1. 5070/21/M/J/16 Q A2d

A2(d)(i)	**1 mark each for any two of:** • High melting point • Does not conduct electricity as a solid • Soluble in water • Conducts electricity as a molten liquid	**2**
A2(d)(ii)	Magnesium (atom) loses 2 electrons (1) Sulfur (atom) gains 2 electrons (1)	**2**

2. 5070/22/M/J/16 Q A2d

A2(d)(i)	**1 mark each for any two of:** • High melting point / high boiling point • Does not conduct electricity as a solid • Soluble in water • Conducts electricity as a molten liquid	**2**
A2(d)(ii)	Magnesium (atom) loses 2 electrons (1) Fluorine (molecule) gains 2 electrons / each fluorine atom gains an electron (1)	**2**

3. 5070/21/O/N/16 Q A5c

A5(c)(i)	potassium (atom(s)) loses electron(s) (1) chlorine (atom(s)) gains electron(s) (1) so there are 8 electrons in outer shells of both ions (1)	**3**
A5(c)(ii)	One mark each for any **two** of : • high melting point / high boiling point • dissolves in water • does not conduct electricity when solid / conducts electricity when molten	**2**

4. 5070/22/O/N/16 Q A4 c,d

A4(c)	atom(s) with same number of protons and different number of neutrons/atom(s) of the same element with different number of neutrons (1)	**1**
A4(d)	$I_2 + 2At^- \rightarrow At_2 + 2I^-$ (1)	**1**

5. 5070/22/O/N/16 A5 d,

A5(d)	isotopes (1) cobalt has greater proportion of heavier isotopes than nickel/nickel has lower proportion of lighter isotopes than nickel (1)	**2**

6. 5070/22/O/N/16 A6 a,

A6(a)	electrons move (throughout the structure)/mobile electrons (1)	**1**

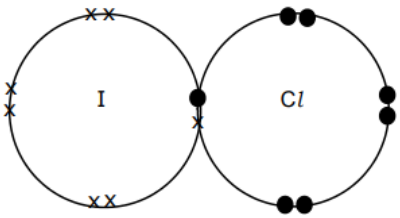
7.

A2(a)	<table><tr><th>sub-atomic particle</th><th>relative electric charge</th><th>relative mass</th></tr><tr><td>**electron**</td><td>**–1**</td><td>**0 / 0.0005**</td></tr><tr><td>**neutron**</td><td>**0**</td><td>1</td></tr><tr><td>**proton**</td><td>+1</td><td>**1**</td></tr></table> All four correct (3) Three correct (2) Two correct (1) One correct (0)	**3**
A2(b)(i)	85	**1**
A2(b)(ii)	Has more electrons than protons	**1**
A2(b)(iii)	**C** and **E** (1) Same number of protons but different number of neutrons (1)	**2**

8. 5070/21/M/J/17 Q A4a,d

A4(a)	Calcium ion is 2.8.8 (1) Chloride ion is 2.8.8 (1)	**2**
A4(d)	Ionic bonds / attraction between positive ions and negative ions (1) Idea of having many (strong) bonds – this mark is dependent on the correct bonding (1)	**2**

9. 5070/21/M/J/17 Q B8d

B8(d)	Correct 'dot-and-cross' diagram 	**1**

10. 5070/21/M/J/17 Q B9c

B9(c)	Atoms do not need to gain or lose electrons / has a stable electronic arrangement	**1**

11. 5070/22/M/J/17 Q A2

A2(a)	<table><tr><th>particle</th><th>atomic number</th><th>number of neutrons in particle</th><th>number of electrons in particle</th></tr><tr><td>^{35}Cl</td><td>17</td><td>18</td><td>**17** (1)</td></tr><tr><td>**^{37}Cl** (1)</td><td>17</td><td>20</td><td>17</td></tr><tr><td>$^{39}K^{+}$</td><td>19</td><td>**20** (1)</td><td>18</td></tr><tr><td>$^{79}Br^{-}$</td><td>**35** (1)</td><td>44</td><td>36</td></tr><tr><td>^{81}Br</td><td>35</td><td>**46** (1)</td><td>35</td></tr><tr><td>**$^{85}Rb^{+}$** (1)</td><td>37</td><td>48</td><td>36</td></tr></table>	**6**
A2(b)(i)	Atoms with same number of protons but different number of neutrons / atoms with same atomic number but different nucleon number / atoms of the same element with different number of neutrons	**1**
A2(b)(ii)	^{35}Cl and ^{37}Cl	**1**

