

O-level

S.t.p (standard temperature and pressure) and r.t.p (room temperature and pressure)

GASES

It is not convenient to weigh gases. They are normally measured by volumes.

Avogadro's law

Equal moles of any gas, under the same conditions of temperature and pressure occupy equal volumes.

- At s.t.p. 1 mole of any gas occupy 22.4dm^3 or 22400cm^3 . This volume is called the **molar volume at s.t.p.**
- At r.t.p. 1 mole of any gas occupy 24dm^3 or 24000cm^3 . This volume is called the **molar volume at r.t.p.**

Example 1

Calculate the mass of magnesium required to produce 2.24 litres of hydrogen at s.t.p on the reaction with dilute sulphuric acid

[Mg = 24, molar volume at s.t.p = 22.4L]

Solution: $\text{Mg(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{MgSO}_4(\text{aq}) + \text{H}_2(\text{g})$

1 mole of Mg produce 1 mole of H_2

1 mole of Mg produced 22.4L of H_2
But 1 mole of mg weigh 24g

22.4L of H_2 require 24g of Mg

2.24L of H_2 require $\frac{2.24 \times 24}{22.4} = 2.4\text{g of Mg}$

Example 2

Magnesium reacts with chlorine when heated, according to the equation

$\text{Mg(s)} + \text{Cl}_2(\text{g}) \rightarrow \text{MgCl}_2(\text{s})$

Calculate the volume of chlorine that will react completely with 0.6g of magnesium.

(1 mole of gas at stp = 22.4 dm^3 , Mg = 24)

Solution

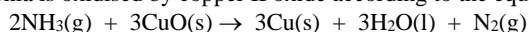
From equation

24g of Mg react with 22.4dm^3 of chlorine

$\therefore 0.6\text{g of Mg}$ react with $\frac{0.6 \times 22.4}{24} = 0.56\text{dm}^3$ of chlorine

Example 3

Ammonia is oxidised by copper II oxide according to the equation



What volume of ammonia gas will be oxidised by 6.0g of copper II oxide at s.t.p? (Cu = 64, O = 16, Molar volume of gas at s.t.p = 22.4l)

Solution

Formula mass of CuO = 64 + 16 = 80g

(3 x 80)g of CuO require (2 x 22.4) l of ammonia

6.0g of CuO require $\frac{2 \times 22.4 \times 6.0}{2 \times 80} = 1,12\text{l of ammonia}$

Example 4

Calculate the molar masses of the following gas at s.t.p?

(One mole of a gas occupies 22.4dm³ at s.t.p.)

- (a) 0.8g of gas X occupies 560cm³ (s.t.p)

Solution

560cm³ weigh 0.8g

1mole or 22400cm³ weigh $\frac{0.8 \times 22400}{560} = 32\text{g}$

∴ formula mass of X = 32 (remember formula mass has no units)

- (b) 1.12dm³ of gas y measured at s.t.p weighted 1.5g

Solution

1.12 dm³ weigh 1.5g

1mole or 22.4 dm³ weigh $\frac{01,5 \times 22,4}{1,12} = 30\text{g}$

∴ formula mass of Y = 30

Exercise

- Calcium carbide reacts with water to produce a gas according to the following equation
 $\text{CaC}_2(\text{s}) + \text{H}_2\text{O}(\text{l}) \longrightarrow \text{Ca}(\text{OH})_2\text{g} + \text{C}_2\text{H}_2(\text{g})$
The volume of a gas produced at s.t.p when 6.4g of calcium carbide reacts completely with water is (Ca = 40, C = 12)
A. $\frac{6.4 \times 64}{31}$ B. $\frac{22.4}{64 \times 6.4}$ C. 64 x 6.4 x 22.4 D. $\frac{6.4 \times 22.4}{64}$
- Copper carbonate when heated in air decompose according to the following equation
 $\text{CuCO}_3(\text{s}) \xrightarrow{\text{heat}} \text{CuO}(\text{s}) + \text{CO}_2(\text{g})$
What volume of carbon dioxide is produced at s.t.p when 0.5 mole of copper (II) oxide is formed? (Cu = 64, O = 16, C = 12)
A. 112.0L B. 44.0L C. 22.4L D. 11.2L
- Methane burns in oxygen according to the following equation
 $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
If 10cm³ of methane and 20cm³ of oxygen are mixed and exploded, the final products cooled to room temperature, the final volume is
A. 10cm³ B. 15cm³ C. 25cm³ D. 30cm³
- Which of the following gases does not react with water?
A. Ammonia B. Chlorine C. carbon monoxide D. sulphur dioxide

