DPP - Daily Practice Problems

Date : **Start Time :** **End Time :**

CHEMISTRY

CC06

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 **5** 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 **1** 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. The $\Delta_f H^\circ$ for $CO_2(g)$, $CO(g)$ and $H_2O(g)$ are –393.5, –110.5 and –241.8 kJ/mol respectively, the standard enthalpy change (in kJ) for the reaction

$$CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g) \text{ is :}$$

(a) 524.1 (b) 41.2 (c) –262.5 (d) –41.2

2. The heats of atomization of $PH_3(g)$ and $P_2H_4(g)$ are 954 kJ mol^{-1} and 1485 kJ mol^{-1} respectively. The P–P bond energy in kJ mol^{-1} is

(a) 213 (b) 426 (c) 318 (d) 1272

3. 2 mole of an ideal gas at 27°C temperature is expanded reversibly from 2L to 20L. Find the entropy change (R = 2 cal/mol K)

(a) 92.1 (b) 0 (c) 4 (d) 9.2

4. The molar heat capacity (C_p) of CD_2O is 10 cals at 1000 K. The change in entropy associated with cooling of 32 g of CD_2O vapour from 1000 K to 100 K at constant pressure will be: (D = deuterium, atomic mass = 2 u)

(a) 23.03 cal deg^{-1} (b) – 23.03 cal deg^{-1}
(c) 2.303 cal deg^{-1} (d) – 2.303 cal deg^{-1}

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ

Space for Rough Work

5. Given :

(I) $H_2(g)+\frac{1}{2}O_2(g) \rightarrow H_2O(l);$

$\Delta H°_{298K} = -285.9 \text{ kJ mol}^{-1}$

(II) $H_2(g)+\frac{1}{2}O_2(g) \rightarrow H_2O(g);$

$\Delta H°_{298K} = -241.8 \text{ kJ mol}^{-1}$

The molar enthalpy of vapourisation of water will be :

(a) 241.8 kJ mol^{-1} (b) 22.0 kJ mol^{-1}

(c) 44.1 kJ mol^{-1} (d) 527.7 kJ mol^{-1}

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. The value of enthalpy change (ΔH) for the reaction

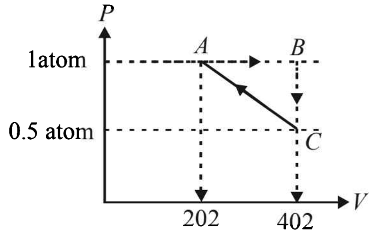
$$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$$

at 27° C is – 1366.5 kJ mol^{-1}. The value of internal energy change for the above reaction at this temperature will be :

(a) – 1369.0 kJ (b) – 1364.0 kJ

(c) – 1361.5 kJ (d) – 1371.5 kJ

7. On the basis of the following graph (P–V graph), choose the correct statements.



(a) The entropy change for the over all process is zero.

(b) For the over all process $\Delta H > \Delta E$.

(c) Total work done, $W = q$

(d) Total work = – 620.77 J

8. Which of the following are correct for an isothermal reversible expansion of an ideal gas

(a) $\Delta E = 0$ (b) $\Delta H = 0$

(c) $W = nRT ln \frac{P_1}{P_2}$ (d) $W = -q$

9. Enthapy of atomization of $C_2H_6(g)$ and $C_3H_8(g)$ are 620 and 880 $kJmol^{-1}$ respectively. The C – C and C – H bond energies are respectively

(a) 80 and 60 $kJmol^{-1}$ (b) 80 and 90 $kJmol^{-1}$

(c) 70 and 90 $kJmol^{-1}$ (d) 100 and 80 $kJmol^{-1}$

Section III - Integer Type

This section contains 5 questions. The answer to each of the questions is a single digit integer ranging from 0 to 9.

10. $\Delta_f H^{\ominus}$ of hypothetical MgCl is – 125 kJ mol^{-1} and for $MgCl_2$ is –642 kJ mol^{-1}. The enthalpy of disproportionation of MgCl is –49x. Find the value of x.

