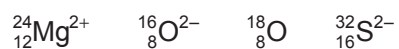


PART C Chemistry

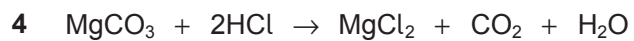
37 Consider the atoms/ions below:



Which of the following statements is/are correct?

- 1 Both ${}^{16}_8\text{O}^{2-}$ and ${}^{24}_{12}\text{Mg}^{2+}$ have the same electronic configuration.
 - 2 ${}^{32}_{16}\text{S}^{2-}$ has double the number of neutrons that are in ${}^{18}_8\text{O}$.
 - 3 The sum of the numbers of electrons in ${}^{16}_8\text{O}^{2-}$ and ${}^{18}_8\text{O}$ is equal to the number of electrons in ${}^{32}_{16}\text{S}^{2-}$.
- A none of them
- B 1 only
- C 2 only
- D 3 only
- E 1 and 2 only
- F 1 and 3 only
- G 2 and 3 only
- H 1, 2 and 3

38 Which two of the following reactions involve oxidation?



A 1 and 2 only

B 1 and 3 only

C 1 and 4 only

D 2 and 3 only

E 2 and 4 only

F 3 and 4 only

- 39** Hydrochloric acid (HCl) is a strong acid. Properties of a solution of 1.00 mol dm^{-3} hydrochloric acid include:
- 1** It turns blue litmus indicator red.
 - 2** On reaction with sodium carbonate gaseous carbon dioxide is evolved.
 - 3** 25.0 cm^3 of this acid solution neutralises 25.0 cm^3 of 1.00 mol dm^{-3} sodium hydroxide solution.

Ethanoic acid (CH_3COOH) is a weak acid.

Which of the three properties is/are also correct for a 1.00 mol dm^{-3} solution of ethanoic acid?

- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

40 Consider the following reactions:



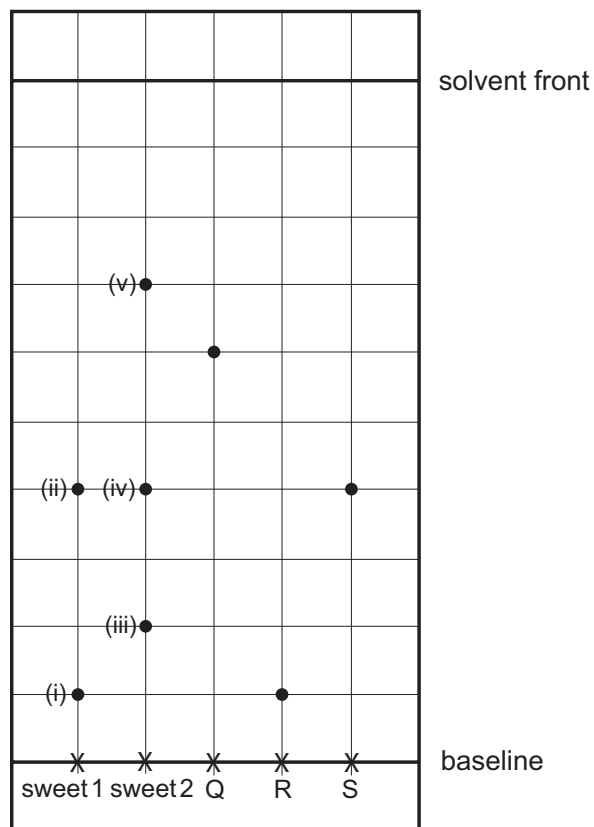
The following actions could be applied independently to each reaction (Q and R) above:

- 1 increase the pressure
- 2 increase the temperature
- 3 use a suitable catalyst

Assuming that all other conditions remain constant, which of these actions will increase the initial rate of reaction **and** increase the yield of products for **both** reactions Q and R?

- A none of them
- B 1 only
- C 1 or 2 only
- D 1 or 3 only
- E 2 only
- F 2 or 3 only
- G 3 only
- H 1, 2 or 3

- 41 Study the chromatogram below showing the spots obtained, labelled (i) to (v), from two sweets and pure samples of the food additives, labelled Q, R and S.



Which of the following statements about the chromatogram is/are correct?

- 1 Both sweet 1 and 2 contain additives R and S.
 - 2 The R_f value for spot (iv) is half that for spot (iii).
 - 3 The R_f value for spot (v) is 0.7.
- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 42 Element X has atomic number 20. Consider only the **simple oxide** of X.