- 5 Steam reacts with methane according to the following equation
 $\text{CH}_4(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \longrightarrow 2\text{H}_2(\text{g}) + \text{CO}_2(\text{g})$
 What volume of a gas will remain when 30cm^3 of methane is reacted with 20cm^3 of steam?
 A. 20cm^3 B. 50cm^3 C. 70cm^3 D. 80cm^3
- 6 Ammonia is oxidized by copper oxide according to the equation
 $2\text{NH}_3(\text{g}) + 3\text{CuO}(\text{s}) \rightarrow 3\text{Cu}(\text{s}) + 3\text{H}_2\text{O}(\text{l}) + \text{N}_2(\text{g})$
 The volume of ammonia oxidised by 6.0g of copper oxide s.t.p is?
 (one mole gas occupies 22.4dm^3 at s.t.p)
 A. $\frac{80}{6} \times \frac{3}{2} \times 22400$ B. $\frac{80}{6} \times \frac{2}{3} \times 22400$
 C. $\frac{6}{80} \times \frac{3}{2} \times 22400$ D. $\frac{6}{80} \times \frac{2}{3} \times 22400$
- 7 What volume of ammonia at s.t.p will be produced when 15cm^3 of nitrogen react completely with hydrogen according to the following equation?
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \longrightarrow 2\text{NH}_3(\text{g})$ Type equation here.
 A. 7.5cm^3 B. 15cm^3 C. 30cm^3 D. 45cm^3
- 8 Zinc reacts with hydrochloric acid according to the following equation
 $\text{Zn}(\text{s}) + 2\text{HCl}(\text{aq}) \longrightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g})$
 The volume of hydrogen liberated at s.t.p when 13.0g of zinc reacts with the acid is (Zn = 65, H = 1, O = 16)
 A. $\frac{65 \times 13}{22.4}$ B. $\frac{13 \times 22.4}{65}$ C. $\frac{13}{65 \times 22.4}$ D. $\frac{65 \times 22.4}{13}$
- 9 Propene burns in oxygen according to equation
 $2\text{C}_3\text{H}_6(\text{g}) + 9\text{O}_2(\text{g}) \longrightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$
 When 2.1g of propene is completely burnt in oxygen, the volume carbon dioxide produced at room temperature is
 A. 1.2dm^3 B. 2.4dm^3 C. 3.6dm^3 D. 4.8dm^3
- 10 Magnesium reacts with chlorine according to the following equation
 $\text{Mg}(\text{s}) + 2\text{HCl}(\text{g}) \longrightarrow \text{MgCl}_2(\text{s}) + \text{H}_2(\text{g})$
 The volume of chlorine in litres, at s.t.p that react completely with 0.6g of magnesium is (1 mole of a gas occupies 22.4dm^3 at s.t.p, Mg = 24)
 A. $\frac{0.6 \times 22.4}{24}$ B. $\frac{0.6 \times 22.4}{24 \times 2}$ C. $\frac{0.6 \times 24}{22.4}$ D. $\frac{0.6 \times 22.4}{22.4 \times 2}$
- 11 80cm^3 of hydrogen and 80cm^3 of oxygen are allowed to react. What volume of gas remains unreacted?
 A. 40cm^3 B. 80cm^3 C. 120cm^3 D. 160cm^3
- 12 Zinc reacts with hydrochloric acid according to the following equation
 $\text{Zn}(\text{s}) + 2\text{HCl}(\text{aq}) \longrightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g})$
 The volume of hydrogen liberated at s.t.p when 13.0g of zinc reacts with the acid is (Zn = 65, H = 1, O = 16)
 A. 2.24dm^3 B. 4.48cm^3 C. 22.4dm^3 D. 11.2dm^3
- 13 Nitrogen monoxide reacts with oxygen according to the following equation
 $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{NO}_2(\text{g})$
 What volume of oxygen would react with 200cm^3 of oxygen monoxide?
 A. 100cm^3 B. 200cm^3 C. 300cm^3 D. 400cm^3
- 14 Sulphuric acid reacts with zinc according to the following equation
 $\text{Zn}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \longrightarrow \text{ZnSO}_4(\text{aq}) + \text{H}_2(\text{g})$
 The number of moles of zinc that will react with excess sulphuric acid to produce 60cm^3 of hydrogen at room temperature is
 (one mole of a gas at r.t.p is 24dm^3)