11. The lattice energy of solid KCl is 181 kcal mol^{-1} and the enthalpy of solution of KCl in H_2O is 1.0 kcal mol^{-1}. If the hydration enthalpies of K^+ and Cl^- ions are in the ratio of 2 : 1 then the enthalpy of hydration of K^+ is –20x k cal mol^{-1}. Find the value of x.

12. A heated iron block at 127°C loses 300 J of heat to the surroundings which are at a temperature of 27°. This process is 0.05x JK^{-1}. Find the value of x.

13. An intimate mixture of ferric oxide, Fe_2O_3, and aluminium, Al, is used in solid fuel rockets. Calculate the fuel value per gram and fuel value per cc of the mixture. Heats of formation and densities are as follows :

$H_f(Al_2O_3) = 399$ kcal/mol;

$H_f(Fe_2O_3) = 199$ kcal/mol;

Density of Fe_2O_3 = 5.2 g/cc;

Density of Al = 2.7 g/cc.

14. An insulated container contains 1 mole of a liquid, molar volume 100 mL, at 1 bar. When liquid is steeply pressed to 100 bar, volume decreases to 99 mL. Find the value of $\frac{\Delta H + \Delta U}{1000} - 2$.

RESPONSE GRID	
	5. ⓐⓑⓒⓓ 6. ⓐⓑⓒⓓ 7. ⓐⓑⓒⓓ 8. ⓐⓑⓒⓓ 9. ⓐⓑⓒⓓ
	10. ⓪①②③④⑤⑥⑦⑧⑨ 11. ⓪①②③④⑤⑥⑦⑧⑨
	12. ⓪①②③④⑤⑥⑦⑧⑨ 13. ⓪①②③④⑤⑥⑦⑧⑨
	14. ⓪①②③④⑤⑥⑦⑧⑨

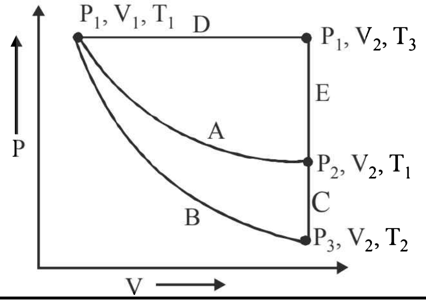
Space for Rough Work

Section IV - Comprehension Type

Directions (Qs. 15-19) : Based upon the given paragraphs, 5 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-1

For an ideal gas, four different paths A, D (B + C) and D + E, from an initial state P_1, V_1, T_1 to a final state P_2, V_2, T_1 is shown in the given figure.



	Column I **Path**		**Column II** **Path presentation**		**Column III** $q_{reversible}$
(I)	A	(i)	Reversible adiabatic expansion followed by reversible heating at constant volume	(P)	Zero
(II)	B + C	(ii)	Reversible expansion at constant pressure followed by a reversible cooling at constant volume	(Q)	$P_1(V_2 - V_1)$
(III)	D + E	(iii)	Reversible expansion at constant pressure	(R)	$-nRT_1, \ln\frac{V_2}{V_1}$
(IV)	D	(iv)	Reversible isothermal expansion	(S)	$-nR, \ln\frac{V_2}{V_1}$

15. Find combination, which represents the q_{rev}, for path (a)

(a) (I) (iii) (S) (b) (I) (iv) (R)

(c) (I) (i) (Q) (d) (I) (ii) (P)

16. q_{rev}, for path (B + C) represented by

(a) (II) (ii) (R) (b) (II) (iv) (S)

(c) (IV) (i) (Q) (d) (II) (i) (S)

17. What is q_{rev}, for path (D + E) ?

(a) (IV) (iii) (S) (b) (III) (i) (P)

(c) (III) (ii) (Q) (d) (III) (iv) (R)

PARAGRAPH-2

Entropy changes for ideal gas are as follows:

(i) Entropy change is terms of temperature and volume is given by

RESPONSE GRID	**15.** ⓐⓑⓒⓓ **16.** ⓐⓑⓒⓓ **17.** ⓐⓑⓒⓓ

$$\Delta S = nC_v ln\frac{T_2}{T_1} + nR\,ln\frac{V_2}{V_1}$$

It is for n moles of an ideal gas from V_1 to V_2 when temperature changes from T_1 to T_2. C_v is the heat capacity at constant volume.

