1 **(a)** compounds are highly coloured **[1]**
used as catalysts **[1]**
more than one oxidation state **[1]**
Four boxes ticked that include three correct choices [2]
Four boxes ticked that include two correct choices [1]
Four boxes ticked that include one correct choices [0]
Five boxes ticked [0]

(b) period 4 **[1]**

(ii) 26*p* and 30*n* **[1]**

(c) limestone **[1]**

(ii) slag **[1]**

(iii) iron ore **[1]**

(d) to burn **or** provide heat **[1]**
to make carbon monoxide **[1]**

(e) mild steel cars **or** machinery **or** fridges etc. **[1]**
stainless steel cutlery **or** chemical plants etc. **[1]**

[TOTAL = 12]

2 **(a)** protons 2
electrons 2
neutrons 4 [3]

(b) **(i)** $La^{3+} + 3e- = La$ [1]
(ii) hydrogen [1]
bromine NOT Bromide [1]
caesium hydroxide [1]
ignore any comments about electrodes

(c) metal hydroxide or hydroxide ions [1]
hydrogen [1]

(d) correct formula 1Ba to 2Cl
charges correct
8e around the anion
All three points [2]
Two points ONLY [1]
If covalent [0] out [2]

(e) alternating (positive and negative) [1]
pattern [1]

(f) **(i)** barium - oxygen or ionic [1]
(ii) bond forming energy released/exothermic [1]
bond breaking energy taken in/endothermic [1]
more energy released [1]

TOTAL = 17

3 (a) (i) high densities
high fixed points mp or bp
coloured compounds
hardness
complex ions
ANY three [3]

(ii) 13 [1]

(b) (i) manganese chloride [1]
water [1]

(ii) manganese(III) **and** (IV) oxides [1]

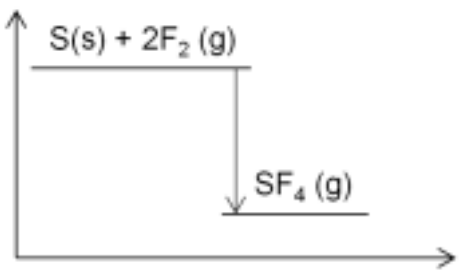
(c) (i) rate decreases **or** becomes zero [1]
do **NOT** accept rate increases then decreases
COND concentration decreases [2]
hydrogen peroxide used up **ONLY** [1]

(ii) steeper initial gradient [1]
double final volume [1]

(iii) initial gradient less [1]
final volume the same [1]
must relate to shape of graph

TOTAL=14

Question	Answer	Marks
4(a)	number of moles of $NaNO_3$ used: 3.40 / 85 = 0.04(00) (mol) **OR** 4.(00) × 10 ^{2} (mol); number of moles of O_2 formed: 0.04 / 2 = 0.02(00) (mol) **OR** 2.(00) × 10 ^{2} (mol); volume of O_2 formed: 0.02 × 24 = 0.48 (dm^3);	**3**
(b)(i)	(a substance which is) a proton / H^+ / hydrogen ion acceptor;	**1**
(b)(ii)	$Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$ $Mg(OH)_2$; rest of equation;	**2**
(c)	**M1** add a *named* acid, e.g. HC*l* **and** a named alkali, e.g. NaOH; **M2** A*l*$_2O_3$ will react with / neutralises both reagents; **M3** and so it will dissolve into the reagent / form a solution;	**3** 1 1 1
(d)(i)	cov	**1**
(d)(ii)	any 2 from: high melting point / high boiling point; poor conductor (of electricity); hard; insoluble;	**2**
(e)(i)	**M1** (electrostatic) attraction; **M2** between oppositely charged ions;	**2** 1 1
(e)(ii)	$_3(PO_4)_2$;	**1**

Question	Answer	Marks
(f)(i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; **M2** *label of product mark*: SF_4; **M3** *correct direction of vertical heat of reaction arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head;	**3** 1 1 1
(f)(ii)	**M1** *bond energy of $2F_2$*: 2 × F–F = 2 × 160 = 320 (kJ / mol); **M2** *bond energy of all bonds in SF_4*: 780 + 320 = 1100 (kJ / mol); **M3** *calculated bond energy of SF_4 divided by 4*: 1100 / 4 = 275 (kJ / mol);	**3** 1 1 1
(g)(i)	bacteria;	**1**
(g)(ii)	name of compound: cobalt(II) chloride; from: blue; to: pink;	**3** 1 1 1
(h)(i)	it has a complete outer shell / a full outer shell / 8 electrons in the outer shell;	**1**
(h)(ii)	lamps;	**1**