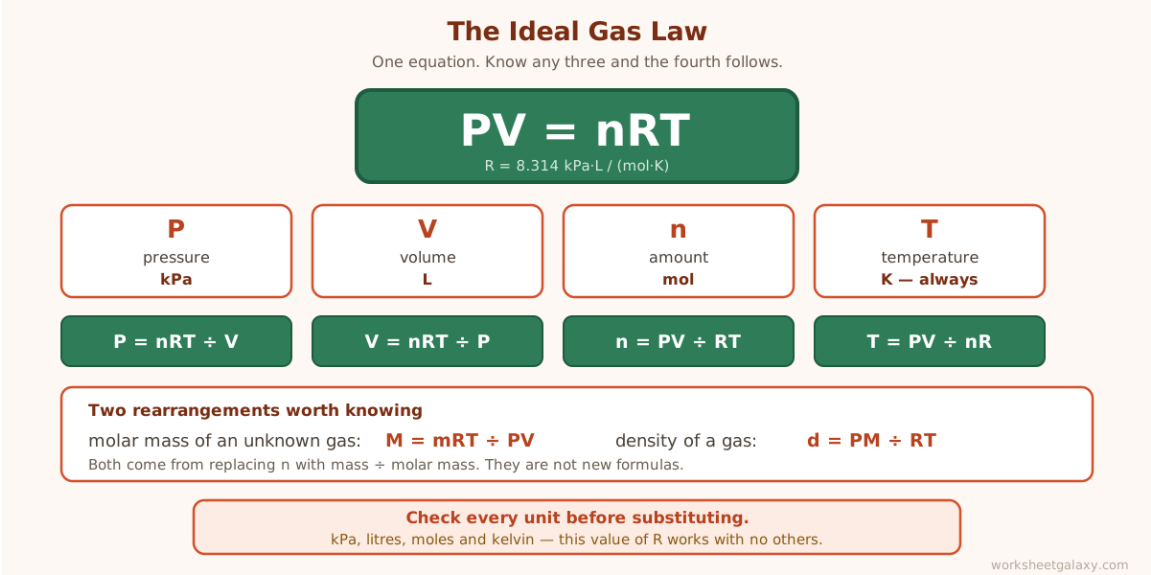
Ideal Gas Law Worksheet

Grade 11 Chemistry · PV = nRT, molar mass from gas data, and gas density

Name: _____ Date: _____ Score: / 24



Before you start: use R = 8.314 kPa·L/(mol·K). That value only works with pressure in kPa, volume in litres, amount in moles and temperature in kelvin, so convert first. Three significant digits throughout.

Part A · Find the Missing Value Everything is already in the right units.

#	P (kPa)	V (L)	n (mol)	T (K)	Answer
1	?	10.0	2.00	300.0	
2	101.3	?	1.00	273.15	
3	200.0	5.00	?	298.15	
4	150.0	8.00	0.500	?	
5	?	2.50	0.750	350.0	
6	250.0	?	3.00	400.0	
7	99.0	1.50	?	295.0	

Part B · Convert First Each of these gives at least one quantity in the wrong unit.

1. What amount of gas occupies 4.00 L at 101.0 kPa and 25.0 °C?

Answer: _____

2. What amount of gas occupies 500.0 mL at 120.0 kPa and 300.0 K?

Answer: _____

3. What amount of gas occupies 10.0 L at 2.00 atm and 273.15 K? (1 atm = 101.325 kPa)

Answer: _____

4. What volume does 8.00 g of oxygen gas occupy at 100.0 kPa and 300.0 K?

Answer: _____

5. What amount of gas occupies 250.0 mL at 95.0 kPa and 20.0 °C?

Answer: _____

Part C · Molar Mass of an Unknown Gas

Find the amount first, then divide the mass by it.

1. A sample of gas weighing 2.00 g occupies 1.50 L at 100.0 kPa and 300.0 K. What is its molar mass?

Answer: _____

2. A sample of gas weighing 4.40 g occupies 2.24 L at 101.3 kPa and 273.15 K. What is its molar mass?

Answer: _____

3. A sample of gas weighing 0.500 g occupies 0.400 L at 150.0 kPa and 298.15 K. What is its molar mass?

Answer: _____

4. A sample of gas weighing 1.60 g occupies 1.25 L at 80.0 kPa and 320.0 K. What is its molar mass?

Answer: _____

Part D · Gas Density

Density is mass per litre, and one mole has a mass of M grams.

1. What is the density of O_2 gas at 100.0 kPa and 300.0 K?

Answer: _____

2. What is the density of CO_2 gas at 101.3 kPa and 273.15 K?

Answer: _____

3. A gas has a density of 1.25 g/L at 100.0 kPa and 273.15 K. What is its molar mass?

Answer: _____

4. What is the density of NH_3 gas at 95.0 kPa and 298.15 K?

Answer: _____

Part E · Challenge Stoichiometry, the limits of the model, and where the combined gas law came from.

1. **$2H_2 + O_2 \rightarrow 2H_2O$**

   What volume of O_2, measured at 100.0 kPa and 298.15 K, is needed to react completely with 5.00 g of H_2?

   Answer: _____

2. Why is it called the *ideal* gas law? Describe the two assumptions the model makes, and give the conditions under which a real gas stops obeying it.

