# DPP - Daily Practice Problems

Date : ☐ Start Time : ☐ End Time : ☐

# PHYSICS

**CP10**

**SYLLABUS :** Thermodynamics

**Max. Marks : 74** **Time : 60 min.**

**GENERAL INSTRUCTIONS**

- The Daily Practice Problem Sheet contains 20 Questions divided into 5 sections.
  **Section I** has **5** MCQs with ONLY 1 Correct Option, **3** marks for each correct answer and **–1** for each incorrect answer.
  **Section II** has **4** MCQs with ONE or MORE THAN ONE Correct options.
  For each question, marks will be awarded in one of the following categories:
  Full marks: **+4** If only the bubble(s) corresponding to all the correct option(s) is (are) darkened.
  Partial marks: **+1** For darkening a bubble corresponding to each correct option provided NO INCORRECT option is darkened.
  Zero marks: If none of the bubbles is darkened.
  Negative marks: **–2** In all other cases.
  **Section III** has **4** Single Digit Integer Answer Type Questions, **3** marks for each Correct Answer and 0 marks in all other cases.
  **Section IV** has Comprehension/Matching Cum-Comprehension Type Questions having **5** MCQs with ONLY ONE correct option, **3** marks for each Correct Answer and 0 marks in all other cases.
  **Section V** has **2** Matching Type Questions, **2** mark for the correct matching of each row and 0 marks in all other cases.
- You have to evaluate your Response Grids yourself with the help of Solutions.

## Section I - Straight Objective Type

This section contains 5 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** is correct.

**1.** An ideal gas is subjected to cyclic process involving four thermodynamic states, the amounts of heat (Q) and work (W) involved in each of these states

$Q_1 = 6000$ J; $Q_2 = -5500$ J; $Q_3 = -3000$ J; $Q_4 = +3500$ J
$W_1 = 2500$ J; $W_2 = -1000$ J; $W_3 = -1200$ J; $W_4 = x$J

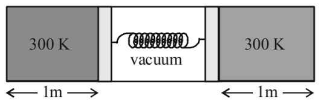
The ratio of the net work done by the gas to the total heat absorbed by the gas is $\eta$. The values of $x$ and $\eta$ respectively are

(a) 500; 7.5% (b) 700; 10.5%
(c) 1000; 21% (d) 1500; 15%

| RESPONSE GRID | 1. ⓐⓑⓒⓓ |
|---|---|

*Space for Rough Work*

2. Consider the shown diagram where the two chambers separated by piston-spring arrangement contain equal amounts of certain ideal gas. Initially when the temperatures of the gas in both the chambers are kept at 300 $K$ the compression in the spring is $1m$. The temperature of the left and the right chambers are now raised to 400 $K$ and 500 $K$ respectively. If the pistons are free to slide, the compression in the spring is about




(a) 1.3m (b) 1.5m (c) 1.1m (d) 1.0m

3. The heat ($Q$) supplied to a solid, which is otherwise thermally isolated from its surroundings, is plotted as a function of its absolute temperature, $\theta$. It is found that they are related by the equation.

$Q = a\theta^2 + b\theta^4$. ($a$, $b$ are constants).

The heat capacity of the solid is given by

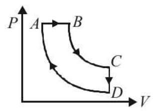
(a) $a\frac{\theta^3}{3}+b\frac{\theta^5}{5}$ (b) $a\theta + b\theta^3$

(c) $a\frac{\theta}{3}+b\frac{\theta^3}{5}$ (d) $2a\theta + 4b\theta^3$

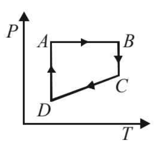
4. A Carnot engine absorbs 1000 J of heat energy from a reservoir at 127°C and rejects 600 J of heat energy during each cycle. The efficiency of engine and temperature of sink will be:

(a) 20% and – 43°C (b) 40% and – 33°C
(c) 50% and – 20°C (d) 70% and – 10°C

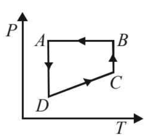
5. A cyclic process $ABCD$ is shown in the $P$-$V$ diagram. Which of the following P-T curves represent the same process?



