01. 0620_s21_ms_41 Q: 3

Question	Answer	Marks
(a)	2K + Cl_2 → 2KCl Cl_2 on left hand side (1) equation fully correct (1)	2
(b)	K outer shell with **8 crosses** (1) Cl outer shell with **7 dots and 1 cross** (1) $^+$ and $^-$ (1)	3
(c)(i)	**breakdown** by (the passage of) **electricity** (1) of an **ionic compound** in **molten or aqueous** (state) (1)	2

Question	Answer	Marks
(c)(ii)	(anode) chlorine (cathode)potassium	1
(d)(i)	$2H^+ + 2e(^-) \rightarrow H_2$ H+ and e($^-$) on left hand side (1) equation fully correct (1)	2
(d)(ii)	chlorine	1
(d)(iii)	potassium hydroxide (1)	1
(e)	one shared pair of electrons and 6 non-bonding electrons on each chlorine atom	1
(f)(i)	liquid (1) **BOTH** melting point is below –75 °C **AND** boiling point is above –75 °C **OR** **BOTH** –75 °C is higher than –101 °C / melting point **AND** lower than –35 °C / boiling point **OR** **–75 °C is between** melting point or –101 °C **and** boiling point or –35 °C	2
(f)(ii)	**ionic bonds** in KCl (1) attraction **between molecules** in Cl_2 (1) weak**er** attraction (between particles) in Cl_2 **ORA** (1)	3

02. 0620_s21_ms_42 Q: 4

Question	Answer	Marks
(a)	electrolyte	1
(b)(i)	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ balance of charge (1) rest of equation (1)	2
(b)(ii)	(OH^-(aq) ions) lose electrons	1
(c)	fizzing	1
(d)	$2H^+ + 2e^- \rightarrow H_2$ species correct (1) fully correct equation (1)	2
(e)(i)	fizzing (1) green gas (1)	2
(e)(ii)	(litmus turns) blue **and** alkali / base forms (1) Sodium hydroxide / NaOH (forming) (1)	2
(f)	platinum	1

03. 0620_s21_ms_43 Q: 3

Question	Answer	Marks
(a)	$2Na + F_2 \rightarrow 2NaF$ F_2 (1) equation fully correct (1)	2
(b)	Na outer shell with 8 crosses (1) F outer shell with 7 dots and 1 cross (1) Na^+ and F^- (1)	3
(c)(i)	**breakdown** by (the passage of) **electricity** (1) of an **ionic compound** in **molten / aqueous** (state) (1)	2

Question	Answer	Marks
(c)(ii)	oxygen hydrogen	2
(d)(i)	(anode) fluorine (1) (cathode) sodium (1)	2
(d)(ii)	$Na^+ + e(^-) \rightarrow Na$	1
(e)	one shared pair of electrons and 6 non-bonding electrons on each fluorine atom	1
(f)(i)	liquid (1) **BOTH** melting point is below –195 °C **and** boiling point is above –195 °C **OR** –195 °C is in between melting point and boiling point / –220 °C and –188 °C (1) **OR** **BOTH** –195 °C is higher than –220 °C / melting point **AND** lower than –188 °C / boiling point	2
(f)(ii)	**ionic bonds** in NaF (1) attraction **between molecules** in F_2 (1) weaker attraction (between particles) in F_2 **ORA** (1)	3

04. 0620_w21_ms_41 Q: 3

Question	Answer	Marks
(a)(i)	$2Cl^- \rightarrow Cl_2 + 2e^-$ Cl_2 (1) rest of equation (1)	2
(a)(ii)	Oxidation AND lose electrons	1
(b)	effervescence (of colourless gas)	1
(c)	$2H^+ + 2e^- \rightarrow H_2$ $H^+ + e$ as only species on LHS (1) rest of equation fully correct (1)	2
(d)(i)	1	1
(d)(ii)	**M1** increase (1) **M2** H+ ions being removed (1)	2
(e)	**M1** cathode: silver / grey solid (1) **M2** anode: bubbles of orange / brown gas (1)	2
(f)	**M1** inert (1) **M2** conducts electricity (1)	2

