Redox

Mark Scheme

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Application of Core Principles of Chemistry
Sub Topic	Redox
Booklet	Mark Scheme

Time Allowed: **71 minutes**

Score: **/59**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Question Number	Correct Answer	Mark
1	B	**(1)**
	Incorrect answers A – is not a redox reaction so cannot be disproportionation C – is a redox reaction but is not disproportionation D - is not a redox reaction so cannot be disproportionation	

Question Number	Correct Answer	Mark
2	A	**1**

Question Number	Correct Answer	Reject	Mark
3	C		1

Question Number	Correct Answer	Reject	Mark
4	C		1

Question Number	Correct Answer	Reject	Mark
5	A		**1**

Question Number	Acceptable Answers	Reject	Mark
6(a)(i)	Any value or range of values from pH 8 to 13 (inclusive)	**Just** greater / > than any value	**1**

Question Number	Acceptable Answers	Reject	Mark
6 (a)(ii)	$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$ **M1** - All four species are correct **(1)** **M2** - State symbols all correct **(1)** M2 can only be awarded for the correct state symbols if M1 has already been awarded OR for a 'near-miss' equation with species almost correct		**2**

Question Number	Acceptable Answers	Reject	Mark
6 (b)(i)	Three / 3 (moles of ions)		**1**

Question Number	Acceptable Answers	Reject	Mark
6 (b)(ii)	Ten / 10 (moles of electrons)		**1**

Question Number	Acceptable Answers	Reject	Mark
6 (c)	**Mark independently:** **First mark – M1:** Heat (strongly) $CaCO_3$ ALLOW 'thermal decomposition' / 'thermally decompose' / 'high temperature' **(1)** **Second mark – M2:** $CaCO_3 \rightarrow CaO + CO_2$ IGNORE State symbols, even if incorrect **(1)** NOTE The correct equation for M2 with 'heat' or just a 'Δ' written above the arrow would also score M1. **Third mark – M3:** Add (a few drops of) water to **CaO** ALLOW If $CaO + H_2O(l)/H_2O$ seen on the LHS of any equation, even if the equation overall is incorrect **(1)** **Fourth mark:** $CaO + H_2O \rightarrow Ca(OH)_2$ IGNORE State symbols, even if incorrect **(1)**	No M1 if refers to 'oxidation' of $CaCO_3$ when heated / Heating $CaCO_3$ in a sealed tube / closed apparatus Add 'steam' to CaO Adding water to **$CaCO_3$** Adding water to **Ca** Use of heat / gentle heat / use of warm water / Forming $Ca(OH)_2$ **solution** / 'Dissolve the CaO in water' / Drying or heating the $Ca(OH)_2$ product All no M3 $CaO + 2H_2O \rightarrow Ca(OH)_2$ **+ H_2**	**4**

Question Number	Acceptable Answers	Reject	Mark
6 (d)(i)	$2SO_2(g) + 2H_2O(l) + O_2(g) \rightarrow 2H_2SO_4(aq)$ **ALLOW** Multiples **M1** - Species and balancing **(1)** **M2** - All state symbols correct M2 can only be awarded for the correct state symbols if M1 has already been awarded OR for a 'near-miss' equation with the species almost correct **(1)**		**2**

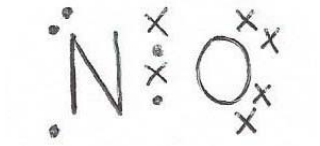
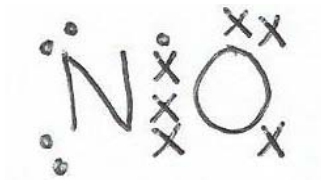
Question Number	Acceptable Answers	Reject	Mark
6 (d)(ii)	CaO is basic / is a base / is a metal oxide OR CaO **neutralizes** (acidic) SO_2 / H_2SO_4 OR CaO reacts with a **non-metal oxide** (SO_2) OR Basic oxides react with acidic gases ALLOW Alkaline for basic/ alkali for base IGNORE References to forming a salt / formation of calcium sulfate References to the large surface area of powder / effect on rate of reaction		**1**