12. 5070/22/M/J/17 Q A4a,c

A4(a)	Sodium ion: 2.8 (1) Oxide ion: 2.8 (1)	**2**

A(c)	Ions move / mobile ions / ions free to move	**1**

13. 5070/21/O/N/17 A1b

A1(b)	<table><tr><th></th><th>number of electrons</th><th>number of neutrons</th></tr><tr><td>^{33}S</td><td>16 (1)</td><td>17 (1)</td></tr><tr><td>$^{25}Mg^{2+}$</td><td>10 (1)</td><td>13 (1)</td></tr></table>	**4**

14. 5070/21/O/N/17 A3a

A3(a)(i)	**Any two of:** reference to layers (1) (layers) slide (1)	**2**

15. 5070/21/O/N/17 Q B7a

B7(a)(i)	giant (molecular) structure / many covalent bonds (1) takes a lot of energy to break the bonds / needs a high temperature to break the bonds (1)	**2**
B7(a)(ii)	Diamond has a giant covalent structure whereas tin has a metallic structure (1) because diamond or carbon has a much higher melting point **OR** diamond does not conduct electricity but tin does (1)	**2**

16. 5070/22/O/N/17 A1b

A1(b)	^{41}K electrons 19 (1) neutrons 22 (1) $^{17}O^{2-}$ electrons 10 (1) neutrons 9 (1)	**4**

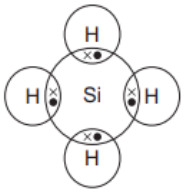
17. 5070/22/O/N/17 Q A2a,b,c

A2(a)	Arrangement: ordered / lattice / regular / layers / uniformly arranged / repeated pattern (1) Type of force: electrostatic (1)	**2**
A2(b)	Crystals: ions cannot move (1) Aqueous: ions can move (1)	**2**
A2(c)	Magnesium ion 2,8 (1) Chloride ion 2,8,8 (1)	**2**

18. 5070/22/O/N/17 B7a,b

B7(a)(i)	Magnesium has strong bonding between positive ions / cations and electrons / magnesium is a giant structure (1) Sulfur is a simple molecule / weak forces between sulfur molecules (1)	**2**
B7(a)(ii)	Magnesium has electrons which move (from place to place) (1) Sulfur does not have delocalised electrons / no mobile electrons / electrons don't move (1)	**2**
B7(b)	Giant structure / many covalent <u>bonds</u> (1) Need high temperature / lot of energy to break the <u>bonds</u> (1)	**2**

19. 5070/21/M/J/18 Q5c

5(c)(i)	correct 'dot-and-cross' diagram for silane (1)  	**1**
5(c)(ii)	has a simple (molecular or covalent) structure (1) weak intermolecular forces / van der Waals' forces between molecules / easy to overcome the forces between molecules / weak forces between molecules / easy to break attraction between molecules (1)	**2**

20. 5070/22/M/J/18 Q 4b,c

4(b)	**Any two from:** • low melting point / low boiling point (1) • poor conductor of electricity / poor conductor of heat (1) • does not dissolve in water (1)	**2**
4(c)	has a giant (ionic) structure (1) strong attraction between <u>ions</u> / difficult to break attraction between <u>ions</u> / lot of energy needed to overcome (strong) attractive forces between <u>ions</u> (1)	**2**
4(d)	<table><tr><td>particle</td><td>$^{30}_{15}P$</td><td>$^{31}_{15}P^{3-}$</td></tr><tr><td>number of electrons</td><td>**15**</td><td>18</td></tr><tr><td>number of neutrons</td><td>**15**</td><td>16</td></tr><tr><td>number of protons</td><td>**15**</td><td>15</td></tr><tr><td></td><td>(1)</td><td>(1)</td></tr></table>	**2**

21. 5070/21/O/N/18 Q1

1(a)(i)	C	**1**
1(a)(ii)	D	**1**
1(a)(iii)	B	**1**
1(a)(iv)	A	**1**
1(a)(v)	D	**1**
1(b)(i)	20	**1**
1(b)(ii)	molecule containing two atoms	**1**

22. 5070/21/O/N/18 Q 5d(i)