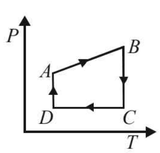

(a)



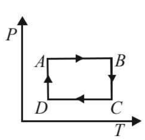

(b)




(c)




(d)




## Section II - Multiple Correct Answer Type

This section contains 4 multiple correct answer(s) type questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONE OR MORE** is/are correct.

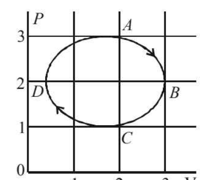
6. During an experiment, an ideal gas is found to obey a condition $\frac{P^2}{\rho}$ = constant [$\rho$ = density of the gas]. The gas is initially at temperature T, pressure P and density $\rho$. The gas expands such that density changes to $\rho/2$. Then

(a) the pressure of the gas changes to $\sqrt{2}P$
(b) the temperature of the gas changes to $\sqrt{2}T$
(c) the graph of the above process on the P-T diagram is parabola
(d) the graph of the above process on the P-T diagram is hyperbola

7. Four Carnot engines operate between reservoir temperature of (i) 300 K and 400 K (ii) 400 K and 500 K (iii) 500 K and 600 K (iv) 600 K and 800 K. Which engines has/have greatest thermal efficiency?

(a) (i) (b) (ii) (c) (iii) (d) (iv)

8. The figure shows the P-V plot of an ideal gas taken through a cycle $ABCDA$. The part $ABC$ is a semi-circle and $CDA$ is half of an ellipse. Then,




(a) the process during the path A → B is isothermal
(b) heat flows out of the gas during the path B → C → D
(c) work done during the path A → B → C is zero
(d) positive work is done by the gas in the cycle $ABCDA$

9. During the melting of a slab of ice at 273 K at atmospheric pressure,

(a) positive work is done by the ice-water system on the atmosphere
(b) positive work is done on the ice- water system by the atmosphere
(c) the internal energy of the ice-water system increases
(d) the internal energy of the ice-water system decreases

## Section III - Integer Type

This section contains 4 questions. The answer to each of the questions is a single digit integer ranging from 0 to 9.

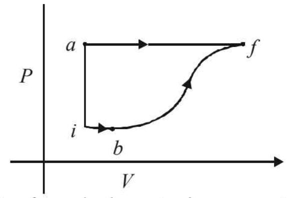
10. A metal rod AB of length $10x$ has its one end $A$ in ice at 0°C, and the other end B in water at 100 °C. If a point P on the rod is maintained at 400 °C, then it is found that equal amounts of water and ice evaporate and melt per unit time. The latent heat of evaporation of water is 540 $cal/g$ and latent heat of melting of ice is 80 $cal/g$. If the point $P$ is at a distance of $\lambda x$ from the ice end $A$, find the value $\lambda$.

[Neglect any heat loss to the surrounding.]

11. A thermodynamic system is taken from an initial state $i$ with internal energy $U_i$ = 100 J to the final state $f$ along two different paths $iaf$ and $ibf$, as schematically shown in the figure. The work done by the system along the paths $af$, $ib$ and $bf$ are $W_{af}$ = 200 J, $W_{ib}$ = 50 J and $W_{bf}$ = 100 J respectively. The heat

| RESPONSE GRID | |
|---|---|
| | 2. ⓐⓑⓒⓓ 2. ⓐⓑⓒⓓ 4. ⓐⓑⓒⓓ 4. ⓐⓑⓒⓓ 5. ⓐⓑⓒⓓ |
| | 6. ⓐⓑⓒⓓ 7. ⓐⓑⓒⓓ 8. ⓐⓑⓒⓓ 9. ⓐⓑⓒⓓ |
| | 10. ⓪①②③④⑤⑥⑦⑧⑨ 11. ⓪①②③④⑤⑥⑦⑧⑨ |

supplied to the system along the path iaf, ib and bf are $Q_{iaf}$, $Q_{ib}$ and $Q_{bf}$ respectively. If the internal energy of the system in the state b is $U_b = 200$ J and $Q_{iaf} = 500$ J, The ratio $\frac{Q_{bf}}{Q_{ib}}$ is