(ii) Entropy change in terms of temperature and pressure:

$$\Delta S = nC_p\,ln\frac{T_2}{T_1} + nRln\frac{P_2}{P_1} \quad \text{(For } n \text{ moles of gas)}$$

C_p is the molar heat capacity at constant pressure.

18. The entropy change for expansion of 14 g of nitrogen when heated from 27°C to 127°C at constant volume and constant pressure will be (in cal/degree) respectively.
(Given, $C_v = 4.94$ cal/mol in this temperature range)

(a) 0.70, 0.99 (b) 0.99, 0.70
(c) 0.50, 0.70 (d) 0.70, 0.50

19. When two moles of an ideal gas $\left(C_{p,m} = \frac{5}{2}R\right)$ is heated from 300K to 600K at constant pressure, the value of ΔS is

(a) $\frac{3}{2}$Rln2 (b) $-\frac{3}{2}$Rln2
(c) 5 Rln2 (d) $\frac{5}{2}$Rln2

Section V - Matrix-Match Type

This section contains 1 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:

	p	q	r	s
A	●	ⓠ	●	ⓢ
B	●	ⓠ	ⓡ	●
C	ⓟ	ⓠ	●	●
D	ⓟ	●	ⓡ	ⓢ

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20. Match the following :

	Column I		**Column II**
(A)	$\Delta S_{Total} = 0$	p.	Adiabatic
(B)	$\Delta S_{System} = R\,ln\,\frac{V_2}{V_1}$	q.	Reversible Process
(C)	$\mu_{J.T.} = 0$	r.	Perfect gas
(D)	PV^{γ} = a constant	s.	Isothermal process

RESPONSE GRID	**18.** ⓐⓑⓒⓓ **19.** ⓐⓑⓒⓓ **20. A -** ⓟⓠⓡⓢ; **B -** ⓟⓠⓡⓢ; **C -** ⓟⓠⓡⓢ; **D -** ⓟⓠⓡⓢ

DAILY PRACTICE PROBLEM DPP CHAPTERWISE 6 - CHEMISTRY			
Total Questions	20	Total Marks	74
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	24	Qualifying Score	35
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

CHEMISTRY SOLUTIONS

DPP/CC06

1. **(b)** $\Delta H = \Sigma\left[\Delta H_f^\circ \text{ products}\right] - \Sigma\left[\Delta H_f^\circ \text{ reactants}\right]$

$$\Delta H^\circ = [\Delta H_f^\circ(CO)(g) + \Delta H_f^\circ(H_2O)(g)] -$$

$$[\Delta H_f^\circ(CO_2)(g) + \Delta H_f^\circ(H_2)(g)]$$

$$= [-110.5 + (-241.8)] - [-393.5 + 0] = 41.2$$

2. **(a)** In $PH_3(g)$, energy required to break 3 P–H bonds $= 954 \text{ kJ mol}^{-1}$

$\therefore$ Energy required to break 1 P – H bond

$$= \frac{954}{3} = 318 \text{ kJ mol}^{-1}$$

In $P_2H_4(g)$, energy of 1 P – P bond + 4 P – H bonds $= 1485 \text{ kJ mol}^{-1}$

$\because$ Energy of 1 P – H bond $= 318 \text{ kJ mol}^{-1}$

$\therefore$ Energy of 4 P – H bond $= 318 \times 4$

$= 1272 \text{ kJ mol}^{-1}$

Thus, the P – P bond energy $= 1485 - 1272$

$= 213 \text{ kJ mol}^{-1}$

3. **(d)** For isothermal reversible expansion

$$w = q = nRT \times 2.303 \log\frac{V_2}{V_1}$$

$$= 2RT \times 2.303 \log\frac{20}{2}$$

$$= 2 \times 2 \times T \times 2.303 \times 1 = 9.2\,T$$

Entropy change, $\Delta S = \frac{q}{T} = \frac{9.2T}{T} = 9.2$ cal.

