Purity and Separating mixtures – 2021/20 GCSE Gateway Chemistry A

1. Nov/2021/Paper_J248/01/No.5

What is the **mass number** of an atom?

A The total number of neutrons and electrons in an atom.

B The total number of protons and electrons in an atom.

C The total number of protons and neutrons in an atom.

D The total number of protons, neutrons and electrons in an atom.

Your answer ☐ **[1]**

2. Nov/2021/Paper_J248/01/No.7

Steel is a mixture of iron and carbon.

What is the name of this type of mixture?

A Alloy

B Ion

C Isotope

D Molecule

Your answer ☐ **[1]**

3. Nov/2021/Paper_J248/01/No.8

Fractional distillation is used to separate mixtures, such as crude oil.

Which statement about fractional distillation is correct?

A Fractional distillation causes a chemical change.

B Fractional distillation separates mixtures of solids.

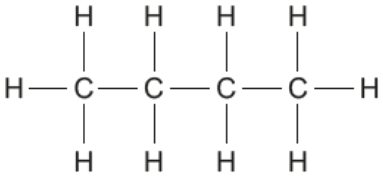
C Fractions are separated based on their boiling point.

D The fractional distillation column is hottest at the top.

Your answer ☐ **[1]**

4. Nov/2021/Paper_J248/01/No.15

Butane is a hydrocarbon. The displayed formula of butane is shown.



What is the **empirical formula** of butane?

A CH

B CH_2

C C_2H_5

D C_4H_{10}

5. Nov/2021/Paper_J248/01/No.17

Mendeleev developed an early version of the Periodic Table.

Mendeleev arranged the elements in order of increasing **relative atomic mass**.

He thought that some elements were in the wrong order. He swapped the position of these elements so that elements with similar properties were in the same group.

(a) Explain why some elements appeared to be in the wrong order, when arranged by **relative atomic mass**.

.....

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

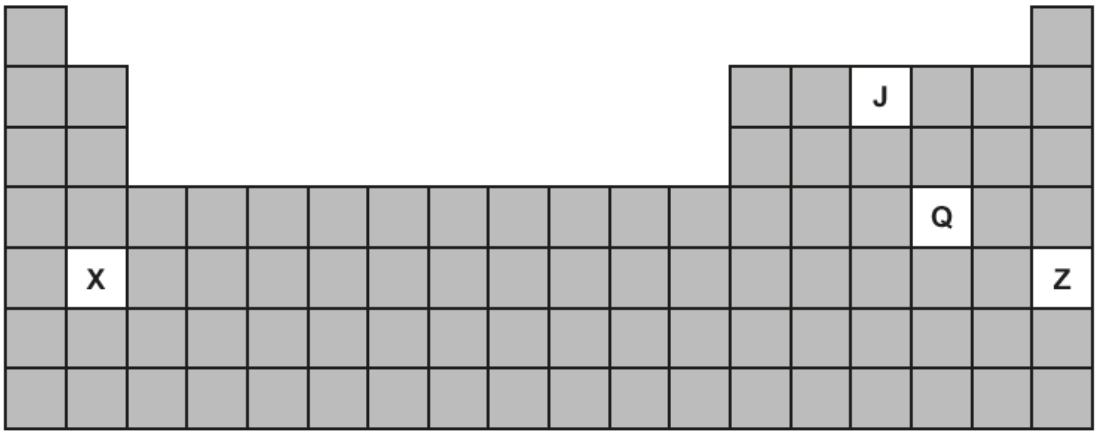
(b) Look at the Periodic Table provided on the data sheet.

Write down the symbols of **two** elements that are **not** arranged in order of increasing **relative atomic mass**.

1 .....

2 ..... **[1]**

(c) The diagram shows a simplified version of the modern Periodic Table. The letters, **J**, **Q**, **X** and **Z** are **not** the symbols for the elements shown.



(i) Which element, **J**, **Q**, **X**, or **Z**, is an unreactive gas with a full outer shell of electrons?

Tick (✓) **one** box.

J ☐

Q ☐

X ☐

Z ☐

Explain your answer.

.....

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

(ii) Which element, **J**, **Q**, **X** or **Z**, is a shiny element that forms positive ions?

Tick (✓) **one** box.

J ☐

Q ☐

X ☐

Z ☐

Explain your answer.

.....

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

6. Nov/2021/Paper_J248/01/No.18

A scientist uses thin layer chromatography to investigate some samples.

