Transition work - Mark Scheme

Activity 1 – Structure and bonding

Q1.

(a) 6 **1**

(b) 7 **1**

(c) 6 **1**

(d) C_2F_6 **1**

(e) only intermolecular forces are weak **1**

(f) spherical **1**

(g) 3 **1**

(h) giant structure

allow lattice **1**

(of atoms joined by) covalent bonds **1**

each carbon / atom forms four bonds **1**

[10]

Q2.

(a) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given. **3-4**

Level 1: Relevant points are made. They are not logically linked. **1-2**

No relevant content **0**

Indicative content

relevant points

- silver is the best electrical conductor

- aluminium is the least dense
- aluminium is the least expensive

- copper is a better conductor than aluminium
  or
  copper is almost as good a conductor as silver
- copper is much less expensive than silver

- overhead power cables need a low density metal
- wiring in homes needs to be affordable
- printed circuit boards only require small amounts of material

judgements
- use aluminium for overhead wires because of aluminium's low density and/or lower cost

- use copper for domestic wiring because copper is a very good conductor and not too expensive

- use silver only for small uses such as circuit boards due to high cost

- copper is a good compromise between electrical conductivity and cost

(b) (metals have) delocalised electrons **1**

the electrons carry (electrical) charge

ignore current / electricity for charge **1**

the electrons move through the structure / metal

ignore throughout for through **1**

(c) in alloys different sized atoms distort the layers / structure **1** (so) the movement of (delocalised) electrons is restricted

1

[9]

Q3.

(a) propane is a small molecule

allow propane is a simple molecule

1

(so) the forces between molecules are weak
or
(so) the intermolecular forces are weak

*do **not** accept covalent bonds are weak*

1

(which) require little energy to overcome

*do **not** accept answers in terms of breaking covalent bonds*

1

Q4.

(a) **M1** C_nH_{2n+2}

1

M2 14.0*n* + 2.0 or 14n + 2

or 2(7.0n + 1.0) or 2.0(7n + 1) or 2(7n + 1)

1

(b) **M1** nonane has stronger / greater / more <u>van der Waals' forces between molecules</u>

or converse arguments for 2,4-dimethylbutane having lower boiling point

question refers to nonane if not expressly stated by candidate

intermolecular forces = forces between molecules

***M1** ignore abbreviations vdW and/or imf*

1

M2 nonane molecules pack closer together / more (surface) contact

***M2** ignore reference to surface area alone*

CE=0 reference to breaking (covalent) bonds / breaking chain

1

Q5.

(a) Strongest: $SrCl_2$ > ICl > Br

If wrong can award 1 for one in the correct 'position'

2

$SrCl_2$ <u>strong ionic</u> bonds / <u>(strong</u> electrostatic attraction between opposite ions)

1

Lattice so <u>many</u> strong bonds to overcome

1

Both ICl and Br_2 have intermolecular forces:

ICl has (dipole-dipole) weak intermolecular forces between molecules – weaker than ionic bonds, but stronger than those in Br_2

1

Br_2 has (van der Waals) **very** weak intermolecular forces between molecules – much weaker than those in ICl.

Accept answers related to London / dispersion / induced dipole forces

1

Activity 2 – Quantitative chemistry

Question	Answer
What is the equation that links mass, molecular mass and moles?	$mass = moles \times M_R$ $moles = \frac{mass}{M_R}$ $M_R = \frac{mass}{moles}$
What is the equation that links mass, concentration and volume?	$mass = concentration \times volume$ $concentration = \frac{mass}{volume}$ $volume = \frac{mass}{concentration}$
What is the equation that links moles, volume and concentration?	$moles = concentration \times volume$ $concentration = \frac{moles}{volume}$ $volume = \frac{moles}{concentration}$
What is Avogadro's number? What does it mean?	6.022×10^{23} The number of particles (atoms, molecules, ions) in one mole of a substance.
What is the equation for percentage yield?	$\%\ yield = \frac{actual\ mass}{theoretical\ mass} \times 100$
What is the equation for atom economy?	$\%\ atom\ economy = \frac{M_R\ of\ desired\ product}{total\ M_R\ of\ all\ reactants} \times 100$
What is the fundamental difference between atom economy and percentage yield?	% yield = how much product you get in relation to reactants – mass or moles. Atom economy = measure of the efficiency of a reaction – determines how much waste is produced.

