PART C Chemistry

37 Which row in the following table gives the numbers of protons, neutrons and electrons in $^{64}_{29}Cu^{2+}$?

	number of protons	*number of neutrons*	*number of electrons*
A	27	33	27
B	27	35	29
C	29	35	27
D	29	35	29
E	31	33	29
F	31	35	29

38 The following exothermic reaction reaches equilibrium at room temperature.

$$C_2H_5OH(l) + CH_3COOH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$$

Which of the following changes, when applied independently, will alter the position of the equilibrium?

1 increasing the temperature by 25 °C

2 adding 20 cm^3 of water to the equilibrium mixture

3 adding a catalyst

4 adding an extra 0.5 mol of ethanol (C_2H_5OH)

A 1 only

B 1 and 3 only

C 1, 2 and 4 only

D 2 and 4 only

E 1, 2, 3 and 4

39 What is the overall process that takes place at the cathode (negative electrode) in the electrolysis of dilute aqueous sodium sulfate?

A $2H^+ + 2e^- \rightarrow H_2$

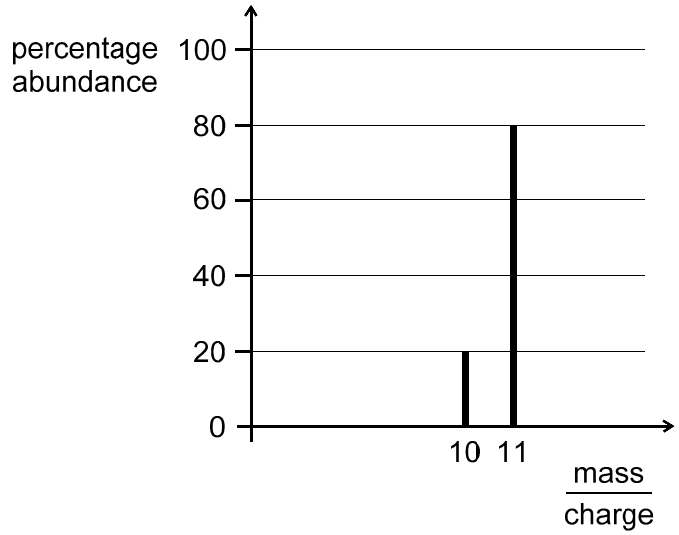
B $2O^{2-} \rightarrow O_2 + 4e^-$

C $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

D $Na^+ + e^- \rightarrow Na$

E $SO_4^{2-} \rightarrow SO_2 + O_2 + 2e^-$

40 A mass spectrum of a sample of element X with atomic number 5 is shown.



Using the data, which row in the following table best describes the position of X in the Periodic Table and the relative atomic mass of this sample of X?

	Period	*Group*	*relative atomic mass*
A	1	15	10.2
B	1	15	10.8
C	2	13	10.2
D	2	13	10.8
E	3	2	10.2
F	3	2	10.8

41 The gases nitrogen, oxygen and argon can be separated from liquefied air by fractional distillation.

Given the data in the table, in which order would the gases be collected?

	melting point / °C	*boiling point* / °C
nitrogen	−210	−196
oxygen	−218	−183
argon	−189	−186

A nitrogen, oxygen, argon

B nitrogen, argon, oxygen

C oxygen, nitrogen, argon

D oxygen, argon, nitrogen

E argon, nitrogen, oxygen

F argon, oxygen, nitrogen

42 Concentrated aqueous sodium chloride was electrolysed. After a few minutes, the remaining electrolyte solution was tested with a pH probe at 25 °C.

The gases produced at the electrodes were collected and tested with a colourless aqueous solution of sodium bromide.

Which row in the following table best describes the observations in these tests?

	pH of the remaining solution	*test of gas from anode (positive electrode)*	*test of gas from cathode (negative electrode)*
A	2	no observable change	no observable change
B	2	no observable change	orange solution forms
C	7	orange solution forms	no observable change
D	7	orange solution forms	orange solution forms
E	12	orange solution forms	no observable change
F	12	no observable change	orange solution forms

43 The following equations show the main reactions that take place in a blast furnace during the extraction of iron and the removal of the impurities:

$$C + O_2 \rightarrow CO_2$$

$$\underline{CO_2} + C \rightarrow 2CO$$

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

$$\underline{CaCO_3} \rightarrow CaO + CO_2$$

$$\underline{CaO} + SiO_2 \rightarrow CaSiO_3$$

Which row in the following table correctly identifies whether the underlined substance is oxidised, or reduced, or neither?