5(d)(i)	2 pairs of bonding electrons in overlap area (1) only 2 lone pairs on each oxygen atom (1)	**2**

23. 5070/22/O/N/18 Q1

1(a)(i)	E	**1**
1(a)(ii)	A	**1**
1(a)(iii)	C	**1**
1(a)(iv)	B	**1**
1(a)(v)	A	**1**
1(b)(i)	atoms with same number of protons but different number of neutrons / atoms with same atomic number but different mass number (1)	**1**
1(b)(ii)	44	**1**

24. 5070/22/O/N/18 Q5c

5(c)(i)	correct dot and cross diagram showing 3 pairs of bonding electrons and two non-bonding electrons (2) If two marks not scored, award one mark for one pair of bonding electrons in each of the three overlap areas	**2**

25. 5070/21/M/J/19 Q1 AND Q2

1(a)	$^{39}_{20}Ca$ (1)	1
1(b)	$^{35}_{17}Cl$ (1)	1
1(c)	$^{37}_{17}Cl^-$ (1)	1
1(d)	$^{20}_{10}Ne$ (1)	1
1(e)	$^{64}_{29}Cu$ (1)	1

2(a)	all have 2 electrons in their outer shell (1)	1
2(b)	atomic radius is always increasing / the melting point goes up and down (1)	1
2(c)(i)	2.8 (1)	1
2(c)(ii)	negative electrode: $Mg^{2+} + 2e^- \rightarrow Mg$ (1) positive electrode: $2Cl^- \rightarrow Cl_2 + 2e^-$ (1)	2

26. 5070/21/M/J/19 Q3

3(a)	high melting point / high boiling point / high density / (good) conductor of electricity / (good) conductor of heat / malleable / ductile / hard / strong / sonorous (1)	1
3(b)	coloured / variable oxidation state / catalyst (1)	1
3(c)	idea that there are atoms or ions of different size in steel (1) in steel the layers (of atoms, ions or particles) cannot move as easily (1)	2

27. 5070/21/M/J/19 Q7e

7(e)	in solid ions cannot move (1) in aqueous solution ions can move (1)	2

28. 5070/21/M/J/19 Q8d

8(d)	outer shell of phosphorus is correct (3 bond pairs with chlorine and 2 non-bonding electrons) (1) rest of outer shells of all three chlorine atoms correct (1)	2

29. 5070/21/M/J/19 Q9e

9(e)	sand is a giant molecule / giant covalent / macromolecule (1) has many strong bonds (that have to be broken or overcome) / needs lots of energy to break or overcome the many bonds / difficult to break the many bonds (1)	2

30. 5070/22/M/J/19 Q1 Q2

1(a)	H_2S (1)	**1**
1(b)	MnO_4^- (1)	**1**
1(c)	NH_4^+ (1)	**1**
2(a)(i)	0.155 – 0.190 (nm) (1)	**1**
2(a)(ii)	the melting point goes up and down (1)	**1**
2(b)	has **many** strong bonds (that have to be broken or overcome) / needs lots of energy to break or overcome **many** bonds (1)	**1**
2(c)(i)	aluminium oxide (dissolved) in (molten) cryolite (1)	**1**
2(c)(ii)	carbon / graphite (1)	**1**
2(c)(iii)	negative electrode: $Al^{3+} + 3e^- \rightarrow Al$ (1) positive electrode: $2O^{2-} \rightarrow O_2 + 4e^-$ (1)	**2**
2(d)	Al because it loses electrons (1)	**1**
2(e)	has a layer of oxide / aluminium oxide layer (1) layer is impermeable (to water) / coating is impermeable (to water) (1)	**2**

31. 5070/22/M/J/19 Q3b

3(b)(i)	simple covalent molecule / simple covalent molecular (1)	**1**

32. 5070/22/M/J/19 Q7e

7(e)	in solid ions cannot move (1) in aqueous / solution ions can move (1)	**2**

33. 5070/22/M/J/19 Q8d

8(d)	correct structure (1)	**1**

34. 5070/22/M/J/19 Q9e

NO MARKSCHEME AVAILABLE

35. 5070/21/O/N/19 Q1

1(a)	P	**1**
1(b)	Fe	**1**
1(c)	Fe	**1**
1(d)	Mg	**1**
1(e)	C	**1**

36. 5070/21/O/N/19 Q2

2(a)	**Any two from** ∞ low melting point / low boiling point (1) ∞ low density (1) ∞ soft (1)	**2**
2(b)	drawing of electronic structure of 2.8.1	**1**