What is the equation used in a bond energy calculation?	$\Delta H = reactants - products$ $\Delta H = bonds\ broken - bonds\ formed$

Question	Answer (Show working)
1m into mm	1 x 100 x 10 = 1000
0.5dm^3 into cm^3	0.5 x 1000 = 500
1.72 tonnes into g	1.72 x 1 million = 1.72×10^6
2034000cm^3 into m^3	2034000 ÷ 10^6 = 2.034
374 K into ^{o}c	374 – 273 = 101
134mg into g	134 ÷ 1000 = 0.134
-12.3^{o}c into K	-12.3 + 273 = 261.7
101kPa into Pa	101 x 1000 = 101000

Question	Answer
Round 2748493 to 3 significant figures	2750000
Round 0.3748596 to 3 significant figures	0.375
Round 0.00003465 to 3 significant figures	0.0000347
Round 35.65545 to 2 decimal places	35.66
Round 0.000094 to 1 decimal place	0.00009
Give ⅜ as a decimal to 2 significant figures	0.38
Give ⅞ as a decimal to 2 decimal places	0.88
Give the following values to the same **appropriate precision:** 0.012, 0.0134, 0.00145	0.012, 0.013, 0.015 Appropriate precision means to the accuracy of **the lowest significant figures** provided. 0.012 is to 2sf, so all numbers should be rounded to match.

Q1.

(a)

(percentage =)

$$\frac{63.5}{159.5} \times 100$$

= 39.81191 (%)

1

= 39.8 %

allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses both the values in the question

1

(b) (conversion 25 cm^3 =) 0.025 dm^3

1

(concentration =) $\frac{6.75}{0.025}$ (g/dm^3)

allow correct use of an incorrectly determined or unconverted volume

1

= 270 (g/dm^3)

1

Q2.

(a) (percentage atom economy =) $\frac{48}{80} \times 100$

1

= 60 (%)

1

(b) (conversion)

(800 cm^3 = $\frac{800}{1000}$ =) 0.8

1

(dm^3)

allow correct use of incorrect / no volume conversion

1

(mass =) 0.8 × 258 (g)

1

= 206.4 (g)

= 206 (g)

allow an answer correctly calculated to 3 significant figures from an incorrect calculation which uses the values in the question

1

(c)

$$92.8 = \frac{\text{mass produced}}{12.5} \times 100$$

allow mass produced =

$$\%\ \text{yield} \times \frac{\text{max theoretical mass}}{100}$$

1

(mass produced) = $\frac{92.8}{100} \times 12.5$

1

= 11.6 (g)

1

Q3.

(a) (3 × M_r H_2O = 3 × (2 + 16) =) 54

(A_r **R** = 150 – 54 =) 96

ignore units

1

alternative approach:

(M_r **R**O_3 = 150 – 6 =) 144 (1)

(A_r **R** = 144 – (3 × 16) =) 96 (1)

ignore units

1

(b) **(R** =) molybdenum / Mo

*allow ecf from question **(a)***

1

Q4.

