03 The Gaseous State

Set A **Foundations**

Name _____ Time **1 hour** Total **40 marks** Score _____ / 40

Data: R = 8.31 J mol^{-1} K^{-1}, 1 atm = 101 325 Pa, L = 6.02 × 10^{23} mol^{-1}, A_r: H 1.0, C 12.0, O 16.0.

A From the lesson

13 MARKS

1 Convert each quantity into S.I. units.

(a) 25 °C

[1]

(b) 250 cm^3

[1]

(c) 2.00 atm

[1]

/3

Source: Learners' Alley, The Gaseous State slides

2 A 2.00 dm^3 sample of gas at 27 °C is heated to 127 °C at constant pressure.

(a) Calculate the new volume of the gas.

[2]

(b) Explain why the new volume is not 2.00 × 127 ÷ 27 = 9.41 dm^3.

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[1]

/3

Source: Learners' Alley, The Gaseous State slides

3 COMMON 0.320 g of a gas occupies 246 cm^3 at 1.00×10^5 Pa and 23 °C. Calculate the M_r of the gas and suggest its identity.

[2]

/2

Source: Learners' Alley, The Gaseous State slides

4 2.00 dm^3 of a gas at 27 °C and 100 kPa is compressed to 0.500 dm^3 and heated to 127 °C. Calculate the final pressure of the gas.

[2]

/2

Source: Learners' Alley, The Gaseous State slides

5 Dry air is 78% N_2, 21% O_2 and 1% Ar by amount. Calculate the partial pressure of O_2 when the total pressure is 101 kPa.

[1]

/1

Source: Learners' Alley, The Gaseous State slides

6 COMMON Which gas deviates more from ideal behaviour, NH_3 or CH_4? Explain your answer.

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[2]

/2

Source: Learners' Alley, The Gaseous State slides

B Practice

27 MARKS

7 A small spacecraft of capacity 10 m^3 is connected to another of capacity 30 m^3. Before connection, the pressure inside the smaller craft is 50 kPa and the pressure inside the larger craft is 100 kPa. All measurements are made at the same temperature.

What is the pressure in the combined spacecraft after connection?

A 75 kPa **B** 87.5 kPa **C** 100 kPa **D** 125 kPa **E** 150 kPa

Answer [1]

/1

Source: N90/1/5, via EJC 2022 JC1 Gaseous State Tutorial, A1

8 Deuterium, ^2H, is an isotope of hydrogen. A 2 g sample of hydrogen, H_2, at temperature T and volume V exerts a pressure p.

Which of the following would also exert a pressure p at the same temperature T?

A 2 g of deuterium, D_2, in volume V

B 4 g of deuterium, D_2, in volume V/2

C a mixture of 1 g of H_2 and 2 g of D_2 in a total volume V

D a mixture of 2 g of H_2 and 1 g of D_2 in a total volume 2V

Answer [1]

/1

Source: J98/3/8, via EJC 2022 JC1 Gaseous State Tutorial, A6

9 A vessel contains 120 g of oxygen at a pressure of 3.00 atm at 25 °C.

(a) 5.00 g of hydrogen is added at the same temperature, without changing the volume of the vessel. Calculate the final pressure.

[2]

(b) The mixture is then exploded and allowed to cool back to 25 °C. Calculate the pressure of the gas in the vessel.

[2]

/4

Source: RJC 2010/11 Gaseous State Tutorial, Q8

10 COMMON Under what conditions of temperature and pressure do real gases behave most like ideal gases? Give reasons for your answers.

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..... **[3]**

/3

Source: AJC 2017 Promo P2 Q4(a)(ii), via Physical Chemistry Revision Package 2020

11 1.00 mol of carbon dioxide is held in a 0.250 dm^3 container at 25 °C.

(a) Calculate the pressure that the carbon dioxide would exert if it behaved as an ideal gas.

[1]

(b) COMMON The actual pressure is 6.12×10^6 Pa. Suggest a reason for the difference between this value and your answer to (a).

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..... **[1]**

/2

Source: AJC 2017 Promo P2 Q4(b), adapted, via Physical Chemistry Revision Package 2020

12 A gaseous hydrocarbon A contains 85.7% carbon by mass. When 10.0 cm^3 of A underwent complete combustion in 80.0 cm^3 of oxygen, the remaining gases occupied 65.0 cm^3. After shaking these gases with aqueous sodium hydroxide, 35.0 cm^3 of gas remained. All volumes were measured at room temperature and pressure.
Determine the empirical and molecular formulae of A.

[3]

/3

Source: AJC 2017 Promo P2 Q4(c), via Physical Chemistry Revision Package 2020

13 COMMON Arrange these gases in order of increasing deviation from ideal behaviour. Explain your order.

$$He \quad Ne \quad O_2 \quad H_2O \quad NH_3 \quad C_2H_6$$

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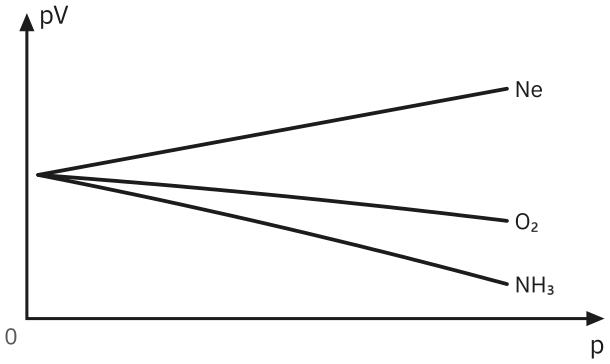
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/3

Source: RJC 2010/11 Gaseous State Tutorial, Q7(b)

14 COMMON The graph shows pV against p for Ne, O_2 and NH_3 at the same temperature.



(a) Explain why the three lines meet at zero pressure.

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(b) Explain why pV decreases with increasing pressure for O_2 and NH_3 but increases for Ne.

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..... **[3]**

/4

Source: RJC 2010/11 Gaseous State Tutorial, Q7(c)

15 CHALLENGE At sea level, an inflated bicycle tyre contains 670 cm^3 of air at an internal pressure of 6.00 bar and 20 °C. The tyre is marked "maximum internal pressure 8 bar". Atmospheric pressure at sea level is 1.01 bar. The tyre bursts if the difference between the internal and external pressures becomes too great.

(a) Use the ideal gas equation to calculate the amount of air in the tyre at sea level. (1 bar = 1.00 × 10^5 Pa)

[2]

(b) The bicycle is carried in the luggage hold of an aircraft at a height of 10 000 m, where the temperature is 5 °C and the pressure is 0.28 bar. The volume of the tyre does not change. Calculate the pressure inside the tyre in the hold.

[2]

(c) Some airlines insist that bicycle tyres are let down before a flight. Should this tyre be let down? Use your answer to (b) to justify your answer.

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[2]

16

Source: EJC 2022 JC1 Gaseous State Tutorial, C1