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O LEVEL CHEMISTRY

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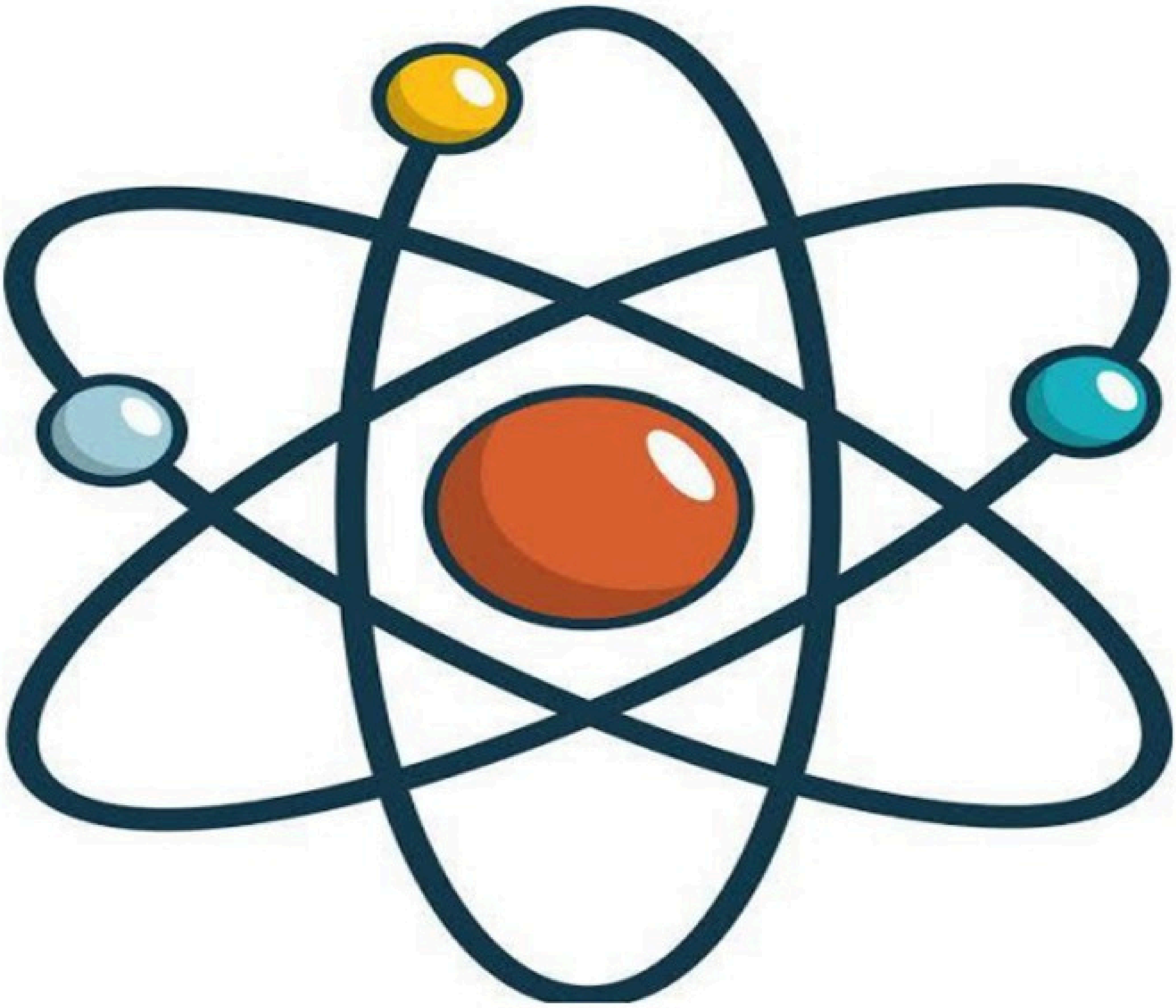
CONTENT

Topic 2

Atomic Structure



1. May 2015 V2 - Q1

Complete the following table which gives the number of protons, electrons and neutrons in each of the five particles.

particle	number of protons	number of electrons	number of neutrons
....	19	19	20
$^{56}_{26}Fe$	....	....	....
....	3	2	4
$^{70}_{31}Ga^{3+}$	....	....	....
....	34	36	45

[Total: 8]

2. Nov 2015 V1 - Q1

(a) The symbols of six particles are shown below.

