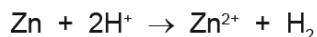


## 7.4 Redox

01.0620\_s15\_qp\_31 Q: 3

(a) The reactions between metals and acids are redox reactions.

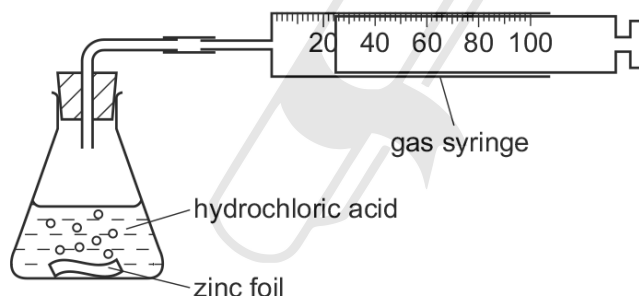
(i) Which change in the above reaction is oxidation, Zn to  $\text{Zn}^{2+}$  or  $2\text{H}^+$  to  $\text{H}_2$ ? Give a reason for your choice.

.....  
 ..... [2]

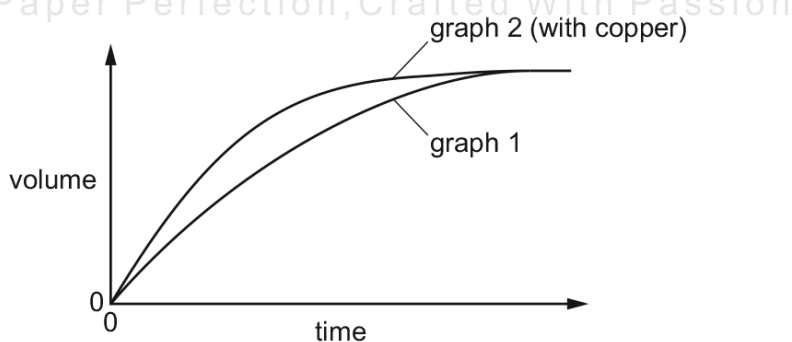
(ii) Which reactant in the above reaction is the oxidising agent? Give a reason for your choice.

.....  
 ..... [2]

(b) The rate of reaction between a metal and an acid can be investigated using the apparatus shown below.



A piece of zinc foil was added to  $50 \text{ cm}^3$  of hydrochloric acid, of concentration  $2.0 \text{ mol/dm}^3$ . The acid was in excess. The hydrogen evolved was collected in the gas syringe and its volume measured every minute. The results were plotted and labelled as graph 1.



The experiment was repeated to show that the reaction between zinc metal and hydrochloric acid is catalysed by copper. A small volume of aqueous copper(II) chloride was added to the acid before the zinc was added. The results of this experiment were plotted on the same grid and labelled as graph 2.

7.4. REDOX

- (i) Explain why the reaction mixture in the second experiment contains copper metal. Include an equation in your explanation.

.....  
..... [2]

- (ii) Explain how graph 2 shows that copper catalyses the reaction.

.....  
.....  
..... [3]

- (c) If the first experiment was repeated using ethanoic acid,  $\text{CH}_3\text{COOH}$ , instead of hydrochloric acid, how and why would the graph be different from graph 1?

.....  
.....  
.....  
..... [4]

- (d) Calculate the maximum mass of zinc which will react with  $50\text{ cm}^3$  of hydrochloric acid, of concentration  $2.0\text{ mol/dm}^3$ .



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[3]

[Total: 16]

02. 0620\_s15\_qp\_32 Q: 3

Calcium reacts with nitrogen to form the ionic compound calcium nitride,  $\text{Ca}_3\text{N}_2$ .

- (a) Draw a diagram, based on the correct formula, which shows the charges on the ions and the arrangement of the electrons around the negative ion.

Use o to represent an electron from a calcium atom.

Use x to represent an electron from a nitrogen atom.

[3]

- (b) In the lattice of calcium nitride, the ratio of calcium ions to nitride ions is 3 : 2.

- (i) What is meant by the term *lattice*?

.....  
 ..... [2]

- (ii) In terms of ionic charges, explain why the ratio of ions is 3 : 2.

.....  
 ..... [2]

- (c) The reaction between calcium and nitrogen to form calcium nitride is a redox reaction.

In terms of electron transfer, explain why calcium is the reducing agent.