**12.** The amount of work done to increase the temperature of one mole of an ideal gas by 30°C is 10 x cal. Find the value of x, if it is expanding under the condition $V \propto T^{2/3}$. (R = 2 cal / mol–K)

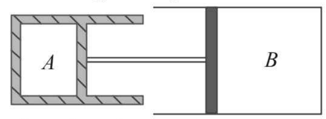
**13.** A weightless piston divides a thermally insulated cylinder into two parts of volumes $V$ and $3V$. 2 moles of an ideal gas at pressure $P = 2$ atmosphere are confined to the part with volume $V = 1$ litre. The remainder of the cylinder is evacuated. Initially the gas is at room temperature. The piston is now released and the gas expands to fill the entire space of the cylinder. The piston is then pressed back to the initial position. If the increase of internal energy in the process is $x \times 10^2$ J then find the value of $x$. The ratio of the specific heat of the gas $\gamma = 1.5$.

## Section IV - Comprehension/Matching Cum-Comprehension Type

**Directions (Qs. 14 and 15) :** Based upon the given paragraph, 2 multiple choice questions have to be answered. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** is correct.

**PARAGRAPH**

Two cylinder A and B having pistons (massless) of cross sectional area 100 $cm^2$ and 200 $cm^2$ respectively. The pistons are connected by massless rod. The pistons can move freely without friction. The cylinder $A$ contains 100 gm of an ideal gas ($\gamma = 1.5$) at pressure $10^5$ $N/m^2$ and temperature $T_0$. The cylinder B contains identical gas at same temperature $T_0$ but has different mass. The pistons are held at the state such that volume of gas in cylinder A and cylinder B are same and is equal to $10^{-2}$ $m^3$. The walls and piston of cylinder A are thermally insulated whereas gas in cylinder B is maintained at temperature $T_0$. Now the temperature $T_0$. The whole system is in vacuum. Now the piston is slowly released and it moves towards left and mechanical equilibrium is reached at the state when the volume of gas in cylinder A beocmes $25 \times 10^{-4}$ $m^3$.




**14.** The mass of gas in cylinder $B$ is
(a) 200 gm (b) 600 gm (c) 500 gm (d) 1 kg

**15.** The compressive force in the connecting rod at equilibrium is
(a) 2000 N (b) 4000 N (c) 8000 N (d) 10000 N

**Directions (Qs. 16-18) :** This passage contains a table having 3 columns and 4 rows. Based on the table, there are three questions. Each question has four options (a), (b), (c) and (d) **ONLY ONE** of these four options is correct.

First Law of Thermodynamics states that, "If certain quantity of heat dQ is added to a system a part of it is used in increasing the internal energy by dU and dW in performing external work i.e dQ = dU + dW." The following columns show (Internal energy/Work done/Heat given or taken out) in the four different thermodynamic processes. Here P = pressure, v = volume. dT = change in temperature.

| | Column I | | Column II | | Column III |
|---|---|---|---|---|---|
| I | Isothermal process | (i) | $dU = 0$ | (P) | $dQ = 0$ |
| II | Adiabatic process | (ii) | $dU = nC_v\,dT$ | (Q) | $dQ = 2.303\,nRT \log_{10} \frac{V_2}{V_1}$ |
| III | Isobaric process | (iii) | $dW = 0$ | (R) | $dQ = nC_p\,dT$ |
| IV | Isochoric process | (iv) | $dW = P(V_2 - V_1)$ | (S) | $dQ = nC_v\,dT$ |