The scientist wants to check if the samples contain the same compounds.

(a) **Fig. 18.1** shows the apparatus the scientist uses.

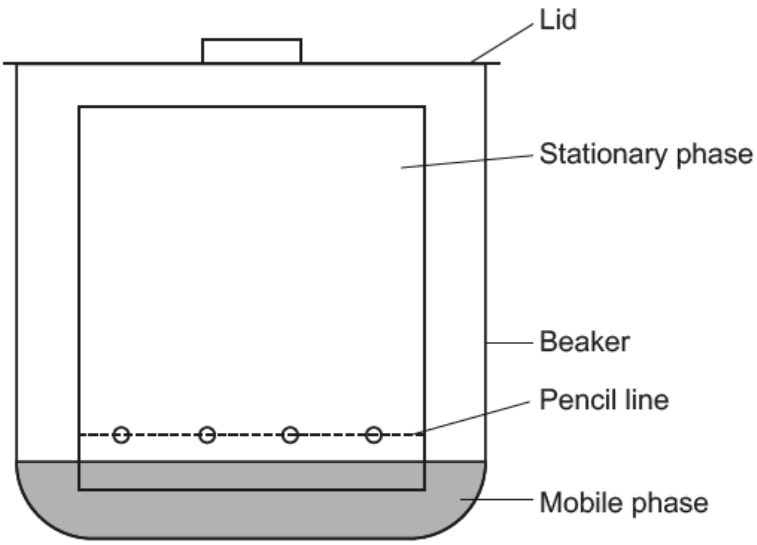


Fig. 18.1

(i) What could be used as the **mobile phase** in the experiment?

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

(ii) Why does the scientist put a lid on top of the beaker?

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

(b) **Fig. 18.2** shows the scientist's chromatogram.

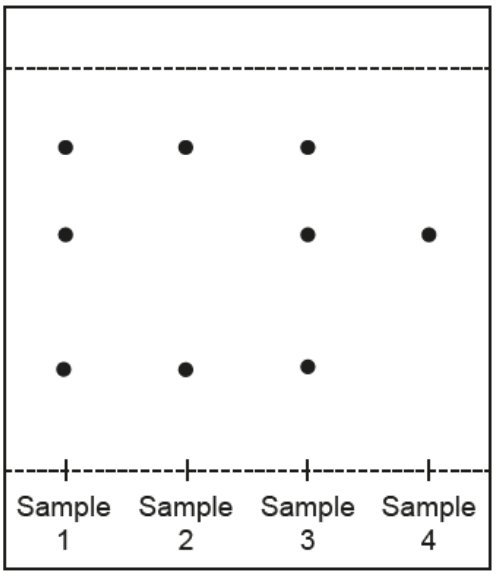


Fig. 18.2

The scientist thinks one of the samples is a **pure substance**.

(i) Is the scientist correct?

Explain your answer.

.....

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

(ii) Explain what is meant by a pure substance.

.....

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

(iii) Which **two** samples contain the same mixture of chemicals?

Tick (✓) **two** boxes.

Sample 1 ☐

Sample 2 ☐

Sample 3 ☐

Sample 4 ☐

[1]

(c) Another scientist is investigating the **formulation** of a medicine.

The scientist uses gas chromatography to calculate the amount of three compounds in the medicine.

The results are shown in the table.