2(d)	sodium (atom) loses electron(s) (1) oxygen (atom or molecule) gains electron(s) (1) two electrons gained by oxygen (atom) (1)	3
2(e)(i)	high melting point / high boiling point / does not conduct electricity when solid / does conduct electricity when molten / does conduct electricity when in aqueous solution	1

37. 5070/21/O/N/19 Q8

8(a)	*electrons*: 14 (1) *neutrons:* 16 (1) *protons:* 14 (1)	3
8(b)	$3Si + 2N_2 \rightarrow Si_3N_4$	1
8(c)(i)	**Any two from:** both have covalent bonds / covalent (lattice) (1) both have giant structures (1) tetrahedral arrangement of structure (1)	2
8(c)(ii)	many strong bonds / strong bonding throughout the structure (1) needs a high temperature to break (all) the bonds / needs a lot of energy to break (all) the bonds (1)	2
8(d)	$SiO_2C_4H_{12}$	1
8(e)	pair of shared electrons between each of the 4 C*l* atoms and central Si **AND** 6 non-bonding electrons around each chlorine	1

38. 5070/22/O/N/19 Q2

2(a)	**Any two from:** conducts electricity / conducts heat (1) malleable (1) ductile (1) shiny / lustrous (1)	2
2(b)	electronic structure of 2.8.2	1
2(c)(i)	magnesium (atom) loses electron(s) (1) bromine (atom or molecule) gains electron (1) two electrons transferred from magnesium (1)	3
2(c)(ii)	high melting point / high boiling point (1) **OR** does not conduct electricity when solid / conducts when molten / conducts in aqueous solution (1)	1

39. 5070/22/O/N/19 Q8

8(a)(i)	*electrons*: 15 (1) *neutrons:* 16 (1) *protons:* 15 (1)	3
8(a)(ii)	atoms with the same number of protons and different numbers of neutrons / atoms of the same element with different numbers of neutrons	1
8(b)	$\mathbf{5}KClO_3 + \mathbf{6}P \rightarrow \mathbf{5}KCl + \mathbf{3}P_2O_5$	1

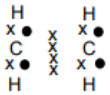
40. 5070/22/M/J/20 Q1

1(a)	calcium chloride (1)	**1**
1(b)	ammonium chloride (1)	**1**
1(c)	silver chloride (1)	**1**
1(d)	hydrogen chloride (1)	**1**
1(e)	iron(III) chloride	**1**

41. 5070/21/M/J/20 Q7

7(e)	electrons cannot move / no mobile electrons	**1**

42. 5070/22/M/J/20 Q6

6(d)	electrons cannot move / no mobile electrons (1)	**1**
6(e)	 two shared pairs of electrons between both carbon atoms (1) two shared pairs between carbon and hydrogen atoms for each carbon atom (1)	**2**

43. 5070/22/M/J/20 Q7

7(d)	giant covalent (1)	**1**

44. 5070/21/O/N/20 Q1

1(a)	silver nitrate	**1**
1(b)	silver nitrate	**1**
1(c)	magnesium carbonate	**1**
1(d)	lithium bromide	**1**
1(e)	methane	**1**

45. 5070/21/O/N/20 Q2

2(a)	carbon dioxide is a (simple) molecule **and** calcium carbide is ionic (1) for carbon dioxide: weak (attractive) forces between molecules / weak intermolecular forces(1) for calcium carbide: strong (attractive) forces between ions (1)	**3**

46. 5070/21/O/N/20 Q8

8(d)(i)	H H : N : N : H H	**1**

47. 5070/21/O/N/20 Q9

9(b)	electrons:18 (1) neutrons: 24 (1)	**2**

48. 5070/22/O/N/20 Q1

1(a)	ammonia	**1**
1(b)	copper(II) sulfate	**1**
1(c)	aluminium sulfate	**1**
1(d)	calcium carbonate	**1**
1(e)	potassium nitrate	**1**

49. 5070/22/O/N/20 Q2

2(a)	chlorine is a (simple) molecule **and** sodium chloride is ionic (1) for chlorine: weak (attractive) forces between molecules / weak intermolecular forces(1) for sodium chloride: strong (attractive) forces between ions (1)	**3**
2(b)	2,8,7	**1**

