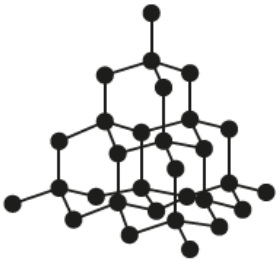
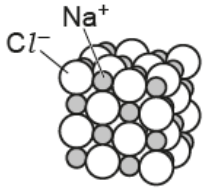
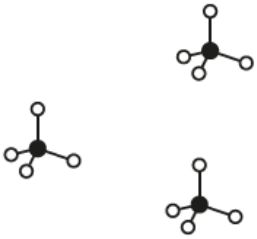
Material choices – 2021/20 GCSE 21st Chemistry Combined Science B

1. Nov/2021/Paper_ J260/02/No.4

The table shows some information about diamond, sodium chloride and methane.

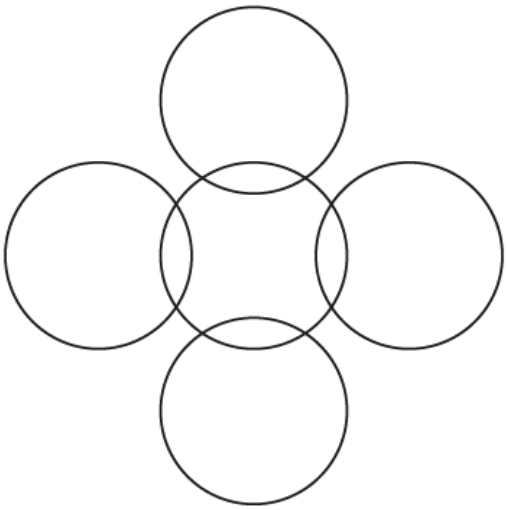
	Diamond	Sodium chloride	Methane
3D Structure			
Element or compound?	.....	.....	Compound
Type of bonding	.....	.....	Covalent
High or low boiling point?	High	.....	Low

(a) Complete the table. **[4]**

(b) Structures can also be shown by dot and cross diagrams.

(i) Complete the dot and cross diagram for methane.

Show outer electrons only, and label each atom.



[2]

(ii) Which features of a **methane** molecule are shown by a 3D structure and a dot and cross structure?

Tick (✓) **one** box in each row.

Feature	Shown only by 3D structure	Shown only by dot and cross structure	Shown by 3D structure and by dot and cross structure
Shape of molecule			
Number of bonds			
Number of electrons in bonds			

[3]

(c) Why does diamond have a much higher boiling point than methane?

Tick (✓) **two** boxes.

All bonds in diamond are strong. ☐

Bonds between atoms in methane are weak. ☐

Bonds in methane are ionic. ☐

Covalent bonds are weak. ☐

Forces between methane molecules are weak. ☐

[2]

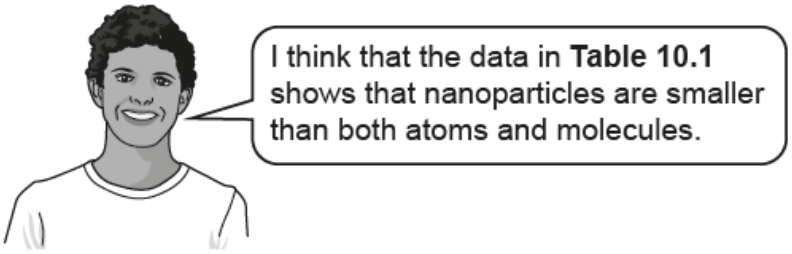
2. Nov/2021/Paper_ J260/02/No.10

Table 10.1 shows data about the sizes of some particles.

Particle	Approximate size (m)
Nanoparticles	between 1×10^{-9} and 1×10^{-7}
Hydrogen atom	1.06×10^{-10}
Oxygen atom	1.56×10^{-10}
Water molecule	2.75×10^{-10}
Carbon atom	1.54×10^{-10}
Polymer molecules	1.00×10^{-6}

Table 10.1

James comments on the data in **Table 10.1**.



(a) Discuss James' comment.

Use **Table 10.1** to support your answer.

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..... **[3]**

(b) **Table 10.2** shows information about the particles in some silver powders.

Type of powder	Size of particles (nm)	Surface area to volume ratio
Nanoparticles	50	0.12
Fine powder	5000	0.0012
Coarse powder	10 000	0.0006

Table 10.2

(i) Which type of powder in **Table 10.2** provides the biggest surface area for a given volume of silver?

Give **one** reason for your answer.

Type of powder .....

Reason .....

.....

[1]

(ii) James thinks that the data in **Table 10.2** gives this relationship.

surface area to volume ratio ∝ size of particle

Is James correct?

Yes ☐

No ☐

Explain your answer.

.....

.....

.....

.....

[2]

(c) The different ways that nanoparticles are used depends on their properties.