	Active ingredient	**Lactose**	**Starch**
Mass (g)	0.50	0.45	0.16

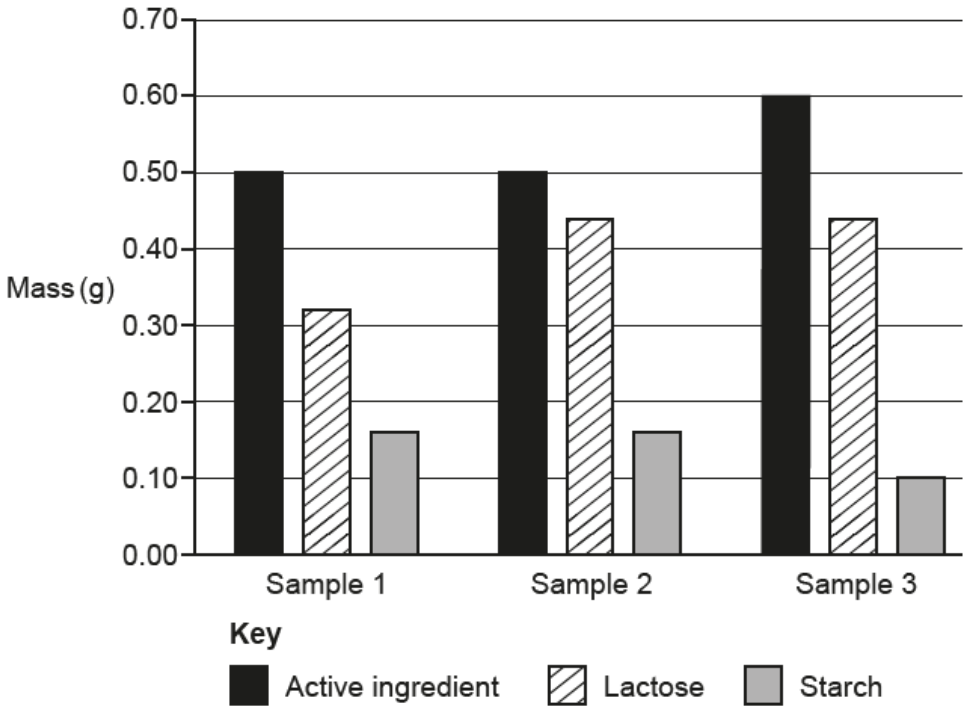
(i) Calculate the percentage of **lactose** in the medicine.

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

Percentage of lactose = ... % **[3]**

(ii) The scientist tests some samples to determine whether they have the same formulation as the medicine.

The graph shows their results.



Which sample has the same formulation as the medicine?

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

(iii) Why does the scientist use gas chromatography, instead of thin layer chromatography, in this investigation?

.....

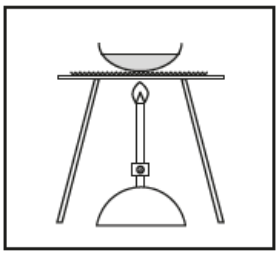
..... **[1]**

7. Nov/2021/Paper_J248/01/No.23(a_ b)

The table shows information about some properties of four substances.

Substance	Melting point (°C)	Boiling point (°C)	Solubility in water	Does the substance conduct electricity?
M	−98	65	Soluble	No
N	−114	78	Soluble	No
O	661	1304	Soluble	Only when molten or dissolved
P	1085	2562	Insoluble	Yes

(a) Which diagram shows the apparatus that should be used to separate a mixture of substance **M** and substance **N**? Tick (✓) **one** box.



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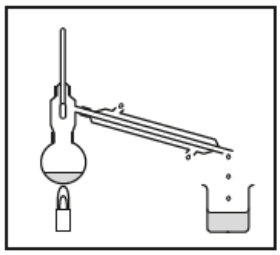

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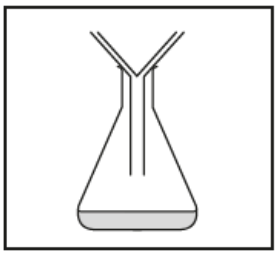

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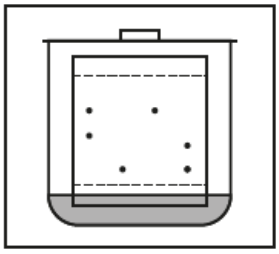

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[1]

(b) **(i)** Describe a method that could be used to separate a mixture of substance **O** and substance **P** to obtain pure samples.

.....

.....

.....

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

(ii) A student separates substance **O** from a mixture.

They start with 6.2 g of the mixture and obtain 2.6 g of pure substance **O**.

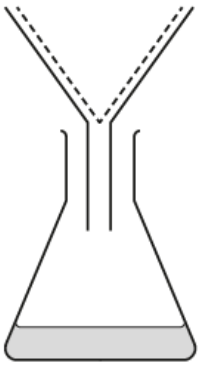
Calculate the mass of pure substance **O** that could be separated from 10.0 g of the mixture.

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

Mass of pure substance **O** = ... g **[3]**

8. Nov/2020/Paper_J248/01/No.1

Which separation technique is this equipment used for?



A Crystallisation

B Distillation

C Evaporation

D Filtration

Your answer ☐ **[1]**

9. Nov/2020/Paper_J248/01/No.4

The formula of magnesium chloride is $MgCl_2$.

What is the relative formula mass of magnesium chloride?

