



Essential Pre-Uni Chemistry C1.2

A Level



Use the ideal gas equation of state to answer the following questions. In SI units, the equation is $pV = nRT$, where $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$.

Part A Pressure of the gas at 85 cm^3

50 cm^3 of gas at a pressure of 2.5 atm is allowed to expand slowly at constant temperature until it fills a volume of 85 cm^3 . Calculate the new pressure of the gas.

Part B Volume of gas.

20 dm^3 of gas at a pressure of 750 torr is compressed slowly at constant temperature until the pressure reaches $3.0 \times 10^5 \text{ torr}$. Calculate the volume now occupied by the gas.

Part C New pressure inside.

A sealed, rigid container of air at 1.0 atm pressure falls in temperature from 296 K to 270 K . Find the new pressure inside the container.

Part D New temperature in $^{\circ}\text{C}$.

If the temperature of a gas measured in kelvin is doubled and the gas is initially at 17°C , give its new temperature in $^{\circ}\text{C}$.

Part E **Temperature to explode.**

A canister of gas will explode once the pressure exceeds 40 atm. If the pressure inside is 8.0 atm at 20 °C, find the temperature at which the canister will explode.

Part F **Find the new volume.**

A sac of gas freely changes its volume to keep its internal pressure equal to atmospheric pressure. If the sac has a volume of 1.2 m³ at −10 °C and then warms up to 17 °C with no change in pressure, find its new volume.



Essential Pre-Uni Chemistry C1.4



Use the ideal gas equation of state to answer the following questions. In SI units, the equation is $pV = nRT$, where $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$.

A gas cylinder is being filled with argon gas. The gas cylinder has a volume of 24 dm^3 and holds 1 mol of gas at room temperature and pressure.

Part A Amount of gas

Calculate the amount of gas (in moles) which must be added to raise the pressure in the cylinder from 1 atm to 250 atm. Assume that the volume is constant. Give your answer to 3 significant figures.

Part B New pressure

If the gas cylinder in Part A contains a pressure of 250 atm at 20°C , and is caught in a fire, so that its temperature is raised to 350°C , calculate the new pressure inside the cylinder. Give your answer to 3 significant figures.



Essential Pre-Uni Chemistry C1.7

A Level



Use the ideal gas equation of state to answer this question. In SI units, the equation is $pV = nRT$, where $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$.

When 2.0 moles of a gas mixture at 1 atm and 296 K is compressed to half its original volume, the temperature rises to 312 K and the pressure rises to 1.7 atm. Some of the gas slowly leaks out during compression.

Calculate the amount of gas present in the smaller volume.



Essential Pre-Uni Chemistry C1.8

A Level



Use the ideal gas equation of state to answer this question. In SI units, the equation is $pV = nRT$, where $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$.

A vacuum line is lowered to a pressure of 1.3 kPa at 77 K.

Give the number of molecules of gas per mm^3 .



Essential Pre-Uni Chemistry C1.9

A Level



Use the ideal gas equation of state to answer the following questions. In SI units, the equation is $pV = nRT$, where $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$.

The endothermic reaction between sodium hydrogencarbonate and ethanoic acid is used to inflate a plastic bag.

Part A Find the volume at 101 kPa

If the gas produced is at a temperature of 13°C , and 4.0 g of sodium hydrogencarbonate reacts with excess acid, find the volume of gas produced at a pressure of 101 kPa.

Part B New volume

If the gas then warms up to a room temperature of 32°C with no change in pressure, find the new volume of gas.



Essential Pre-Uni Chemistry I1.2

A Level



Write balanced equations to show the equilibria represented by the following equilibrium constants, K_p .

Part A (a)

$$\frac{p(\text{Cl})^2}{p(\text{Cl}_2)}$$

Part B (b)

$$\frac{p(\text{SO}_3)^2}{p(\text{SO}_2)^2 p(\text{O}_2)}$$

Part C (c)

$$\frac{p(\text{CO})^2 p(\text{H}_2)^2}{p(\text{CH}_4) p(\text{CO}_2)}$$

Essential Pre-Uni Chemistry I1.3

Complete the following table:

TOTAL PRESSURE	MOLE FRACTION	PARTIAL PRESSURE
1.0 atm	0.075	(a)
125 MPa	4.00×10^{-7}	(b)
4.0 lb ft^{-2}	0.30	(c)
50 bar	(d)	200 mbar
2.0 GPa	(e)	40 kPa
(f)	2.5×10^{-3}	$1.4 \times 10^4 \text{ Pa}$
(g)	80 %	120 mmHg

Where only one of total and partial pressure is given, use the same units for the other.

