Properties of Materials (F)

1. Substance **Y** melts at −7 °C and boils at 59 °C.

What is the state of substance **Y** at room temperature?

A Gas
B Liquid
C Plasma
D Solid

Your answer ☐ **[1]**

2. Ammonia has a simple molecular structure.

Which statement explains why ammonia has a low melting point and a low boiling point?

A The covalent bonds between the atoms are strong.
B The covalent bonds between the atoms are weak.
C The intermolecular forces between the molecules are strong.
D The intermolecular forces between the molecules are weak.

Your answer ☐ **[1]**

3. The diameter of one type of carbon nanotube is 20 nm.

What is 20 nm in metres?

A 2×10^{-3} m
B 2×10^{-8} m
C 2×10^{-20} m
D 2×10^{-16} m

Your answer ☐ **[1]**

4 (a). Look at the structure of a metal in **Fig. 22.2**. Metals are malleable, which means they can be hammered or pressed into shape without breaking or cracking.

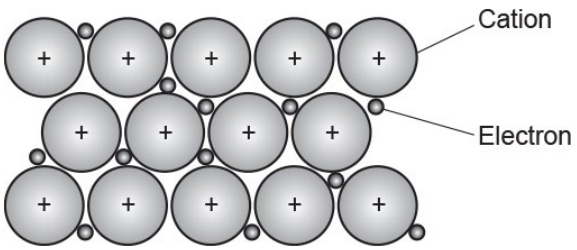

Fig. 22.2

Explain why metals are **malleable**.

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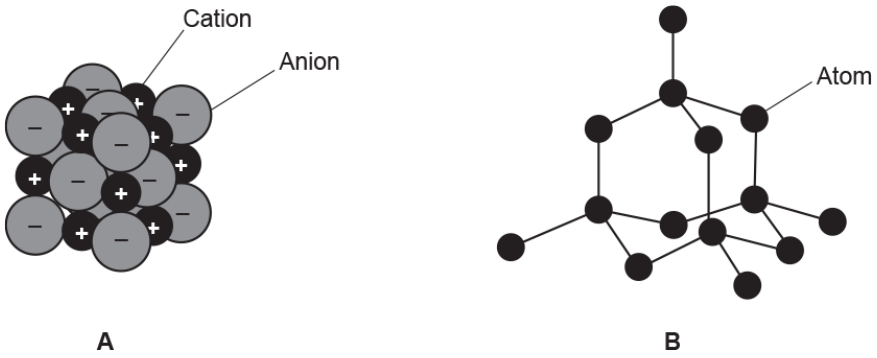
[2]

(b). This question is about structure and bonding.

Look at the two structures, **A** and **B**, in **Fig. 22.1**.



A **B**

Fig. 22.1

i. Identify the bonding in structure **A**.

Explain your answer.

Bonding

Explanation

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[2]

ii. Explain why structure **B** has a high melting point.

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[2]

iii. Explain why structure **B** does **not** conduct electricity.

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[1]

5(a). The table shows the properties of different substances.

Substance	Melting point (°C)	Boiling point (°C)	Soluble in water?	Conducts electricity in solid state?	Conducts electricity in molten state?
A	−210	−196	No	No	No
B	1084	2562	No	Yes	Yes
C	605	1137	Yes	No	Yes
D	−78	−34	Yes	No	No

i. Which **two** substances are gases at room temperature?

Tick (✓) **two** boxes.

A ☐

B ☐

C ☐

D ☐

[1]

ii. Substance **C** is an ionic substance.

Use the information in the table to explain why.

---

[2]

(b). You are provided with a mixture of substances **B** and **C**.

Substance **B** is insoluble in water. Substance **C** is soluble in water.

i. Describe how you could separate substance **B** from the mixture.

---**[3]**

ii. Describe how you would then obtain substance **C** after separating substance **B**.

---**[2]**

6 (a).

i. Scientists compare the size of nanoparticles to the sizes of other small objects.

Look at the table.

Object	Diameter (nm)
Gold atom	0.14
Water molecule	0.27
DNA strand	2.5
Zinc oxide nanoparticle	32
Red blood cell	7000
Human hair	100 000

The diameter of a DNA strand is 2.5 nm.

Explain why DNA is a nanoparticle but a water molecule is **not** a nanoparticle.

---**[2]**

ii. Calculate how many zinc oxide nanoparticles would fit across a human hair.

Give your answer to **2** significant figures.

Number of nanoparticles = ... **[2]**

(b). A new sun cream has been developed using zinc oxide nanoparticles.

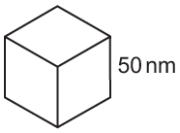
The small particles provide better protection from the sun and they do not leave white marks on the skin.