Question Number	Acceptable Answers	Reject	Mark
6 (d)(iii)	**NOTE:** **Can only award scoring point for the environmental problem if it is linked to the correct substance** **Substance mark (M1) stand-alone** Carbon dioxide/ CO_2 **(1)** with Global warming OR Greenhouse effect ACCEPT as an alternative a description of the above phenomenon IGNORE acid rain for CO_2 **(1)** **OR** Carbon particulates / soot **(1)** with Breathing difficulties / breathing disorders / carcinogenic / 'blocking out' sky / blackening of buildings / covering buildings **(1)** ALLOW Nitrogen dioxide/ NO_2 OR nitrogen monoxide/ NO **(1)** with Destruction of ozone layer/breathing problems IGNORE acid rain for NO_2 **(1)** ALLOW Carbon monoxide/ CO **(1)** with (Highly) toxic (gas) / poisonous / 'lethal' (gas) **(1)**	SO_2 / SO_3 / H_2SO_3 / H_2SO_4 scores **(0)** for question as already mentioned earlier 2nd mark for 'ozone depletion' IF this is linked to CO_2	**2**

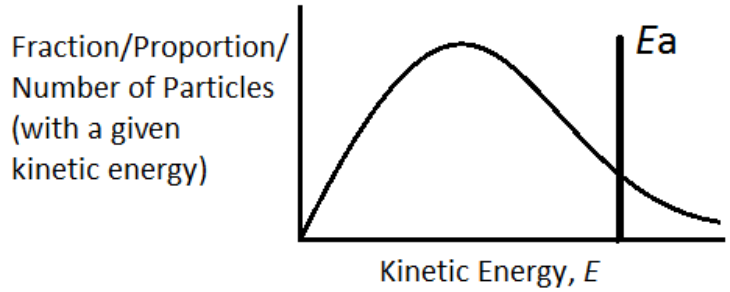
(Total for Question 6 = 14 marks)

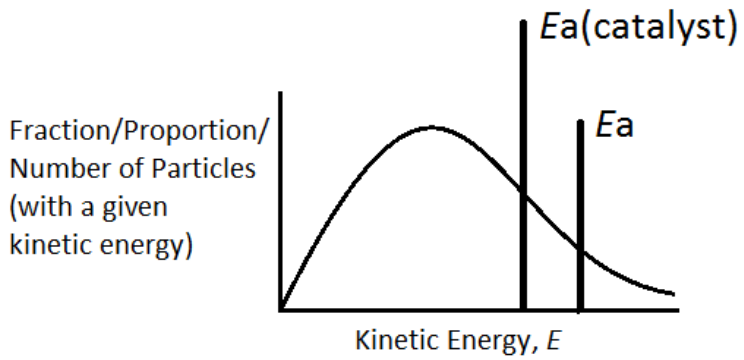
Question Number	Acceptable Answers	Reject	Mark
7(a)	(in NH_3 =) -3/3-/-III (1) (in NO =) +2/2+/+II (1)	Just '2'	2

Question Number	Acceptable Answers	Reject	Mark
7(b)(i)	It has an unpaired electron ALLOW non-paired Ignore references to reactivity/stability/orbital/charge/location of unpaired electron	Just 'single electron' 'lone electron' Electron**s** Free electron	1

Question Number	Acceptable Answers	Reject	Mark
7(b)(ii)	 ALLOW  Double bond as shown in either of above diagrams **(1)** 2 lone pairs on one atom and 1 lone pair + 1 unpaired electron on the other atom **(1)** Second mark dependent on the first		2

Question Number	Acceptable Answers	Reject	Mark
7(c)	To score 2 marks look for one of the following **pairs** of answers: Carry out in a fume cupboard IGNORE (face) masks **and** NH_3/ NO **toxic / poisonous** ALLOW Cr_2O_3 is **toxic / poisonous** **(2)** OR Wear gloves **and** (Concentrated) ammonia is corrosive /causes burns (2) OR Safety screens / **students** wearing safety goggles **and** Risk of explosion / very exothermic **(2)** If the linked points are not made for 2 marks, then any of the above precautions or hazards scores 1 mark max Ignore correct but irrelevant chemistry and penalise incorrect statements, e.g. environmental damage by NO can be ignored but flammability of chromium(III) oxide is incorrect	Harmful/ Dangerous 'Fireflies' flashes	2