- A. 0.0025 B. 0.005 C. 0.025 D. 0.05
- 15 Calcium carbonate reacts dilute hydrochloric acid according to the following equation
 $\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
 What volume of carbon dioxide would be evolved at s.t.p when 1g of calcium carbonate is reacted with excess hydrochloric acid?
 (Ca= 40, H=1, Cl= 35.5, O = 16, one mole of a gas occupies 22.4dm³ at s.t.p)
 A. 2240cm³ B. 224cm³ C. 112cm³ D.448cm³
- 16 Carbon dioxide is produced from sodium hydrogen carbonate according to the following equation
 $2\text{NaHCO}_3(\text{s}) \xrightarrow{\text{heat}} \text{Na}_2\text{CO}_3(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
 The volume in litres of carbon dioxide evolved at s.t.p when 21.0g of sodium hydrogen carbonate is heated is
 (NaHCO₃ = 84, 1 mole of a gas at s.t.p occupies 22.4dm³)
 A. $\left(\frac{21}{168} \times \frac{1}{2} \times 22.4\text{l}\right)$ B. $\left(\frac{168}{21} \times 2 \times \frac{1}{22.4} \text{l}\right)$
 C. $\frac{21}{84} \left(x \frac{1}{2} \times 22.4\text{l}\right)$ D. $\left(\frac{84}{21} \times 2 \times \frac{1}{22.4} \text{l}\right)$
- 17 Calculate the relative molecular mass of gas P, if 8.4dm³ of the gas at s.t.p has a mass of 0.93g (1 mole of a gas at s.t.p occupies 22.4dm³)
 A. $\left(\frac{0.93 \times 22.4}{8.4}\right)$ B. $\left(\frac{8.4 \times 22.4}{0.93}\right)$ C. $\left(\frac{0.93 \times 8.4}{22.4}\right)$ D. $\left(\frac{0.93}{8.4 \times 22.4}\right)$
- 18 When 2.5g of a solid is heated, 560 cm³ of a gas was produced at s.t.p and a residue of 1.4g was left. The molecular mass of the gas is
 (1 mole of a gas at s.t.p is 22400cm³).
 A. $\left(\frac{22400 \times 2.5}{560} \text{ cm}^3\right)$ B. $\left(\frac{22400 \times 1.4}{560} \text{ cm}^3\right)$
 C. $\left(\frac{22400 \times 1.1}{560} \text{ cm}^3\right)$ D. $\left(\frac{22400}{560} \text{ cm}^3\right)$
- 19 What mass of ethane gas (C₂H₆) Mr =30 will occupy the same volume as 8g of methane (CH₄) Mr = 16 at s.t.p?
 (molar gas volume at s.t.p = 22.4dm³)
 A. $\frac{16}{30} \times 8$ B. $\frac{8}{16} \times 30$ C. $\frac{16}{8} \times 30$ D. $\frac{8}{30} \times 16$
- 20 The mass of 560cm³ of a gas X is 1.10g at s.t.p. the relative formula mass of the gas is (Molar gas volume at s.t.p = 22400 cm³)
 A. $\frac{22400}{1.1} \times 560$ B. $\frac{1.1}{560} \times 22400$ C. $\frac{1.1}{22400} \times 560$ D. $\frac{560}{1.1} \times 22400$
- 21 Ammonia is oxidized by copper oxide according to the equation
 $2\text{NH}_3(\text{g}) + 3\text{CuO}(\text{s}) \rightarrow 3\text{Cu}(\text{s}) + 3\text{H}_2\text{O}(\text{l}) + \text{N}_2(\text{g})$
 The volume of ammonia oxidised by 6.0g of copper oxide s.t.p is?
 (one mole gas occupies 22.4dm³ at s.t.p)
 A. $\frac{80}{6} \times \frac{3}{2} \times 22400$ B. $\frac{80}{6} \times \frac{2}{3} \times 22400$
 C. $\frac{6}{80} \times \frac{3}{2} \times 22400$ D. $\frac{6}{80} \times \frac{2}{3} \times 22400$
- 22 Calcium hydrogen carbonate when heated decompose according to the equation
 $\text{Ca}(\text{HCO}_3)_2 \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
 The volume of carbon dioxide evolved at s.t.p when 27g of hydrogen carbonate is heated is (H = 1, C =12, Ca = 40, O = 16, 1 mole of a gas occupies 22.4dm³ at s.t.p)
 A. 27 x 22.4 B. $\frac{162}{27 \times 22.4}$ C. $\frac{2 \times 27 \times 22.4}{162}$ D. $\frac{162}{2 \times 27 \times 22.4}$

