PART C Chemistry

41 The following pairs of 0.1 mol dm^{-3} solutions are mixed separately in test tubes.

1 $AgNO_3(aq)$ with NaI(aq)

2 $Cl_2(aq)$ with NaI(aq)

3 HCl(aq) with NaOH(aq)

4 $MgCl_2(aq)$ with NaBr(aq)

Which pair(s) of solutions, when mixed, would produce a visible chemical change?

A 1 only

B 2 only

C 3 only

D 4 only

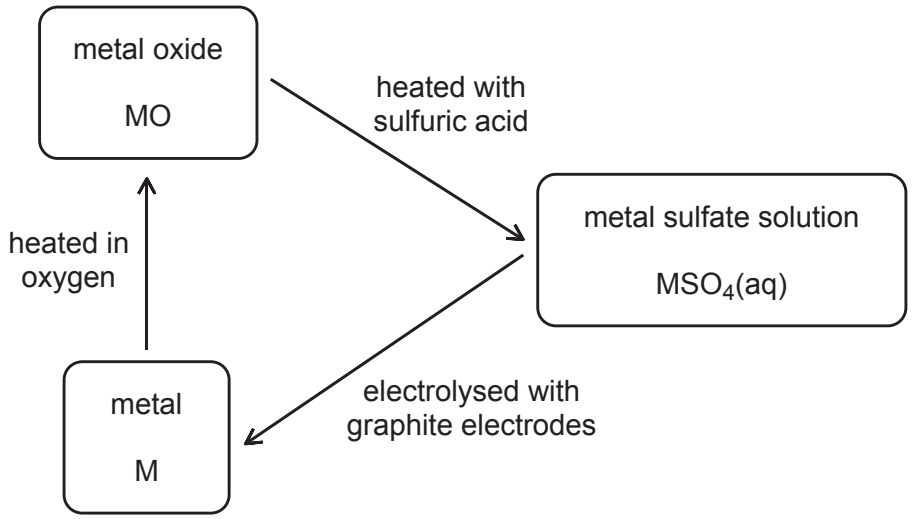
E 1 and 2 only

F 1 and 3 only

G 2 and 4 only

H 3 and 4 only

42 Some reactions of metal M and its compounds are shown in the following diagram.



Which one of the following could be the identity of metal M?

A aluminium

B copper

C magnesium

D potassium

E silver

43 Consider the following properties of compound X:

melting point	–114 °C
boiling point	–85 °C
conductivity as a solid	poor
conductivity as a liquid	poor
conductivity in aqueous solution	good

Which one of the following could be the identity of compound X?

A ammonium chloride, NH_4Cl

B barium chloride, $BaCl_2$

C hydrogen chloride, HCl

D potassium chloride, KCl

E tetrachloromethane, CCl_4

44 Which of the following statements about losing electrons is/are correct?

1 During the electrolysis of a molten binary compound the ions attracted to the cathode (negative electrode) lose electrons at that electrode.

2 Descending Group 1 of the Periodic Table from lithium to caesium, the atoms of the elements lose electrons more easily.

3 When a substance is acting as a reducing agent it loses electrons.

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

45 Which of the following chemical reactions is/are redox reactions?

1 $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

2 $PCl_5(s) + H_2O(l) \rightarrow POCl_3(l) + 2HCl(aq)$

3 $KrF_2(s) \rightarrow Kr(g) + F_2(g)$

A none of them

B 1 only

C 2 only

D 3 only

E 1 and 2 only

F 1 and 3 only

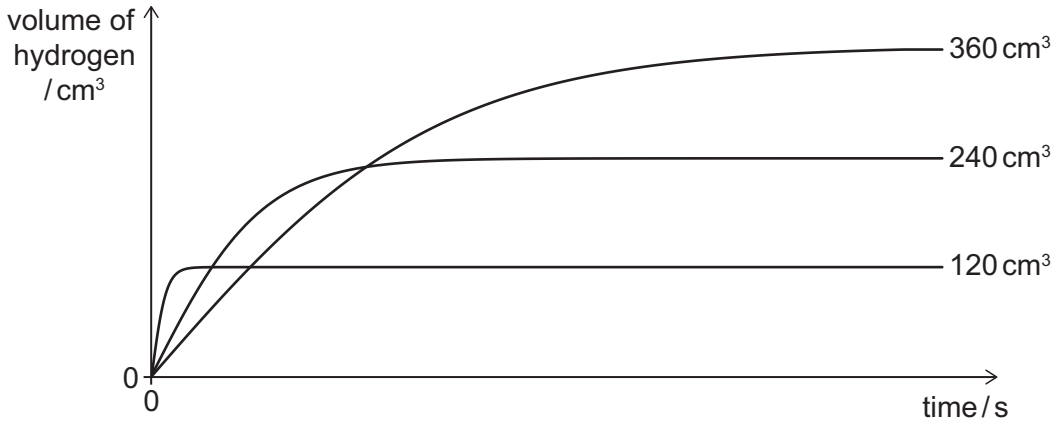
G 2 and 3 only

H 1, 2 and 3

46 Three samples of calcium of different masses were added separately to excess dilute hydrochloric acid and the volume of gas released, measured at room temperature and pressure, was monitored.