4. **(b)** Given, $C_p = 10$ cals at 1000 K

$T_1 = 1000$ K. $T_2 = 100$ K

$m = 32$ g

$\Delta S = ?$

at constant pressure

$$\Delta S = C_p \ln\frac{T_2}{T_1}$$

$$= 2.303 \times C_p \log\frac{T_2}{T_1}$$

$$= 2.303 \times 10 \log\frac{100}{1000}$$

$$= -23.03 \text{ cal deg}^{-1}$$

5. **(c)** Given

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$;

$\Delta H^\circ = -285.9 \text{ kJ mol}^{-1}$ ...(1)

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(g)$;

$\Delta H^\circ = -241.8 \text{ kJ mol}^{-1}$ ...(2)

We have to calculate

$H_2O(l) \longrightarrow H_2O(g)$; $\Delta H^\circ = ?$

On substracting eqn. (2) from eqn. (1) we get

$H_2O(l) \longrightarrow H_2O(g)$;

$\Delta H^\circ = -241.8 - (-285.9)$

$= 44.1 \text{ kJ mol}^{-1}$

6. **(b)** $C_2H_5OH(l) + 3O_2(g)$

$\rightarrow 2CO_2(g) + 3H_2O(l)$

$$\Delta n_g = 2 - 3 = -1$$

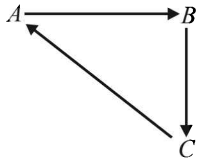
$$\Delta U = \Delta H - \Delta n_g RT$$

$$= -1366.5 - (-1)RT$$

$$= -1366.5 - (1) \times \frac{8.314}{10^3} \times 300$$

$$= -1366.5 + 0.8314 \times 3 = -1364 \text{ kJ}$$

7. **(a, d)** The over all process can be depicted as



Thus it is a cyclic process.

Hence, $\Delta E = 0$, $\Delta H = 0$, $\Delta S = 0$ (cyclic process)

and $\Delta E = q + W$ (Ist law)

$\therefore \quad 0 = q + W$

or $\quad q = -W$

Total work done $= W_{A\rightarrow B} + W_{B\rightarrow C} + W_{C\rightarrow A}$

$$\therefore \quad W = -P(V_B - V_A) + 0 + 2.303\, nRT \log\frac{V_C}{V_A}$$

$$= -(40 - 20) + 0 + 2.303 \times 1 \times 0.082 \times \log\frac{V_C}{V_A}$$

$= -6.13$ litre-atmosphere

$= -620.77$ J

8. **(a, b, d)** For such a process,

$$W = -nRT\ln\frac{P_1}{P_2}$$

9. **(b)** $C_2H_6(g) \longrightarrow 2C(g) + 6H(g)$

$$\Delta H_{C-C} + 6\Delta H_{C-H} = 620 \text{ kJ mol}^{-1}$$

$C_3H_8(g) \longrightarrow 3C(g) + 8H(g)$;

$$2\Delta H_{C-C} + 8\Delta H_{C-H} = 880\,\text{kJ mol}^{-1}$$

Hence, $\Delta H_{C-C} = 80$ kJ mol^{-1};

$$\Delta H_{C-H} = 90 \text{ kJ mol}^{-1}$$

10. (8) $2MgCl \rightarrow Mg + MgCl_2 \qquad \Delta H = ?$

$Mg(s) + 1/2Cl_2(g) \rightarrow MgCl \quad \Delta H_1 = -125 \text{ kJ mol}^{-1}$

