

Mark Scheme - 2.3 Metals and their Extraction

1.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)		1	B and F (both needed)			
(b)		1	D			
(c)	(i)	2	it is a semi metal / metalloid / shows properties of both metal and non-metal (1) must give example of one property of a metal and one of non-metal e.g. conducts electricity but low density etc. (1)	idea of conflicting properties	A	
	(ii)	1	D and E (both needed)			
(d)	(i)	2	310 – 250 (1) 540 / 60 = 9 g/cm ³ (1) cao (2)			
	(ii)	2	measurements are inaccurate / not precise / incorrect credit (1) for basic idea and additional (1) for sensible reason e.g. measuring cylinder not precise enough, only measures to nearest 10cm ³ (2) accept any other sensible answers e.g. sample is impure / oxidised or volume (liquid or solid) changes with temperature		human error	

2.

Sub-section	Mark	Answer	Accept	Neutral answer	Do not accept	
(a)	(i)	1	sodium, magnesium and aluminium (ignore 'silicon')	Na, Mg and Al		
	(ii)	1	silicon	Si		
	(iii)	1	both gases (at room temperature)		very low density	
	(iv)	1	density of the metals increases across the period			
(b)		2	the evidence supports the statement for P, Cl, Ar and/or S, Cl, Ar (1) P is lower than S/P or S does not follow the trend (1) need to look at data for other periods (1) any two for (1) each	if Si is included in their list		

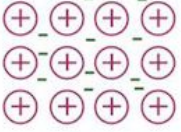
3.

Sub-section	Mark	Answer	Accept	Neutral answer	Do not accept	
(a)		2	metallic → malleable and ductile / high melting point simple molecular → gas or liquid at room temperature giant covalent → high melting point all 3 for (2) any 1 for (1)			
(b)		3	thermochromic pigment (1) shape memory polymer (1) hydrogel (1)			

4.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)		2	(silicon difficult to classify) because it has metallic and non-metallic properties (1) response clearly indicating one or more metallic property and contrasting non-metallic property, e.g. it has a high melting point/boiling point like a metal but is brittle like a non-metal (2)	semi-metal / metalloid		it is a metal and a non-metal
(b)		1	Mg (ignore atomic number / mass number)		magnesium	
(c)	(i)	1	2			
	(ii)	1	Ag ₂ O	Ag ⁺ 2O ²⁻		
(d)	(i)	1	antibacterial / antiviral / antifungal	kills germs / kills bacteria / antiseptic	disinfectant reduces smells	
	(ii)	1	silver nanoparticles can get into drinking water / water supplies / lakes / rivers could be dangerous to health / harmful / toxic don't know the effect / long term effect not known <i>uncertainty must be implied</i>		reference to the air / atmosphere / rain pollutes water / the environment	

5.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)		1	2,8,1			
(b)		2	 <p>positive ions fixed positions electrons mobile / sea</p> <p>– all four points (2) – two/three points (1)</p>			
(c)	(i)	1	floats moves fizzes / bubbles goes into a round shape / melts – any two		vigorous reaction dissolves	
	(ii)	1	sodium hydroxide and hydrogen – both needed	NaOH + H ₂	H	
(d)		1	potassium burns / lilac flame		potassium moves faster	yellow / orange / red / green flame
(e)		2	atoms get bigger / greater distance between the (positive) nucleus and the (outer) electron (1) outer electron more weakly held (1)			

6.

	Mark	Answer
(a)	6 QWC	<p>Indicative content</p> <ul style="list-style-type: none">• all three metals float, move about the water surface and produce bubbles• lithium reacts slowly without melting• sodium reacts quickly forming a sphere• potassium reacts violently forming a sphere and burning with a lilac flame• reactivity increases down the group <p><i>word /symbol equations not expected but creditworthy</i></p> <p>5-6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3-4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1-2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p>
(b)	2	<p>Na₂O (1) correctly balanced (1)</p> <p>formula must be correct before balancing mark can be awarded</p>

7.

Indicative content:

copper – good conductor of electricity = electrical wiring; good conductor of heat = saucepan bases; malleable = water pipes; ductile = electrical wiring; attractive colour and lustre = jewellery

titanium – hard and strong = hip replacements and rotor blades; low density = rotor blades; resistant to corrosion = rotor blades / hip replacements / pipes in chemical industry; high melting point = rotor blades.