One sample was powdered calcium, one was granules of calcium, and one was a solid piece of calcium.

The results are shown on the graph.



What is the mass of powdered calcium used in this experiment?

(A_r value: Ca = 40. Assume that one mole of gas occupies a volume of 24 dm^3 at room temperature and pressure.)

A 0.200 g

B 0.400 g

C 0.600 g

D 1.20 g

E 8.00 g

F 16.0 g

G 24.0 g

47 Concentrated aqueous solutions of three compounds are electrolysed with inert electrodes.

The constituent elements of which of the following compounds may be collected using this process?

1 copper(II) bromide

2 hydrogen chloride

3 potassium chloride

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 50 cm^3 of 0.100 mol dm^{-3} hydrochloric acid has a pH of 1.0.

What is the pH of the mixture formed when 450 cm^3 of 0.010 mol dm^{-3} calcium hydroxide solution is added?

A pH = 1.0

B 1.0 < pH < 2.0

C pH = 2.0

D 2.0 < pH < 7.0

E pH = 7.0

F pH > 7.0

49 Carboxylic acid X reacts with propanol in the presence of an acid catalyst to form compound Y.

Compound Y has a relative molar mass of 116.

What is the relative molar mass (M_r) of X?

(A_r values: C = 12; H = 1; O = 16)

A 45

B 46

C 55

D 56

E 59

F 60

G 73

H 74

50 Element Z is in Group 1 of the Periodic Table.

A pure sample of element Z consists of two isotopes with mass numbers 85 and 87, and has a relative atomic mass of 85.5.

Which of the following statements is/are correct about element Z in this sample?

1 Element Z reacts with bromine to form an ionic compound with formula ZBr_2.

2 Element Z forms a basic oxide.

3 More than 70% of the atoms of element Z have mass number 85.

A none of them

B 1 only

C 2 only

D 3 only

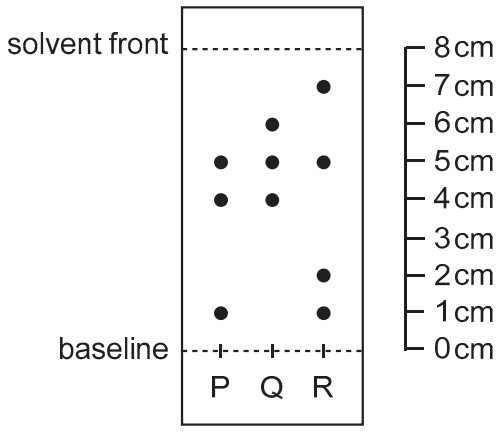
E 1 and 2 only

F 1 and 3 only

G 2 and 3 only

H 1, 2 and 3

51 Three mixtures (P, Q and R) of amino acids were separated using paper chromatography.



The test was repeated with the same mixtures, paper and solvent but this time the distance travelled by the common component of the mixtures was 7.5 cm.

How far did the most mobile component of mixture Q travel in the second test?

A 6.0 cm

B 8.5 cm

C 9.0 cm

D 9.6 cm

E 10.5 cm

F 12.0 cm

52 A typical sample of dry air is at room temperature and pressure. There is a total of 25.0 mol of gas in this sample.

One of the gases in the sample, X, contributes 1.50×10^{23} separate particles to the mixture.

A second gas in the sample, Y, would, if alone, occupy a volume of 468 dm^3 at room temperature and pressure.

What are the identities of gases X and Y, and what would be the total amount of all of the remaining gases in the sample?

(Take Avogadro's number as 6.00×10^{23}. Assume that one mole of any gas occupies a volume of 24.0 dm^3 at room temperature and pressure.)

	identity of gas X	*identity of gas Y*	*total amount of all of the remaining gases in the sample in moles*
A	Ar	N_2	5.250 mol
B	O_2	N_2	5.250 mol
C	O_2	Ar	5.250 mol
D	Ar	O_2	5.375 mol
E	Ar	N_2	5.375 mol
F	O_2	N_2	5.375 mol

53 The atomic number of fluorine is 9.

An element X forms a fluoride with the formula XF_3. Each molecule of XF_3 has 32 electrons in total.

Element X has two isotopes. One isotope has the same number of neutrons as protons and the other isotope has a number of neutrons one greater than the number of protons.

The relative abundance of the heavier isotope is 0.80 (80%).

What is the relative atomic mass of element X?

A 5.2

B 5.8

C 10.2

D 10.8

E 14.2

F 14.8

G 16.2

H 16.8

54 1 mol of compound X undergoes complete combustion to produce 144 dm^3 of carbon dioxide (measured at room temperature and pressure).

