$\Rightarrow \quad 50 - 20 = 36 - W_{ibf}$$

$$\Rightarrow \quad W_{ibf} = 6 \text{ Cal}$$

Ans. a

Solution 8:

In isobaric process

$$\Delta Q = nC_p \Delta T$$

$$\Rightarrow 140 = 2\left(\frac{f+2}{2}\right)R(50-40)$$ where f is degree of freedom

$$\Rightarrow 70 = (f+2) \times 10$$

$$\Rightarrow f = 5$$

$\Rightarrow$ Diatomic gas

Ans (a)

Solution 9:

$$\Delta Q = \Delta U + W_{gas}$$

$$\Rightarrow \quad -20 = (U_f - 30) + (-8)$$

$$\Rightarrow \quad U_f = 38 - 20 = 18\ J$$

Ans (c)

Solution 10:

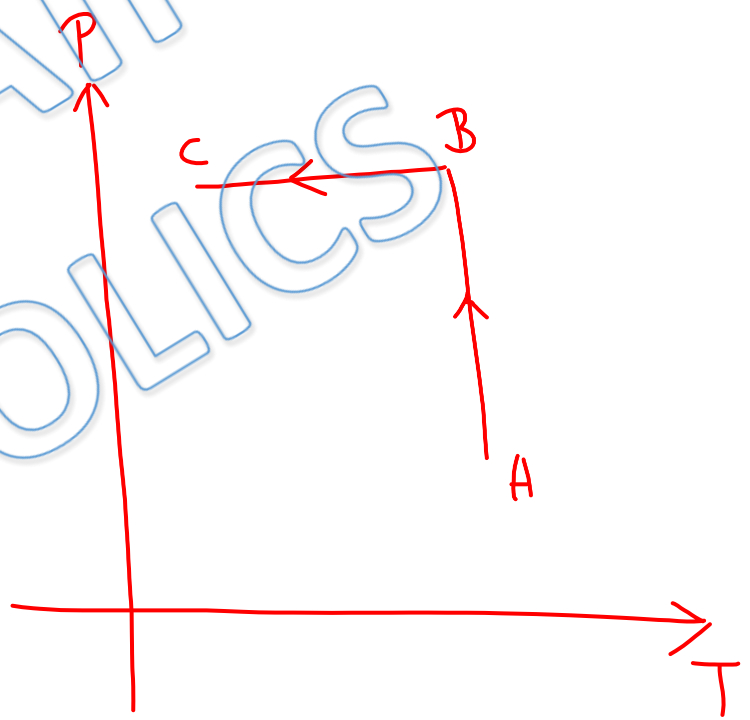
AB is isothermal Process with increasing P

$\Rightarrow$ V is decreasing $\Rightarrow W_{AB} = -ve$

Since $\Delta U = 0$ in AB

$\Delta Q_{AB} = W_{AB} = -ve$

$\Rightarrow$ Heat is rejected by gas in AB



ANS (b)

Solution 11:

both processes are from A to B

$\Rightarrow$ ΔU must be same in both

$\Rightarrow$ $\Delta Q - W$ must be same in both

Ans. d

Solution 12:

$$\Delta Q = \Delta U + W$$

$$\Rightarrow 1000\ \text{Cal} = 2515\ \text{J} + 1675\ \text{J}$$

$$\Rightarrow 1000\ \text{Cal} = 4190\ \text{J}$$

$$1\ \text{Cal} = 4.19\ \text{J}$$

$$\Rightarrow J = 4.19\ \text{J/Cal}$$

Ans (d)

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Chalo Niklo