05. 0620_w21_ms_43 Q: 2

Question	Answer	Marks
(a)	**M1** ionic compound **AND** either molten or aqueous(or both)(1) **M2** conducts electricity / undergoes electrolysis(1)	**2**
(b)(i)	**M1** oxygen (1) **M2** pink / brown solid (1) **M3** copper (1) **M4** orange / brown / yellow liquid (1) **M5** bromine (1)	**5**

Question	Answer	Marks
(b)(ii)	$2H^+ + 2e(^-) \rightarrow H_2$ (2)	**2**
(b)(iii)	**M1** inert (1) **M2** good conductor of electricity (1)	**2**
(b)(iv)	electron	**1**

06. 0620_s20_ms_42 Q: 5

(a)	**breakdown** of an ionic **compound** when molten or in aqueous solution (1) (using) electricity / electric current / electrical energy (1)	**2**
(b)	platinum / graphite	**1**
(c)	$2H^+ + 2e \rightarrow H_2$	**1**
(d)	Na^+ H^+ Cl^- OH^- all four (2) 3 or 2 (1)	**2**
(e)	H^+ and Cl^- are discharged / removed (1) Na^+ and OH^- remain (1)	**2**

07. 0620_s19_ms_43 Q: 4

(a)(i)	inert / unreactive / does not react with chlorine	**1**
(a)(ii)	bubbles / fizzing / effervescence	**1**
(a)(iii)	**M1** increases **M2** (solid) copper deposited	**2**
a(iv)	**M1** colour fades / becomes pale(r) / becomes colourless / becomes lighter **M2** copper (ions) removed (from solution)	**2**
(a)(v)	**M1** species oxidised: chloride (ions) / Cl^- **M2** explanation: loss of electrons / increase in oxidation state	**2**
(b)(i)	**M1** spoon as cathode **M2** (pure)silver as anode **M3** aqueous silver nitrate as electrolyte **M4** $Ag^+ + e^- \rightarrow Ag$	**4**
(b)(ii)	any one from: □ Improves appearance □ prevent / resist corrosion / oxidation □ antibacterial	**max 1**

08. 0620_w19_ms_41 Q: 6

(a)	correct final answer = 0.072(0) **M1** moles HC*l* = 0.0036(0) **M2** moles Na_2CO_3 = 0.0018(0) (**M1** / 2) **M3** concentration Na_2CO_3 = 0.072 (**M2** / 0.025)	**3**
(b)	0.002(00)	**1**
(c)(i)	720(.09)	**1**
(c)(ii)	(it contains) ions (1) (ions) are able to move (1)	**2**
(c)(iii)	magnesium is not inert	**1**
(b)(iv)	bromine / Br_2	**1**
(b)(v)	H^+ and $e^{(-)}$ on LHS (1) fully correct, i.e.: $2H^+ + 2e^- \rightarrow H_2$ (1)	**2**

09. 0620_w19_ms_42 Q: 4

(a)	electrons (1) electrons (1) Cu^{2+} (ions) (1) Br^- (ions) (1)	**4**
(b)(i)	platinum	**1**
(b)(ii)	chlorine	**1**
(b)(iii)	$2H^+(aq) + 2e^- \rightarrow H_2(g)$ $H^+ + e^-$ on left hand side (1) rest of equation (1) state symbols of (aq) $\rightarrow$ (g) (1)	**3**
(b)(iv)	increases (sodium) hydroxide is formed (sodium) hydroxide is an alkali	**3**
(c)(i)	arrow (anywhere) going from Zn $\rightarrow$ Cu	**1**
(c)(ii)	reading would decrease (1) Fe less reactive than Zn (1) **OR** difference in reactivity (between Fe and Cu) is smaller	**2**
(c)(iii)	Ag less reactive than Cu	**1**