	CO_2	$CaCO_3$	CaO
A	oxidised	reduced	neither
B	oxidised	neither	neither
C	oxidised	reduced	oxidised
D	oxidised	neither	oxidised
E	reduced	reduced	neither
F	reduced	neither	neither
G	reduced	reduced	oxidised
H	reduced	neither	oxidised

44 X, Y and Z have the **same** electron configuration.

X is an atom, Y is a monatomic anion and Z is a monatomic cation.

Which of the following statements is **always** correct?

A Anion Y has fewer protons than atom X.

B Cation Z has more electrons than protons.

C X, Y and Z are in the same group of the Periodic Table.

D X, Y and Z have consecutive atomic numbers.

E X, Y and Z have the same mass number.

45 In the Contact process, sulfur dioxide reacts with oxygen to make sulfur trioxide in a reversible reaction.

$$SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$$

When 5.00 mol of SO_2 and 11.0 mol of O_2 are allowed to reach equilibrium at 450 °C, 80.0% of the SO_2 is converted to SO_3.

What is the volume of the resulting mixture?

(Assume that temperature and pressure are constant, and that at this temperature the volume of one mole of gas is 60.0 dm^3.)

A 240 dm^3

B 336 dm^3

C 600 dm^3

D 720 dm^3

E 840 dm^3

F 960 dm^3

46 The non-metallic element phosphorus forms two stable chlorides: PCl_3 (boiling point 76 °C) and PCl_5 (boiling point 161 °C).

Which of the following statements explain(s) the difference in boiling points?

1 There are more covalent bonds in PCl_5 so more energy is required to break them.

2 The forces between the molecules in liquid PCl_5 are stronger.

3 The covalent bonds in PCl_3 are weaker so less energy is required to break them.

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

47 A student calculated the mass of anhydrous copper(II) sulfate ($CuSO_4$) required to make 250 cm^3 of an aqueous solution of concentration 0.200 mol dm^{-3}.

However, the student mistakenly made the solution using the same mass of hydrated copper(II) sulfate ($CuSO_4 \cdot 5H_2O$) instead.

What is the concentration, in mol dm^{-3}, of the solution made with the hydrated copper(II) sulfate?

(A_r values: Cu = 64; S = 32; O = 16; H = 1.0)

A 0.128 mol dm^{-3}

B 0.160 mol dm^{-3}

C 0.180 mol dm^{-3}

D 0.200 mol dm^{-3}

E 0.223 mol dm^{-3}

F 0.313 mol dm^{-3}

48 Bromine is an element in Group 17 of the Periodic Table.

Which of the following statements is/are correct about the element bromine?

1 Bromine will oxidise chloride ions in aqueous solution to form chlorine.

2 Bromine has a lower boiling point than chlorine.

3 Bromine reacts with calcium (Group 2) to form a compound containing 80% bromine by mass.

(A_r values: Cl = 35.5; Ca = 40; Br = 80)

A none of them

B 1 only

C 2 only

D 3 only

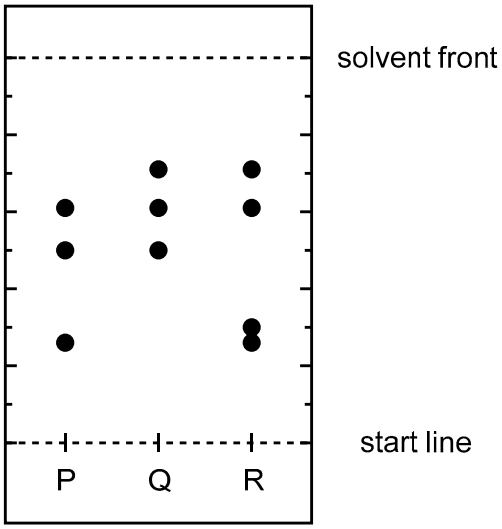
E 1 and 2 only

F 1 and 3 only

G 2 and 3 only

H 1, 2 and 3

49 Paper chromatography was used to separate three mixtures of amino acids. The mixtures were labelled P, Q and R.



Each mixture contains some of the five amino acids in the following table. The R_f values were measured for each amino acid with the solvent used to produce the chromatogram.

amino acid	R_f *value*
asparagine	0.50
glutamic acid	0.30
glycine	0.26
leucine	0.71
valine	0.61

Which of the following statements is/are correct?

