CHEMISTRY ONLINE
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CHEMISTRY

Physical Chemistry

Level & Board	AQA (A-LEVEL)
TOPIC:	Oxidation Reducation & Redox
PAPER TYPE:	SOLUTION - 3
TOTAL QUESTIONS	10
TOTAL MARKS	30

Oxidation, Reduction and Redox Equations - 3

1.

(a)

An oxidizing agent is a substance that can accept electrons from another substance during a chemical reaction. So, it itself undergoes reduction (gains electrons) and causes the other substance to be oxidized (lose electrons). E.g. Cl can act as oxidising agent.

(1)

(b)

i.

NO_3^- (Nitrate ion):

$3x(-2)+x=-1$ (the sum of oxidation states equals the charge of the ion)

$-6+x=-1$

$x=+5$

Therefore, the oxidation state of nitrogen in the nitrate ion is +5.

NO_2 (Nitrogen dioxide):

$2x(-2)+x=0$ (the sum of oxidation states equals zero for a neutral molecule)

$-4+x=0$

$x=+4$

The oxidation state of nitrogen in nitrogen dioxide is +4.

NO (Nitric oxide):

$-2+x=0$ (the sum of oxidation states equals zero for a neutral molecule)

$x=+2$

Thus, the oxidation state of nitrogen in nitric oxide (NO) is +2.

(2)

ii.

The formation of NO_2 from NO_3^- ions in the presence of H+ ionsis reduction. As

$$4H^+ + NO_3^- + 3e^- \rightarrow NO + 2H_2O$$

(2)

iii.

$2H^+ + NO_3^- + e^- \rightarrow NO_2 + H_2O$

(2)

iv.

$Cu + 4H^+ + 2\ NO^{3-} \rightarrow Cu^{2+} + 2H_2O + 2NO_2$

(2)

2. (D)

(Total 1 mark)

3.

(a)

The formation of carbon monoxide from carbon is :

$2C + O_2 \rightarrow 2CO$

(1)

(b)

The reduction of iron(III) oxide to iron by carbon monoxide is :

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(1)

(c)

Economic Benefit:
Recycling scrap iron/steel saves energy, avoids the need for a blast furnace, and uses higher iron content, reducing production costs.

Environmental Impact:
Recycling lowers greenhouse gas emissions, cuts air pollutants like CO_2 and SO_2, reduces mining, minimizes landfill waste, and enhances aesthetics by removing eyesores.

(2)

4. (D)

(Total 1 mark)

5.

(a)

The equation for the conversion of titanium(IV) oxide into titanium(IV) chloride is:

$TiO_2 + 2Cl_2 + 2C \rightarrow TiCl_4 + 2CO$

(2)

(b)

The equation for the extraction of titanium from titanium(IV) chloride is :

$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$

(2)

(c)

Titanium is not extracted directly from titanium(IV) oxide using carbon because titanium carbide (TiC) is produced instead of pure titanium, resulting in a brittle product that is unsuitable as an engineering material.

(1)

6. (B)

(Total 1 mark)

7.

(a)

The electrolysis of a molten mixture of aluminum oxide is necessary:
To allow ions to move, current to flow, and to conduct electricity effectively during the extraction process.

(1)

(b)

The equation for the reaction of oxide ions at the positive electrode during the electrolysis is :

$2O^{2-} \rightarrow O_2 + 4e^-$

(1)

(c)

The positive electrodes, typically made of carbon or graphite, need frequent replacement because they oxidize or burn in reaction to the oxygen formed during the electrolysis process.
This leads to the production of carbon dioxide (CO_2) and the degradation of the electrode material, so regular replacement is necessary to maintain the efficiency of the process.

(1)

(d)

It is less expensive to recycle aluminium than to extract it from aluminium oxide by electrolysis because recycling aluminum involves significantly lower energy consumption compared to the energy-intensive electrolysis process used to extract aluminum from aluminum oxide.

(1)

8. (C)

(Total 1 mark)

9. (B)

(Total 1 mark)

10.

(a)

Oxidising agent : HgO

(1)

(b)

Half-equation showing that oxidising agent in reaction 1 is an electron acceptor

$Hg^{2+} + 2e^- \rightarrow Hg$

(1)

(c)

Half-equation for the oxidation process occurring in reaction 2 is :

$2H_2O + SO_2 \rightarrow H_2SO_4 + 2e^-$

(1)

(d)

Half-equation for the reduction process occurring in reaction 2 is:

$Cl_2 + 2e^- \rightarrow 2Cl^-$

(1)

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