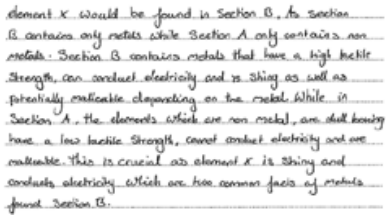
Mark scheme

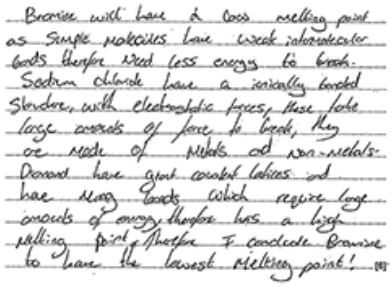
Question			Answer/Indicative content	Marks	Guidance
1	a		Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5-6 marks)** Detailed description of physical properties of metals and non-metals, correctly attributing metal properties to section A and non-metal properties to section B. Correctly identifies X as a metal/from section A. Contains properties extra to shiny and conducts electricity. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3-4 marks)** Clear description of physical properties of metals and non-metals, correctly attributing metal properties to section A and non-metal properties to section B. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1-2 marks)** Basic description of physical properties of metals/section A **OR** non-metals/section B. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 mark** *No response or no response worthy of credit.*	6 (2 x AO 1.1) (4 x AO 2.1)	**AO1.1 - Demonstrates knowledge and understanding of structures and bonding.** • Section A contains metals. • Section B contains non-metals. • Element X is from section A, as section A contains metals and metals are shiny and conduct electricity. **AO2.1 - Applies knowledge and understanding of physical properties of metals and non-metals.** <u>Examples of physical properties of elements:</u> • Metals (or section A elements) are shiny, malleable, ductile, sonorous. • Non-metals (or section B elements) are dull, brittle. • Metals are good conductors of electricity and heat. • Non-metals are poor conductors of electricity and heat. • Metals have high melting and boiling points • Non-metals have low melting and boiling points **<u>Examiner's Comments</u>** Level 1 required a description of the basic properties of Section A or Section B. Level 2 required a clear description of the properties and correctly assigning them to Section A/metals and Section B/non-metals. Level 3 required a detailed description of the properties of metals assigning them to Section A and non-metals assigning them to Section B which included properties in addition to those of X and also assigning X to section A/metals.

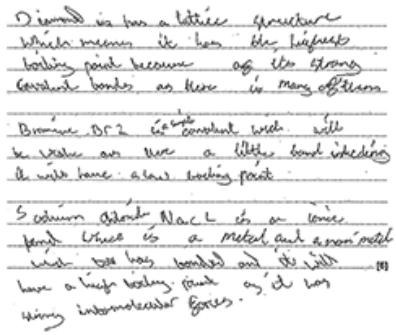
					Most candidates assigned X to metals/Section A. Some assigned the properties of X to A and B and the strongest candidates discussed properties in excess of shiny and conduction of electricity. Some reversed metals and non-metals or Sections A and B. The non-metals were often considered to be either gases (often halogens or noble gases) or liquids. Many discussed the properties of metals without including any properties of non-metals. Exemplar 1  element X would be found in Section B, As Section B contains only metals while Section A only contains non metals. Section B contains metals that have a high ductile strength, can conduct electricity and is shiny as well as potentially malleable depending on the metal. While in Section A, the elements which are non metal, are dull having have a low ductile strength, cannot conduct electricity and are malleable. This is crucial as element X is shiny and conducts electricity which are two common facts of metals found Section B. The candidate discusses the properties of metals in the question and two other properties of metals. They also discuss the properties of non-metals and two other properties of non-metals. However, they have reversed Sections A and B and have X in Section B. This is Level 2, 4 marks. **OCR support** Our Candidate Exemplars, produced for every series, will provide even more ways to see how our team of examiners apply the mark scheme and help you with marking via their detailed commentary. We produce four varieties: Level of Response, Maths skills, Practical activity and short answer. They are all available on Teach Cambridge.
	b		Properties ✓ Were undiscovered ✓	3 (3 x AO 1.1)	**Examiner's Comments** The work of Mendeleev was well