Part A (a)

Partial pressure (a)

Part B (b)

Partial Pressure (b)

Part C (c)

Partial Pressure (c)

Part D (d)

Mole Fraction (d)

Part E (e)

Mole fraction (e)

Part F (f)

Total pressure (f)

Part G (g)

Total pressure (g)

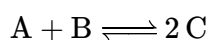


Essential Pre-Uni Chemistry I1.5

A Level



The reaction



occurs in the gas phase. Its value of K_p at a temperature of 600 K is 2500. Each row in the table below shows possible partial pressures at equilibrium at 600 K. Find the missing value in each row.

$p(\text{A})$	$p(\text{B})$	$p(\text{C})$
20 kPa	20 kPa	(a)
1.00 MPa	(b)	100 MPa
12.5 cm H ₂ O	3.75 cm H ₂ O	(c)
(d)	4.0×10^6 torr	1.60×10^8 torr
8.0×10^{-4} atm	5.0×10^{-4} atm	(e)

Use the same units for your answers as those used in that row of the table.

Part A (a)

Partial pressure (a)

Part B (b)

Partial pressure (b)

Part C (c)

Partial pressure (c)

Part D (d)

Partial pressure (d)

Part E (e)

Partial pressure (e)

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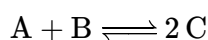


Essential Pre-Uni Chemistry I1.6

Further A



The reaction



occurs in the gas phase. Its value of K_p at a temperature of 600 K is 2500.

The table below shows initial pressures before equilibration at 600 K. Calculate the equilibrium pressures in each case. Assume that the total gas pressure is kept constant.

Initial $p(\text{A})$	Initial $p(\text{B})$	Initial $p(\text{C})$	Equilibrium $p(\text{A})$	Equilibrium $p(\text{B})$	Equilibrium $p(\text{C})$
10.0 atm	10.0 atm	0.0 atm	(a)	(b)	(c)
0.0 MPa	0.0 MPa	12.0 MPa	(d)	(e)	(f)
250.0 bar	250.0 bar	0.0 bar	(g)	(h)	(i)
0.00 psi	0.00 psi	2400.00 psi	(j)	(k)	(l)

Give your answers in the same units as those used in that row.

Part A (a)

Equilibrium pressure (a). Give your answer to 3 significant figures.

Part B (b)

Equilibrium pressure (b). Give your answer to 3 significant figures.

Part C (c)

Equilibrium pressure (c). Give your answer to 3 significant figures.

Part D (d)

Equilibrium pressure (d). Give your answer to 3 significant figures.

Part E (e)

Equilibrium pressure (e). Give your answer to 3 significant figures.

Part F (f)

Equilibrium pressure (f). Give your answer to 3 significant figures.

Part G (g)

Equilibrium pressure (g). Give your answer to 4 significant figures.

Part H (h)

Equilibrium pressure (h). Give your answer to 4 significant figures.

Part I (i)

Equilibrium pressure (i). Give your answer to 4 significant figures.

Part J (j)

Equilibrium pressure (j). Give your answer to 4 significant figures.

Part K (k)

Equilibrium pressure (k). Give your answer to 4 significant figures.

Part L (l)

Equilibrium pressure (l). Give your answer to 4 significant figures.

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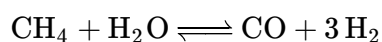


Essential Pre-Uni Chemistry I1.8

A Level



The reaction



has an equilibrium constant, K_p , of 150.5 Pa^2 at a temperature of 1073 K . [1]

$$K_p = \frac{p(\text{CO})p(\text{H}_2)^3}{p(\text{CH}_4)p(\text{H}_2\text{O})}$$

Part A (a)

If the partial pressures at equilibrium are $p(\text{CH}_4) = 20.0 \text{ kPa}$, $p(\text{H}_2\text{O}) = 20.0 \text{ kPa}$ and $p(\text{CO}) = 50.0 \text{ kPa}$, find the partial pressure of hydrogen at equilibrium.

Part B (b)

If equal amounts of methane and steam are mixed and allowed to reach equilibrium, and the partial pressures $p(\text{CO}) = 40.0 \text{ kPa}$ and $p(\text{H}_2) = 120 \text{ kPa}$, find the partial pressure of methane at equilibrium.

Once the gases have reached equilibrium, the total pressure is suddenly doubled by the engineer. Will the following increase, decrease or stay the same as the system reaches a new equilibrium?

 K_p

- ☐ increase
- ☐ stay the same
- ☐ decrease
-

Mole fraction of CO

- ☐ increase
- ☐ stay the same
- ☐ decrease
-

Mole fraction of CH₄

- ☐ increase
- ☐ stay the same
- ☐ decrease
-

 $p(\text{H}_2\text{O})$

- ☐ increase
- ☐ stay the same
- ☐ decrease
-

[1]

$$K_p = \frac{p(\text{CO})p(\text{H}_2)^3}{p(\text{CH}_4)p(\text{H}_2\text{O})}$$

[1] Charles O. Hawk et al, Ind. Eng. Chem., 1932, **24** (1), pp23-27