Draw lines to connect each **property** of nanoparticles with the **use** that depends on it.

Property	**Use**
Atoms arranged in balls	Carry medicines into the body
Atoms arranged in tubes	Catalysts
High surface area to volume ratio	Molecular sieves

[2]

(d) Nanoparticles are used as catalysts.

Which **two** statements explain how a catalyst increases the rate of a reaction?

Tick (✓) **two** boxes.

Catalysts decrease the activation energy of the reaction. ☐

Catalysts increase the energy change of the reaction. ☐

Catalysts increase the kinetic energy of the particles. ☐

Catalysts increase the temperature. ☐

Catalysts reduce the energy needed to break the bonds in the reactants. ☐

[2]

3. Nov/2021/Paper_ J260/04/No.2

Households in the UK are asked to separate recyclable materials such as metal cans, glass bottles and plastic containers from their waste.

Table 2.1 shows data about the recycling of these materials in the UK.

Packaging material	Packaging waste (thousand tonnes)	Total packaging recycled (thousand tonnes)	Percentage recycled (%)
Aluminium	177	94	53.1
Steel	559	431	77.1
Glass	2399	1623	67.7
Plastic	2260	1044	

Table 2.1

(a) (i) Which packaging material produces the highest amount of packaging waste?

Use data from **Table 2.1**.

Put a (ring) around the correct answer.

Aluminium **Glass** **Plastic** **Steel** **[1]**

(ii) Calculate the percentage of plastic recycled.

Use data from **Table 2.1**.

Use the equation: percentage recycled = $\frac{\text{total packaging recycled}}{\text{packaging waste}} \times 100$

Give your answer to **1** decimal place.

Percentage of plastic recycled = ... % **[3]**

(b) The UK government has recycling targets.

Table 2.2 shows the percentage of aluminium, steel and glass recycled in the UK in 2017.

Packaging material	Percentage recycled in the UK (%)	Recycling target (%)
Aluminium	53.1	50.0
Steel	77.1	50.0
Glass	67.7	60.0

Table 2.2

(i) Which packaging material has the UK been most successful in recycling?

Use data from **Table 2.2** to explain your answer.

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..... **[2]**

(ii) Household waste for recycling is sent to a sorting centre. Steel contains iron.

Suggest how the sorting centre could separate the steel cans from the aluminium cans.

.....

..... **[1]**

(iii) Producing glass from recycled materials uses less **energy** than producing glass from new resources.

Name **two** other factors that would be important when deciding that a product should be made from recycled materials instead of new resources.

Factor 1 .....

Factor 2 .....

[2]

4. Nov/2020/Paper_ J260/02/No.4

Cotton is a natural fibre made from plants. Polyester is a man-made, synthetic fibre made from crude oil.

(a) Which **two** statements explain why plants are more sustainable raw materials than crude oil?

Tick (✓) **two** boxes.

- Crude oil is finite. ☐
- Crude oil is found underground. ☐
- Plants are recyclable. ☐
- Plants are renewable. ☐
- Plants can be used as food but crude oil cannot. ☐

[2]

(b) Most shirts are made from polyester or cotton fabric.

The table shows data from two parts of a life-cycle assessment, for both polyester shirts and cotton shirts.

The data is for 1000 polyester shirts and 1000 cotton shirts.

	1000 polyester shirts	**1000 cotton shirts**
Production of the two fabrics from raw materials		
Raw material	Crude oil	From plants
Energy used to make fibres from raw materials (MJ)	97	60
Energy used to make the fabric from the fibres (MJ)	33	40
Total water used in production (dm^3)	1307	25900
Total carbon dioxide emissions during production (kg)	3.8	5.3
Disposal of the shirts (by burning)		
Energy released (MJ)	33	7
Carbon dioxide emissions (kg)	5.8	5.5

(i) What should be considered when completing a life-cycle assessment for both polyester shirts and cotton shirts?

Tick (✓) **two** boxes.

The amount that workers are paid. ☐

The cost of the shirts. ☐

The energy used to transport the shirts. ☐

The energy and water used to wash the shirts. ☐

Which shirt customers prefer. ☐

[2]

(ii) Calculate the difference in the **total** energy used for the production of the **two fabrics** from raw materials.

Use data from the table.

Difference in total energy = ... MJ

[2]

(iii) Give **two** advantages to the environment of making polyester fabric rather than cotton fabric.

Use data from the table to support your answers.

1. .....

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2. .....

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[2]

(iv) Give **one** disadvantage to the environment of making polyester fabric rather than cotton fabric.

Use data from the table to support your answer.

.....

..... **[1]**

(c) (i) There are many different methods of disposing of shirts at the end of their life-cycle.

The table gives some information about disposal by burning.

Suggest **two** other methods of disposing of shirts.

1. .....

2. .....

[2]

(ii) When shirts are disposed of by burning, energy is released.

