Mark scheme – Properties of Materials (F)

Question			Answer/Indicative content	Marks	Guidance
1			B	1 (AO2.1)	
			Total	**1**	
2			D	1 (AO1.1)	
			Total	**1**	
3			B	1 (AO2.1)	**Examiner's Comments** Candidates found the unit conversion very difficult. All responses seen, A being the most common.
			Total	**1**	
4	a		Layers / metal ions ✓ slide over each other ✓	2 (AO1.1)	**IGNORE** metal atoms / electrons **Mark independently**
	b	i	ionic✓ oppositely charged ions✓	2 (AO1.1)	**ALLOW** oppositely charged particles / has + and – particles **IGNORE** contains anions and cations (in diagram) **IGNORE** oppositely charged atoms / molecules **DO NOT ALLOW** positive nucleus and negative electrons **Mark independently**
		ii	**Any two from:**	2 (AO1.1)	**Reference to intermolecular forces / bonds /**

			Idea of many strong ✓ covalent bonds ✓ (which) require a lot of energy to break ✓		**molecular forces scores 0 for question** **ALLOW** many covalent bonds break at high temperatures for 2 marks **ALLOW** idea that each atom has 4 strong covalent bonds for 2 marks **ALLOW** giant covalent structure for 1 mark
		iii	No delocalised electrons / no sea of electron / no mobile charge carriers / ions / electrons structure contains atoms ✓	1 (AO1.1)	**IGNORE** just free electrons
			Total	**7**	
5	a	i	A **AND** D ✓	1 (AO3.1a)	
		ii	**Any two from:** Conducts electricity in molten state ✓ Does not conduct electricity in solid state ✓ High melting point ✓	2 (AO3.2b)	ALLOW dissolve in water
	b	i	Add water (and stir) ✓ Filtration ✓ **B** collects on filter paper ✓	3 (AO3.3a 1.2 3.3a)	
		ii	Distillation **OR** evaporation **OR** heating ✓ Removes water **OR** dries C **OR** removes some water and leave to crystalise ✓	2 (AO1.2 3.3a)	**ALLOW** boiling
			Total	**8**	
6	a	i	Nanoparticles have diameter between 1 nm – 100 nm / idea that (diameter of) DNA is more than 1 nm but less than 100 nm ✓	2 (AO 1.1)	**ALLOW** has at least one dimension on

			Water (molecule) is too small / 0.27 nm is less than 1 nm / idea that 0.27 nm is not in range 1 nm – 100 nm ✓		the nanoscale **Examiner's Comments** Higher ability students appreciated that a water molecule is too small to be a nanoparticle but very few candidates discussed the dimensions of a nanoparticle. Many omitted the question. Incorrect responses included: water molecules cannot be found on their own, DNA can be seen but water molecules can't and water being a liquid.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3100 award 2 marks** 100000 ÷ 32 ✓ = 3100 (2 significant figures) ✓	2 (AO2.2)	**ALLOW** 3125 for 1 mark **ALLOW** 0.00032 for 1 mark (correct sig figs from incorrect working out, ie 32 ÷ 100000) **Examiner's Comments** More able candidates calculated the value correctly, but many did not give their answer to 2 significant figures.
	b		Could be breathed in / Idea of absorbed by skin / Idea of absorbed into bloodstream / Take a long time to break down in the environment ✓	1 (AO2.1)	**ALLOW** cannot see so may leave (areas of) skin unprotected **ALLOW** idea that we don't know the

					long term risks **IGNORE** idea that they are not fully understood / there could be side effects / idea that they may react with skin / harmful to humans **Examiner's Comments** Higher ability candidates appreciated that the smallness of the nanoparticles means they are easily absorbed into the bloodstream or body. Many thought they would irritate or react with the skin without appreciating that they could not be sold where this true. Side effects, particles too small to cover the skin and non-understanding of nanoparticles were common non-creditworthy responses.
	c		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.12 OR 0.12:1 or 1:8.3 award 4 marks** Surface area = $6 \times 50^2 = 15000$ ✓ Volume = $50^3 = 125000$ ✓ Surface area / volume ratio = 15000 ÷ 125000 ✓ = 0.12 or 0.12:1 or 1:8.3 ✓	4 (AO3 × 2.2) (AO1.2)	**Units not needed** **ALLOW** surface area = 1.5×10^4 nm^2 **ALLOW** volume = 1.25×10^5 nm^3 **ALLOW** ECF from incorrect surface area and/or volume **ALLOW** any ratio that simplifies to 0.12:1 eg 3:25 or 1.5:12.5 for 4 marks **DO NOT ALLOW** ratio wrong way

					round eg 1:0.12 **Examiner's Comments** Higher ability candidates calculated both correctly and determined a ratio. Common errors included calculating the surface area for one face only and missing 0's on the volume. Most showed the steps of their working and many then scored follow through marks for using their values to determine a ratio. A significant number omitted the question.
			Total	**9**	
7	a		**Any two from:** Conducts electricity because touchscreens need to be able to conduct electricity ✓ High strength so screen does not break when dropped/ so doesn't wear off / rub off / crack from pressure of fingers ✓ Transparent so can see light through the display ✓	2 (AO3.2a)	**ALLOW** doesn't break easily **ALLOW** can see work/can see through it **Examiner's Comments** Many candidates gained at least partial credit, usually for the transparency of the screen so that the display could be seen. Some candidates listed the properties from the table with no application to the touch screen.