Na^+ Ca^{2+} Kr P Si O^{2-}

Select from the list of particles to answer the following questions. A particle may be selected once, more than once or not at all.

(i) Which **two** ions have the same electronic structure? .... [1]

(ii) Which ion has the same electronic structure as an atom of argon? .... [1]

(iii) Which atom can form an ion of the type X^{3-}? .... [1]

(iv) Which atom can form a hydride which has a formula of the type XH_4? .... [1]

(b) **(i)** How many protons, neutrons and electrons are there in one copper(II) ion $^{64}_{29}Cu^{2+}$?

number of protons ....

number of neutrons ....

number of electrons ....

[2]

(ii) $^{45}_{21}Sc$ represents an atom of scandium.

How many nucleons and how many charged particles are there in one atom of scandium?

number of nucleons ....

number of charged particles ....

[2]

(c) Two different atoms of sodium are $^{23}_{11}Na$ and $^{24}_{11}Na$.

(i) Explain why these two atoms are isotopes.

....

.... [2]

(ii) $^{24}_{11}Na$ is radioactive. It changes into an atom of a different element which has one more proton.

Identify this element.

.... [1]

3. Feb 2016 V2 - Q1 A,C

(a) The table below gives information about particles.

Complete the table. The first line has been done for you.

particle	number of protons	number of electrons	electronic configuration	charge on particle
A	12	10	2,8	2+
B		18	2,8,8	1–
C	18		2,8,8	0
D	8	10		

[4]

(b) Gallium is a Group III element.

Define the term *element*.

....

....

.... [1]

(c) The following are gallium atoms.

$^{69}_{31}Ga$ $^{71}_{31}Ga$

Complete the following table.

atom	number of protons	number of neutrons	number of electrons
$^{69}_{31}Ga$			
$^{71}_{31}Ga$			

[3]

4. May 2016 V1 - Q1

Protons, neutrons and electrons are subatomic particles.

(a) Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

particle	relative mass	relative charge
proton		
neutron		
electron	$\frac{1}{1840}$	

[3]

(b) Bromine has two isotopes.

(i) Define the term *isotope*.

....

.... [2]

(ii) Explain why the two isotopes of bromine have the same chemical properties.

....

.... [2]

(c) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

particle	number of protons	number of neutrons	number of electrons
$^{7}_{3}Li$			
$^{34}_{16}S^{2-}$			
	19	22	18

[5]

5. May 2016 V2 – Q2

(a) **(i)** Define the term *atomic number*.

.... [1]

(ii) Define the term *nucleon number*.

....

.... [2]

(b) The table shows the number of protons, neutrons and electrons in some atoms or ions.

Complete the table. The first line is given as an example.

particle	number of protons	number of electrons	number of neutrons	symbol or formula
A	6	6	6	$^{12}_{6}C$
B	12	12	12	
C	8			$^{16}_{8}O^{2-}$
D	11	10	13	

[6]

6. Nov 2016 V2 – Q2

This question is about atoms, ions and isotopes.

(a) Define the term *nucleon number*.

....

.... [2]

(b) Give the electronic structure of the following atom and ion.

Na ....

P^{3-} ....

[2]

(d) What is meant by the term *relative atomic mass*?

....

....

.... [2]

(e) Suggest why the relative atomic mass of chlorine is **not** a whole number.

....

....

.... [2]

7. Nov 2016 V3 - Q1a,b

(a) Complete the table.

particle	charge	relative mass
proton	+1	
neutron		1
electron		

[2]

(b) The following are isotopes of carbon.