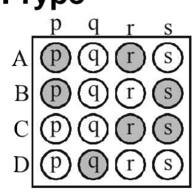
**16.** For the process volume remains constant, which of the following options is corrcet?
(a) IV (iii) S (b) I (iii) Q
(c) III (i) P (d) II (iv) P

**17.** Which of the following shows the correct match for the process pressure remains constant?
(a) III (iv) R (b) IV (iii) R
(c) I (i) R (d) III (i) S

**18.** What is the correct match for the process temperature remains constant?
(a) IV (i) R (b) I (i) Q
(c) II (ii) P (d) III (ii) S

## Section V - Matrix-Match Type

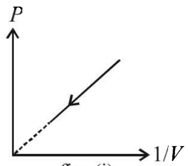
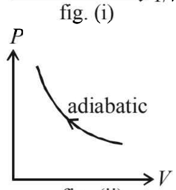
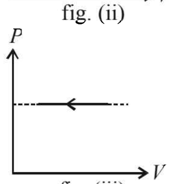
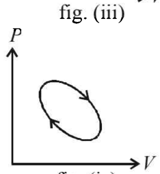
This section contains 2 questions. It contains statements given in two columns, which have to be matched. Statements in column I are labelled as A, B, C and D whereas statements in column II are labelled as p, q, r and s. The answers to these questions have to be appropriately bubbled as illustrated in the following example. If the correct matches are A-p, A-r, B-p, B-s, C-r, C-s and D-q, then the correctly bubbled matrix will look like the following:




| **RESPONSE GRID** | |
|---|---|
| 12. ⓪①②③④⑤⑥⑦⑧⑨ | 13. ⓪①②③④⑤⑥⑦⑧⑨ |
| 14. ⓐⓑⓒⓓ 15. ⓐⓑⓒⓓ 16. ⓐⓑⓒⓓ | 17. ⓐⓑⓒⓓ 18. ⓐⓑⓒⓓ |

*Space for Rough Work*

**19.** The figures given below show different processes (relating pressure $P$ and volume $V$) for a given amount for an ideal gas. $\Delta W$ is work done by the gas and $\Delta Q$ is heat absorbed by the gas.

| | **Column I** | | **Column II** |
|---|---|---|---|
| (A) |  fig. (i) | (p) | $\Delta Q > 0$ |
| (B) |  fig. (ii) | (q) | $\Delta W < 0$ |
| (C) |  fig. (iii) | (r) | $\Delta Q < 0$ |
| (D) |  fig. (iv) | (s) | $\Delta W > 0$ |

**20.** One end of a copper rod is immersed in boiling water at 100°C, the other end in ice water mixture at 0°C. The sides of the rod are insulated. During a certain time interval, 0.5 kg of ice melts. Match the following columns:

| | **Column - I** | | **Column - II** |
|---|---|---|---|
| (A) | The entropy change of the boiling water | (p) | 610 J/K |
| (B) | The entropy change of the ice-water mixture | (q) | zero |
| (C) | The entropy change of the copper rod | (r) | – 446 J/K |
| (D) | The total entropy change of the entire system | (s) | 164 J/K |

| RESPONSE GRID | |
|---|---|
| | **19.** A - ⓟⓠⓡⓢ; B - ⓟⓠⓡⓢ; C - ⓟⓠⓡⓢ; D - ⓟⓠⓡⓢ |
| | **20.** A - ⓟⓠⓡⓢ; B - ⓟⓠⓡⓢ; C - ⓟⓠⓡⓢ; D - ⓟⓠⓡⓢ |

| DAILY PRACTICE PROBLEM DPP CP10 - PHYSICS | | | |
|---|---|---|---|
| Total Questions | 20 | Total Marks | 74 |
| Attempted | | Correct | |
| Incorrect | | Net Score | |
| Cut-off Score | 24 | Qualifying Score | 35 |