   Answer: _____

3. Starting from PV = nRT, show that the combined gas law follows when the amount of gas does not change.

   Answer: _____

4. A 2.00 L container holds 4.00 g of He at 300.0 K. Calculate the pressure. Then work out the pressure if the He is replaced by 4.00 g of Ar at the same temperature, and explain the difference.

   Answer: _____

Answer Key · Ideal Gas Law

Full worked solutions — Grade 11 Chemistry

Part A · Find the Missing Value

1. 1. P = nRT ÷ V
   2. P = 2.00 × 8.314 × 300.00 ÷ 10.0
   499 kPa
2. 1. V = nRT ÷ P
   2. V = 1.00 × 8.314 × 273.15 ÷ 101.3
   22.4 L
3. 1. n = PV ÷ RT
   2. n = 200.0 × 5.00 ÷ (8.314 × 298.15)
   0.403 mol
4. 1. T = PV ÷ nR
   2. T = 150.0 × 8.00 ÷ (0.500 × 8.314)
   289 K
5. 1. P = nRT ÷ V
   2. P = 0.750 × 8.314 × 350.00 ÷ 2.50
   873 kPa
6. 1. V = nRT ÷ P
   2. V = 3.00 × 8.314 × 400.00 ÷ 250.0
   39.9 L
7. 1. n = PV ÷ RT
   2. n = 99.0 × 1.50 ÷ (8.314 × 295.00)
   0.0605 mol

Part B · Convert First

1. 1. the temperature is in degrees Celsius
   2. 25.0 °C + 273.15 = 298.15 K
   0.163 mol
2. 1. the volume is given as 500.0 mL
   2. 300.0 K is already in kelvin
   0.0241 mol
3. 1. the pressure is given as 2.00 atm
   2. 273.15 K is already in kelvin
   0.892 mol
4. 1. the amount is given as a mass of oxygen
   2. 300.0 K is already in kelvin
   6.24 L
5. 1. both the volume and the temperature need converting
   2. 20.0 °C + 273.15 = 293.15 K
   0.00974 mol

Part C · Molar Mass of an Unknown Gas

1. 1. n = PV ÷ RT = 100.0 × 1.50 ÷ (8.314 × 300.00) = 0.0601 mol
   2. M = m ÷ n = 2.00 g ÷ 0.0601 mol
   33.3 g/mol

2. 1. n = PV ÷ RT = 101.3 × 2.24 ÷ (8.314 × 273.15) = 0.0999 mol
   2. M = m ÷ n = 4.40 g ÷ 0.0999 mol
   44.0 g/mol

3. 1. n = PV ÷ RT = 150.0 × 0.400 ÷ (8.314 × 298.15) = 0.0242 mol
   2. M = m ÷ n = 0.500 g ÷ 0.0242 mol
   20.7 g/mol

4. 1. n = PV ÷ RT = 80.0 × 1.25 ÷ (8.314 × 320.00) = 0.0376 mol
   2. M = m ÷ n = 1.60 g ÷ 0.0376 mol
   42.6 g/mol

Part D · Gas Density

1. 1. $M(O_2)$ = 32.00 g/mol
   2. density = mass ÷ volume, and for one mole that is M ÷ V
   3. d = PM ÷ RT = 100.0 × 32.00 ÷ (8.314 × 300.00)
   1.28 g/L

2. 1. $M(CO_2)$ = 44.01 g/mol
   2. density = mass ÷ volume, and for one mole that is M ÷ V
   3. d = PM ÷ RT = 101.3 × 44.01 ÷ (8.314 × 273.15)
   1.96 g/L

3. 1. rearranging d = PM ÷ RT gives M = dRT ÷ P
   2. M = 1.25 × 8.314 × 273.15 ÷ 100.0
   28.4 g/mol

4. 1. $M(NH_3)$ = 17.04 g/mol
   2. density = mass ÷ volume, and for one mole that is M ÷ V
   3. d = PM ÷ RT = 95.0 × 17.04 ÷ (8.314 × 298.15)
   0.653 g/L

Part E · Challenge

1. • $n(H_2)$ = 5.00 g ÷ 2.02 g/mol = 2.48 mol
   • $n(O_2)$ = 2.48 mol × 1/2 = 1.24 mol
   • V = nRT ÷ P = 1.24 × 8.314 × 298.15 ÷ 100.0
   30.7 L

2. • an ideal gas is a model: its particles take up no space at all and do not attract one another
   • at ordinary pressures and temperatures real gases are spread thinly enough that both assumptions are close enough to true
   • at high pressure the particles are crowded together and their own volume stops being negligible
   • at low temperature they move slowly enough for the attractions between them to matter, and eventually the gas condenses, at which point the law has nothing left to describe
   Because it describes an idealised gas. It fails at high pressure and at low temperature, where real particles have volume and attract one another.

3. • PV = nRT can be rearranged to PV ÷ T = nR
   • if the amount of gas does not change, n is fixed and R is a constant, so the whole right-hand side is a constant
   • that means PV ÷ T has the same value before and after any change

   $P_1V_1/T_1 = P_2V_2/T_2$, which is the combined gas law.

4. • n(He) = 4.00 g ÷ 4.00 g/mol = 1.00 mol, so P = 1250 kPa
   • n(Ar) = 4.00 g ÷ 39.95 g/mol = 0.100 mol, so P = 125 kPa
   • the same mass of argon contains about 10 times fewer particles, because each one is that much heavier
   • pressure comes from particles striking the walls, so it depends on how many there are and not on what each one weighs

   1250 kPa with He, falling to 125 kPa with Ar.