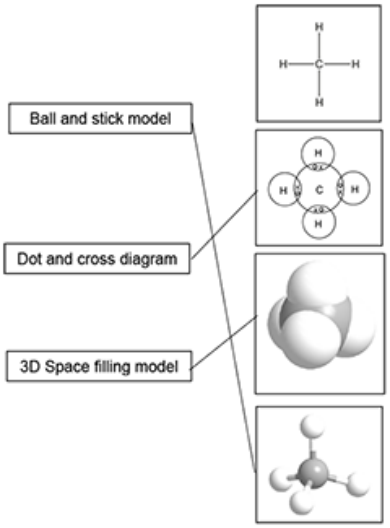
			Left gaps for ✓		known. Neutrons was quite a popular response for the first gap. Those that chose the wrong mass for gap two usually also had reweighed for gap three.
	c		Group 0 elements have a full outer shell (of electrons) ✓ Group 1 elements will react (lose an electron) to form a full outer shell (of electrons) ✓	2 (2 x AO 1.1)	**ALLOW** references to helium for Group 0 and lithium for Group 1 **ALLOW** one mark for the idea that a complete outer shell of electrons is a stable configuration, if no other mark gained **ALLOW** helium has a filled shell **ALLOW** Group 1 elements are reactive because they don't have a filled outer shell of electrons. **ALLOW** Group 1 elements will lose an electron to form a full outer shell (of electrons) **Examiner's Comments** Some candidates appreciated that Group 0 have a filled outer shell of electrons hence are stable. While many appreciated that Group 1 have 1 electron in their outer shell and lose it, few explained why they lost this electron. Many discussed filled shells of electrons with no reference to outer shell, thought Group 0 had no outer shell or discussed trends down the groups.
			Total	**11**	
2		i	Idea that a covalent bond is a shared **pair** of electrons (between atoms) ✓	1 (AO 1.1)	**Examiner's Comments** Candidates found this very challenging with few appreciating the sharing of a pair of electrons. Many thought electrons would be swapped or that metallic bonds were formed. A significant number omitted the question.
		ii	**Any two from:** Plastic bag polymer stretches or plastic bottle polymer is rigid / plastic bottle polymer is hard(er than plastic	2 (2 x AO 2.1)	**ORA** **ALLOW** bottle has a (more) fixed shape / bag doesn't have a fixed shape

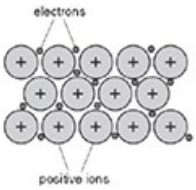
			bag) polymer ✓ Polymer used for plastic bottle will have high(er) melting point (than plastic bag polymer) ✓ Plastic bottle polymer is strong(er than plastic bag polymer) ✓ Plastic bag polymer has weak intermolecular forces ✓ Plastic bottle polymer has strong cross-links ✓		**ALLOW** Plastic bag polymer is flexible / plastic bottle polymer is not flexible/is hard to squeeze **IGNORE** elastic / brittle **ALLOW** hard to break for strong **IGNORE** thicker and thinner **Examiner's Comments** Highly successful candidates usually discussed strength or flexibility of the polymers and rarely both. The many incorrect responses included: thickness and thinness, strong and weak bonds, transparent and not, more and less polymers used, lighter and heavier, moving and not moving freely, larger and smaller polymers, hard to make and easy to make and recycled and not recycled.
			Total	**3**	
3			Model 3 ✓ Idea that model 3 is a 3D model ✓	2 (2 x AO 3.2b)	**IGNORE** gives size of molecule / can be visualised / gives the shap **Examiner's Comments** Some candidates appreciated that Model 3 should be chosen and many of these explained the model was 3D. Non-creditworthy reasons included showing the size or showing the volume. Many candidates chose Model 2 as it showed where the electrons were or Model 1 as it showed the bonds.
			Total	**2**	
4			C ✓	1 (AO 1.1)	**Examiner's Comments** Candidates found bonding very challenging. All responses were seen with D being the slightly more popular incorrect response
			Total	**1**	
5			B ✓	1 (AO 2.2)	**Examiner's Comments** Some candidates recognised the single covalent bonding in a molecule