Question Number	Acceptable Answers	Reject	Mark
7(d)(i)	 Labelled y axis: fraction / proportion / number of molecules (with a given kinetic energy) **and** activation energy labelled with a vertical line to the right of the curve peak ALLOW Particles for molecules **(1)** Shape of curve **(1)** The curve **must** clearly start from the origin, rise to a peak and then decrease, approaching the x axis **without** crossing/touching it. If the curve is concave at the start or rises at the end then this mark is lost.	Atoms	2

Question Number	Acceptable Answers	Reject	Mark
7*(d)(ii)	Can be shown on diagram (as below): (A catalyst) provides (an alternative reaction pathway with) a lower activation energy (1) Greater Proportion/More particles (as shown in the diagram) have or exceed the (lower) activation energy (so greater proportion of successful collisions) (1)  Ignore references to temperature change Graphs with two curves scores max 1	Ea catalyst to the RHS =0	2

Question Number	Acceptable Answers	Reject	Mark
7(e)	**Marking point 1** Catalysts weaken/break the bonds of the reactants OR Increase the collision rate/number of collisions **(1)** **Marking point 2** Any one of: Reaction takes place on the (catalyst) surface /active sites **(1)** The gaseous reactant molecules **adsorb** on the catalyst (and then react) **(1)** The product molecules desorb from the surface **(1)** Marks are stand alone Ignore general definitions of a catalyst	Absorb	2

Question Number	Acceptable Answers	Reject	Mark
7(f)(i)	$(NH_4)_2Cr_2O_7$ OR Formula with **balanced** charges		1

Question Number	Acceptable Answers	Reject	Mark
7(f)(ii)	Fill the flask with nitrogen / noble gas / argon / helium (and the reaction still takes place) ALLOW Carry out in a vacuum/remove the air		1

Question Number	Acceptable Answers	Reject	Mark
7(f)(iii)	Orange to green Ignore such descriptors as 'bright' or 'dark' etc	Any other colours in combination e.g. orange-yellow	1

TOTAL FOR QUESTION 7 = 16 MARKS

Question Number	Acceptable Answers	Reject	Mark
8 (a)	$NaCl + H_2SO_4 \rightarrow HCl + NaHSO_4$ ALLOW Multiples $HNaSO_4$ $2NaCl + H_2SO_4 \rightarrow 2HCl + Na_2SO_4$ IGNORE state symbols even if incorrect COMMENT ALLOW Capitals or lower case in formulae		1

Question Number	Acceptable Answers	Reject	Mark
8 (b)	Ammonia (gas) / NH_3 Allow Ammonia solution/ $NH_3(aq)$ **(1)** White smoke/solid ALLOW white cloud **/ Dense** white fumes **(1)** The observation mark is consequential on use of ammonia. If name and formula are given, both must be correct.	Ammonium Incorrect identification of white smoke Misty fumes / steamy fumes/ white gas/ white ppt	2

Question Number	Acceptable Answers	Reject	Mark
8 (c)	White ppt/solid ALLOW white crystals **(1)** IGNORE identification of white solid, even if wrong (ppt/solid) dissolves (in excess) /(colourless) solution forms ALLOW (ppt/solid) disappears/ soluble **(1)** IGNORE clear solution ($c.NH_3$) dissolves AgBr (as well as AgCl) **(1)**	Just "white" Cream ppt other colours of solution Dissolves bromide ions/ bromine Just "Only AgCl dissolves in dilute NH_3" $c.NH_3$ dissolves other things	3

TOTAL FOR Q8 = 6 MARKS

Question Number	Acceptable Answers	Reject	Mark
9 (a)	(Fe_2O_3 + 2Al →) Al_2O_3 + 2Fe Allow products in either order.	Fe_2 / Fe^{2+} / Fe(II)	**1**