- 23 Methane burns in oxygen according to the equation
 $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
 The volume of methane that remains unburnt when 50cm^3 of methane is reacted with 40cm^3 of oxygen is
 A. 10cm^3 B. 20cm^3 C. 30cm^3 D. 45cm^3
- 24 Hydrogen chloride reacts with ammonia according to the following equation
 $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \longrightarrow \text{NH}_4\text{Cl}(\text{g})$
 The mass of ammonium chloride formed when excess ammonia is reacted with 0.56dm^3 of hydrogen chloride at s.t.p is (N = 14, H = 1, Cl = 35.5)
 A. $\frac{0.56 \times 22.4}{53.5}$ B. $\frac{53.5 \times 0.56}{22.4}$ C. $\frac{0.56 \times 50.5}{50.5}$ D. $\frac{0.56 \times 50.5}{22.4}$
- 25 Copper (II) oxide reacts with hydrogen according to the equation
 $\text{CuO}(\text{s}) + \text{H}_2(\text{g}) \longrightarrow \text{Cu}(\text{s}) + \text{H}_2\text{O}(\text{l})$
 The volume of hydrogen in litres, required to react completely with 16.0g of copper (II) at s.t.p is (Cu = 64, O = 16, one mole of a gas occupies 22.4l at s.t.p)
 A. 1.12 B. 2.24 C. 4.48 D. 11.20
- 26 Hydrogen burns in oxygen according to the following equation
 $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\text{l})$
 The mass of steam formed when 100cm^3 of hydrogen is burnt in excess oxygen is at s.t.p is (H = 1, O = 16, one mole of a gas occupies 22.4l at s.t.p)
 A. 0.04g B. 0.08g C. 0.12g D. 0.16g
- 27 Propane burns in oxygen according to equation
 $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \longrightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$
 When 10l of propene is completely burnt in oxygen, the volume of oxygen used at room temperature is
 A. 5l B. 10l C. 15l D. 50l
- 28 Glucose burn in oxygen according to the following equation
 $\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g}) \longrightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l}) + \text{energy}$
 The volume of oxygen at s.t.p that is required to produce 150g of carbon dioxide is (H = 1, C = 12, O = 16, 1 mole of a gas at s.t.p occupies 22.4dm^3)
 A. $\frac{150 \times 22.4 \text{ cm}^3}{44}$ B. $\frac{50 \times 22.5}{44 \times 6}$ C. $\frac{44}{150 \times 22.4}$ D. $\frac{44 \times 6}{150 \times 22.4}$
- 29 On heating sodium nitrate produces sodium nitrite and oxygen according to the following equation
 $2\text{NaNO}_3(\text{s}) \longrightarrow 2\text{NaNO}_2(\text{s}) + \text{O}_2(\text{g})$
 The mass of sodium nitrite formed when 480cm^3 of oxygen was evolved at room temperature. (Na = 23, N = 14, O = 16, 1 mole of a gas occupies 24dm^3 at s.t.p)
 A. 1.38g B. 2.76g C. 5.52g D. 0.114g
30. When 3.0g of X was heated, 210cm^3 of a gas was evolved at s.t.p and 2.4g of solid remained. The relative molecular mass of the gas is [1 mole of a gas at s.t.p occupies 22.4dm^3 at s.t.p]
 A. $\frac{0.6 \times 22400}{210}$ B. $\frac{3 \times 22400}{210}$ C. $\frac{2.4 \times 22400}{210}$ D. $\frac{5.4 \times 22400}{210}$
- 31 Calcium carbonate decompose according to the equation
 $\text{CaCO}_3(\text{s}) \longrightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
 The maximum volume of carbon dioxide produced at s.t.p when 100g of calcium carbonate is heated is (Ca = 40, O = 16, 1 mole of a gas occupies 22.4dm^3 at s.t.p.)
 A. $\frac{10 \times 22.4}{100} \text{ dm}^3$ B. $\frac{10 \times 100}{22.4} \text{ dm}^3$ C. $\frac{22.4}{10 \times 100} \text{ dm}^3$ D. $\frac{100}{10 \times 22.4} \text{ dm}^3$
- 32 Methane burns in oxygen according to the following equation