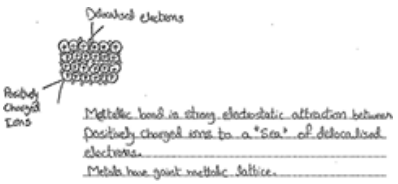
					of fluorine. Most appreciated that the bonding was not ionic, hence responses A and D were popular incorrect responses.
			Total	**1**	
6			A ✓	1 (AO 1.1)	**Examiner's Comments** Some candidates appreciated the organisation of the Periodic Table in terms of electrons. D was a popular incorrect response.
			Total	**1**	
7			Chlorine forms negative ions. ☑ Chlorine has 3 electrons in its outer shell. ☐ Chlorine has 7 electron shells. ☐ Chlorine has 7 electrons. ☐ Chlorine is a metal. ☐ Chlorine is a non-metal. ☑ ✓✓	2 (AO 2 x 2.1)	**Examiner's Comments** Many candidates knew that either chlorine is a non-metal or that chorine forms negative ions. Chlorine has 3 shells and chlorine has 7 electrons were popular responses.
			Total	**2**	
8			**Level 3 (5–6 marks)** Applies detailed knowledge and understanding to describe the types of bonding and accurately links this to compare the melting points. **AND** Predicts that bromine has the lowest melting point *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Applies some knowledge and understanding to describe the types of bonding. Basic comparison made. **AND**	6 (AO 4 x 2.1) (AO 2 x 3.2b)	**AO2.1 Apply knowledge and understanding of scientific ideas** • Ionic bonds / electrostatic forces in NaCl are very strong • Ionic bonds / electrostatic forces in NaCl require a lot of energy to break • Covalent bonds in diamond are very strong • Diamond has many strong covalent bonds • Covalent bonds in diamond require a lot of energy to break • Intermolecular forces in Br_2 are weak • Intermolecular forces in Br_2 require less energy to break **AO3.2b Analyse information to make judgements and draw conclusions**

			Predicts that bromine has the lowest melting point *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Attempts to apply knowledge and understanding to describe the types of bonding. Limited or no comparison made. **OR** Predicts that bromine has the lowest melting point. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 mark** *No response or no response worthy of credit.*		• Bromine has the lowest melting point • Sodium chloride has a higher melting point than bromine • Diamond has a higher melting point than bromine **Examiner's Comments** Level 1 needed a comment about bromine being the lowest melting point or a discussion of the forces in some of the substances. Level 2 needed choosing bromine as the lowest and a discussion of the bonding in more detail. Level 3 needed discussion of intermolecular forces and of energy needed to break bonds/forces. Sodium chloride was often chosen as having covalent bonding or the lowest melting point. Many candidates discussed bonding between a metal and a non-metal or rewrote the information from the table. Exemplar 1  Bromine will have a less melting point as simple molecules have weak intermolecular bonds therefore need less energy to break. Sodium chloride have a ionically bonded structure, with electrostatic forces, these take large amounts of force to break, they are made of metals and non-metals. Diamond have giant covalent lattices and has many bonds which require large amounts of energy, therefore has a high melting point, therefore I conclude Bromine to have the lowest melting point! (1) Bromine was chosen as having the lowest melting point with weak intermolecular forces as the reason, linked to less energy to break them. Sodium chloride has electrostatic forces which require large force to break (force was condoned in this context since energy is used when referring to bonds in diamond). Diamond has many covalent bonds which require large amounts of energy (to break), hence high melting point. A response does not need to be perfect in order to score 6 marks. This

					response has the lowest melting point substance chosen, the bonding discussed, weak intermolecular forces in bromine and the energy required to overcome the bonding for all three substances. This is level 3, 6 marks. Exemplar 2  Sodium chloride and diamond have high melting point and bromine low, hence bromine has the lowest melting point. Diamond has many strong bonds. Strong intermolecular forces in sodium chloride was incorrect. This is Level 1, 2 marks. Exemplar 3  This response has bromine chosen as having the lowest melting point. It also includes sodium chloride and diamond having strong bonds. Weak intermolecular forces are not discussed, nor is the energy required to break the bonds in the three substances. The response suggests that bromine has weak bonds; however the bonds in bromine are strong – it is the forces between the

					molecules that are weak. This is Level 2, 3 marks.
			Total	**6**	
9	a		 ✓✓✓	3 (AO 3 x 1.2)	
	b		Electrons can be seen in the bonds/shared electrons in Model 1 / **ORA** ✓ The lone pairs of electrons/unshared electrons can also be seen in Model 1 ✓	2 (AO 2 x 3.1b)	If no marks scored **ALLOW** for 1 mark Model 1 shows the number of electrons(in the outer shells) **Examiner's Comments** The highest attaining candidates appreciated that the shared electrons in the bonds and the non-bonding electrons were both shown in Model 1. Rewriting the question stem was the most common response. Other popular responses included easier to read and understand and it is more detailed.
			Total	**5**	
10			**D**	1 (AO 1.1)	**Examiner's Comments** Many candidates thought the improvement Mendeleev made to his Periodic Table was to arrange the