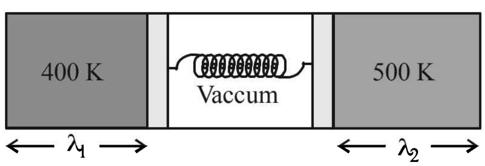
$$\text{Net Score} = \sum_{i=I}^{V}\left[\left(\text{correct}_i \times MM_i\right) - \left(In_i - NM_i\right)\right]$$

*Space for Rough Work*

# DAILY PRACTICE PROBLEMS | PHYSICS SOLUTIONS | DPP/CP10

1. **(b)**
$$Q=Q_1+Q_2+Q_3+Q_4$$
$$=6000-5500-3000+3500$$
$$=+1000\text{ J}$$
$$W=W_1+W_2+W_3+W_4$$
$$=2500-1000-1200+x$$
$$=+300+x$$
In cyclic process,
$$\Delta U=0$$
Now, $Q=\Delta U+W$
or $1000=0+(300+x)$
$\therefore$ $x=700\text{ J}$
$$\eta=\frac{W}{Q_1+Q_4}$$
$$=\frac{1000}{6000+3500}=10.5\%$$

2. **(a)** Let $l_1$ and $l_2$ be the final lengths of the two parts, then from gas equation :




$$\frac{P_0Al_0}{T_0}=\frac{PAl_1}{T_1}=\frac{PAl_2}{T_2} \qquad ...(i)$$
Considering the equilibrium of piston in initial and final states, we have
$$P_0A=kx_0 \text{ and } PA=kx$$
or $$\frac{P}{P_0}=\frac{x}{x_0} \qquad ...(ii)$$
Decrease in length of spring = total increase in the lengths of the two chambers.
$$\therefore \quad x-x_0=l_1+l_2-2l_0 \qquad ...(iii)$$
From eq. (i),
$$l_1=\frac{P_0l_0T_1}{PT_0} \text{ and } l_2=\frac{P_0l_0T_2}{PT_0}$$
Using eq. (ii),
$$l_1=\frac{x_0l_0T_1}{xT_0} \text{ and } l_2=\frac{x_0l_0T_2}{xT_0}$$
Putting these in eq. (iii)
$$x-x_0=\frac{x_0l_0}{xT_0}[T_1+T_2]-2l_0$$
Substituting the values and solving for $x$, we get
$$x\approx 1.3\,m.$$

3. **(d)** The heat capacity of the solid is
$$\frac{dQ}{d\theta}=2a\theta+4b\theta^3.$$

4. **(b)** Given : $Q_1=1000\text{ J}$
$Q_2=600\text{ J}$
$T_1=127°C=400\text{ K}$
$T_2=?$
$\eta=?$
Efficiency of carnot engine,
$$\eta=\frac{W}{Q_1}\times 100\%$$
or, $$\eta=\frac{Q_2-Q_1}{Q_1}\times 100\%$$
or, $$\eta=\frac{1000-600}{1000}\times 100\%$$
$$\eta=40\%$$
Now, for carnot cycle $\frac{Q_2}{Q_1}=\frac{T_2}{T_1}$
$$\frac{600}{1000}=\frac{T_2}{400}$$
$$T_2=\frac{600\times 400}{1000}$$
$$=240\text{ K}$$
$$=240-273$$
$$\therefore\ T_2=-33°C$$

5. **(a)** Process $AB$ is isobasic and $BC$ is isothermal, $CD$ isochoric and $DA$ isothermic compression.

6. **(b, c)** $\frac{P^2}{\rho}=k\Rightarrow\frac{P^2RT}{PM}=k\Rightarrow PT=\left(\frac{kM}{R}\right)$ ... (1)
$$\frac{P^2}{\rho}=\frac{P'^2}{\rho/2}\Rightarrow P'=\frac{P}{\sqrt{2}}$$
Hence from (1), $T'=T\sqrt{2}$.
PT = constant hence P-T curve is a parabola.