(a) $2\,Fe + 3\,Cl_2 \rightarrow 2\,FeCl_3$

1

(b) $1\,Fe^{2+} : 2\,Fe^{3+} : 4\,O^{2-}$

1

(c) (M_r Fe_3O_4 =) 232

1

$$(\%\ Fe =)\ \frac{3 \times 56}{232} \times 100$$

allow $\frac{168}{232} \times 100$

allow correct use of an incorrectly determined M_r using the values of A_r given in the question

1

= 72.4 (%)

allow 72.41379 correctly rounded to at least 2 significant figures

1

(d) (40.0 kg =) 40 000 (g)

*a maximum of **4** marks can be awarded for a method which determines and uses the volume of iron oxide as a gas*

1

$$(\text{moles } Fe_2O_3 = \frac{40\,000}{160} =)\ 250$$

allow correct use of an incorrectly converted or unconverted mass

1

$$(\text{moles } CO_2 = 250 \times \frac{3}{2} =)\ 375$$

allow correct use of an incorrectly determined number of moles of Fe_2O_3

1

(volume of CO_2 =) 375 × 24

allow correct use of an incorrectly determined number of moles of CO_2

1

= 9000 (dm^3)

1

Q5.

(a) (volume = 39 − 25 =) 14 (cm^3)

1

(14 cm^3 =) 0.014 (dm^3)

allow correct use of an incorrectly determined volume

1

(moles of hydrogen =)

$$\frac{0.014}{24}$$

allow correct use of an incorrectly determined volume

allow correct use of an incorrect / no conversion of volume

1

= 5.8 x 10^{-4} (mol)

allow 5.833333 x 10^{-4} correctly rounded to at least 2 significant figures

allow 0.00058 (mol)

1

alternative approach 1:

(24 dm^3 =) 24 000 (cm^3) (1)

(volume = 39 − 25 =)
14 (cm^3) (1)

(moles of hydrogen =)

$$\frac{14}{24000}\ (1)$$

allow correct use of an incorrectly determined volume

allow correct use of an incorrect / no conversion of volume

= 5.8 x 10^{-4} (mol) (1)

allow 5.833333 x 10^{-4} correctly rounded to at least 2 significant figures

allow 0.00058 (mol)

alternative approach 2:

($24\ dm^3$ =) 24 000 (cm^3) (1)

(moles of hydrogen at 100 s =

$\frac{39}{24000}$ =) 0.001625

allow correct use of an incorrect / no conversion of volume

and

(moles of hydrogen at 40 s =

$\frac{25}{24000}$ =) 0.00104 (1)

(moles 100 s – moles 40 s =)
0.001625 – 0.00104 (1)

allow correct use of an incorrectly determined number of moles

= 5.8×10^{-4} (mol) (1)

allow 5.833333×10^{-4} correctly rounded to at least 2 significant figures

allow 0.00058 (mol)

alternative approach 3:

($39\ cm^3$ =) 0.039 (dm^3)
and
($25\ cm^3$ =) 0.025 (dm^3) (1)

(moles of hydrogen at 100 s =
$\frac{0.039}{24}$ =) 0.001625

allow correct use of an incorrect / no conversion of volume

and

(moles of hydrogen at 40 s =
$\frac{0.025}{24}$ =) 0.00104 (1)

(moles 100 s – moles 40 s =)
0.001625 – 0.00104 (1)

allow correct use of an incorrectly determined number of moles

= 5.8×10^{-4} (mol) (1)

allow 5.833333×10^{-4} correctly rounded to at least 2 significant figures *allow 0.00058 (mol)*

(b) tangent drawn at 45 s

1

correct values for *y* step **and** *x* step from tangent

allow correct use of an incorrectly drawn tangent

allow a tolerance of ± ½ a small square for each coordinate

1

$$(\text{rate} =)\ \frac{\text{value for } y \text{ step}}{\text{value for } x \text{ step}}$$

allow correct use of incorrectly determined value(s) from the tangent for y step and/or x step

1

correct calculation of rate (mol/s)

1

rate given in standard form (mol/s)

allow a correctly calculated answer in standard form from an incorrect attempt at rate determination

1

Q6.

(a)

$$(\text{volume of HCl} = \frac{0.0045}{0.15})$$
$$= 0.030\ (\text{dm}^3)$$

1

(conversion 0.030 dm^3 =)
30 (cm^3)

allow correct conversion of an incorrectly determined volume in dm^3

1

Q7.