50. 5070/22/O/N/20 Q8

8(c)	: Cl : S : Cl :	**1**

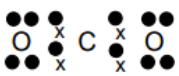
51. 5070/22/O/N/20 Q9

9(a)	electrons = 80 (1) neutrons = 125 (1)	**2**

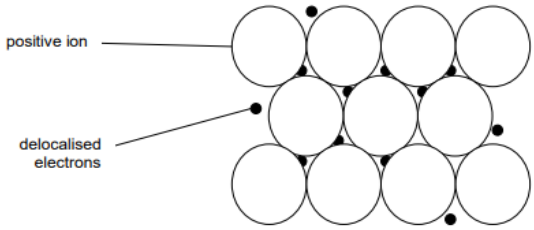
52. 5070/21/M/J/21 Q2

2(c)	outer shell has 8 electrons	**1**
2(d)(i)	86 protons / 86 electrons / same electronic structure	**1**
2(d)(ii)	radon-222 has two more neutrons / radon-220 has two fewer neutrons / radon-220 has 134 neutrons and radon-222 has 136 neutrons	**1**

53. 5070/21/M/J/21 Q6

6(b)		1

54. 5070/21/M/J/21 Q8

8(a)	five	1
8(b)	 closely packed positive ions (1) delocalised electrons / sea of electrons (1) strong electrostatic attraction between the (positive) ions and the electrons (1)	3

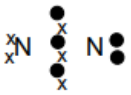
55. 5070/22/M/J/21 Q2

2(c)(i)	same electronic structure / same electronic configuration	1
2(c)(ii)	polonium-210 has one more neutron / polonium-209 has one less neutron / polonium-209 has 125 neutrons and polonium-210 has 126 neutrons	1

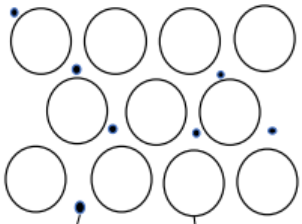
56. 5070/22/M/J/21 Q4

4(b)	zinc loses electrons and bromine gains electrons (1) reference to (transfer of) two electrons (1)	2

57. 5070/22/M/J/21 Q6

6(c)(ii)		1

58. 5070/22/M/J/21 Q8

8(a)(i)	six	1
8(a)(ii)	four	1
8(b)		3

59. 5070/21/O/N/21 Q5

5(d)	layers made of ions (1) layers slide (1)	**2**

60. 5070/21/O/N/21 Q7

7(a)	**Any two from:** high melting point for Ag / high boiling point for Ag / **ORA** for K (1) high density for Ag / **ORA** for K (1) hard for Ag / soft for K (1)	**2**
7(b)	protons: **47** (1) neutrons: **62** (1) electrons: **46** (1)	**3**

61. 5070/22/O/N/21 Q7

7(a)	**Any two from:** sodium conducts electricity / diamond does not conduct electricity (1) sodium malleable / diamond brittle (1) brittle (1) sodium ductile / diamond not ductile (1) sodium soft / diamond hard (1)	**2**
7(b)	protons: 11 (1) neutrons: 12 (1) electrons: 10 (1)	**3**

62. 5070/22/O/N/21 Q10

10(a)(i)	values between 6.00 and 9.50 (inclusive of these values)	**1**
10(a)(ii)	there is no trend (down the group)	**1**
10(b)(i)	R is an ionic structure / R has an ionic lattice / R is giant ionic (1) R bonds (throughout lattice) are strong (1) (dependent on the mention of ions / ionic for R) S is a simple molecular structure / small molecule / simple molecule (1) S weak forces between molecules (1)	**4**

10(b)(ii)	ions can move / has mobile ions	1
10(b)(iii)	3 pairs of bonding electrons between each H and P **AND** 2 non-bonding electrons on P	1

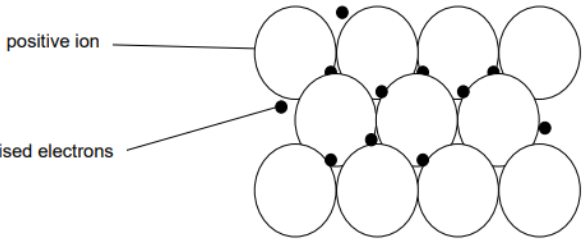
63. 5070/21/M/J/22 Q2

2(a)	2, 8, 5	1
2(b)	boiling point has a trend / melting point does not have a trend	1
2(c)	melting point is below 1000 °C and boiling point is above 1000 °C / 1000 °C is between the melting point and the boiling point	1
2(d)(i)	correct dot-and-cross diagram	1
2(d)(ii)	weak intermolecular forces / intermolecular forces are easy to break or overcome	1