Suggest **one** use for this energy.

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..... **[1]**

5. Nov/2021/Paper_ J260/06/No.2

Table 2.1 shows data about the sizes of some particles.

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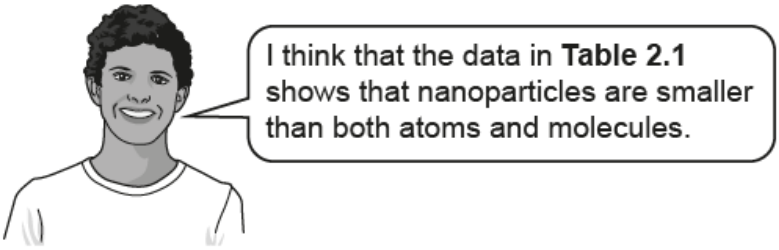
Table 2.1

James comments on the data in **Table 2.1**.



(a) Discuss James' comment.

Use **Table 2.1** to support your answer.

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..... **[3]**

(b) **Table 2.2** shows information about the particles in some silver powders.

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Nanoparticles	50	0.12
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(i) Which type of powder in **Table 2.2** provides the biggest surface area for a given volume of silver?

Give **one** reason for your answer.

Type of powder .....

Reason .....

.....

[1]

(ii) James thinks that the data in **Table 2.2** gives this relationship.

surface area to volume ratio ∝ size of particle

Is James correct?

Yes ☐

No ☐

Explain your answer.

.....

.....

.....

.....

[2]

(c) The different ways that nanoparticles are used depends on their properties.

Draw lines to connect each **property** of nanoparticles with the **use** that depends on it.

Property	**Use**
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(d) Nanoparticles are used as catalysts.

Which **two** statements explain how a catalyst increases the rate of a reaction?

Tick (✓) **two** boxes.

Catalysts decrease the activation energy of the reaction. ☐

Catalysts increase the energy change of the reaction. ☐

Catalysts increase the kinetic energy of the particles. ☐

Catalysts increase the temperature. ☐

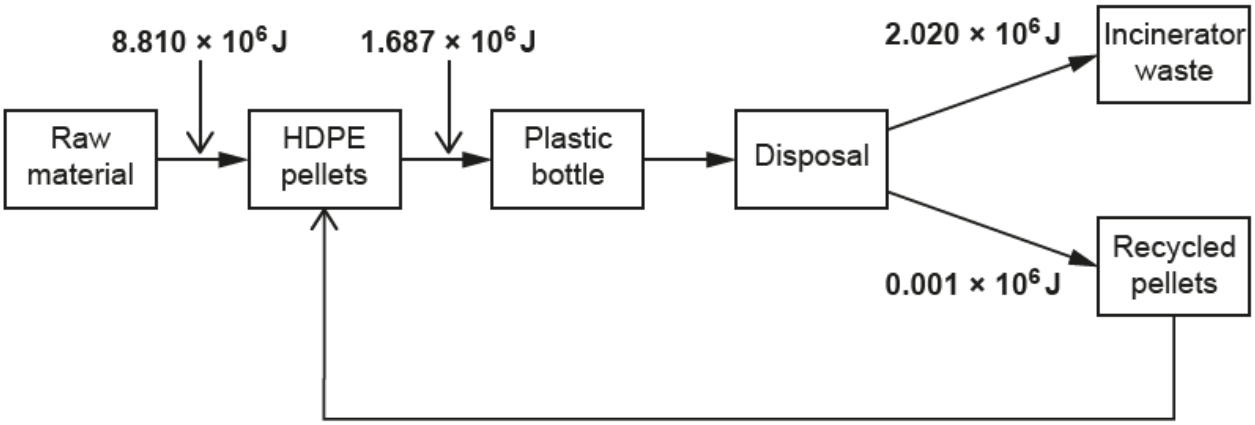
Catalysts reduce the energy needed to break the bonds in the reactants. ☐

[2]

6. Nov/2021/Paper_ J260/06/No.7

Beth is looking at a life-cycle assessment diagram for a plastic bottle made from the polymer HDPE.

The energy used in the life-cycle of one plastic bottle is shown in the diagram.



Explain the factors that should be considered when deciding if plastic bottles should be made from raw materials or from recycled pellets.

Use calculations to support your answer.

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..... **[6]**

7. Nov/2021/Paper_ J260/06/No.6

Information about the bonding, structure and melting points of **three** different compounds are shown in the table.

Compound	Sodium chloride	Phosphorus(III) chloride	PVC
Formula	$NaCl$	PCl_3	$(C_2H_3Cl)_n$
Type of bonding and structure	ionic	simple covalent molecules	covalent polymer
Melting point (°C)	801	−96	100–260

Describe and explain the differences in the melting points of the **three** compounds.

Use ideas about their structures, bonding, and intermolecular forces in your answer.

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..... **[6]**