10. 0620_s18_ms_43 Q: 5

(a)	14.01/59 : 60.33/127 : 2.85/1 : 22.81/16 **OR** 0.237 : 0.475 : 2.85 : 1.43	1
	$NiI_2H_{12}O_6$	1
(b)(i)	electrons	1
(b)(ii)	(positive and negative) ions	1
(b)(iii)	nickel	1
	iodine	1
	$Ni^{2+} + 2e^- \rightarrow Ni$ **OR** $2I^- \rightarrow I_2 + 2e^-$	1
(c)(i)	copper formed/copper deposited	1
(c)(ii)	oxygen	1
(c)(iii)	copper removed or copper lost **or** copper forms ions	1
(c)(iv)	any **three** from: (apparatus **A**): solution becomes paler/fades in **A** (apparatus **B**): solution stays the same colour in **B** (explanation): copper ions removed (but not added) copper ions not replaced in **A** **OR** copper ions both removed and added (at the same rate) copper ions are being replaced (continually)	3

11. 0620_w18_ms_43 Q: 2

(a)(i)	**M1** breakdown of an ionic **compound** when molten or in aqueous solution **M2** (using) electricity / electric current	2
(a)(ii)	**M1** electron(s) **M2** ion(s)	2
(b)(i)	**M1** inert / unreactive **M2** conducts **electricity**	2

(b)(ii)		observation at anode(+)	name of product at anode(+)	observation at cathode(–)	name of product at cathode(–)
		M1 green / yellow bubbles	**M2** chlorine		**M3** hydrogen
			M4 oxygen	**M5** pink / brown solid	**M6** copper

12. 0620_m17_ms_42 Q: 4

(a)(i)	arrow labelled **A** on or near wire going in an anti-clockwise direction	**1**
(a)(ii)	arrow labelled **B** in electrolyte pointing towards the cathode	**1**
(b)(i)	electrons are lost	**1**
(b)(ii)	**M1** Cu^{2+} ions on left	**1**
	M2 rest of equation correct and correctly balanced ($Cu^{2+} + 2e^- \rightarrow Cu$ scores [2])	**1**
(c)	**M1** anode mass decreases	**1**
	M2 copper lost as ions **OR** copper (atoms) becomes ions **OR** $Cu \rightarrow Cu^{2+} + 2e^-$	**1**
	M3 cathode mass increases	**1**
	M4 copper deposited / layer of copper forms / copper collected at cathode **OR** $Cu^{2+} + 2e^- \rightarrow Cu$	**1**

13. 0620_s16_ms_41 Q: 4

(a)(i)	reduction **and** (the Cu^{2+} ion / copper ions) is gaining electrons / is decreasing in oxidation number;	**1**
(a)(ii)	formation of Cu^{2+} / copper ions at the anode happens at the same rate as; removal of Cu^{2+} / copper ions at the cathode ora;	**2** 1 1
(b)	replace (anode of) copper with nickel; replace electrolyte with nickel(II) sulfate / $NiSO_4$;	**2** 1 1
(c)	(good) catalysts; variable oxidation numbers; form coloured compounds / coloured ions;	**3** 1 1 1

14. 0620_w16_ms_43 Q: 4

(a)	*silicon(IV) oxide*: covalent *sodium chloride*: ionic / electrovalent	1 1
(b)	giant molecular / macromolecular / giant covalent / giant atomic	1
(c)(i)	**M1** (covalent) bonds are strong **M2** a lot of heat or energy is needed to break / weaken / overcome bonds **OR** there are no weak bonds **OR** there are no intermolecular forces **OR** covalent bonds are the only bonds **OR** strong bonds are the only bonds	2
(c)(ii)	(it has) no moving ions / no moving electrons / all electrons are used in bonding / no moving charged particles	1
(d)	(sodium chloride contains) ions / is ionic in the solid ions are not moving / they are in fixed positions ions can move when molten	1 1 1
(e)(i)	*product at the positive electrode:* chlorine *product at the negative electrode:* hydrogen	1 1
(e)(ii)	$2H^+ + 2e(^-) \rightarrow H_2$ **OR** $2H_3O^+ + 2e(^-) \rightarrow H_2 + 2H_2O$	1
(f)	oxygen	1
(g)(i)	sodium	1
(g)(ii)	$Na^+ + e(^-) \rightarrow Na$	1
(g)(iii)	*test:* (damp blue) litmus *result:* bleached / removes colour / (turns) white	1 1

