01. 0620_m21_ms_42 Q: 2

Question	Answer	Marks
(a)	chlorine	1
(b)	fluorine	1
(c)(i)	random motion of **molecules / particles**	1
(c)(ii)	hydrogen lowest (relative) molecular mass	2
(d)(i)	78	1

Question	Answer	Marks
(d)(ii)	argon / Ar	1
(d)(iii)	carbon dioxide	1
(d)(iv)	fractional (1) distillation (1)	2

02. 0620_m20_ms_42 Q: 3

(a)	selenium / Se	1
(b)	Ca has 2 and Cl has outer electrons 7 (1) Ca (atoms) lose electrons (1) Cl (atoms) gain electrons (1) Ca^{2+} (ions) (1) Cl^- (ions) (1)	5

(c)(i)	any number in the range 72 – 129°C	**1**
(c)(ii)	attraction increase (1) between molecules (1)	**2**
(c)(iii)	3 P – C*l* dot cross bonds (1) 2 (only) non-bonding electrons to make an octet on P (1) 6 (only) non-bonding electrons to make an octet on each C*l* (1)	**3**
(d)(i)	constant concentrations (1) rate of forward reaction = rate of reverse reaction (1)	**2**
(d)(ii)	*increased temperature*: (equilibrium) shifts to LHS (1) (forward) reaction is exothermic (1) *increased pressure*: (equilibrium) shifts to RHS (1) fewer moles (of gas) on RHS (1)	**4**
(d)(iii)	rate increases **and** particles have more energy (1) more collisions (between particles) occur per second / per unit time more (of the) particles / collisions have energy greater than activation energy **or** more (of the) particles / collisions have sufficient energy to react **or** a greater percentage / proportion / fraction of collisions (of particles) are successful	**3**
(e)	mol of $LiPF_6$ = 3.04 / 152 = 0.02(00) (1) mol of LiF = 0.02(00) × 6 = 0.12(0) (1) mass of LiF = 3.12 g (1)	**3**
(f)(i)	oppositely charged ions (ions) are attracted	**2**
(f)(ii)	any two from: *physical constants*: high boiling point / melting point *conductivity*: conduct (electricity) when aqueous or conduct (electricity) when molten *solubility*: soluble in water	**2**

03. 0620_s20_ms_43 Q: 3

(a)(i)	same number of electrons same electronic configuration	**2**
(a)(ii)	<table><tr><th></th><th>number of electrons</th><th>number of neutrons</th><th>number of protons</th></tr><tr><td>$^{35}_{17}Cl$</td><td>17</td><td>18</td><td>17</td></tr><tr><td>$^{37}_{17}Cl^-$</td><td>18</td><td>20</td><td>17</td></tr></table>	**3**
(b)(i)	displacement / redox	**1**

(b)(ii)	iodine is less reactive than bromine	**1**
(c)	magnesium ion has an outer shell with eight crosses chloride ion has an outer shell with seven dots **and** one cross chloride has a charge of 1– **and** magnesium has a charge 2+	**3**
(d)	energy needed to break bonds = 436 + 243 = 679 energy released when bonds formed = 2 × 432 = 864 energy change = 679 – 864 = – **AND** 185	**3**

04. 0620_s19_ms_42 Q: 6

(a)	**M1** solid (1) **M2** black (1)	**2**
(b)(i)	**M1** colourless (1) **M2** to brown / orange / yellow (1)	**2**
(b)(ii)	$Cl_2 + 2KBr \rightarrow 2KCl + Br_2$ **OR** $Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$ **M1** all formulae (1) **M2** equation balanced correctly (1)	**2**
(c)	**M1** two ticks for Cl_2 / KI, Br_2 / KI (1) **M2** three crosses for Br_2 / KCl, I_2 / KCl and I_2 / KBr (1)	**2**

05. 0620_w19_ms_43 Q: 2

(a)	F	**1**
(b)	I	**1**
(c)	F (1) H (1) I (1)	**3**
(d)	G (1) good conductor when solid (1)	**2**
(e)	D (1) high melting point (1) non-conductor of electricity when solid or liquid (1)	**3**
(f)	E (1) only conducts when liquid / conducts when liquid but not when solid (1)	**2**

