4. States of matter

4.1 The gaseous state- ideal and real gases

Paper 1

Question Paper

1 In this question you may assume that nitrogen behaves as an ideal gas. One atmosphere pressure = 101 kPa.

Which volume does 1.0 g of nitrogen occupy at 50 °C and a pressure of 2.0 atmospheres?

A 70 cm^3 **B** 150 cm^3 **C** 470 cm^3 **D** 950 cm^3

2 What is the density of a sample of fluorine gas at 32 °C and 100 000 Pa? Assume fluorine behaves as an ideal gas under these conditions.

A 1.4 g dm^{-3} **B** 1.5 g dm^{-3} **C** 1.6 g dm^{-3} **D** 1.7 g dm^{-3}

3 In this question it should be assumed that nitrogen behaves as an ideal gas under the conditions stated.

Which volume is occupied by 1.00 g of nitrogen at 50.0 °C and at a pressure of 120 kPa?

A 0.124 dm^3 **B** 0.799 dm^3 **C** 1.60 dm^3 **D** 22.4 dm^3

4 When an evacuated tube of volume 400 cm^3 is filled with gas at 300 K and 101 kPa, the mass of the tube increases by 0.65 g.

Assume the gas behaves as an ideal gas.

What is the identity of the gas?

A argon

B helium

C krypton

D neon

5 At a temperature of 2500 K and a pressure of 1.00×10^{-4} Pa, a sample of 0.321 g of sulfur vapour has a volume of 2.08×10^{6} m^3.

What is the molecular formula of sulfur under these conditions?

A S **B** S_2 **C** S_4 **D** S_8

6 A mixture of the three gases, oxygen, nitrogen and argon, is at a total pressure of 500 kPa. There is a total of 1.2 moles of gas in the mixture.

If the oxygen gas alone occupied the entire volume of the mixture, it would exert a pressure of 150 kPa.

At room conditions the amount of nitrogen gas in the mixture would occupy a volume of 5.76 dm^3.

What is the partial pressure of the argon gas in the mixture?

A 150 kPa

B 200 kPa

C 250 kPa

D 300 kPa

7 The volume of a vessel is $1.20 \times 10^{-3}\ m^3$. It contains pure argon at a pressure of 1.00×10^5 Pa, and at a temperature of 25.0 °C. Under these conditions it can be assumed that argon behaves as an ideal gas.

Which mass of argon does it contain?

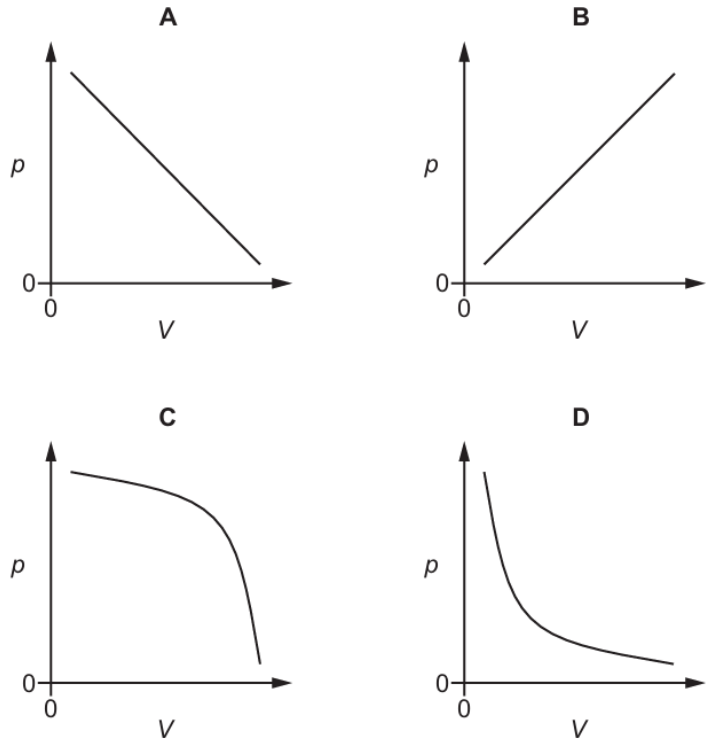
A 0.0485 g **B** 1.93 g **C** 10.4 g **D** 23.0 g

8 Each of the substances shown is gaseous.

Which substance is most likely to show ideal behaviour in the conditions shown?

	substance	temperature / K	pressure / Pa
A	carbon dioxide	250	1.00×10^5
B	hydrogen chloride	1000	1.00×10^6
C	nitrogen	1000	1.00×10^5
D	oxygen	250	1.00×10^6

9 Which graph represents the variation of pressure p and volume V of a sample of an ideal gas at constant temperature?



10 'Black powder' is a mixture of potassium nitrate, carbon and sulfur. The mixture reacts as shown.

$$4KNO_3(s) + 7C(s) + S(s) \rightarrow 3CO_2(g) + 3CO(g) + 2N_2(g) + K_2S(s) + K_2CO_3(s)$$

A sealed tube containing black powder has a volume of 10.0 cm^3. When all of the black powder reacts, the reaction causes a pressure of 2×10^6 Pa and a temperature of 2500 K.

The volume of the K_2CO_3 and K_2S produced can be ignored.

How many moles of KNO_3 are contained in the sealed tube?

