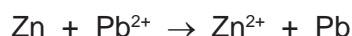


SIMPLE CELLS

1 The reactivity series shows the metals in order of reactivity.

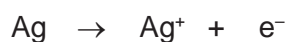
- (a) The reactivity series can be established using displacement reactions. A piece of zinc is added to aqueous lead nitrate. The zinc becomes coated with a black deposit of lead.



Zinc is more reactive than lead.

The reactivity series can be written as a list of ionic equations.

..... \rightarrow + most reactive metal: the best reductant (reducing agent)



- (i) In the space at the top of the list, write an ionic equation for a metal which is more reactive than zinc. [1]

- (ii) Write an ionic equation for the reaction between aqueous silver(I) nitrate and zinc. [2]

..... [2]

- (iii) Explain why the positive ions are likely to be oxidants (oxidising agents). [1]

..... [1]

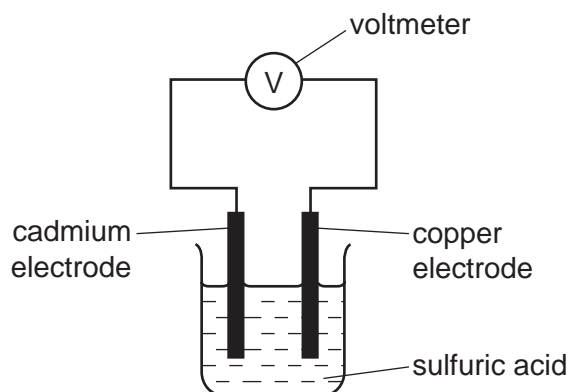
- (iv) Deduce which ion is the best oxidant (oxidising agent). [1]

..... [1]

- (v) Which ion(s) in the list can oxidise lead metal? [1]

..... [1]

(b) A reactivity series can also be established by measuring the voltage of simple cells. The diagram shows a simple cell.



Results from cells using the metals tin, cadmium, zinc and copper are given in the table below.

cell	electrode 1 positive electrode	electrode 2 negative electrode	voltage / volts
1	copper	cadmium	0.74
2	copper	tin	0.48
3	copper	zinc	1.10

Write the four metals in order of increasing reactivity and explain how you used the data in the table to determine this order.

.....

.....

..... [3]

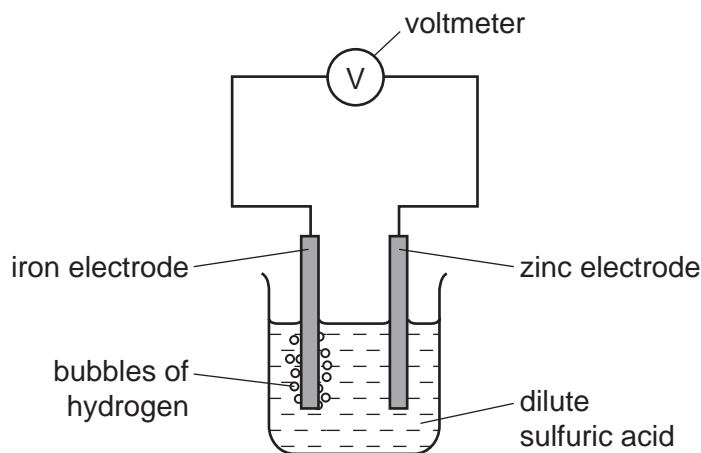
[Total: 9]

MARKING SCHEME:

