B8 · The ideal gas law, PV = nRT · Notes

Goals: State the ideal gas law and what each symbol stands for. Put every value into the units that match the gas constant. Use the ideal gas law to find a volume, a pressure, an amount or a mass.

Name: _____ Date: _____

Slide 1 of 6 · A gas that is not at STP or SATP

In lesson B7 the molar volume linked moles and litres. It only worked at STP and SATP. Today you get a law that works anywhere.

What is the volume of one mole?

STP	SATP	another gas
0 °C	25 °C	22 °C
101.325 kPa	100 kPa	150 kPa
22.4 L/mol	24.8 L/mol	? L/mol

Key ideas

The molar volume is _____ L/mol at STP.

Most gases in a lab are at some other _____ and temperature.

The _____ can change a gas to STP, but that is slow.

Example

Can you use 24.8 L/mol for a gas at 150 kPa and 22 °C? Say why or why not.

Try it

Name the two things from earlier lessons that you could use together for a gas that is not at STP.

Slide 2 of 6 · The ideal gas law

The last slide asked for one law that works at any pressure and temperature. This slide gives it.

$$PV = nRT$$

P	V	n	T
pressure, kPa	volume, L	amount, mol	temperature, K

R = 8.314 kPa·L/(mol·K)

R is the gas constant.

Key ideas

The ideal gas law is _____.

The letter n is the _____ of gas in moles.

R is a fixed number called the _____.

R = _____ kPa·L/(mol·K).

Example

Write the ideal gas law. Say what each of P, V, n and T stands for.

Try it

Use PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. STP is 0 °C and 101.325 kPa. Use the law to find the volume of 1.00 mol of gas at STP.

Slide 3 of 6 · The units must match R

The last slide gave the gas constant R with its units. Those units decide the units of everything else.

symbol	unit	if the question gives something else
P	kPa	change atm or mm Hg to kPa (lesson B1)
V	L	divide mL by 1000
n	mol	change grams with the molar mass
T	K	add 273 to °C (lesson B2)

Key ideas

Pressure must be in _____.

Volume must be in _____.

Temperature must be in _____.

To change millilitres to litres, divide by _____.

Example

A question gives a volume of 250 mL and a temperature of 22 °C. What do you change before you use the ideal gas law?

Try it

Use 1 atm = 101.325 kPa. A question gives a pressure of 1.20 atm. What is it in kPa, ready for the ideal gas law?

Slide 4 of 6 · Finding a volume or a pressure

The last slide set the units. Now you use the ideal gas law to find a volume, then a pressure.

$n = 0.500\ \text{mol}, P = 125\ \text{kPa}, T = 30 + 273 = 303\ \text{K}$

$V = nRT / P$

$V = (0.500\ \text{mol} \times 8.314 \times 303\ \text{K}) / 125\ \text{kPa}$

$V = 10.1\ \text{L}$

Key ideas

To find a volume, divide both sides by _____.

So V = _____.

To find a pressure, divide both sides by _____.

Example

Use PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. What is the volume of 1.00 mol of gas at 150 kPa and 27 °C?

Try it

Use PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. 0.500 mol of gas is in a 10.0 L tank at 27 °C. What is the pressure?

Slide 5 of 6 · Finding moles, then mass

The last slide found a volume and a pressure. The ideal gas law can also tell you how much gas there is.

P = 150 kPa, V = 8.00 L, T = 295 K

n = PV / (RT)

n = (150 kPa × 8.00 L) / (8.314 × 295 K) = 0.4893 mol

m = 0.4893 mol × 28.02 g/mol

m = 13.7 g of N_2

Key ideas

To find the amount, n, divide both sides by _____.

So n = _____.

Moles change to grams with the _____.

Example

Use PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. The molar mass of N_2 is 28.02 g/mol. What is the mass of 4.00 L of nitrogen gas at 100 kPa and 25 °C?

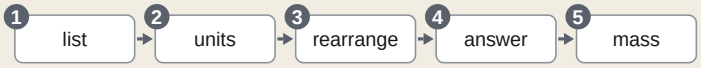
Try it

Use PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. The molar mass of CO_2 is 44.01 g/mol. What is the mass of 2.00 L of carbon dioxide at 150 kPa and 30 °C?

Slide 6 of 6 · Method: how to answer an ideal gas law question

You just used the ideal gas law four times. Each time you did the same things. Here they are as steps.

1. **List** P, V, n and T. One is unknown.
2. **Change** to kPa, L, mol and K.
3. **Rearrange** PV = nRT for the unknown.
4. **Calculate** and round.
5. **Change** moles to grams, if asked.



Check: at SATP, one mole fills about 24.8 L.

Used again in: gas questions in Unit D

Key ideas

Step 1: _____ P, V, n and T. One is unknown.

Step 2: _____ to kPa, L, mol and K.

Step 3: _____ PV = nRT for the unknown.

Step 4: _____ and round. Step 5: change moles to grams, if asked.

Example

Use PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. Use the steps. What is the volume of 3.00 mol of gas at 250 kPa and 50 °C?

Try it

Use PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. Use the steps. How many moles of gas are in 25.0 L at 100 kPa and 27 °C?