(A_r: Mg = 24.3, Cl = 35.5)

A 59.8

B 95.3

C 119.6

D 84.1

Your answer ☐ **[1]**

10. Nov/2020/Paper_J248/01/No.7

Butane has the molecular formula C_4H_{10}.

What is the **empirical** formula of butane?

A CH_5

B C_2H_5

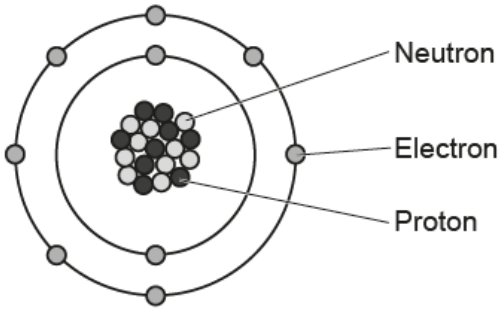
C C_4H_{10}

D CH_{14}

Your answer ☐ **[1]**

11. Nov/2020/Paper_J248/01/No.10

The diagram shows an atom of an element.



What is the name of the element?

A Boron

B Beryllium

C Fluorine

D Neon

Your answer ☐ **[1]**

12. Nov/2020/Paper_J248/01/No.16(c)

(c) 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**.

.....

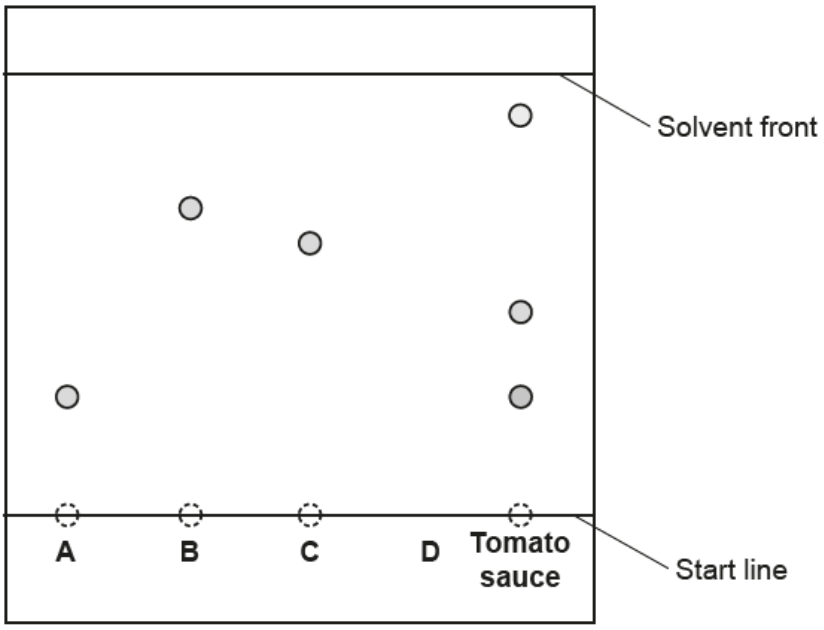
.....

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

13. Nov/2020/Paper_J248/01/No.20

A scientist analyses a sample of tomato sauce using chromatography.

The tomato sauce is compared to four known food additives, **A**, **B**, **C** and **D**, as shown in the chromatogram.



(a) The start line is **not** drawn in ink.

Explain why.

.....

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

(b) Food additive **D** is insoluble in the solvent used.

Draw on the diagram the spot for food additive **D** at the end of the experiment. **[1]**

(c) Which additive is in the **tomato sauce**?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

[1]

(d) Calculate the R_f value for additive **C**.

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

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

R_f value = ... **[3]**

14. Nov/2020/Paper_J248/01/No.21(b)

(b) The student finds out that phosphate fertilisers are used to help to grow flowers.

Compound **A** is a fertiliser of a metal **M** with the formula $\mathbf{M}_3PO_4$.

The relative formula mass of compound **A** is 164.0.

Do a calculation to identify metal **M**.

Use the relative atomic masses in the Periodic Table.

Metal **M** = ... **[3]**

15. Nov/2020/Paper_J248/01/No.23

Dmitri Mendeleev produced a Periodic Table of elements which is the basis for our modern Periodic Table. He left gaps for elements that had not been discovered yet as shown in **Fig. 23.1**.