1 Mixture P contains valine and glycine.

2 Leucine is found in all three mixtures.

3 Glutamic acid is the least mobile amino acid with this solvent.

4 Mixtures P and Q both contain asparagine.

A 1 and 2 only

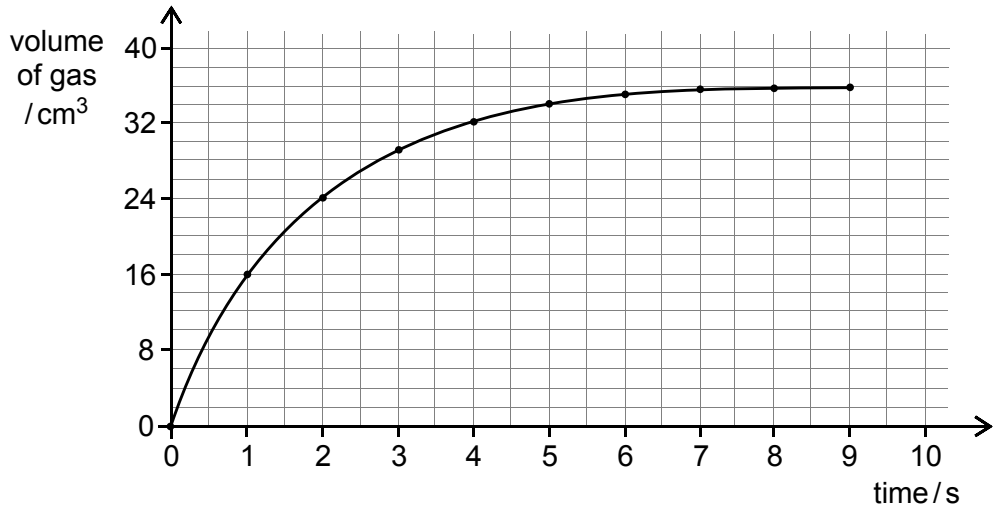
B 1 and 4 only

C 2 and 3 only

D 3 only

E 4 only

50 Dilute hydrochloric acid and magnesium were mixed and the total volume of gas released was measured over time.



What is the average rate of reaction, in $g\,s^{-1}$, with respect to the magnesium over the first **two** seconds?

(A_r value: Mg = 24. Assume that the volume of one mole of gas is $24\,dm^3$.)

A $0.012\,g\,s^{-1}$

B $0.024\,g\,s^{-1}$

C $0.048\,g\,s^{-1}$

D $12\,g\,s^{-1}$

E $24\,g\,s^{-1}$

F $48\,g\,s^{-1}$

51 Copper can react with concentrated nitric acid to form the gas nitrogen monoxide.

$$3Cu + a\,HNO_3 \rightarrow b\,Cu(NO_3)_2 + c\,H_2O + d\,NO$$

What is the value of a when the equation is balanced?

A 6

B 7

C 8

D 9

E 10

F 11

G 12

52 A small amount of a solid mixture, containing calcium carbonate and an inert substance, was added to 50.00 cm^3 dilute hydrochloric acid of concentration 0.1000 mol dm^{-3}.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

After all of the calcium carbonate had reacted, the solution was heated to drive off the carbon dioxide.

The resulting solution was neutralised by 12.50 cm^3 of 0.1000 mol dm^{-3} sodium hydroxide solution.

What was the mass of calcium carbonate in the mixture added to the hydrochloric acid?

(M_r value: $CaCO_3$ = 100.0)

A 0.06250 g

B 0.1250 g

C 0.1875 g

D 0.3750 g

E 0.6250 g

F 0.7500 g