Explain **one** possible risk of using nanoparticles in sun cream.

_____

_____ **[1]**

(c). A cube-shaped nanoparticle has sides of length 50 nm.

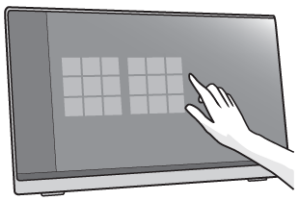


Calculate the surface area to volume ratio for this nanoparticle.

Use the equation: ratio = surface area ÷ volume

Surface area to volume ratio = ... **[4]**

7 (a). Graphene is another substance made of carbon atoms. Graphene is a single layer of graphite.
It is just one atom thick. Graphene can be used to make touchscreens for electronic devices.



Look at the table. It shows some properties of graphite and graphene.

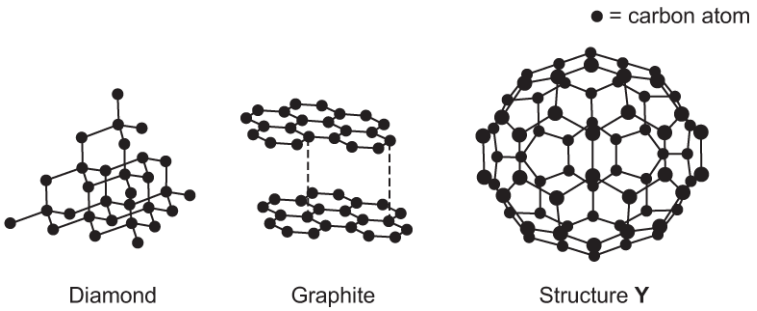
Substance	Cost	Electrical conductivity	Density	Strength	Colour
Graphite	low	high	low	low	black
Graphene	high	high	low	high	transparent

Explain why **graphene** is suitable for making touchscreens.

Use the information from the table.

---**[2]**

(b). The diagrams show three different structures of carbon.



i. What is the name of structure **Y**?

---**[1]**

ii. Diamond can be described as having a **giant lattice** structure.

Why is diamond described as a giant lattice structure?

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[2]

(c).

i. Diamond is the hardest naturally occurring substance on Earth.

Explain why diamond is hard.

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[2]

ii. Graphite is used in pencils. Graphite is a soft material.

Explain why graphite is soft.

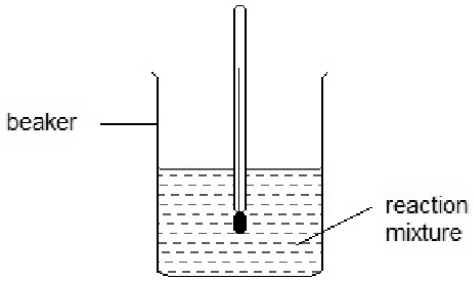
---

[1]

8. Phil investigates some exothermic and endothermic reactions.

He measures the temperature changes during some chemical reactions.

Look at how Phil does the experiment.



1. He measures the temperature of one of the reactants at the start.
2. He then adds the second reactant and stirs the mixture.
3. He removes the thermometer from the beaker and then reads it to take the temperature at the end of the reaction.

How should Phil improve his method? Explain your answer.

---

[2]

9. Ethanol contains carbon.

Look at some information about ethanol.

Melting point = −114 °C

Boiling point = 78 °C

Predict the state of ethanol at 25 °C. How can you tell?

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[2]

10 (a). Look at the table. It shows information about some atoms and ions.

Particle	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Electronic structure
A	11	23	11	.....	11	2.8.1
B	9	19	9	10	9	.....
C	.....	37	17	.....	17	2.8.7
D	13	27	.....	.....	10	2.8

Complete the table.

[4]

(b). Particle **A** is a metal **atom**, particle **D** is an **ion**.

Explain why.

---

[2]

(c). Element **C** has the electronic structure 2.8.7.

What does this tell you about the position of element **C** in the periodic table?

Explain your answer.

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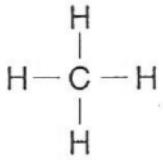
[4]

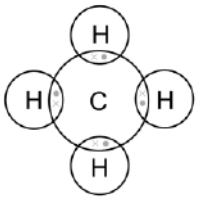
11. Methane has the formula, CH_4.

Look at the representations of methane.

ball and stick model



displayed formula



dot and cross diagram

Describe the limitations of a **displayed** formula.

[2]

12. Propane gives out 50 000 J/g when it reacts with oxygen.

A propane burner is used to boil water to make a cup of tea.

63 000 J of energy are required to boil the water.

There is only 3 g of propane in the burner.

Do a calculation to find out if there is enough propane in the burner to boil the water.