The volume of carbon dioxide produced when 20cm³ of methane is burnt in 40cm³ of oxygen is

- A. 10cm³ B. 20cm³ C. 40cm³ D. 60cm³

33 Propane burns in air according to the following equation



Which of the following is the volume of air required for complete combustion of 60cm³ of propane?

(The percentage of oxygen in air is 21%)

- A. $\frac{5 \times 100}{24} \text{cm}^3$ B. $\frac{21 \times 5 \times 60}{100} \text{cm}^3$ C. $\frac{5 \times 60 \times 100}{21}$ D. $\frac{100 \times 60}{5 \times 21} \text{cm}^3$

In each of the questions 34 to 35 one or more of the answers given may be correct. Read each question carefully and then indicate the correct answer according to the following

- A. If 1, 2, 3, only are correct
 B. If 1 and 3 only are correct
 C. If 2 and 4 only are correct
 D. If 4 only is correct

34. Which of the following contains the same volume as 8.0g of oxygen at s.t.p?

1. 17.0g of ammonia
2. 22.0g of carbon dioxide
3. 2.0g of hydrogen
4. 7g of nitrogen

35. Which one of the following contains the same number of moles as 2.4dm³ of hydrogen gas at room temperature? (1mole of a gas occupies 24dm³ at room temperature)

1. 17g of ammonia
2. 1.7g of ammonia
3. 35.5g of chlorine
4. 3.55g of chlorine

show clear working

36 Sulphuric acid reacts with potassium hydrogen carbonate according to the equation
 $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{KHCO}_3(\text{aq}) \longrightarrow \text{K}_2\text{SO}_4(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$

Calculate the volume of carbon dioxide produced at s.t.p when 20cm³ of 0.5M sulphuric acid is reacted with excess potassium hydrogen carbonate

37 Sulphur dioxide combine with air to form sulphur trioxide according to the equation
 $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{SO}_3(\text{g})$

Calculate the volume of sulphur trioxide that would be formed when 20cm³ of sulphur dioxide was reacted with 100cm³ of oxygen.