.....  
 .....  
 .....  
 ..... [3]

[Total: 10]

01. 0620\_s15\_ms\_31 Q: 3

|         |   |   |   |
|---------|---|---|---|
| (a)(i)  | Zn to Zn <sup>2+</sup> ;<br>because electron loss;  | 2 | A because oxidation number has increased for M2   |
| (a)(ii) | (2)H <sup>+</sup> or 'hydrogen ion(s)';<br>it accepts electrons or takes electrons (from zinc atoms);   | 2 | R H <sub>2</sub> or 'hydrogen'<br>A because it is reduced or because it decreases in oxidation number<br>A it causes zinc to lose electrons   |
| (b)(i)  | zinc displaces copper or zinc more reactive than copper;<br><br>Zn + CuCl <sub>2</sub> → ZnCl <sub>2</sub> + Cu<br>OR Zn + Cu <sup>2+</sup> → Cu + Zn <sup>2+</sup> ;   | 2 | A copper less reactive than zinc<br>I zinc reacts with copper ions or with Cu <sup>2+</sup> or with copper chloride<br>I zinc reacts with copper<br>I Cu <sup>2+</sup> ions are reduced<br><br>A multiples<br>I state symbols                                     |
| (b)(ii) | steeper (line) or higher gradient;<br>(means an) increased rate;<br><br>but the same (final) volume;  | 3 | A less time to complete the reaction / same amount of gas in less time / faster reaction / more gas in the same time period<br><br>A same volume of hydrogen produced<br>A 'amount' for volume<br>A no extra gas is made  |
| 3(c)    | M1 less steep (line) or lower gradient;<br>M2 (because of) decreased rate;<br><br>M3 ethanoic is a weak(er) acid;<br><br>M4 only partially ionised or dissociated<br>OR lower concentration of hydrogen ions; | 4 | A alternative phrases e.g. 'shallower'<br><br>A more time to complete the reaction<br>A same amount of gas in more time<br>A slower rate or slower reaction<br><br>ORA<br>A not fully dissociated or ionised<br>A ionises less (than HCl)<br>I less hydrogen ions |
| (d)     | M1 moles of HCl = 0.1 (mol);<br>M2 moles of Zn = 0.05 (mol);<br>mass of zinc = 3.25 g;  | 3 | A ECF for M1 × ½<br><br>A ECF for M2 × 65<br>Unit required for M3   |

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|         |  |  |
|---------|--|--|
| (a)     | <p>M1<br/>both correct charges of ions (calcium 2+ and nitrogen 3-);</p> <p>M2<br/>8 electrons around nitrogen (can be 3 dots and 5 crosses or 5 crosses and 3 dots or all dots or all crosses, but reject any other combinations of dots and crosses);</p> <p>M3<br/>Two electrons on the inner shell on any nitride ions/nitrogen atom: allow 2x or 2o once;</p>   | <p>Charges can be shown anywhere<br/>I missing symbols for nitrogen<br/>R wrong symbol of nitrogen <b>anywhere</b></p> <p>A if electron configuration of nitride is given as 2,8 or N is given as 2,5<br/>I any missing inner shells as long as one is present</p> <p>3 <i>General guidance:</i><br/>I electron configuration /symbol of calcium ion<br/>I formulae/stoichiometry<br/>Covalent can score <b>only</b> M3</p>  |
| (b)(i)  | <p>regular /repeated /pattern /framework /periodic /ordered /altemating /organised;</p> <p>(of)particles /atoms /molecules /ions /cations /anions;</p>   | <p>I layers</p> <p>2 A ionic /molecular /atomic<br/>I arrangement /bonding /properties</p>   |
| (b)(ii) | <p>M1<br/>(so that ionic) charges balance or cancel / charge = 0 /no charge /number of positive = number of negative charges /charge is neutral or neutralised;</p> <p>M2<br/><math>3(-) \times 2 = 2(+) \times 3</math> ;</p>   | <p>A <math>6(+) = 6(-)</math></p> <p>2 I statements about electron transfer /valency /ox state unless valency is referring to ionic charges e.g. valencies 3+ and 2- can get credit if used properly<br/>Ratio of ions is 3:2 therefore ratio of charges is 2:3 scores 2</p>   |
| (c)     | <p>it (refers to Ca) /Calcium /Ca (atom) loses /gives /donates electrons /e /e<sup>-</sup> ;</p> <p>(these are) gained by nitrogen /N /N<sub>2</sub> ;</p> <p>nitrogen /N /N<sub>2</sub> is reduced so calcium /Ca is the reducing agent (these two statements could be split i.e. not in same sentence)<br/><b>OR</b> reducing agents are electron donors /give /lose electrons<br/><b>OR</b> calcium /Ca is oxidised (by electron loss) therefore calcium is the reducing agent (these two statements could be split i.e. not in same sentence);</p> | <p>A half-equation with electrons on right-hand side<br/>R calcium ion /Ca<sup>2+</sup></p> <p>A half-equation with electrons on left-hand side<br/>R nitride ion /N<sup>3-</sup><br/>I numbers of electrons /charges on ions /oxidation state /valency if mentioned<br/>R reference to oxygen /hydrogen if there is a suggestion that oxygen /hydrogen are involved in the reaction<br/>I reference to oxygen /hydrogen if in general statement e.g. oxidation is gain of oxygen</p> <p>Electrons /e /e<sup>-</sup> move from calcium to nitrogen<br/>get marks 1 and 2</p> <p>A calcium /Ca /it is a reductant or calcium /Ca /it reduces</p> <p>3</p> |