06. 0620_s18_ms_41 Q: 2

(a)	calcium / Ca	**1**
(b)	7	**1**
(c)	4	**1**
(d)(i)	radioisotopes	**1**
(d)(ii)	^{286}Fl 114p 172n 114e	**1**
	^{289}Fl 114p 175n 114e	**1**
(e)(i)	any **two** from: high melting point / boiling point hard dense conduct electricity conduct heat ductile / malleable sonorous lustrous / shiny	**2**
(e)(ii)	basic (oxide)	**1**

07. 0620_s18_ms_42 Q: 4

(a)	$2K(s) + Br_2(l) \rightarrow 2KBr(s)$ 1 mark for formulae all correct 1 mark for balancing 1 mark for state symbols	3
(b)(i)	(ionic): made of, positive and negative ions / anions and cations / oppositely charged ions / unlike charged ions / different charged ions	1
	(lattice): regular / sequence / pattern / alternating / repeated / framework / ordered / organised / network / uniform	1
(b)(ii)	(in solid) ions don't move	1
	(when molten) ions move / ions mobile	1

(c)(i)	substance that conducts electricity / (undergoes) electrolysis	1
	decomposed / chemically changed **OR** molten or liquid or solution or aqueous **AND** containing ions/or ionic	1
(c)(ii)	$2H^+ + 2e(^-) \rightarrow H_2$ 1 mark for $H^+ + e(^-)$ as the only species on the left 1 mark for equation fully correct 1 mark for bromine at the anode 1 mark for potassium hydroxide	4
(c)(iii)	potassium	1
(d)(i)	$I_2 + Cl_2 \rightarrow 2ICl$ 1 mark for formulae all correct 1 mark for correct balancing	2
(d)(ii)	one bonding pair	1
	6 non-bonding electrons on each atom	1
(e)	(potassium bromide): ionic bonds / attraction between ions	1
	(iodine monochloride): intermolecular forces / forces between molecules / named intermolecular forces, e.g. van der Waals / London forces / dispersion forces / dipole- dipole	1
	bonds in KBr are stronger / need more energy to break bonds / ORA	1
(f)(i)	$Cl_2 + 2e(^-) \rightarrow 2Cl^-$	1
(f)(ii)	(bromide ions) lose electrons / donate electrons / are oxidised	1

08. 0620_w18_ms_41 Q: 2

(a)	**M1** 11 **M2** 18 **M3** 2.8.8 **M4** –1	4
(b)	A **and** B	1
(c)	Li / Lithium	1
(d)	it has a complete **or** full **or** 8 electrons in the outer shell	1

09. 0620_s17_ms_42 Q: 5

(a)(i)	<table><tr><th></th><th>aqueous potassium chloride</th><th>aqueous potassium bromide</th><th>aqueous potassium iodide</th></tr><tr><td>chlorine</td><td></td><td></td><td>✓</td></tr><tr><td>bromine</td><td>×</td><td></td><td>✓</td></tr><tr><td>iodine</td><td>×</td><td>×</td><td></td></tr></table> 5 cells completed correctly = [3] 3 or 4 cells completed correctly = [2] 2 cells completed correctly = [1]	3
(a)(ii)	Cl_2 + 2KBr → 2KC*l* + Br_2 **OR** Cl_2 + $2Br^-$ → $2Cl^-$ + Br_2	1
(b)(i)	white	1
(b)(ii)	0.02 (mol)	1
(b)(iii)	0.02 (mol)	1
(b)(iv)	1:2	1
	VCl_2	1

(c)(i)	solid	1
(c)(ii)	2Na + At_2 → 2NaAt **M1** formula of NaAt **M2** equation fully correct	2
(d)(i)	393 (kJ)	1
(d)(ii)	416 (kJ)	1
(d)(iii)	–23 (kJ / mol)	1

10. 0620_w17_ms_42 Q: 1

(a)(i)	Brownian (motion)	1
(a)(ii)	molecules	1
	nitrogen / N_2 / N **OR** oxygen / O_2 / O	1
(a)(iii)	nitrogen **OR** oxygen (particles) collide with / bombard / hit the dust (particles)	1
	(the bombarding particles) move **randomly**	1
(b)(i)	diffusion	1
(b)(ii)	Br_2 has an M_r of 160 **AND** Cl_2 has an M_r of 71 / bromine has an A_r of 80 **AND** chlorine has an A_r of 35.5	1
	(heavier) bromine (molecules / particles) diffuses more slowly	1
(b)(iii)	particles have more energy / move faster	1

11. 0620_p16_ms_40 Q: 1

(a) A [1]