[3]

13 (a). Which element is oxidised and which element is reduced?

oxidised: .....

reduced: .....

[1]

(b). Magnesium burns in oxygen to make magnesium oxide.

The reaction involves both oxidation and reduction.

$$2Mg(....) + O_2(....) \longrightarrow 2MgO(s)$$

magnesium + oxygen ⟶ magnesium oxide

Complete the equation above by adding the state symbols for magnesium and oxygen at room temperature.

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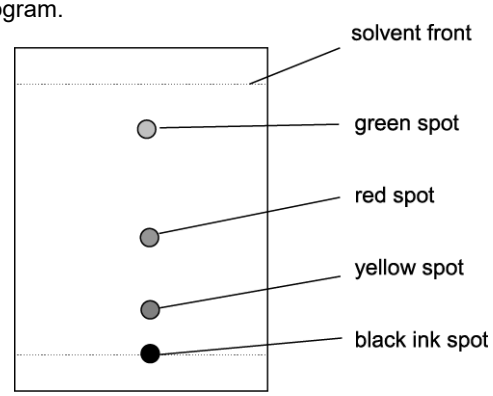
[2]

14. Look at Tim's chromatogram.



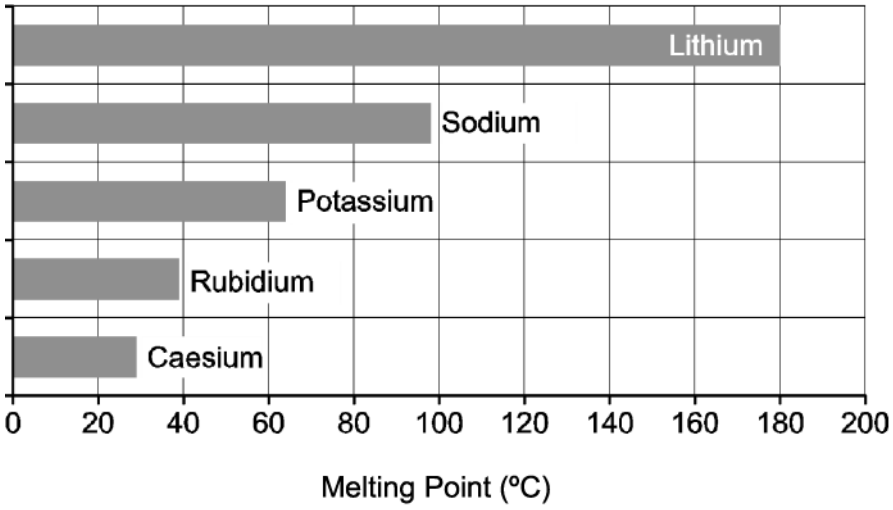
What is the R_f value of the **green** spot? Use a ruler to help you.

A. 0.17
B. 0.42
C. 0.83
D. 1.00

Your answer ☐

[1]

15. The bar chart shows some information about the melting points of Group 1 elements.



What are the melting points of rubidium and caesium?

	Melting point of rubidium (°C)	Melting point of caesium (°C)
A	39	29
B	40	25
C	29	41
D	41	25

Your answer ☐

[1]

16. Zinc and dilute sulfuric acid react to make hydrogen.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

Inga measures the rate of this reaction by measuring the **loss in mass** of the reaction mixture.

She finds that the change in mass is very small and difficult to measure.

The reaction between zinc and dilute sulfuric acid is slow.

Inga decides to try and find a catalyst for this reaction.

She tests four possible substances.

Each time she adds 0.5 g of the substance to 1.0 g of zinc and 25 cm^3 of dilute sulfuric acid.

Look at her table of results.

Substance	Colour of substance at start	Colour of substance at end	Relative rate of reaction
no substance			1
calcium sulfate powder	white	white	1
copper powder	pink	pink	10
copper(II) sulfate powder	blue	pink	30
manganese(IV) oxide powder	black	black	1

i. It is important to do the reaction with **only** zinc and dilute sulfuric acid.

Explain why.

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[1]

ii. It is important to do all of the reactions with the same concentration of acid.

Explain why.

---

[1]

iii. Which of the substances could be a catalyst for the reaction between zinc and dilute sulfuric acid?

Explain your answer.

---

[2]

iv. There is not enough evidence to confirm which substance is a catalyst.

Suggest an extra piece of experimental evidence that could be collected to confirm which substance is a catalyst.

---

[1]

v. Inga does the experiment with copper, zinc and dilute sulfuric acid again.

This time she uses a lump of copper rather than copper powder.

Predict, with reasons, the relative rate of reaction.

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[2]

END OF QUESTION PAPER