I	II	III	IV	V	VI	VII
H						
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca		Ti	V	Cr	Mn
Cu	Zn			As	Se	Br
Rb	Sr	Y	Zr	Nb	Mo	
Ag	Cd	In	Sn	Sb	Te	I
Ce	Ba	La		Ta	W	
Au	Hg	Ti	Pb	Bi		

Fig. 23.1

(a) Describe **two** ways Mendeleev arranged the elements in his Periodic Table.

1 .....

.....

2 .....

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

(b) Describe how the elements are arranged in the modern Periodic Table.

.....

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

(c) Mendeleev left gaps in his Periodic Table for undiscovered elements. He predicted properties of these elements.

Table 23.1 shows the predicted properties for one of these elements in one of the gaps.

Mendeleev called this element 'eka-silicon'.

Appearance	Grey metal
Melting point (°C)	Over 800
Relative atomic mass	72
Density (g/cm^3)	5.5

Table 23.1

Table 23.2 shows some of the elements that were discovered after Mendeleev published his Periodic Table.

	Scandium (Sc)	**Gallium (Ga)**	**Germanium (Ge)**	**Technetium (Tc)**
Appearance	Silver-white metal	Silver-blue metal	Grey-white metal	Grey metal
Melting point (°C)	1541	30	947	2157
Relative atomic mass	45.0	69.7	72.6	98.0
Density (g/cm^3)	3.0	5.9	5.35	11.0

Table 23.2

(i) Which element matches Mendeleev's predictions for 'eka-silicon'?

Tick (✓) **one** box.

Scandium ☐

Gallium ☐

Germanium ☐

Technetium ☐

[1]

(ii) Give **two** reasons for your answer to **(c)(i)**.

1 .....

.....

2 .....

.....

[2]

(d) (i) Mendeleev did not predict the existence of argon, neon, krypton or xenon.

The electron arrangement of argon is 2,8,8.

What does this tell you about the reactivity of argon?

Explain your answer.

.....

.....

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

(ii) Neon is an element that has isotopes. Two of the isotopes are shown below.

$^{20}_{10}Ne$ $^{22}_{10}Ne$

Complete **Table 23.3** to show the number of protons, neutrons and electrons in each neon isotope.

	$^{20}_{10}Ne$	$^{22}_{10}Ne$
Proton		
Neutron		
Electron		

Table 23.3 **[3]**

16. Nov/2021/Paper_J248/03/No.4

Oxygen has three naturally occurring **isotopes**.

Which statement about isotopes of oxygen is correct?

A All isotopes of oxygen have 8 electrons and 8 neutrons.

B All isotopes of oxygen have 8 electrons and 8 protons.

C All isotopes of oxygen have 8 neutrons and 8 protons.

D All isotopes of oxygen have the same mass number.

Your answer ☐ **[1]**

17. Nov/2021/Paper_J248/03/No.11

The **empirical formula** of a hydrocarbon is CH_2.

The relative formula mass of the hydrocarbon is 126.0.

What is the **molecular formula** of the hydrocarbon?

A C_7H_{14}

B C_8H_{16}

C C_9H_{18}

D $C_{10}H_{20}$

Your answer ☐ **[1]**

18. Nov/2021/Paper_J248/03/No.13

A student investigates if an unknown liquid sample is pure.

Which method should the student use?

A Filter the sample to see if any solid can be separated.

B Gas chromatography.

C Measure the boiling point of the sample.

D Titration.

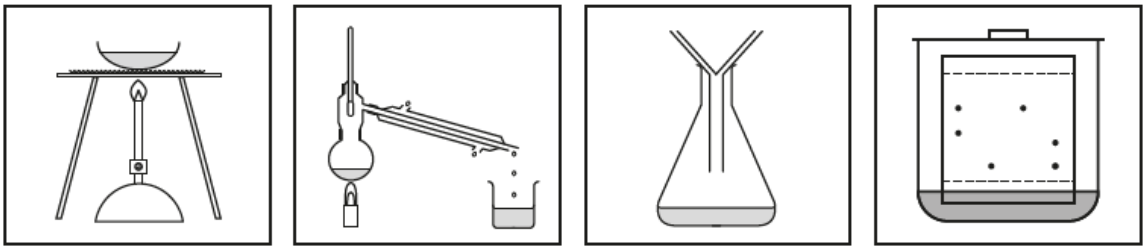
Your answer ☐ **[1]**

19. Nov/2021/Paper_J248/03/No.17(a, b)

The table shows information about some properties of four substances.