(b) D and F note: both needed for mark [1]

(c) E [1]

(d) B [1]

(e) C [1]

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12. 0620_p16_ms_40 Q: 5

one redox equation from: [1]
$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$
$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$
$C + O_2 \rightarrow CO_2$
$CO_2 + C \rightarrow 2CO$

one acid/base equation: [1]
$CaO + SiO_2 \rightarrow CaSiO_3$
$CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$

Any three additional equations or comments from: [3]
carbon burns or reacts to form carbon dioxide;
this reaction is exothermic or produces heat;
carbon dioxide is reduced to carbon monoxide;
carbon monoxide reduces hematite to iron;
carbon reduces hematite to iron;
limestone removes silica to form slag;
limestone decomposes;

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13. 0620_s15_ms_31 Q: 5

(b)	M1 (0.013 moles of I and 0.065 moles of F atoms gives a) ratio 1:5; Formula = IF_5 ;	2	Award 2 marks for IF_5 **A** one mark for I_5F (as ratio is inverted) **A** one mark for IFl_5 or I_5Fl

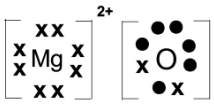
(c)(i)	example of a reversible reaction including attempts at removing / adding waters of crystallisation **OR** example of a reaction which under closed conditions would be reversible;	**1**	**A** written description of the reaction e.g. 'Haber process' unless equation is attempted in which case ignore written description **A** word equations / unbalanced equations **A** equations without equilibrium arrows **I** descriptions of physical changes
(c)(ii)	*Any **two** from:* (a reaction) M1 which can take place in both directions **OR** which can be approached from both directions; M2 in which concentrations / macroscopic properties do not change (with time); M3 the two reaction rates are equal;	 **2**	**I** reference to 'closed system' **A** 'a reaction which can go forwards and backwards' for M1 **I** 'a reaction with an equilibrium arrow' or with '⇌' for M1 **R** concentrations (of reactants and products) are the same
(d)	M1 equilibrium goes to LHS **OR** equilibrium goes to reactants side; M2 because the concentration of chlorine decreases;	 **2**	**A** reaction goes to LHS but **R** 'equilibrium goes to LHS and to products side' **A** backward reaction is favoured **I** less yield or less products **A** 'reactant' for 'chlorine' but not reactants **A** to replace missing chlorine
(e)	M1 equilibrium goes to RHS **OR** equilibrium goes to products side; M2 exothermic reactions are favoured by low temperatures; M3 the forward reaction is exothermic;	 **3**	**A** reaction goes to RHS but **R** 'equilibrium goes to RHS and to reactants side' **A** forward reaction is favoured **I** more yield or more products **A** for M1 and M2 'decreasing temperature makes the equilibrium go to RHS' **A** backward reaction is endothermic

14. 0620_w15_ms_32 Q: 1

(a)(i)	NF_3;	**1**
(a)(ii)	P_2S_3;	**1**
(b)(i)	Se^{2-};	**1**
(b)(ii)	Ga^{3+};	**1**
(c)(i)	$Cr_2(SO_4)_3$;	**1**
(c)(ii)	$Ba(OH)_2$;	**1**

15. 0620_w15_ms_32 Q: 6

(a)	the number of e^- gained or lost = numerical value of oxidation state; any two from: • Na to A*l* (Si) lose e^-; • (Si) P to C*l* gain e^-; • Si gains and loses e^- / Ar neither gains nor loses e^-;	**1** **2**
(b)	**M1** positive ions / cations / metallic ions; the (correct) particles named in **M1** are arranged in a lattice / rows / layers; sea of electrons / delocalised electrons;	**3**
(c)	they have mobile electrons;	**1**
(d)	chlorine;	**1**
(e)	strong covalent bonds ; in a giant lattice / macromolecule / giant (structure);	**2**

(f)	any two from: • sodium chloride is ionic **and** PCl_3 is covalent; • ionic bonds are strong **and** intermolecular forces are weak; • PCl_3 reacts with water **and** NaCl does not;	**2**
(g)	MgO will react with / dissolve in / neutralise hydrochloric acid / acid / acid oxide; if amphoteric, MgO will react with or dissolve in or neutralise hydrochloric acid or acid or acid oxide **and** MgO will react with dissolve in or neutralise sodium hydroxide or alkali or base or basic oxide; MgO will not react with or dissolve in or neutralise sodium hydroxide or alkali or base or basic oxide = [2]	**2**
(h)	 magnesium with 8 or 0 outer shell electrons; oxygen with 8 outer shell electrons and 2 indicated differently from the other 6 and these 2 electrons must match the Mg electrons if these have been shown; correct charges;	**3**