					elements in order of mass number and chose response A.
			Total	**1**	
11			**C**	1 (AO 1.1)	**Examiner's Comments** Higher attaining candidates appreciated that non-metals gain electrons and that these are found in part C of the Periodic Table. All responses were popular.
			Total	**1**	
12			**Y** ✓ Because it does not conduct electricity ✓	2 (2 × AO 2.2)	**Examiner's Comments** Almost all candidates identified Y as the non-metal for the first mark, and well over half of them gave electrical conductivity as the most appropriate reason. Candidates who gained 1 mark often listed all properties for Y, rather than selecting the relevant one.
			Total	**2**	
13		i	Positive (metal) ions ✓ Idea of the ions being surrounded by a sea of electrons ✓ Idea that there are strong forces of attraction between ions and electrons ✓	3(AO1.1)	**Any reference to ionic or covalent bonding or IMF scores 0** **ALLOW** a labelled diagram  In a diagram there must be at least one electron in the body of the ions Diagram must show **close packed** metal ions, in a regular arrangement **ALLOW** - / e / e- / dots for electrons labelled If e or e- are used they do not need labelling but just a dot or – unlabelled does not score **ALLOW** circles with + or circles labelled positive ions **IGNORE** free electrons If M1 **and** M2 scored allow strong

					(metallic) bond for M3 **Examiner's Comments** The most successful responses gave a labelled diagram and described the bonding. Diagrams were often missing or unlabelled and often diamond. Many discussed ionic or covalent bonding. A large number omitted the question. Exemplar 1  Diagram has close packed regular positive ions and labelled, ions interspersed with delocalised electrons and labelled; text has strong attraction between positive ions and delocalised electrons. This response gained all 3 marks.
		ii	Idea that layers or rows or sheets (of particles) slide over each other ✓	1(AO1.1)	**IGNORE** layers can bend **IGNORE** IMF **Examiner's Comments** The most successful responses discussed layers. Many discussed weak bonding, delocalised electrons or forces between atoms and a large number omitted the question
		iii	Has electrons ✓ (Electrons) that can move (through the metal) ✓ **OR** Delocalised electrons scores ✓ ✓	2(2 × AO1.1)	**DO NOT ALLOW** free ions – scores 0 **IGNORE** free (electrons) for idea of movement **IGNORE** carry charge **Examiner's Comments** More successful responses discussed electrons and the most successful described the electrons as moving. Popular responses included bonding, close packing of atoms allowing conduction and moving ions.

		iv	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3:2 award 2 marks** (Lead:tin ratio in diagram =) 12:8 ✓ Divide by 4 to give smallest ratio = 3:2 ✓	2(2 × AO2.1)	**ALLOW** tin:lead in diagram = 8:12 **Examiner's Comments** This was answered well, a small number of candidates gave 12:8, simplified to 6:4 or reversed the ratio.
		v	As the silver content increases, the melting point decreases **ORA** ✓	1 (AO3.1a)	both variables must be comparative **Examiner's Comments** More successful candidates derived the link between silver content and melting point. Popular incorrect responses included high melting point, low melting point and the melting point increasing as silver content increases.
			Total	**9**	
14			A ✓	1(AO1.1)	**Examiner's Comments** Most candidates remembered that gaps were left and chose option C, the context of tellurium and iodine leads to response A.
			Total	**1**	
15	a	i	Boron has 11 protons. ☐ The atomic number of boron is 5. ☑ ✓ The electrons are heavier than the protons. ☐ The isotopes of boron have different numbers of neutrons. ☑ ✓ The isotopes of boron have different numbers of protons. ☐ The mass number of boron is the same for both isotopes. ☐	2(2 × AO2.1)	**Examiner's Comments** Many candidates confused atomic number and mass number and so ticked mass number the same for both isotopes and boron has 11 protons. A smaller number chose different numbers of protons.
		ii	(Boron) has three electrons in its outer shell ✓	1(AO2.1)	**Examiner's Comments** More successful responses interpreted the diagram to give three electrons on the outer shell. Common incorrect responses said that boron

					contained five electrons and has two shells.
	b		(Non-metals) gain electrons ✓ forms a (more stable) filled outer shell✓	2(2 × AO1.1)	**Ignore** need electrons **Examiner's Comments** Type your commentary here **Misconception** Many candidates described the negative charge arising from a loss of electrons. Very few included the attainment of a filled outer shell.
			Total	**5**	
16			D ✓	1(AO1.1)	**Examiner's Comments** More successful candidates appreciated the difference between a group and a period. C was a popular incorrect response.
			Total	**1**	