Substance	Melting point (°C)	Boiling point (°C)	Solubility in water	Does the substance conduct electricity?
M	−98	65	Soluble	No
N	−114	78	Soluble	No
O	661	1304	Soluble	Only when molten or dissolved
P	1085	2562	Insoluble	Yes

(a) Which diagram shows the apparatus that should be used to separate a mixture of substance **M** and substance **N**? Tick (✓) **one** box.



☐ ☐ ☐ ☐

[1]

(b) **(i)** Describe a method that could be used to separate a mixture of substance **O** and substance **P** to obtain pure samples.

.....

.....

.....

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

(ii) A student separates substance **O** from a mixture.

They start with 6.2 g of the mixture and obtain 2.6 g of pure substance **O**.

Calculate the mass of pure substance **O** that could be separated from 10.0 g of the mixture.

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

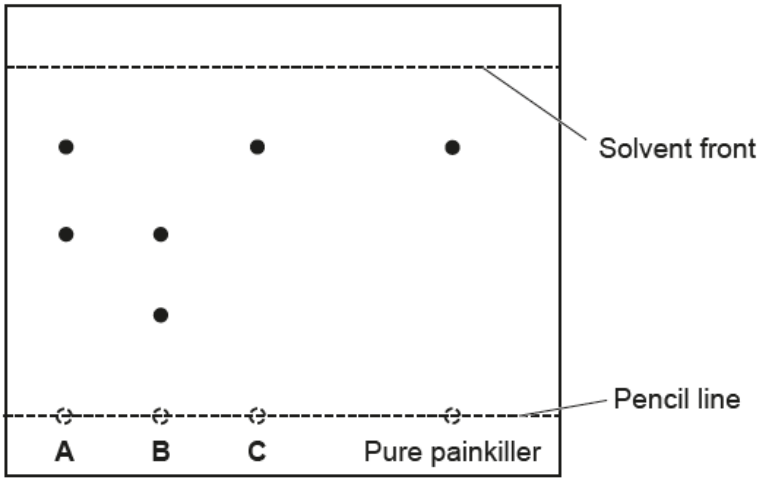
Mass of pure substance **O** = ... g **[3]**

20. Nov/2021/Paper_J248/03/No.21(a, b)

A scientist uses chromatography and melting points to investigate the purity of three samples of a painkiller, **A**, **B** and **C**.

- The scientist compares the three samples with a pure sample of the painkiller.
- The scientist also compares the melting points of the three samples to the pure sample.

Look at the results.



Sample	Melting point (°C)
A	132 – 135
B	111 – 115
C	136
Pure painkiller	136

(a)* Use the chromatogram and melting point data provided to determine which samples, **A**, **B** and **C**, are pure and which contain the painkiller.

Explain your answer.

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

(b) When the painkiller is sold to the public, it is sold as a formulation, not as a pure substance.

Explain how a formulation and a mixture are different.

.....

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

21. Nov/2020/Paper_J248/03/No.1

The formula of ammonium carbonate is $(NH_4)_2CO_3$.

What is the relative formula mass of ammonium carbonate?
(A_r: C = 12, H = 1, N = 14, O = 16)

A 78

B 90

C 96

D 120

Your answer ☐ **[1]**

22. Nov/2020/Paper_J248/03/No.2

Which purification technique is used to separate ethanol and water from a mixture?

A Chromatography

B Distillation

C Evaporation

D Filtration

Your answer ☐ **[1]**

23. Nov/2020/Paper_J248/03/No.5

Carbon-12 and carbon-14 are isotopes.

Which statement describes isotopes?

A Atoms with the same number of protons but a different number of electrons.

B Atoms with the same number of electrons but a different number of protons.

C Atoms with the same number of protons but a different number of neutrons.

D Atoms with the same number of neutrons but a different number of protons.

Your answer ☐ **[1]**

24. Nov/2020/Paper_J248/03/No.14

The accurate relative atomic mass of aluminium is 26.9815385.

What is this number to **5** significant figures?