5–6 marks: The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.

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0 marks: The candidate does not make any attempt or give a relevant answer worthy of credit.

8.

Mark	Answer
6	<p>Indicative content: e.g. aluminium: low density – used to build aircraft; good heat conductor – saucepans; good electrical conductor and low density – overhead power cables etc.</p> <p>copper: good electrical conductor – electrical wires; good heat conductor – saucepan bases etc.</p> <p>titanium: strong with low density – rotors on helicopters, hip replacements etc.</p> <p>credit can be awarded for correct uses and properties of metals not described in the specification</p> <p>5–6 marks: The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3–4 marks: The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1–2 marks: The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks: The candidate does not make any attempt or give a relevant answer worthy of credit.</p>

9.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	3	copper(II) carbonate (1) copper(II) nitrate (1) sodium hydroxide (1)	formulae		
	(ii)	4	A – hydrogen (1) must be correct to award second mark pop with lighted splint (1) D – carbon dioxide (1) must be correct to award second mark limewater turns milky (1)	H ₂ CO ₂	H 'pop test'	
(b)	(i)	1	Na ₂ SO ₄			
	(ii)	2	heat until half volume / remove some water (1) leave to form crystals (1)	evaporate	filtration	to dryness
(c)		1	$\text{Fe}_2\text{O}_3 + 2\text{H}_3\text{PO}_4 \rightarrow 2\text{FePO}_4 + 3\text{H}_2\text{O}$			

10.

Mark	Answer
6	<p>Indicative content Temperature very high. Coke is oxidized to carbon monoxide. ($2\text{C} + \text{O}_2 \rightarrow 2\text{CO}$) Carbon monoxide reduced the iron ore to iron. ($3\text{CO} + \text{Fe}_2\text{O}_3 \rightarrow 2\text{Fe} + 3\text{CO}_2$) Molten iron flows to the bottom of the furnace. Limestone is decomposed by heat to calcium oxide and carbon dioxide. The calcium oxide reacts with the impurities (sand/silica) to form slag which flows to the bottom of the furnace and floats on the molten iron.</p> <p>5-6 marks: The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3-4 marks: The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1-2 marks: The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks: The candidate does not make any attempt or give a relevant answer worthy of credit.</p>

11.

Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	I	1	to burn / act as fuel / heat the furnace to form carbon monoxide	to reduce iron ore / iron oxide		
		II	1	remove impurities / sand / silica react with impurities / sand / silica		to form slag purify the iron	
	(ii)	I	1	$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$			
		II	1	iron oxide / iron(III) oxide		Fe_2O_3 iron ore / haematite	Fe
(b)	(i)		2	<i>basic comment</i> it increases then decreases (1) <i>higher level comment with use of numerical data</i> it increases to a maximum with 0.8 (% carbon) then decreases / it increases up to 800 (MPa) then decreases (2)			
	(ii)		1	cast iron		3.6	

12.

Sub-section	Mark	Answer	Accept	Neutral answer	Do not accept
(a)	1	B	Ne / neon		
(b)	2	D and F (1) both needed <i>either order</i> (D and F) are in the same group / (D and F) are both in Group 6 (D and F) both have 6 electrons in their outer shell (1) [Marks linked (unless no letters given)]			
(c)	2	Set of properties: 2 (1) both metallic and non-metallic properties / metalloid / semi-metal [If referring to specific properties from table it must clearly convey the idea that one (or more) is a metallic property and another is a non-metallic property, e.g. high m.p. and b.p. (like a metal) and brittle (like a non-metal); no credit for a simple list of all properties] (1) [Marks linked (unless no number is given) i.e. second mark cannot be awarded if first is not]	'high m.p., b.p. and shiny BUT brittle'	Reference to Group 4	

13.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)		1	allows the ions to be mobile / move		allows electricity to flow	
(b)		1	$2\text{Br}^- - 2\text{e}^- \rightarrow \text{Br}_2$			
(c)	(i)	1	lead ions would gain electrons			
	(ii)	1	shiny or grey substance		lead – needs qualifying	
	(iii)	2	lead metal formed would link the two electrodes (1) lead/metals conduct electricity (1)			

14.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	1	cryolite			
	(ii)	1	2 4			
(b)	(i)	2	Pb^{2+} (1) + 2e^{-} (1)			
	(ii)	3	<p>any 3 of 4 points for (1) each</p> <p>bromide ions are negative (1)</p> <p>bromide ions attracted to the anode/+ve electrode (1)</p> <p>loss of electrons (1)</p> <p>two bromide ions / bromine atoms form a bromine molecule (1)</p> <p>award credit for above points in suitable equations</p> <p>max (2) if reference to 'bromine ions' or 'bromide atoms'</p>			award 0 if bromide ions are described as positive ions

15.