7. **(a, d)** $\eta_1=1-\frac{300}{400}=\frac{1}{4}$; $\eta_2=1-\frac{400}{500}=\frac{1}{5}$
$\eta_3=1-\frac{500}{600}=\frac{1}{6}$; $\eta_4=1-\frac{600}{800}=\frac{1}{4}$

8. **(b, d)** Process is not isothermal {for option (a)}.

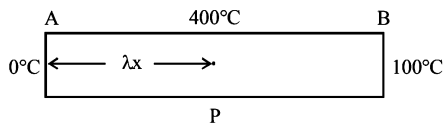
(b) Volume decreases and temperature decreases $\Delta U$ = negative,
So, $\Delta Q$ = negative

(c) Work done in process A $\rightarrow$ B $\rightarrow$ C is positve

(d) Cycle is clockwise, so work done by the gas is positive

**9.** **(b, c)** There is a decrease in volume during melting of an ice slab at 273 K. Therefore, negative work is done by ice-water system on the atmosphere or positive work is done on the ice-water system by the atmosphere. Hence, option (b) is correct.
Secondly heat is absorbed during melting (i.e. $dQ$ is positive) and as we have seen, work done by ice-water system is negative ($dW$ is negative.) Therefore, from first law of thermodynamics
$dU = dQ - dW$
change in internal energy of ice-water system, $dU$ will be positive or internal energy will increase.

**10.** **9**




**For heat flow from P to 0**

$$L_f \frac{dm_1}{dt} = \frac{KA\,400}{\lambda x} \quad .....(i)$$

**For heat flow from P to B**

$$L_{vap} \frac{dm_2}{dt} = \frac{KA\,300}{10x - \lambda x} \quad .....(ii) \left[\text{Given } \frac{dm_1}{dt} = \frac{dm_2}{dt}\right]$$

On solving (i) and (ii), we get $\lambda = 9$

**11.** **2** Applying first law of thermodynamics to path iaf

$$Q_{iaf} = \Delta U_{iaf} + W_{iaf}$$
$$500 = \Delta U_{iaf} + 200 \qquad \therefore \Delta U_{iaf} = 300\text{ J}$$

Now,

$$Q_{ibf} = \Delta U_{ibf} + W_{ib} + W_{bf}$$
$$= 300 + 50 + 100$$
$$Q_{ib} + Q_{bf} = 450\text{ J} \qquad ...(1)$$

Also $Q_{ib} = \Delta U_{ib} + W_{ib}$

$\therefore Q_{ib} = 100 + 50 = 150$ J ...(2)

From (1) & (2) $\dfrac{Q_{bf}}{Q_{ib}} = \dfrac{300}{150} = 2$

**12.** **4** Given, $V = kT^{2/3}$

$$\therefore \quad dV = k \times \frac{2}{3} T^{-1/3} dT = \frac{2}{3} k T^{-1/3} dT$$

Work done $dW = PdV$

$$= \frac{RT}{V} dV$$

$$= \frac{RT}{kT^{2/3}} \times \frac{2}{3} k T^{-1/3} dT = \frac{2}{3} R(dT)$$

Total work done $W = \dfrac{2}{3} R \int_{T_1}^{T_2} dT$

$$= \frac{2}{3} R [T_2 - T_1]$$
$$= 2/3 \times 2 \times 30 = 40\text{ cal}$$

**13.** **4**
If $P_1$ be the pressure after expansion, then

$$PV = P_1 (3V + V)$$
$$\therefore \quad P_1 = \frac{P}{4}.$$

For the adiabatic compression, let $P_2$ be the final pressure, then

$$P_1 (4V)^\gamma = P_2 V$$
$$\therefore \quad P_2 = P_1 (4)^{1.5}$$
$$= 8 P_1$$

The change in internal energy,

$$\Delta U = nC_V \Delta T$$
$$= n \frac{R}{\gamma - 1} [T_2 - T_1]$$
$$= \frac{P_2 V_2 - P_1 V_1}{\gamma - 1} = 400\text{ J.}$$

**For (Q.14-15):**

$m_A = 100$ gm ; $V_A = V_B = 10^{-2}\,\text{m}^3$
$P_A = 10^5\,\text{N/m}^2$.