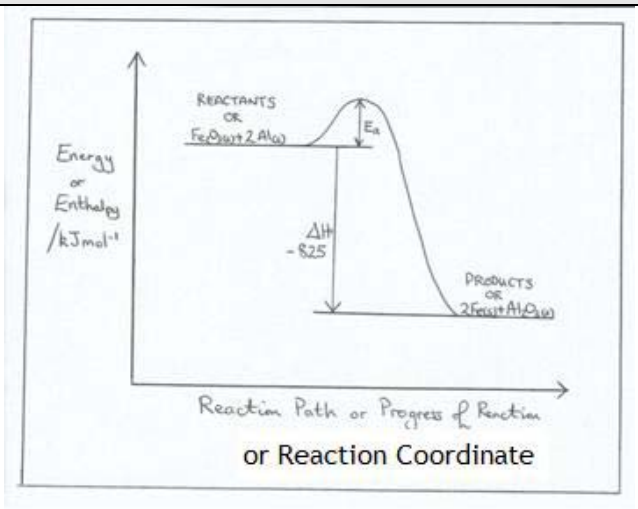
Question Number	Acceptable Answers	Reject	Mark
9 (b)	(use of) 159.6 (g mol^{-1}) **(1)** (34.0÷159.6 =) 0.213 (mol) **(1)** (0.213 x 2 x 27 =) 11.502/11.50/11.5 (g) **(1)** Answer alone scores 3 If units are given, they must be correct. Ignore sf except 1 ALLOW (use of 56 for Fe so Fe_2O_3 =) 160 (g mol^{-1}) **(1)** (34.0÷160 =) 0.2125 (mol) **(1)** (0.2125 x 2 x 27 =) 11.475/11.48/11.5 (g) **(1)**		**3**

Question Number	Acceptable Answers	Reject	Mark
9(c)	Heat (in an oven)/heat (over Bunsen burner)/ heat (to constant mass).	Just 'desiccator' Temp <100°C Burn/warm Drying agents Leave to dry	**1**

Question Number	Acceptable Answers	Reject	Mark
9(d)	To ensure complete reaction /(solids) so must be well-mixed for reactants to come into physical contact/ more surface area in contact. ALLOW More collisions of particles IGNORE Make it easier for the reactants to mix	Just 'to increase the rate of reaction' Just 'both reactants are present in solid form' Any reference to the generation of energy.	**1**

Question Number	Acceptable Answers	Reject	Mark
9(e)(i)	White light/white powder/ White smoke / White flame.	Just 'light' 'bright light' White ppt Colourless flame	**1**

Question Number	Acceptable Answers	Reject	Mark
9(e)(ii)	Magnesium oxide/MgO Allow magnesium nitride/Mg_3N_2 Allow equation to produce MgO, e.g. $2Mg + O_2 \rightarrow 2MgO$ If name and formula given then both must be correct Ignore state symbols.		**1**

Question Number	Acceptable Answers	Reject	Mark
9(e)(iii)	 Labelled y axis (kJ mol^{-1}) The x axis need not be labelled but if labelled must be correct **(1)** If units are given on the axis they must be correct Labelled reactants above products **(1)** Exothermic change of -825 shown **(1)** Activation energy **(1)**	Enthalpy **change** / heat Time on the 'x' axis Mg/O_2	**4**

Question Number	Acceptable Answers	Reject	Mark
9(e)(iv)	(provides the) activation energy/ (provides the) energy for the reaction to occur/heat for the reaction to occur/ overcome the energy barrier Allow this to be written on the diagram	Decreases E_a Just 'to initiate reaction' Acts as a catalyst	**1**

Question Number	Acceptable Answers	Reject	Mark
9(e)(v)	(Chemically) changed by the reaction/ (it is) changed into MgO/ Used up (by the reaction) Allow doesn't lower activation energy	Just 'it reacts' Provides alternative routes or pathway. Does not speed up the reaction Just 'it takes part in the reaction'.	**1**

Question Number	Acceptable Answers	Reject	Mark
9(e)(vi)	(Once reaction is started it provides) enough energy to be self-sustaining/ energy only needed at the start as the reaction is exothermic	Chain Reaction Just 'highly exothermic reaction'	**1**

Question Number	Acceptable Answers	Reject	Mark
9(f)	It may ignite at any time/delay in the reaction/molten metal may be ejected	Just 'explosion' Flammable/ fire	**1**

Question Number	Acceptable Answers	Reject	Mark
9(g)	The iron is melted/molten/liquid (and joins the two pieces of metal/railway line)	Melt Aluminium Just 'melt the metal' Just 'melt the railway lines'	**1**

Question Number	Acceptable Answers	Reject	Mark
9 (h)	Aluminium is readily available/abundant/cheap/easy to handle/easy to store/Al_2O_3 has a low density so floats (and avoids contaminating the weld) OR Reverse argument/other metals may not react and release enough heat (to melt the iron)/other metals are difficult to store	Al does not corrode Other metals are too exothermic.	**1**

TOTAL FOR QUESTION 9 =18 MARKS