$Mg(s) + Cl_2(g) \rightarrow MgCl_2 \quad \Delta H_2 = -642 \text{ kJ mol}^{-1}$

$\Delta H = \Delta H_2 - 2\Delta H_1 = -642 - (2 \times -125) = -392 \text{ kJ mol}^{-1}$

$\therefore -49x = -392$

$x = 8$

11. (6) $KCl(s) \longrightarrow K^+(g) + Cl^-(g), \Delta H_1 = 181 \text{ kcal mol}^{-1}$

$KCl(s) + H_2O(l) \longrightarrow K^+(aq) + Cl^-(aq),$

$$\Delta H_2 = 1.0 \text{ kcal mol}^{-1}$$

Let the enthalpy of hydration of K^+ is 2a kcal mol^{-1}

$K^+(g) + H_2O(l) \longrightarrow K^+(aq), \Delta H_3 = 2a$

$Cl^-(g) + H_2O(l) \longrightarrow Cl^-(aq), \qquad \Delta H_4 = a$

$\therefore \Delta H_3 = -\Delta H_1 + \Delta H_2 - \Delta H_4$

$2a = -181 + 1 - a$

$3a = -180, a = -60$

$\therefore \Delta_{hyd}H^-$ of $K^+ = 2a = -60 \times 2 = -120$

$\therefore -20x = -120$

$x = 6$

12. (5) $\therefore \Delta_{sys}S = \dfrac{q_{sys}}{T_{sys}} = -\dfrac{300}{273+127}$

$$= \frac{-300}{400} = \frac{-3}{4}\text{JK}^{-1}$$

$$\Delta_{surr}S = \frac{-q_{sys}}{T_{surr}} = -\frac{300}{273+27}$$

$$= \frac{300}{300} = +1 \text{ JK}^{-1}$$

$\Delta_{total}S$ or $\Delta_{universe}S = \Delta_{sys}S + \Delta_{surr}S$

$$= \frac{-3}{4} + 1 = \frac{1}{4} = 0.25\text{J K}^{-1}$$

$\therefore 0.05x = 0.25$

$x = 5$

13. (4) $Fe_2O_3 \quad + \quad 2Al \quad \rightarrow 2Fe \; + \; Al_2O_3$

$2 \times 56 + 48 = 160 \quad 2 \times 27 = 54$

Heat of reaction = 399 – 199 = 200 kcal [Al and Fe are in their standard states]

Total weight of reactants = 160 + 54 = 214 g

$\therefore$ Fuel value/gram $= \dfrac{200}{214} = 0.9346$ kcal/g

Volume of Al $= \dfrac{54}{2.7} = 20$ cc

Volume of $Fe_2O_3 = \dfrac{160}{5.2} = 30.77$ cc

Total volume = 20 + 30.77 = 50.77 cc

$\therefore$ Fuel value per cc $= \dfrac{200}{50.77} = 3.94 \simeq 4$ kcal/cc

14. (8) For adiabatic process, $W = P(V_2 - V_1)$

Here $P_1 = 1$ bar, $P_2 = 100$ bar, $V_1 = 100$ mL, $V_2 = 99$ mL;

For adiabatic process, $q = 0 \; \backslash \; \Delta U = w$

$\Delta U = q + W$

$= q - P(V_2 - V_1)$ since $W = -P(V_2 - V_1)$

$= 0 - 100(99 - 100) = 100$ bar mL

$\Delta H = \Delta U + \Delta(PV) = \Delta U + (P_2V_2 - P_1V_1)$

$= 100 + [(100 \times 99) - (1 \times 100)]$

$= 100 + (9900 - 100) = 9900$ bar mL

$\Delta U + \Delta H = 100 + 9900 = 10000$

$\therefore$ the value of $\dfrac{\Delta U + \Delta H}{1000} - 2 = \dfrac{10000}{1000} - 2 = 8$

15. (b) Path A - reversible isothermal expansion.