16. 0620_s14_ms_32 Q: 1

(a) A and E **need both** (1) [1]

(b) D (1) [1]

(c) C (1) [1]

(d) B (1) [1]

(e) F (1) [1]

(f) E (1) [1]

(g) C (1) [1]

[Total: 7]

17. 0620_w14_ms_33 Q: 1

(a) Bromine

Physical: reddish-brown liquid **or** brown liquid **or** volatile liquid/low boiling point liquid **or** poor/non-conductor (of electricity) **or** soluble in water **or** soluble in organic/non-polar solvents [1]

Chemical: Reacts with water **or** reacts with iodides (in solution) **or** displaces iodine **or** reacts with alkenes/named alkene/unsaturated hydrocarbons **or** reacts with alkane in UV/named alkane in UV **or** valency/oxidation state(–)1 **or** forms Br^- **or** gains or shares 1 electron **or** combines or reacts with metals/named metal **or** combines or reacts with non-metals/named non-metal **or** oxidising agent **or** bleaches litmus paper/indicator paper **or** corrosive **or** forms acidic oxides [1]

(b) Graphite

Physical: (good) conductor (of electricity) **or** soft **or** lubricant **or** high melting point/high boiling point **or** grey black **or** black solid **or** slippery or greasy (to touch) **or** brittle/breaks when subjected to stress **or** insoluble in water [1]

Chemical: reducing agent **or** reduces metal oxides/named metal oxide **or** reacts with/burns in air/oxygen **or** forms an acidic oxide (CO_2) **or** valency/oxidation state of 2 or 4 [1]

(c) Manganese

Physical: (good) conductor (of heat/electricity) **or** high melting point/high boiling point **or** forms coloured compounds/coloured ions **or** hard **or** strong **or** high density **or** malleable **or** ductile **or** sonorous **or** shiny [1]

Chemical: Variable or different valency/oxidation state/oxidation number **or** catalytic activity **or** forms coloured compounds/coloured ions **or** forms complex ions/complexes **or** reacts with acids **or** reducing agent **or** reacts with non-metals [1]

[Total: 6]

18. 0620_w13_ms_32 Q: 2

(a) (i) two atoms per molecule [1]

(ii) 7e in outer shell or level / same number of outer electrons / need to gain one electron [1]

(iii) different number of energy levels / different number of electrons [1]

(iv)

halogen	solid, liquid or gas at room temperature	colour
chlorine	gas	yellow / yellow green / green
bromine	liquid	brown / red-brown / orange-brown not: red / orange
iodine	solid	black / grey / silver-grey / purple / violet **NOT**: blue-black

NOTE: one mark for each vertical column [2]

(b) correct formula, AsF_3 [1]
3nbps and 1bp around all 3 fluorine atoms [1]
3bps and 1nbp around arsenic atom [1]

(c) (increased) light increases / causes forward reaction / light causes
AgCl reacts with CuCl [1]
(increased) light increases the amount of silver (and so darkens glass) [1]
decrease in light reverses reaction / uses up silver / silver reacts (and so reduces darkness)[1]

[Total: 11]

19. 0620_s12_ms_31 Q: 3

(a) (i) decrease down group; [1]

(ii) caesium / francium; [1]

(iii) $2Rb + 2H_2O \rightarrow 2RbOH + H_2$ [2]
not balanced = [1]

(b) (i) Li^+ [1]

(ii) N^{3-} [1]

(iii) regular arrangement of ions / particles / positive and negative ions alternate; [1]
not: atoms

(iv) 3:1; [1]
ratio to balance charges / reason in terms of valency; [1]

[Total: 9]

(a) **(i)** become darker; [1]

(ii) increase; [1]

(iii) black / dark grey; [1]
not: brown
solid; [1]

(b) **(i)** same Z / same number of protons; [1]
accept: atoms of the same element
different number of neutrons / different nucleon number / different mass number; [1]

(ii) 53 protons and 53 electrons; [1]

78 neutrons; [1]

(iii) xenon; [1]

(c) BrF_3 / F_3Br; [1]
BrF_5 / F_5Br; [1]

[Total: 11]