64. 5070/21/M/J/22 Q4

4(a)	18	1
4(b)	18	1
4(c)	$^{40}_{19}K$	1
4(d)	loses one electron	1
4(e)(i)	lattice (structure) (1) strong attraction between positive and negative ions / strong electrostatic attraction between ions (1)	2
4(e)(ii)	**any two from:** conducts electricity as a molten liquid (1) does not conduct electricity as a solid (1) dissolves in water (1)	2

65. 5070/21/M/J/22 Q7

7(c)	 closely packed positive ions surrounded by delocalised electrons (1) strong attraction between electrons and positive ions (1)	2

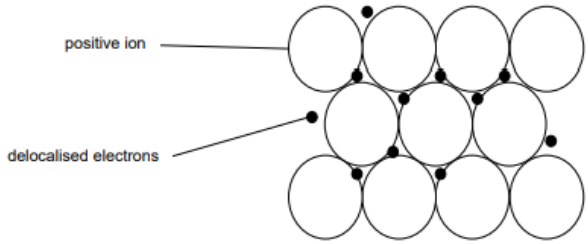
66. 5070/22/M/J/22 Q2

2(a)	2, 8, 6	1
2(b)	any value between 6.8 to 9.4 inclusive (g / cm^3)	1
2(c)	liquid because melting point is below 200 °C and boiling point is above 200 °C / 200 °C is between the melting point and the boiling point	1
2(d)(i)	correct dot-and-cross diagram	1
2(d)(ii)	weak intermolecular forces / intermolecular forces are easy to break or overcome	1

67. 5070/22/M/J/22 Q4

4(a)	79	**1**
4(b)	36	**1**
4(c)	$^{41}_{20}Ca$	**1**
4(d)	loses **two** electrons	**1**
4(e)(i)	in solid ions cannot move / in solid ions are in a lattice / in solid ions are fixed (1) in molten liquid ions can move (1)	**2**
4(e)(ii)	high melting point / high boiling point (1) dissolves in water (1)	**2**

68. 5070/22/M/J/22 Q8

8(b)(i)	 diagram showing closely packed positive ions surrounded by delocalised electrons (1) **strong** attraction between electrons and positive ions (1)	**2**
8(b)(ii)	electrons can move / has mobile electrons	**1**

69. 5070/21/O/N/22 Q2

2(a)(i)	2 bonding pairs between the C atom and each O atom (1) 4 non-bonded electrons on each O atom (1)	**2**

70. 5070/21/O/N/22 Q5

5(e)(i)	the ions can move	**1**

71. 5070/21/O/N/22 Q8

8(a)	in pure metal the layers of **atoms/ions** can slide (1) in alloys there are different sized atoms/ions (1) which stop the layers from sliding (1)	**3**
8(b)	mercury < chromium < uranium < potassium	**1**
8(c)	*number of electrons*: 78 (1) *number of neutrons*: 119 (1)	**2**

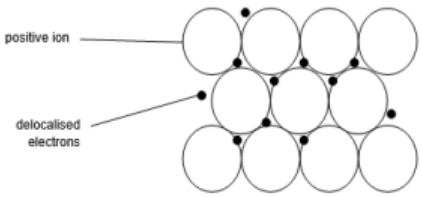
72. 5070/22/O/N/22 Q2

2(a)(i)	one bonding pair between two chlorine atoms (1) 6 non-bonded electrons on each chlorine atom (1)	**2**

73. 5070/22/O/N/22 Q5

5(c)(ii)	giant (ionic) structure / (ionic) lattice(1) strong (forces of) attraction between (positive and negative) ions (1)	**2**

74. 5070/22/O/N/22 Q8

8(a)	 closely packed positive ions (1) (particles) surrounded by delocalised electrons (1) **strong** attraction between electrons and positive ions (1)	**3**
8(b)	nickel < zinc < cerium < rubidium	**1**
8(c)	*number of electrons*: 55 (1) *number of neutrons*: 82 (1)	**2**