According to first law of thermodynamics

$$\Delta U = q - w$$

$$q = w$$

Isothermal process $\Delta U = 0$

$$= \left(nRT_1, \ln\frac{V_2}{V_1}\right)$$

16. (d) Path B + C - reversible adiabatic expansion followed by reversible heating at constant volume q = 0

$$\Delta S = \frac{q_{rev}}{T},\; q_{rev} = T\,\Delta S$$

$$\therefore \quad q_{rev} = nR\ln\frac{V_2}{V_1}$$

17. (c) D + E - Reversible expansion at constant pressure followed by a reversible cooling at constant volume.

$$w = q = P_1(V_2 - V_1)$$

18. (a) At constant volume,

$$\Delta S = nC_v ln\frac{T_2}{T_1}$$

Given n = 14 g of nitrogen

$$= \frac{14}{28}\text{mole or } 0.5 \text{ mole}$$

$$\therefore \quad \Delta S = 0.5 \times 4.94 \times 2.303 \log\frac{400}{300}$$

$$\left[ln\frac{T_2}{T_1} = 2.303\log\frac{T_2}{T_1}\right]$$

$= 0.70\ \text{cal K}^{-1}$

At constant pressure

$$\Delta S = nC_p ln\frac{T_2}{T_1}$$

Since $C_p = C_v + R$

$\therefore\quad C_p = 4.94 + 2.0 = 6.94$ cal/mole

$$\therefore\quad \Delta S = \frac{1}{2}\times 6.94\times 2.303\ \log\frac{400}{300}\ [\because\ n = \frac{1}{2}]$$

$= 0.99\ \text{cal K}^{-1}$

19. **(c)** Using the relation, $\Delta S = nC_p \ln\frac{T_2}{T_1}$

We get,

$$\Delta S = 2\times\frac{5}{2}Rln\frac{600}{300} = 5\,Rln2$$

20. **A-q; B-q, r, s; C-r; D-p, q, r**

(A) For a reversible process, $\Delta S_{\text{system}} = -\ \Delta S_{\text{surr}}$.

or $\Delta S_{\text{system}} + \Delta S_{\text{surr}} = \Delta S_{\text{Total}} = 0$

(B) From first law, $dE = \delta q_{\text{rev}} + W = \delta q_{\text{rev}} - PdV$

$\delta q_{\text{rev}} = TdS = dE + PdV = CvdT + PdV$

$$dS = C_v\frac{dT}{T} + \frac{PdV}{T} = C_v\frac{dT}{T} + R\frac{dV}{V} = R\frac{dV}{V}$$

($dT = 0$ for isothermal process)

$$dS = \int_1^2 R\frac{dV}{T}$$

Integrating $\int_1^2 dS = S_2 - S_1 = \Delta S = \int_1^2 R\frac{dV}{V} = R\ln\frac{V_2}{V_1}$

(C) In perfect gas intermolecular forces do not exit.

Hence, $\left(\frac{dP}{dT}\right)_H = \mu_{\text{J.T.}} = 0$

(D) For adiabatic and reversible process,

$$\delta q_{\text{rev}} = 0 = dE + PdV = CvdT + RT\frac{dV}{V}$$

(for ideal gas)

$$\frac{dT}{T} = -\frac{R}{C_v}\times\frac{dV}{V} = -\frac{Cp - C_v}{C_v}\times\frac{dV}{V} = -(\gamma - 1)\frac{dV}{V}$$

Integrating, $\int_1^2 \frac{dT}{T} = \ln\frac{T_2}{T_1}$

$$= -\int_1^2 (\gamma - 1)\frac{dV}{V} = -(\gamma - 1)\ln\frac{V_2}{V_1} = (\gamma - 1)\ln\frac{V_1}{V_2}$$

$$= \ln\left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$ for ideal gas $\frac{T_2}{T_1} = \frac{P_2V_2}{P_1V_1}$

Hence, $\frac{P_2V_2}{P_1V_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$ $P_1V_1^{\gamma} = P_2V_2^{\gamma} =$ a constant