38 Copper carbonate reacts dilute hydrochloric acid according to the following equation
 $\text{CuCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \longrightarrow \text{CuCl}_2(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$

What volume of carbon dioxide would be evolved at s.t.p when 6.2g of copper (II) carbonate is reacted with excess hydrochloric acid?

(Cu= 64, H=1, Cl = 35.5, O = 16, one mole of a gas occupies 22.4dm³ at s.t.p)

39 Hydrogen chloride gas reacts with silver nitrate according to the equation



Commented [S1]:

Commented [S2R1]:

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Commented [S4R1]:

Calculate the mass of silver chloride produced when 1.2dm³ of hydrogen chloride gas is bubbled through silver nitrate at room temperature.

(Ag= 108, H=1, Cl = 35.5, O = 16, N = 14 one mole of a gas occupies 22.4dm³ at s.t.p)

- 40 Nitrogen reacts with hydrogen to form ammonia according to the following equation
$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \longrightarrow 2\text{NH}_3(\text{g})$$

Calculate the volume of ammonia produced at s.t.p when 18.5 g of hydrogen gas reacted with excess nitrogen
[H = 1, N = 14, 1 mole of a gas occupies 22.4dm³ at s.t.p)
41. Potassium chlorate (V) decompose according to the following equation
$$2\text{KClO}_3 \longrightarrow 2\text{KCl}(\text{s}) + 3\text{O}_2(\text{g})$$

Calculate the volume of oxygen at room temperature when 16 g of potassium chlorate (V) is heated
(K =39, O = 1, Cl = 35.5, 1 mole of a gas at r.t.p 24dm³)
- 42 Sulphur dioxide can be prepared by roasting zinc sulphide according to the following equation
$$2\text{ZnS}(\text{s}) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{ZnO}(\text{s}) + 2\text{SO}_2(\text{g})$$

Calculate the volume of sulphur dioxide evolved at room temperature when 9.7g of zinc sulphide is reacted with excess oxygen
(Zn = 65, S = 32, O = 16 , 1mole of a gas occupies 24dm³ at room temperature)





Answers

Working

1. D Formula mass of $\text{CaC}_2 = 40 + 12 \times 2 = 64$
64g produce 22,4 dm³ of gas
6.4g produce $\frac{6.4 \times 22.4}{64}$
2. D 1mole of CuCO_2 produce 22.4dm³
0.5mole produce $\frac{22.4 \times 0.5}{1} = 11.2L$
3. 10cm³ of methane react with 20cm³ of oxygen to produce 10cm³ of CO₂
4. C
5. A (2 x 22400) cm³ of steam reacts with 22400 cm³ of methane
 $\therefore 20\text{cm}^3$ of steam react with $\frac{20 \times 22400}{2 \times 22400} = 10\text{cm}^3$
The volume of methane that did not react = 30 – 20 = 20cm³
6. D Formula mass of copper oxide, CuO = 64 + 16 = 80
(3 x 80)g of CuO react with (2 x 22400) cm³
 $\therefore 6\text{g}$ of CuO will oxidise $\frac{2 \times 22400 \times 6}{3 \times 80} \text{cm}^3$
7. C 1cm³ of N₂ form 2cm³ of ammonia
 $\therefore 15\text{cm}^3$ of N₂ form $\frac{2 \times 15}{1} = 30\text{cm}^3$
8. B 65g of zinc liberate 22.4dm³ of hydrogen
13g of zinc liberate $\frac{13 \times 22.4}{65} \text{cm}^3$
9. C Formula mass of propane 3 x 12 + 6 x 1 = 42
42 x 2g of propane produce (6 x 24) dm³
2.1g of propane produces $\frac{6 \times 24 \times 2.1}{42 \times 2} = 3.6\text{dm}^3$
10. A 24g of magnesium produce 22.4dm³
0.6g of magnesium produce $\frac{0.6 \times 22.4}{24} \text{dm}^3$
11. A Reaction equation
 $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$
2 x 22400 cm³ of oxygen react with 22400 cm³ of oxygen
80cm³ of hydrogen react with $\frac{80 \times 22400}{2 \times 22400} = 40\text{cm}^3$
Unreacted oxygen = 80 – 40 = 40 cm³
12. B 65g of produces 22.4dm³ of hydrogen
13g of zinc produce $\frac{22.4 \times 13}{65} = 4.48\text{dm}^3$
13. A (2 x 22400) cm³ of nitrogen monoxide react with 22400cm³ of oxygen
200cm³ of nitrogen monoxide will react with $\frac{22400 \times 200}{2 \times 22400} = 100\text{cm}^3$
14. A 24000cm³ of hydrogen require 1mole of zinc
60cm³ of hydrogen require $\frac{60 \times 1}{24000} = 0.0025\text{moles}$ of Zn
15. B Formula mass of $\text{CaCO}_3 = 40 + 12 + 16 \times 3 = 100$
100g of CaCO_3 produce 22400cm³ of carbon dioxide
1g of CaCO_3 produce $\frac{1 \times 22400}{100} = 224 \text{cm}^3$
16. C (2 x 84) g of NaHCO_3 produce 22.4l of carbon dioxide
21 g of NaHCO_3 produce $\frac{21 \times 22.4}{2 \times 84}$
17. A 8.4dm³ of P weigh 0.93g
22.4dm³ (or 1 mole of a gas at s.t.p) will weigh $\frac{22.4 \times 0.93}{8.4} \text{g}$