Mark	Answer
6 QWC	<p>Indicative content</p> <p>Reference to reasons relating to choice of process, rationale for conditions, reasons why products are formed at electrodes, electrode equations e.g. aluminium high in reactivity series / aluminium is a reactive metal aluminium oxide stable \therefore electrolysis used molten electrolyte necessary to allow ions to move electrolysis expensive due to high amount of electricity needed cryolite added to reduce melting point \therefore reduce amount of energy needed Al^{3+} ions attracted to cathode (– electrode) and O^{2-} ions attracted to anode (+ electrode) electrode equations / overall equation</p> <p>5-6 marks</p> <p>The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3-4 marks</p> <p>The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1-2 marks</p> <p>The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks</p> <p>The candidate does not make any attempt or give a relevant answer worthy of credit.</p>

16.

Answer

Indicative content: definition of electrolysis i.e. use of electricity to split compounds; anode is positive electrode; cathode is negative electrode; electrolyte is substance being broken down; electrolyte conducts electricity; needs to be molten for ions to move freely; positive aluminium ions attracted to cathode where they gain electrons to form aluminium atoms; negative oxide ions attracted to anode where they lose electrons to form oxygen gas; electrode equations

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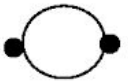
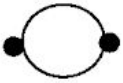
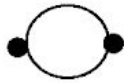
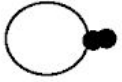
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0 marks: The candidate does not make any attempt or give a relevant answer worthy of credit.

17.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	2	Cu ions are positively charged (1) must be correct to award second mark opposite charges attract / attracted to negative electrode (1)	Cu^{2+}		
	(ii)	1	$\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}$			
(b)	(i)	1	0.20			
	(ii)	1	45 % error carried forward (ecf) possible from (i)			
	(iii)	2	0.26 (1) increase of approximately 0.02 g per 1.0 V / last 3 results increase by 0.02 g per 1.0V (1) ecf possible from (i)			

18.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	1	electrolysis			
	(ii)	I	all points plotted correctly $\pm \frac{1}{2}$ square (1) straight line through all points - ruler must be used (1)			
		II	straight line (ruler used) from (0,0) to (10,10) (2) or straight line from (0,0) and anywhere below hydrogen line (1)			
(b)		2	 correct representation of a water molecule (1)  two water molecules shown (1)	H—O—H 2 		

19.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)		1	magnesium zinc copper (must be correct order)	Mg Zn Cu		
(b)		2	copper (metal) (1) magnesium sulfate (solution) (1)	Cu MgSO ₄		
(c)		1	ZnSO ₄			
(d)	(i)	1	2 PbO 2 Pb both needed			
	(ii)	2	carbon (1) as it gains oxygen (1)	C loses electrons	reacts with oxygen	
	(iii)	1	any one from: aluminium is more reactive (than carbon) aluminium is too reactive carbon is less reactive (than aluminium) carbon is not reactive enough	Al is above C in reactivity series	Al is very reactive	

20.

Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
(a)	(i)	2	iron(III) oxide + aluminium → iron + aluminium oxide (1) for both reactants (1) for both products	correct chemical equation	powder	magnesium as reactant
	(ii)	2	aluminium more reactive than iron (1) must be correct to award second mark takes oxygen from iron / reduces iron(III) oxide (1)			
	(iii)	1	no reaction			
(b)	(i)	3	iron ore – provides the iron (1) coke – reduces iron oxide / fuel / burns to produce heat / forms carbon monoxide (1) limestone – removes impurities (1)		makes iron source of heat forms slag	
	(ii)	I	1	$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$		
		II	1	loss of oxygen / gain of electrons		