Which of the following options identifies the formula, the type of bonding and the acid-base character of the oxide of element X?

	<i>formula of oxide</i>	<i>type of bonding in oxide</i>	<i>acid-base character of oxide</i>
A	X ₂ O	ionic	basic
B	X ₂ O	covalent	basic
C	XO	ionic	basic
D	XO	covalent	acidic
E	XO ₂	ionic	acidic
F	XO ₂	covalent	acidic
G	X ₂ O ₃	ionic	basic
H	X ₂ O ₃	covalent	acidic

- 43 Solid copper(II) chloride contains Cu²⁺ ions and Cl⁻ ions only.

Solid lithium phosphate(V) contains Li⁺ ions and PO₄³⁻ ions only.

Aqueous solutions of copper(II) chloride and lithium phosphate(V) are mixed to produce a precipitate of copper(II) phosphate(V) and an aqueous solution of lithium chloride.

Which of the following represents the balanced ionic equation for this process?

- A** $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$
- B** $2\text{Cu}^{2+}(\text{aq}) + 3\text{PO}_4^{3-}(\text{aq}) \rightarrow \text{Cu}_2(\text{PO}_4)_3(\text{s})$
- C** $2\text{Cu}^{2+}(\text{aq}) + 5\text{PO}_4^{3-}(\text{aq}) \rightarrow \text{Cu}_2(\text{PO}_4)_5(\text{s})$
- D** $3\text{Cu}^{2+}(\text{aq}) + 2\text{PO}_4^{3-}(\text{aq}) \rightarrow \text{Cu}_3(\text{PO}_4)_2(\text{s})$
- E** $3\text{Cu}^{2+}(\text{aq}) + 6\text{Cl}^{-}(\text{aq}) + 6\text{Li}^{+}(\text{aq}) + 2\text{PO}_4^{3-}(\text{aq}) \rightarrow \text{Cu}_3(\text{PO}_4)_2(\text{s}) + 6\text{LiCl}(\text{aq})$
- F** $3\text{CuCl}_2(\text{aq}) + 2\text{Li}_3\text{PO}_4(\text{aq}) \rightarrow \text{Cu}_3(\text{PO}_4)_2(\text{s}) + 6\text{LiCl}(\text{aq})$

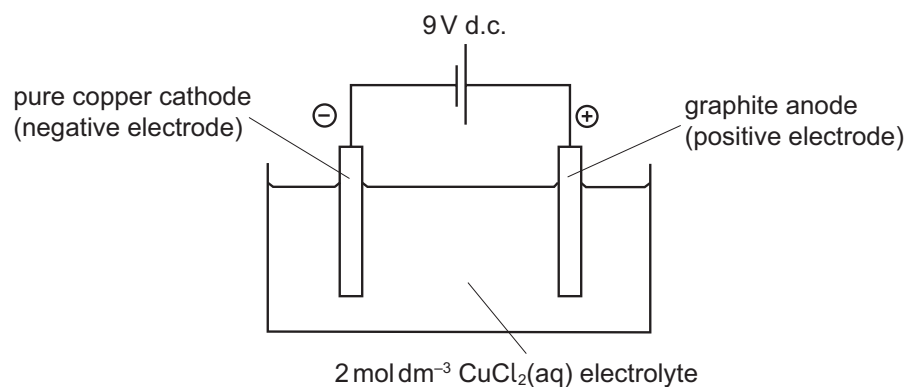
44 Which of the following statements about the reaction of lithium with water are correct?

- 1** The reaction is a redox reaction.
- 2** 7 g of lithium will react with excess water to produce 2 g of hydrogen gas.
- 3** The reaction produces a solution with a pH greater than that of water.
- 4** 14 g of lithium will exactly react with 36 g of water.

(A_r values: H = 1; Li = 7; O = 16)

- A** 1 and 2 only
- B** 1 and 4 only
- C** 1, 2 and 3 only
- D** 1, 3 and 4 only
- E** 2 and 3 only
- F** 3 and 4 only

- 45 Consider this electrochemical cell containing an aqueous copper(II) chloride electrolyte:



Which row in the following table identifies the reactions occurring at the electrodes?

	<i>cathode (negative electrode)</i>	<i>anode (positive electrode)</i>
A	$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$	$\text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-}$
B	$\text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-}$	$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$
C	$2\text{Cl}^{-}(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^{-}$	$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$
D	$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$	$2\text{Cl}^{-}(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^{-}$
E	$\text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-}$	$2\text{OH}^{-}(\text{aq}) \rightarrow \text{H}_2(\text{g}) + \text{O}_2(\text{g}) + 2\text{e}^{-}$

- 46 A fluorocarbon has a relative molecular mass which is twice that of its empirical formula mass.