- 18 C Mass of the gas = $2.5 - 1.5 = 1.1\text{g}$
 560 cm^3 of P weigh 1.1g
 22400 cm^3 (or 1 mole of a gas at s.t.p) will weigh $\frac{22400 \times 1.1}{560}\text{g}$
- 19 C Equal moles of a gas occupy the same volume at the same temperature
Therefore, 16g of CH_4 occupy the same volume as 30g of C_2H_6
 8g of CH_4 occupies $\frac{30 \times 16}{8}$
- 20 B 560 cm^3 of P weigh 1.10g
 22400m^3 (or 1 mole of a gas at s.t.p) will weigh $\frac{22400 \times 1.10}{560}\text{g}$
- 21 D Formula mass of copper oxide, $\text{CuO} = 64 + 16 = 80$
 $(3 \times 80)\text{g}$ of CuO react with $(2 \times 22400)\text{ cm}^3$
 $\therefore 6\text{g}$ of CuO will oxidise $\frac{2 \times 22400 \times 6}{3 \times 80}\text{ cm}^3$
- 22 C Formula mass of $\text{Ca}(\text{HCO}_3)_2 = 40 + 2(1 + 12 + 16 \times 3) = 162$
 162g of $\text{Ca}(\text{HCO}_3)_2$ produce 22.4dm^3
 27g of $\text{Ca}(\text{HCO}_3)_2$ produce $\frac{27 \times 22.4}{162}\text{ dm}^3$
- 23 C 2 mole of oxygen react with 1 mole of methane
Since moles are directly proportion to volumes of gases
 40 cm^3 of oxygen react with $\frac{1 \times 40}{2} = 20\text{cm}^3$
Volume of unreacted methane = $50 - 20 = 30\text{cm}^3$
- 24 B Formula mass of $\text{NH}_4\text{Cl} = 14 + 1 \times 4 + 35.5 = 53.5\text{g}$
 22.4dm^3 of ammonia form 53.5g of NH_4Cl
 0.56gdm^3 of ammonia form $\frac{0.56 \times 53.5}{22.4}\text{g}$
- 25 C Formula mass of $\text{CuO} = 64 + 16 = 80\text{g}$
 80g of CuO is reduce by 22.4l of hydrogen
 16.0g of CuO is reduce by $\frac{22.4 \times 16}{80} = 4.48\text{dm}^3$
- 26 A Formula mass of $\text{H}_2\text{O} = 1 \times 2 + 16 = 18$
 22400 cm^3 of hydrogen produce $\frac{18}{2}\text{g}$ of H_2O
 100cm^3 of hydrogen produce $\frac{18 \times 100}{22400 \times 2} = 0.04\text{g}$
- 27 D 1mole propane react with 5mole of oxygen
 10l of propane react with $5 \times 10 = 50\text{l}$ of oxygen
- 28 A. Formula mass of $\text{CO}_2 = 12 + 16 \times 2 = 44\text{g}$
 $6 \times 44\text{g}$ of carbon dioxide require $6 \times 22.4\text{dm}^3$ of oxygen
 150g of carbon dioxide require $\frac{6 \times 22.4 \times 150}{6 \times 44} = \frac{150 \times 22.4}{44}$
- 29 B Formula mass of $\text{NaNO}_2 = 23 + 14 + 16 \times 2 = 69$
 24000 cm^3 of oxygen is produced with 2×69
 480cm^3 of oxygen is produced with $\frac{2 \times 69 \times 480}{24000} = 2.76\text{g}$
- 30 A Mass of a gas = $3.0 - 2.4 = 0.6\text{g}$
 210cm^3 contain 0.6g
 24000cm^3 contain $\frac{0.6 \times 24000}{210}$
- 31 A Formula mass of $\text{CaCO}_3 = 40 + 12 + 16 \times 3 = 100\text{g}$
 100g of CaCO_3 produce 24dm^3 of carbon dioxide
 10cm^3 of CaCO_3 produce $\frac{24 \times 10}{100}\text{ dm}^3$