- (a) (i) any metal above zinc
 $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^{-}$ [1]
- (ii) $\text{Zn} + 2\text{Ag}^{+} \rightarrow \text{Zn}^{2+} + 2\text{Ag}$ [2]
Note: not balanced only [1]
- (iii) because they can accept or gain electrons / change into atoms or can be reduced [1]
- (iv) Ag^{+} or silver [1]
charge not essential but if given must be correct
- (v) Ag^{+} and Cu^{2+} or silver and copper [1]
charge not essential but if given must be correct
- (b) Cu Sn Cd Zn (*i.e. all 4 in correct order*) [1]
relates order to voltage [1]
- one relevant comment from: [1]
- higher reactivity metals are the negative electrode / copper is least reactive because it is the positive electrode because copper would have the lowest voltage / copper cell $V = 0$ / the bigger the difference in reactivity, the bigger the voltage / zinc has highest voltage because it is most reactive / more reactive metals have higher voltage

[Total: 9]

2 The diagram shows a simple cell.



(a) Write an equation for the overall reaction occurring in the cell.

..... [2]

(b) Explain why all cell reactions are exothermic and redox.

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

(c) Which electrode, zinc or iron, is the negative electrode? Give a reason for your choice.

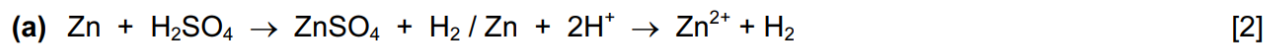
.....
..... [2]

(d) Suggest **two** ways of increasing the voltage of this cell.

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

[Total: 9]

MARKING SCHEME:



marks are for correct reactants [1] correct products [1]
If ionic equation is given don't penalise SO_4^{2-} spectator ions on both sides

(b) (exothermic because) a cell produces (electrical) energy/electricity [1]

the next two marks score for

electrons are lost **AND** gained / oxidation no. or state/valency **both** increases and decreases
/ two correct half equations i.e. $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$ and $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ [2]

(c) zinc [1]

cond it is the more reactive metal / it supplies electrons / it forms ions more readily than iron [1]

(d) replace zinc with magnesium

replace iron with copper

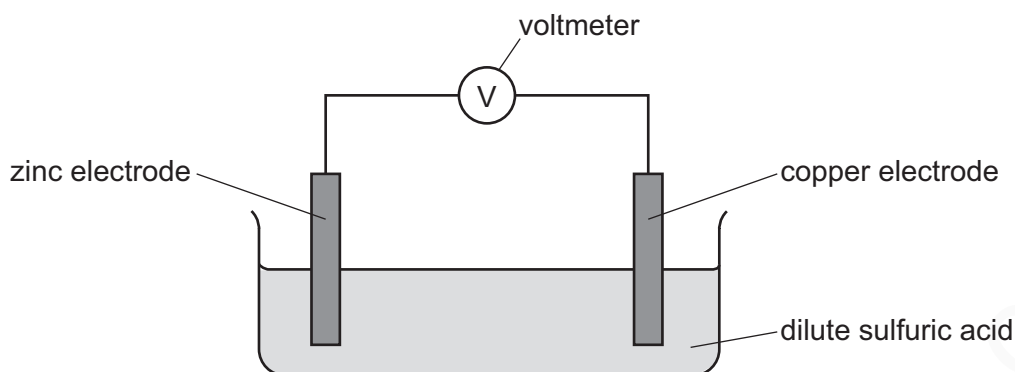
use (more) concentrated sulfuric acid

accept use a more concentrated acid / a more concentrated solution

any **two** [2]

3 A student used the following electrochemical cell.

The reading on the voltmeter was +1.10V.



- (i) Draw an arrow on the diagram to show the direction of electron flow. [1]
- (ii) Suggest the change, if any, in the voltmeter reading if the zinc electrode was replaced with an iron electrode. Explain your answer.

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

- (iii) The zinc electrode was replaced with a silver electrode. The reading on the voltmeter was -0.46V .

Suggest why the sign of the voltmeter reading became negative.

.....
..... [1]

MARKING SCHEME:

(i)	arrow (anywhere) going from Zn → Cu	1
(ii)	reading would decrease (1) Fe less reactive than Zn (1) OR difference in reactivity (between Fe and Cu) is smaller	2
(iii)	Ag less reactive than Cu	1