**In cylinder $A$**, the process is adiabatic, so

$$P_1 V_1^\gamma = P_2 V_2^\gamma$$
$$10^5 (10^{-2})^{1.5} = P_2 (25 \times 10^{-4})^{1.5}$$
$$\therefore \quad P_2 = 8 \times 10^5$$

**14.** **(d)** For cylinder B,

$$P_f = \frac{F}{A_2} = \frac{8000}{200 \times 10^{-4}}$$
$$= 4 \times 10^5\,\text{N/m}^2$$
$$W_B = fx = W_A$$

or $8000x = 2000 \Rightarrow x = 0.25$m

$$\Delta V_B = Ax = 200 \times 10^{-4} \times 0.25$$
$$= 50 \times 10^{-4}\,\text{m}^3$$
$$\therefore \quad V_f = 10^{-2} + 50 \times 10^{-4} = 250 \times 10^{-4}\,\text{m}^3$$

For cylinder A,

$$10^5 \times 10^{-2} = \frac{100}{M} RT_0 \qquad ...(i)$$

For cylinder B,

$$\left(4 \times 10^5\right) \times \left(250 \times 10^{-4}\right) = \frac{m_B}{M} RT_0 \qquad ...(ii)$$

After solving above equations, we get

$$m_B = 1000\text{ gm.}$$

**15.** **(c)** So at equilibrium, the force on the connecting rod

$$F = P_2 A_2 = 8 \times 10^5 \times 1000 \times 10^{-4}$$
$$= 8000\text{N}$$

**16.** **(a)** For an Isochoric process, volume remains constant and hence, $dW = PdV = 0$, $dU = dQ = nC_v dT$

**17.** **(a)** For an Isobaric process, pressure remains constant and hence, $dW = P(V_2 - V_1)$, $dQ = nC_p dT$

**18.** **(b)** For an Isothermal process, temperature remians constant. As internal energy depends only on temperature $dU = 0 \Rightarrow dQ = dW = \int_{V_1}^{V_2} Pdv$

$$\Rightarrow dQ = nRT \log_e \frac{V_2}{V_1} = 2.303\, nRT \log_{10} \frac{V_2}{V_1}$$

**19. (A)→p, s; (B)→q; (C)→q, r; (D)→p,s**

(A) $PV = nRT$

$$P = (nRT)\frac{1}{V} = (\text{constant})\frac{1}{V}$$

$T$ = constant i.e. isothermal process

$\because$ $V$ increases, $\Delta W$ is positive.

$\Delta Q = \Delta U + \Delta W > 0$

(B) $\Delta Q = 0$

$pdV = \Delta W =$ negative

(C) $PV = nRT$

As volume decreases. $T$ also decreases i.e., $\Delta U > 0$

$PdV = \Delta W < 0$ so $\Delta Q < 0$

(D) For cyclic process $\Delta U = 0$

$\Delta W > 0$ (clockwise), $\Delta Q > 0$

**20. (A)→r; (B)→ p; (C)→q; (D)→s**

**(A)→ r**

$$\Delta S = \frac{\Delta Q}{T} = \frac{-mL}{T}$$

$$= \frac{-0.5 \times 4200 \times 80}{373}$$

$$\simeq -446 \text{ J/K}$$

**(B)→ p**

$$\Delta S = \frac{\Delta Q}{T} = \frac{-mL}{T}$$

$$= \frac{-0.5 \times 4200 \times 80}{273} \simeq 610 \text{ J/K}$$

**(C)→ q** As the sides of the rod are insulated, so

$$\Delta S = \frac{\Delta Q}{T} = 0.$$

**(D)→ s** The total change in entropy

$$\Delta S = 610 - 446 = 164 \text{ J/K}$$