A 26.98153

B 26.981

C 26.98154

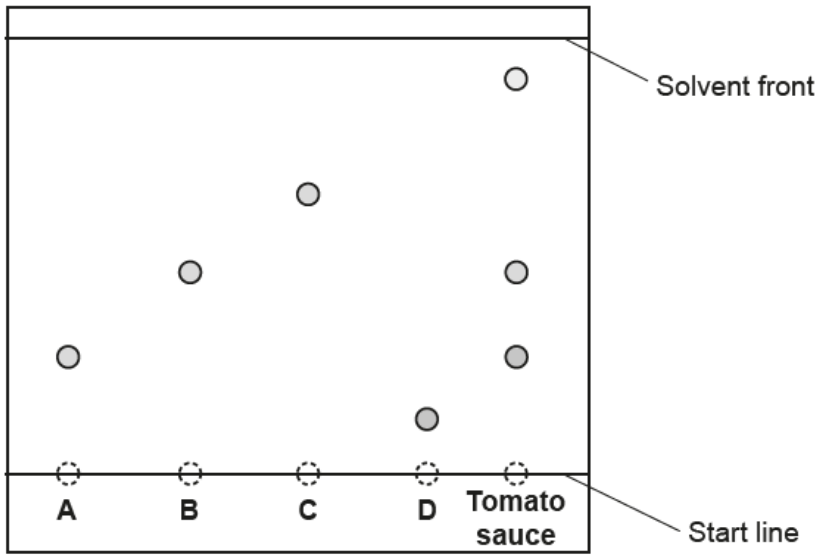
D 26.982

Your answer ☐ **[1]**

25. Nov/2020/Paper_J248/03/No.20

A student analyses a sample of tomato sauce using thin-layer chromatography.

The tomato sauce was compared to four known food additives, **A**, **B**, **C** and **D**, as shown in the chromatogram.



(a) (i) Calculate the R_f value for **C**.

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

R_f value = ... **[3]**

(ii) Which additives are shown to be in the tomato sauce?

Tick (✓) **all the correct** boxes.

A ☐

B ☐

C ☐

D ☐

[1]

(iii) Suggest why **D** has **not** travelled as far up the plate as **C**.

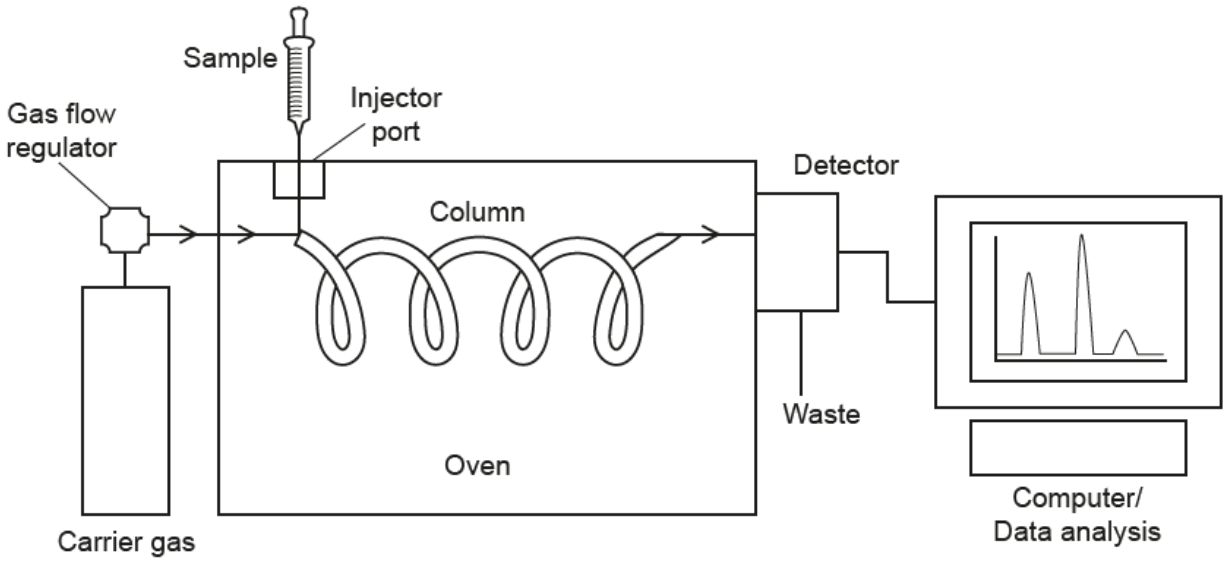
.....

.....

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

(b) Gas chromatography is another type of chromatography.

The diagram shows the equipment used for gas chromatography.



(i) State **one similarity** and **one difference** between gas chromatography and thin-layer chromatography.

Similarity .....

.....

Difference .....

.....

[2]

(ii) Explain why thin-layer chromatography is used instead of gas chromatography to analyse the tomato sauce.

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