15. 0620_w15_ms_33 Q: 3

(a)(i)	vibrate (about fixed position) / vibration;	1
(a)(ii)	electrostatic force of) attraction; (between) positive ions and negative ions / oppositely charged ions / unlike charged ions / cations and anions;	1 1
(a)(iii)	regular / repeated / pattern / framework / ordered / alternating / organised (arrangement of); positive and negative ions / oppositely charged ions / cations and anions / unlike charged ions;	1 1
(b)(i)	correct direction (going towards negative electrode);	1
(b)(ii)	$Li^+ + e^- \rightarrow Li / Li^+ \rightarrow Li - e^-$;	1
(b)(iii)	$2Br^- \rightarrow Br_2 + 2e^- / 2Br^- - 2e^- \rightarrow Br_2$ formulae; balancing;	2
(b)(iv)	Br^- / bromide (ion); electron lost / donated electrons / increased oxidation state / increased oxidation number / oxidation numbers changed from –1 to 0 / increased valency;	1 1

(c)	**M1** (gas) hydrogen (given off at cathode) / H_2; **M2** hydroxide ions / lithium hydroxide / OH^- / LiOH are alkali(ne); **M3** $2LiBr + 2H_2O \rightarrow 2LiOH + H_2 + Br_2$; **or** $2H^+ + 2e^- \rightarrow H_2 / 2H^+ \rightarrow H_2 - 2e^-$; **or** $2Br^- \rightarrow Br_2 + 2e^- / 2Br^- - 2e^- \rightarrow Br_2$; **or** $2H^+ + 2Br^- \rightarrow H_2 + Br_2$;	3

16. 0620_s14_ms_33 Q: 7

(a) bauxite (1) [1]

(b) electrolyte alumina / aluminium oxide dissolved in molten cryolite (1)
use cryolite to reduce mp / comparable idea / temperature of electrolyte 900 to 1000 °C (1)
electrodes carbon (1)
aluminium formed at cathode / $Al^{3+} + 3e \rightarrow Al$ (1)
oxygen formed at anode / $2O^{2-} \rightarrow O_2 + 4e$ (1)
anode burns / reacts to carbon dioxide / $C + O_2 \rightarrow CO_2$ (1) [6]

(c) **(i)** food containers / window frames / cooking foil / cars / bikes / drink cans (1) [1]

(ii) $4OH^- \rightarrow O_2 + 2H_2O + 4e$ (2) [2]

$4Al + 3O_2 \rightarrow 2Al_2O_3$ (2) [2]

[Total: 12]

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17. 0620_w12_ms_32 Q: 6

(a) **(i)** correct arrow from negative terminal of battery or from anode; [1]

(ii) from battery / power supply / cell; [1]
from negative electrode of battery to external circuit; [1]
or from anode;
from iodide ion losing electron **or** oxidation of anion;

(iii) ions cannot move in solid / ions can move in liquid; [1]

(b) copper; [1]
(changes to) sulfuric acid; [1]

hydrogen; [1]
(changes to) potassium hydroxide; [1]

(c) **(i)** $2H^+ + 2e \rightarrow H_2$ [2]
not balanced = [1]

(ii) $4OH^- \rightarrow O_2 + 2H_2O + 4e$ [1]

(iii) water used up; [1]

(d) it is a cell; [1]
hydrogen reacts with oxygen; [1]
this reaction produces energy / is exothermic / produces flow of electrons / changes chemical energy to electrical energy; [1]

[Total: 15]