(a) **M1** Abundance of $^{87}Sr = X$

and Abundance of $^{86}Sr = 1 - 0.83 - X$

$= 0.17 - X$

Allow M1 for

*Abundance of $^{87}Sr = X$ and Abundance of $^{86}Sr = Y$ **if** also states that $X + Y = 17$*

M2 $87.73 = (88 \times 0.83) + (87 \times X) + (86 \times (0.17 - X))$

$87.73 = (88 \times 0.83) + (87 \times X) + (86 \times Y)$

$87.73 = 73.04 + 87X + 14.62 - 86X$

$87.73 = 87.66 + X$

M3 $^{87}Sr = 0.07 = 7\ \%$

M4 Abundance of $^{86}Sr = 1 - 0.83 - 0.07 = 0.1 = 10\ \%$

$M4 = 17 - M3$

4

(b) **M1** Amount of HCl added = 0.200 × 0.040 = 0.00800 mol

M2 Amount of NaOH = 0.100 × 0.02925 = 0.002925 mol

(Amount of HCl = 0.002925 mol)

M3 Amount of HCl reacted with $Mg(OH)_2$ = 0.00800 - 0.002925 = 0.005075 mol

M3 = M1 - M2

M4 Amount of $Mg(OH)_2$ = 0.005075 ÷ 2 = 0.0025375 mol

M4 = M3 ÷ 2

M5 Mass of $Mg(OH)_2$ = 58.3 × 0.0025375 = 0.148 g

M5 = M4 × 58.3

M6 % by mass = $\frac{0.148}{0.200}$ × 100 = 74.0 %

M6 = $\frac{M5}{0.200}$ *× 100*

Do not allow M6 if >100%

6

Activity 3 – Symbol equations

1. $2\ H_2 + 1\ O_2 \rightarrow 2\ H_2O$
2. $2\ Na + 1\ Cl_2 \rightarrow 2\ NaCl$
3. $1\ N_2 + 3\ H_2 \rightarrow 2\ NH_3$
4. $2\ Mg + 1\ O_2 \rightarrow 2\ MgO$
5. $2\ Al + 3\ Br_2 \rightarrow 2\ AlBr_3$
6. $2\ K + 2\ H_2O \rightarrow 2\ KOH + 1\ H_2$
7. $1\ Ca + 2\ HCl \rightarrow 1\ CaCl_2 + 1\ H_2$
8. $4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$
9. $1\ C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$
10. $1\ Zn + 2\ HNO_3 \rightarrow 1\ Zn(NO_3)_2 + 1\ H_2$
11. $2\ NaOH + 1\ H_2SO_4 \rightarrow 1\ Na_2SO_4 + 2\ H_2O$
12. $4\ NH_3 + 3\ O_2 \rightarrow 2\ NO + 6\ H_2O$
13. $2\ Al + 6\ HCl \rightarrow 2\ AlCl_3 + 3\ H_2$
14. $1\ Pb(NO_3)_2 + 2\ KI \rightarrow 1\ PbI_2 + 2\ KNO_3$
    x = KNO_3
15. $1\ CH_4 + 4\ Cl_2 \rightarrow 1\ CCl_4 + 4\ HCl$
16. $1\ Na_2CO_3 + 2\ HCl \rightarrow 2\ NaCl + 1\ H_2O + 1\ CO_2$
17. $1\ C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$
18. $2\ HNO_3 + 1\ Ca(OH)_2 \rightarrow 1\ Ca(NO_3)_2 + 2\ H_2O$
19. $6\ FeSO_4 + 1\ K_2Cr_2O_7 + 7\ H_2SO_4 \rightarrow 3\ Fe_2(SO_4)_3 + 1\ Cr_2(SO_4)_3 + 1\ K_2SO_4 + 7\ H_2$
    x = H_2O
20. $1\ C_2H_5OH + 3\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$
21. $1\ Cu + 4\ HNO_3 \rightarrow 1\ Cu(NO_3)_2 + 2\ NO_2 + 2\ H_2O$
    x = H_2O