81 g of the compound contains 57 g of fluorine.

What is the molecular formula of the compound?

(A_r values: C = 12; F = 19)

- A** C_2F_3
- B** C_2F_5
- C** C_3F_6
- D** C_3F_8
- E** C_4F_6
- F** C_4F_{10}

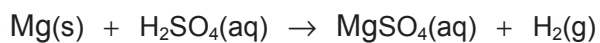
47 In which of the following reactions is there a change in volume of 24 dm^3 , when measured at room temperature and pressure?

- 1** 56 g of carbon monoxide completely reacts with an excess of oxygen
 $2\text{CO(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{CO}_2\text{(g)}$
- 2** 36 g of steam is fully decomposed
 $2\text{H}_2\text{O(g)} \rightarrow 2\text{H}_2\text{(g)} + \text{O}_2\text{(g)}$
- 3** 30 g of nitrogen monoxide completely reacts with an excess of oxygen
 $2\text{NO(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{NO}_2\text{(g)}$

(A_r values: C = 12; O = 16; H = 1.0; N = 14. Assume that one mole of gas occupies a volume of 24 dm^3 at room temperature and pressure.)

- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

48 Magnesium reacts with sulfuric acid according to the following chemical equation:



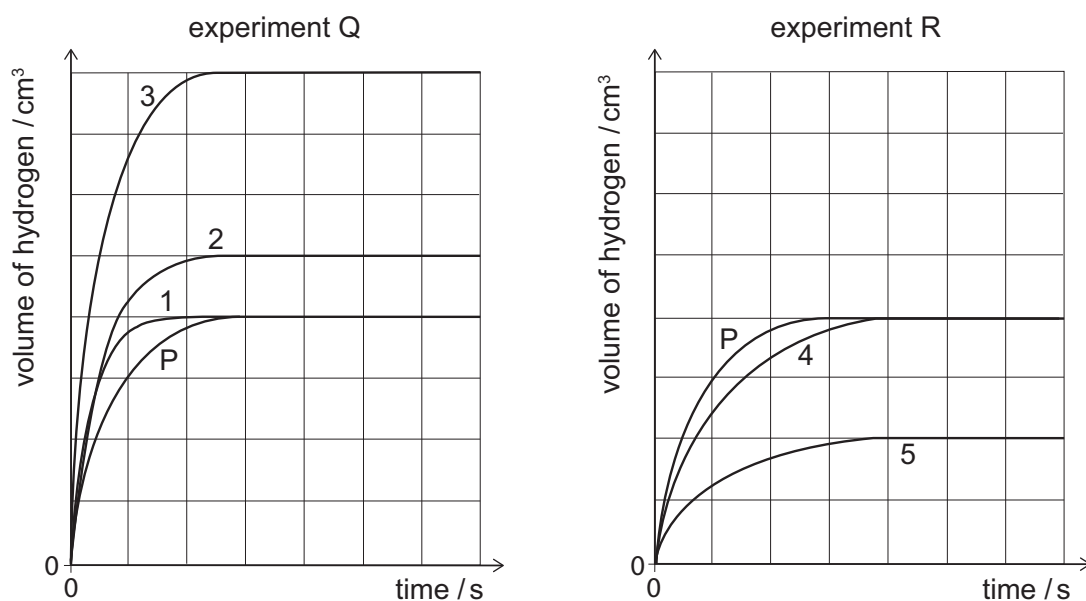
Line P on each graph shows how the volume of hydrogen formed changes with time when 1.2 g of magnesium reacts with 40 cm³ of 1.0 mol dm⁻³ sulfuric acid at 20 °C.

(*A_r* value: Mg = 24)

Two further experiments were carried out and the volumes of hydrogen formed were plotted.

Experiment Q: 1.2 g of magnesium + 40 cm³ of 2.0 mol dm⁻³ sulfuric acid at 20 °C

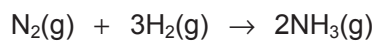
Experiment R: 1.2 g of magnesium + 40 cm³ of 0.5 mol dm⁻³ sulfuric acid at 20 °C



Which lines show how the volume of hydrogen formed will change with time in each experiment?

	experiment Q	experiment R
A	1	4
B	1	5
C	2	4
D	2	5
E	3	4
F	3	5

- 49** Nitrogen and hydrogen react together to form ammonia as shown below:



The energy released by this reaction is 93 kJ mol^{-1} .