	b	i	Buckminsterfullerene / bucky ball ✓	1 (AO1.1)	**ALLOW** C_{60} **IGNORE** fullerene **Examiner's Comments** Candidates found this very difficult and a significant number omitted the question. Common non-creditworthy responses included: fullerene, graphene, carbon, giant covalent.
		ii	Has many atoms joined together (by covalent bonds) ✓ Arranged in a repeating pattern ✓	2 (AO1.1)	**ALLOW** all atoms joined together / each/every C atom joined together **DO NOT ALLOW** imf **Examiner's Comments** Candidates found this extremely difficult with few gaining credit and a significant number omitted the question. Discussion of bond strength, four bonds, layers, large and intermolecular forces were seen alongside a range of guesses.
	c	i	**Many** strong (covalent) bonds ✓ A lot of energy needed to break the bonds ✓	2 (AO1.1)	**ALLOW** each/every C bonded to 4 C atoms (ie network idea) / many bonds / network of bonds / bonds throughout structure ✓ strong (covalent) bonds ✓ **DO NOT ALLOW** IMF/ionic **Examiner's**

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td><u>Comments</u>

Candidates found this difficult. Higher ability candidates knew that the bonds were strong but few appreciated the concept of a high number of the strong bonds giving it hardness.</td></tr>
<tr><td></td><td></td><td>ii</td><td>Layers slide over each other / weak forces between the layers ✓</td><td>1
(AO1.1)</td><td>IGNORE IMF

<u>Examiner's Comments</u>

Higher ability candidates gained credit. Non-creditworthy responses included: layered structure, carbon atoms move, intermolecular forces between the layers, weak covalent bonds between layers and weak bonding.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>8</td><td></td></tr>
<tr><td>8</td><td></td><td></td><td>Idea that thermometer should remain in reaction mixture for temperature at end (1)
otherwise temperature at end will be inaccurate (1)</td><td>2</td><td>ALLOW do not stir with thermometer (1) as it is fragile (1)
ALLOW lag the beaker (1) to reduce energy loss (1)</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
<tr><td>9</td><td></td><td></td><td>liquid (1)
liquid above −114 °C and does not boil until 78 °C (1)</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>10</td><td>a</td><td></td><td>
<table>
<tr><th>Particle</th><th>Atomic number</th><th>Mass number</th><th>Number of protons</th><th>Number of neutrons</th><th>Number of electrons</th><th>Electronic structure</th></tr>
<tr><td>A</td><td>11</td><td>23</td><td>11</td><td>12</td><td>11</td><td>2.8.1</td></tr>
<tr><td>B</td><td>9</td><td>19</td><td>9</td><td>10</td><td>9</td><td>2.7</td></tr>
<tr><td>C</td><td>17</td><td>37</td><td>17</td><td>20</td><td>17</td><td>2.8.7</td></tr>
<tr><td>D</td><td>13</td><td>27</td><td>13</td><td>14</td><td>10</td><td>2.8</td></tr>
</table>
</td><td>4</td><td>one mark scored for each correct line</td></tr>
<tr><td></td><td>b</td><td></td><td>particle A – one electron in outer shell or energy level (1)
particle D – has more protons than electrons (1)</td><td>2</td><td></td></tr>
</table>

	c		group 7 (1) as 7 electrons in outer shell (1) period 3 (1) as 3 shells occupied (1)	4	
			Total	**8**	
11			idea that does not show arrangement in space / is 2-dimensional only (1) bond angles are incorrect (1)	2	
			Total	**2**	
12			Mass of fuel needed to boil water (g) = energy needed to boil water (J) / energy per gram = 63000 / 50000 (1) = 1.2 g (1) Since 3 g in burner, this is enough propane / **AW** (1)	3	
			Total	**2**	
13	a		During this reaction, the oxidising agent is **oxygen** and the reducing agent is **magnesium** (1)	1	
	b		$2Mg(s)$ (1) + $O_2(g)$ (1) $\longrightarrow$ $2MgO(s)$	2	
			Total	**8**	
14			C	1	
			Total	**1**	
15			A	1	
			Total	**1**	
16		i	To allow a comparison between with and without the added substance (1)	1	
		ii	Idea that the rate of reaction will change if concentration is changed (1)	1	It is a fair test is not sufficient **ALLOW** if concentration is increased the rate of reaction is increased **ALLOW** to ensure there are the same number of acid particles present / same number of acid particles per unit volume
		iii	Copper Because the reaction is faster (1) There is no change in appearance (1)	2	**No** marks for copper on its own If substance other than copper given

					then 0 marks for the question
		iv	Measure mass of catalyst before and after (1)	1	
		v	(Relative rate) between above 1 and below 10 because of smaller surface area / less exposed particles / less collisions (2)	2	**No** marks for the prediction on its own **No** marks for whole question if prediction incorrect
			Total	**7**	