- 32 B 1mole of methane produce 1 mole of CO₂ (g)
20cm³ of methane produce same volume of 20cm³ of CO₂
- 33 C 1 mole of propane react with 5 moles of oxygen
60cm³ of propane react with (5 x 60) cm³ of oxygen
But 21cm³ of oxygen is found in 100cm³ of air
∴ (5 x 60)cm³ of oxygen are contained in $\frac{100 \times 5 \times 60}{21} \text{cm}^3$
- 34 D Remember oxygen and nitrogen are diatomic gases
- 35 C
- 36 Moles of sulphuric acid
1000cm³ contain 0.5moles
20cm³ contain $\frac{0.5 \times 20}{1000} = 0.01 \text{moles}$
1mole of H₂SO₄ produce 22.4dm³ of carbon dioxide at s.t.p
0.01 mole of H₂SO₄ produce $\frac{22.4 \times 0.01}{1} = 0.22 \text{dm}^3$
- 37 2mole of SO₂(g) produce 2 mole of SO₃
∴ 20cm³ of SO₂ produce 20 cm³ of SO₃
- 38 Formula mass of CuCO₃ = 64 + 12 + 16 x 3 = 124
124g of copper carbonate produce 22.4dm³
6.2g of copper carbonate produce $\frac{22.4 \times 6.2}{124} = 1.12 \text{cm}^3$
- 39 Formula mass of silver chloride, AgCl = 108 + 35.5 = 143.5
22.4dm³ of HCl produce 143.5g of AgCl
1.2cm³ of HCl produce $\frac{143.5 \times 1.2}{22.4} = 7.6875 \text{g of silver chloride}$
40. 3(1+1)g of hydrogen produce 2 x 22.4 dm³ of ammonia
18.5g of hydrogen produce $\frac{2 \times 22.4 \times 18.5}{6} = 138.1 \text{dm}^3$
41. Formula mass of KClO₃ = 39 + 35.5 + 16 x 3 = 122.5
(122.5 x 2)g of KClO₃ produce 3 x 22.4 dm³ of oxygen at s.t.p
16g of KClO₃ produce $\frac{3 \times 22.4 \times 16}{122.5 \times 2} = 4.4 \text{dm}^3$
- 42 Formula mass of ZnS = 65 + 32 = 97g
97 x 2g of ZnS produce 2 x 24 dm³ of SO₂
9.7g of ZnS produce $\frac{2 \times 24 \times 9.7}{97 \times 2} = 2.4 \text{dm}^3 \text{ of SO}_2$

End

