1. The properties of four different polymer samples are shown in the table.

Polymer	Melting point of sample (°C)	Distance the sample stretches before breaking (cm)
PET	260	0.0
PVC	110	12.5
PS	240	0.1
PE	125	10.4

i. Describe the relationship between the melting point of the sample and the distance the sample stretches before breaking.

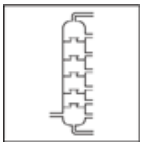
[1]

ii. The molecular formula of the monomer used to make PET is $C_{10}H_{10}O_5$.

State the **empirical** formula of the monomer used to make PET.

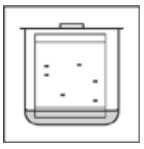
[1]

2. Which equipment is used for **filtration**?

A 

B 

C 

D 

Your answer ☐ **[1]**

3. Which row describes a **formulation**?

	Description	Amount of chemicals
A	compound	exact
B	mixture	exact
C	compound	random
D	mixture	random

Your answer ☐ **[1]**

4. Fig. 18.2 shows a model of octane.

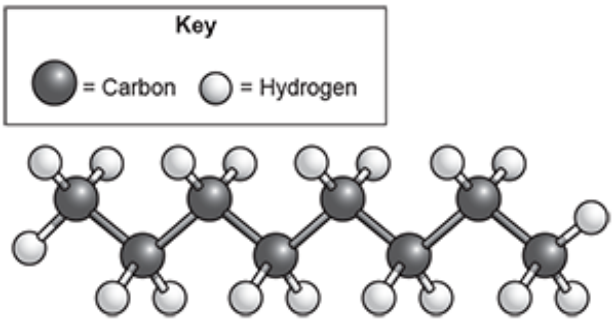


Fig. 18.2

i. What is the **empirical formula** of octane?

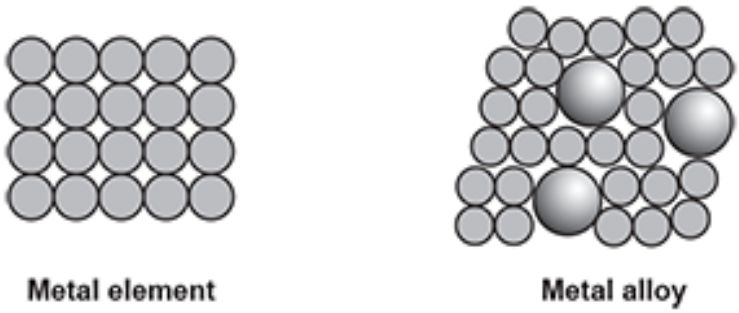
---------- **[1]**

ii. Calculate the **relative formula mass** of octane.

Relative atomic mass (Ar): C = 12.0 H = 1.0.

Relative formula mass = ... **[3]**

5. Titanium is a metal element. Metal **elements** can be mixed with other elements to form metal **alloys**.



Metal element Metal alloy

i. Explain why a metal alloy is harder than a metal element.

[2]

ii. In medicine, titanium alloys are used in hip replacements.

The table shows some properties of alloys. Tensile strength is the amount of load a material can take before it breaks.

Alloy	Density (g / cm^3)	Tensile strength (MPa)	Does it contain any toxic elements?
1	4.43	950	yes
2	4.52	950	no
3	5.70	546	no

Which alloy would be best to use in a hip replacement?
Explain your answer.

Alloy

Reason

[3]

6(a). A scientist measures the melting points of three painkillers.

Painkiller	Melting point (°C)
A	136
B	169
C	76

All of the painkillers are **pure** substances.

i. Explain what is meant by a pure substance.

_____

_____ **[1]**

ii. How can you tell that the three painkillers are pure from their melting points?