A 4.81×10^{-4} **B** 9.63×10^{-4} **C** 1.93×10^{-3} **D** 9.63×10^{-1}

11 Which gas will behave **least** like an ideal gas at 150 °C and 101 kPa?

A ammonia

B fluorine

C krypton

D steam

12 When an evacuated glass bulb of volume 200 cm^3 is filled with a gas at 300 K and 101 kPa, the mass of the bulb increases by 0.68 g. The gas obeys the ideal gas equation.

What is the identity of the gas?

A argon

B krypton

C neon

D nitrogen

13 Which substance shows the greatest deviation from the properties of an ideal gas under room conditions?

A $CO_2(g)$ **B** $H_2(g)$ **C** Ne(g) **D** $NH_3(g)$

14 The general gas equation can be used to calculate the value of the M_r of a gas.

For a sample of a gas of mass m grams, which expression will give the value of M_r?

A $M_r = \frac{mRT}{pV}$ **B** $M_r = \frac{pVRT}{m}$ **C** $M_r = \frac{mpV}{RT}$ **D** $M_r = \frac{pV}{mRT}$

15 Which gas would behave most like an ideal gas under room conditions?

A helium

B nitrogen

C ammonia

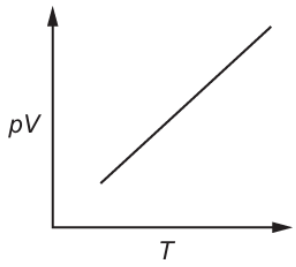
D krypton

16 Flask Q contains 5 dm^3 of helium at 12 kPa pressure. Flask R contains 10 dm^3 of neon at 6 kPa pressure.

If the flasks are connected at constant temperature, what is the final pressure?

A 8 kPa **B** 9 kPa **C** 10 kPa **D** 11 kPa

17 A graph of pV against T is shown for a fixed mass of gas. (p = pressure, V = volume and T = temperature in K.)



Which gas gives this graph over the widest range of temperatures and pressures?

A hydrogen, H_2

B hydrogen chloride, HCl

C hydrogen fluoride, HF

D oxygen, O_2

18 A weather balloon is filled with 12.0 kg helium. The weather balloon reaches a height of 20 km, the pressure inside the balloon is 6000 Pa and the temperature is 216 K.

What is the volume of the weather balloon at this height, correct to three significant figures?

A 897 dm^3 **B** 1790 dm^3 **C** 897 000 dm^3 **D** 1 790 000 dm^3

19 10 cm^3 of ethane is burned in 45 cm^3 of oxygen at a pressure of 101 kPa and a temperature of 200 °C. Complete combustion takes place.

What is the total volume of gas present when the reaction is complete, measured under the same conditions?

A 30 cm^3 **B** 50 cm^3 **C** 55 cm^3 **D** 60 cm^3

20 A sample of argon gas has a mass of 0.20 g, at a pressure of 100 000 Pa and a temperature of 12 °C.

Which volume does the gas occupy?

A 1.2×10^{-4} cm^3

B 5.0 cm^3

C 59 cm^3

D 119 cm^3

21 In this question you should assume the vapour behaves as an ideal gas.

0.175 g of a volatile liquid produces a vapour of volume $4.50 \times 10^{-5}\,m^3$ at 100 °C and pressure of 1.013×10^5 Pa.

What is the M_r of the liquid?

A 31.9 **B** 87.1 **C** 119 **D** 127

22 When an evacuated tube of volume 400 cm^3 is filled with gas at 300 K and 101 kPa, the mass of the tube increases by 0.65 g.

Assume the gas behaves as an ideal gas.

What could be the identity of the gas?

A argon

B helium

C krypton

D neon

23 Under which conditions will nitrogen behave most like an ideal gas?

	temperature	pressure
A	low	high
B	high	low
C	low	low
D	high	high

24 X, Y and Z are all gases that behave ideally and react according to the equation shown.

$$X(g) + 2Y(g) \rightarrow 2Z(g)$$

When 3.0 mol of X and 3.0 mol of Y are placed inside a container with a volume of 1.0 dm^3, they react to form the maximum amount of Z.

The final temperature of the reaction vessel is 120 °C.

What is the final pressure inside the reaction vessel?

A 4.49×10^6 Pa

B 9.80×10^6 Pa

C 1.47×10^7 Pa

D 1.96×10^7 Pa

25 What is a basic assumption of the kinetic theory, as applied to an ideal gas?

A Collisions between gas molecules are elastic.

B Each gas molecule occupies a finite volume.

C Gases consist of particles that experience the force of gravity.

D Gas molecules attract each other with weak intermolecular forces.

26 In this question you should assume methane behaves as an ideal gas.

The gas laws can be summarised in the ideal gas equation below.

$$pV = nRT$$

The volume of a sample of methane is measured at a temperature of 60 °C and a pressure of 103 kPa. The volume measured is 5.37×10^{-3} m^3.

What is the mass of the sample of methane, given to two significant figures?

A 0.0032 g **B** 0.018 g **C** 3.2 g **D** 18 g

27 Flask X contains 5 dm^3 of helium at 12 kPa pressure and flask Y contains 10 dm^3 of neon at 6 kPa pressure.

If the flasks are connected at constant temperature, what is the final pressure?

A 8 kPa **B** 9 kPa **C** 10 kPa **D** 11 kPa

28 Which gas is likely to deviate most from ideal gas behaviour?

A HCl **B** He **C** CH_4 **D** N_2