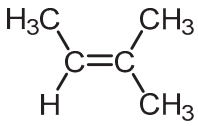
1 mol of X can also undergo an addition reaction with 1 mol of hydrogen to form a saturated compound that has one branch.

X undergoes addition polymerisation. A section of the addition polymer containing three repeating units has an M_r value greater than 200 but less than 300.

Which one of the following structural formulae could be that of compound X?

(A_r values: C = 12; H = 1; F = 19. Assume that one mole of any gas occupies a volume of 24 dm^3 at room temperature and pressure.)

A



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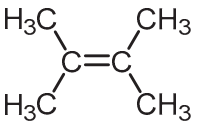

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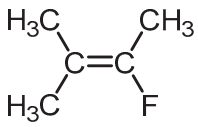

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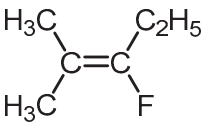
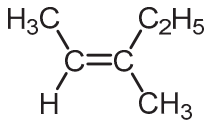


E



55 The equation shows the complete combustion of an alkane.

$$\text{alkane} + aO_2 \rightarrow bCO_2 + cH_2O$$

100 cm^3 of a gaseous alkane requires 650 cm^3 of oxygen for complete combustion. The volumes of both gases were measured at the same temperature and pressure.

What is the value of $a + b + c$?

A 10.5

B 12

C 14

D 15.5

E 17.5

F 19

56 A sample of magnesium carbonate, $MgCO_3$, was reacted completely with 50 cm^3 of 0.10 mol dm^{-3} hydrochloric acid, which is an excess.

The remaining hydrochloric acid was titrated with 0.20 mol dm^{-3} sodium hydroxide solution. 5.0 cm^3 of sodium hydroxide was required for complete neutralisation.

What was the original mass of magnesium carbonate used, in mg?

(M_r value: $MgCO_3$ = 84)

A 42 mg

B 84 mg

C 168 mg

D 210 mg

E 336 mg

F 420 mg

57 A student mixed together 30.0 cm^3 of 3.0 mol dm^{-3} hydrochloric acid and 20.0 cm^3 of 4.0 mol dm^{-3} aqueous ammonia in an insulated container.

The initial temperatures of both solutions were 20.0 °C.

The maximum temperature observed was 40.0 °C.

Assume that the specific heat capacity of any aqueous solution is 4.0 J g^{-1} $°C^{-1}$ and that the density of the reaction mixture is 1.0 g cm^{-3}.

Using this information, what is the molar enthalpy change, in kJ mol^{-1}, for the reaction of hydrochloric acid and aqueous ammonia?

A -4 kJ mol^{-1}

B -20 kJ mol^{-1}

C -25 kJ mol^{-1}

D -30 kJ mol^{-1}

E -44 kJ mol^{-1}

F -50 kJ mol^{-1}

G -75 kJ mol^{-1}

H -100 kJ mol^{-1}

58 An oxide of nitrogen can be prepared by the reaction of copper with hot nitric acid.

The other products of the reaction are copper(II) nitrate and water.

0.060 mol of copper reacted exactly with 40.0 cm^3 of 4.00 mol dm^{-3} nitric acid.

What is the empirical formula of the oxide of nitrogen produced in the reaction?

A NO

B NO_2

C NO_3

D N_2O

E N_2O_3

F N_2O_5

59 One mole of an unsaturated hydrocarbon reacts with exactly one mole of bromine to form a compound that contains $\frac{6}{15}$ carbon, $\frac{1}{15}$ hydrogen and $\frac{8}{15}$ bromine by mass.

What is the relative molar mass (M_r) of this product?

(A_r values: C = 12; H = 1; Br = 80)

A 150

B 210

C 220

D 290

E 300

F 420

G 440

H 713

60 Airbags in cars contain sodium azide (NaN_3) as a primary reagent, and potassium nitrate (KNO_3) as a secondary reagent.

The sodium azide decomposes according to the following equation to form nitrogen gas, which rapidly fills the airbag:

$$2NaN_3 \rightarrow 2Na + 3N_2$$

The sodium by-product of this first reaction then reacts with excess potassium nitrate according to this second equation:

$$10Na + 2KNO_3 \rightarrow K_2O + 5Na_2O + N_2$$

Assume that both reactions go to completion.

An airbag contains 130 g of sodium azide.

What is the total volume of nitrogen gas formed in this airbag, measured at room temperature and pressure?

(A_r values: N = 14.0; Na = 23.0. Assume that one mole of gas occupies 24.0 dm^3 at room temperature and pressure.)

A 72.0 dm^3

B 76.8 dm^3

C 84.0 dm^3

D 89.6 dm^3

E 96.0 dm^3

F 112 dm^3

G 120 dm^3

H 140 dm^3