_____

_____ **[1]**

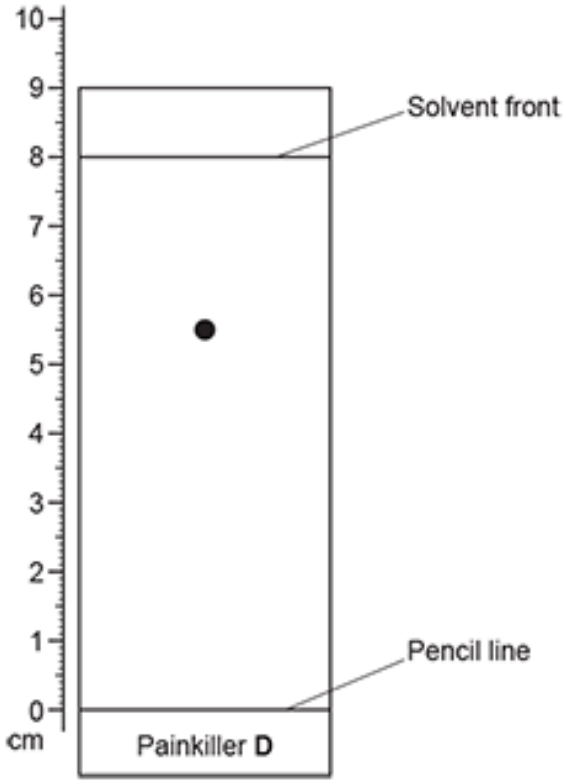
(b). The scientist uses gas chromatography to investigate a **mixture** of painkiller **A** and painkiller **B**.

How many peaks will the scientist see in the gas chromatogram?

_____ **[1]**

(c). A scientist analyses painkiller **D** using thin layer chromatography.

The chromatogram is shown in the diagram.



i. Calculate the R_f value of painkiller **D**.

Use the formula: $R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$

Give your answer to **2** decimal places.

R_f of painkiller ***D*** = ... **[3]**

ii. Which components are needed for thin layer chromatography?
Put a (ring) around the **two** correct components.

balance	**Bunsen burner**	**mobile phase**
paper	**stationary phase**	**thermometer**

[2]

(d). A scientist thinks that an impure painkiller will **only** have **two** spots on a thin layer chromatogram.

Give **two** reasons why the scientist is **incorrect**.

1 _____

_____

2 _____

_____

[2]

7. What is the relative formula mass of iron chloride, $FeCl_3$?

Relative atomic mass (A_r): C*l* = 35.5 Fe = 55.8.

A 91.3
B 126.8
C 162.3
D 202.9

Your answer ☐ **[1]**

8. This is the equation for a reaction.

$NaOH + HCl \rightarrow NaCl + H_2O$

i. What type of reaction is this?

Tick (✓) **one** box.

Polymerisation ☐
Neutralisation ☐
Reversible ☐
Thermal decomposition ☐

[1]

ii. Water is a waste product in this reaction.

Calculate the **atom economy** for the reaction.

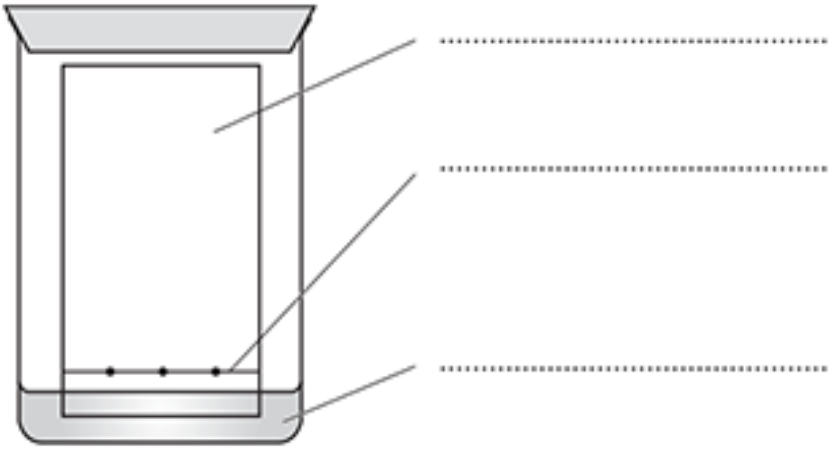
Relative atomic mass (A_r): H = 1.0 O = 16.0 Na = 23.0 C*l* = 35.5

Atom economy = ... % **[3]**

9(a). A student investigates dyes.