What is the bond energy in the nitrogen molecule?

(Bond energies: $\text{H}-\text{H} = 436 \text{ kJ mol}^{-1}$; $\text{N}-\text{H} = 391 \text{ kJ mol}^{-1}$)

- A** 315 kJ mol^{-1}
- B** 513 kJ mol^{-1}
- C** 644 kJ mol^{-1}
- D** 864 kJ mol^{-1}
- E** 945 kJ mol^{-1}
- F** 1131 kJ mol^{-1}

50 Consider the following two electrolytic processes:

electrolysis of molten lead(II) chloride

electrolysis of brine (sodium chloride solution)

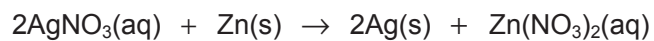
Which of the following statements is/are correct?

- 1** In both processes, reduction takes place at the negative electrode.
- 2** If 20.0 g of product is formed at the negative electrode in each process, then both processes produce the same volume of chlorine gas, measured at room temperature and pressure.
- 3** In both processes, a metal is produced at the negative electrode.

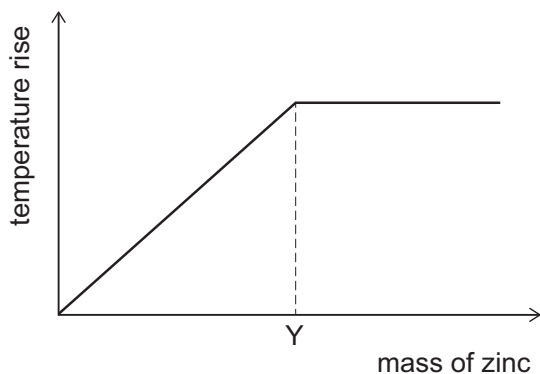
(A_r values: Cl = 35.5; H = 1.00; Na = 23.0; Pb = 207. Assume that one mole of gas occupies 24.0 dm^3 at room temperature and pressure.)

- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 51 Silver nitrate solution reacts with zinc powder in an exothermic reaction:



The graph shows the maximum temperature rise as different masses of zinc react with separate 50.0 cm^3 samples of 0.100 mol dm^{-3} silver nitrate solution.



What is the mass of zinc at the position labelled Y?

(A_r value: $\text{Zn} = 65$)

- A 0.163 g
- B 0.325 g
- C 0.650 g
- D 1.63 g
- E 3.25 g
- F 6.50 g

- 52** Natural samples of copper contain two isotopes: ^{63}Cu which has a relative isotopic mass of 62.93, and ^{65}Cu which has a relative isotopic mass of 64.93.

The relative atomic mass of a sample of elemental copper is 63.55.

What is the percentage abundance of each of the two isotopes to the nearest whole number?

- A** 27% ^{63}Cu and 73% ^{65}Cu
- B** 73% ^{63}Cu and 27% ^{65}Cu
- C** 31% ^{63}Cu and 69% ^{65}Cu
- D** 69% ^{63}Cu and 31% ^{65}Cu
- E** 36% ^{63}Cu and 64% ^{65}Cu
- F** 64% ^{63}Cu and 36% ^{65}Cu

- 53 The reaction between calcium carbonate and hydrochloric acid was used to measure the effect of changing conditions on the mass of CO₂ produced and the rate of CO₂ production.



The experiment was carried out five times with different conditions at a constant temperature.

The following conditions were varied:

CaCO₃ as chips or powder

mass of CaCO₃

volume of HCl

concentration of HCl

Which experiment (**A-E**) in the following table will produce 8.8 g of carbon dioxide in the shortest time?

(*M_r* values: CaCO₃ = 100; CO₂ = 44)

	CaCO ₃		HCl	
	<i>type</i>	<i>mass / g</i>	<i>volume / cm³</i>	<i>concentration / mol dm⁻³</i>
A	chips	10	400	2.0
B	powder	20	100	2.0
C	chips	20	200	2.0
D	powder	10	200	2.0
E	chips	20	400	1.0

- 54** An atom of ${}^1_1\text{H}$ has a radius of 0.05 nanometres.

The radius of the nucleus of this atom is approximately 50 000 times smaller.

What is the approximate radius of the nucleus in femtometres?

(1 femtometre = 10^{-15} m)

- A** 1000
- B** 100
- C** 10
- D** 1
- E** 0.1
- F** 0.01