The student uses paper chromatography to separate the dyes.

The diagram shows the apparatus at the start of the experiment.



Label the apparatus. Use phrases from the list.

Ink spot
Mobile phase
Pencil line
Solvent front
Stationary phase

[3]

(b). At the end of the experiment one of the dyes has moved 55 mm.

The solvent has moved 65 mm.

i. Calculate the R_f value of this dye.

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

R_f value of dye = ... **[2]**

ii. Another dye, **X**, has an R_f value of 0.22.

The student knows that the food colouring tartrazine has an R_f value of 0.11.

The student thinks dye **X** is tartrazine.

Explain why the student is incorrect.

[2]

10. A catalytic converter on a car removes nitrogen monoxide and carbon monoxide from exhaust gases.

Nitrogen gas and carbon dioxide gas are made.

This is the equation for the reaction that takes place.

$2CO + 2NO \rightarrow N_2 + CO_2$

On a car journey 1.4 tonnes of nitrogen is made.

Calculate the **mass of nitrogen monoxide** removed from the exhaust gases.

Relative atomic mass (A_r): N = 14.0 O = 16.0.

Mass of nitrogen monoxide = ... tonnes **[3]**

11. A student neutralises 6.00 g of nitric acid, HNO_3, with ammonia, NH_3, to make ammonium nitrate, NH_4NO_3.

The equation shows this reaction.

$HNO_3 + NH_3 \rightarrow NH_4NO_3$

Calculate the **theoretical yield** of ammonium nitrate, NH_4NO_3.

Give your answer to **3** significant figures.

Relative atomic mass (A_r): H = 1.0 N = 14.0 O = 16.0.

Theoretical yield of ammonium nitrate = ... g **[4]**

12. A scientist investigates some metals and metal alloys.

i. Describe the structure and bonding in a metal.

You can include a labelled diagram in your answer.

[3]

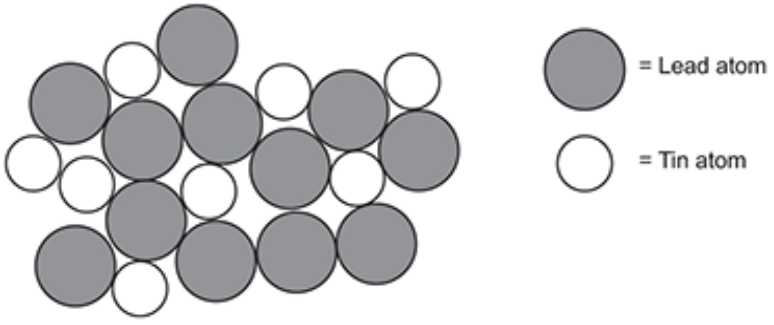
ii. Explain why metals are malleable.

[1]

iii. Explain why metals can conduct electricity

[2]

iv. The scientist has a diagram of one type of metal alloy as shown.



What is the smallest ratio of lead to tin in the alloy?

Ratio of lead to tin = ... **[2]**

v. The table shows data about other alloys made from tin, copper and silver.

	Alloy 1	**Alloy 2**	**Alloy 3**
Tin content (%)	95.5	99.0	96.5
Copper content (%)	0.7	0.7	0.5
Silver content (%)	3.8	0.3	3.0
Melting point (°C)	217	227	220

What is the relationship between the silver content and the melting point?

---

[1]

13. What is the relative formula mass of potassium chloride, KC*l*?

Relative atomic mass (A_r): C*l* = 35.5 K = 39.1

A 36.0
B 67.4
C 74.6
D 79.0

Your answer ☐ **[1]**

14. Which pieces of apparatus are used for **filtration**?

A Beaker, filter paper and condenser
B Beaker, filter paper and funnel
C Beaker, funnel and mass balance
D Filter paper, funnel and condenser

Your answer ☐ **[1]**

END OF QUESTION PAPER