$^{12}_{6}C$ $^{13}_{6}C$ $^{14}_{6}C$

(i) In terms of numbers of protons, neutrons and electrons, how are these **three** isotopes the same and how are they different?

They are the same because ....

....

They are different because ....

....

[3]

(ii) Why do all isotopes of carbon have the same chemical properties?

.... [1]

8. Nov 2016 V3 - Q2a

Beryllium is a metallic element in Group II.

(a) Give the electronic structure of a beryllium atom.

.... [1]

9.May 2017 V1 - Q1

This question is about subatomic particles.

(a) Define the terms

proton number, ...

....

nucleon number. ....

....

[3]

(b) Why is the $^{1}_{1}H$ hydrogen atom the **only** atom to have an identical proton number and nucleon number?

....

.... [1]

(c) Complete the table to show the number of protons, neutrons and electrons in the atoms and ions given.

	number of protons	number of neutrons	number of electrons
^{19}F			9
^{26}Mg	12		
$^{31}P^{3-}$			
$^{87}Sr^{2+}$			

[6]

10.May 2017 V2 - Q1b

(b) State what is meant by the terms

(i) *element*,

....

.... [1]

(ii) *compound*,

....

.... [1]

(iii) *ion*.

....

.... [1]

11.May 2017 V2 - Q2

Carbon and silicon are elements in Group IV of the Periodic Table. Both carbon and silicon exist as more than one isotope.

(a) Define the term *isotopes*.

....

.... [2]

(b) Complete the following table which gives information about carbon atoms and silicon atoms.

	carbon	silicon
proton number		
electronic structure		
nucleon number	12	28
number of neutrons in one atom		

[3]

12. May 2017 V3 - Q1

Six different atoms can be represented as follows.

$^{3}_{1}A$ $^{3}_{2}D$ $^{12}_{6}E$ $^{13}_{6}G$ $^{14}_{7}J$ $^{19}_{9}L$

(a) Answer the following questions using atoms from the list. Each atom may be used once, more than once or not at all.

Select **one** atom from the six shown which

(i) has exactly seven protons,

.... [1]

(ii) has exactly six neutrons,

.... [1]

(iii) has more protons than neutrons,

.... [1]

(iv) has the electronic structure [2,5],

.... [1]

(v) is an atom of an element from Group VII of the Periodic Table,

.... [1]

(vi) is an atom of a noble gas.

.... [1]

(b) Two of the six atoms shown are isotopes of each other.

(i) What is meant by the term *isotopes*?

....

.... [2]

(ii) Which **two** of the six atoms shown are isotopes of each other?

.... [1]

(iii) Why do isotopes have identical chemical properties?

....

.... [1]

13. Nov 2017 V1 - Q1

The table gives information about five particles. The particles are all atoms or ions.

particle	number of protons	number of neutrons	number of electrons
A	6	8	6
B	12	12	12
C	13	14	10
D	8	8	10
E	11	12	11

Answer the following questions using the information in the table.
Each particle may be used once, more than once or not at all.

(a) Which particle, **A**, **B**, **C**, **D** or **E**,

(i) is an atom with atomic number 12,

.... [1]

(ii) is an atom with nucleon number 14,

.... [1]

(iii) is an ion with a positive charge,

.... [1]

(iv) has only **one** electron in its outer shell?

.... [1]

(b) **D** is an ion of an element.

Identify the element and write the formula of **D**.

.... [2]

14. Nov 2017 V2 – Q2a

(a) Complete the table to show the electronic structure of the atoms and ions.

	electronic structure
F	2,7
Si	
Ca^{2+}	
N^{3-}	

[3]

15. Nov 2017 V3 - Q1

Substances can be classified as elements, compounds or mixtures.

State whether each of the following is an element, a compound or a mixture.

(a) brass .... [1]

(b) gold .... [1]

(c) butane .... [1]

(d) air .... [1]

16. Nov 2017 V3 - Q2

(a) (i) Define the term *molecule*.

....

.... [2]

(ii) Define the term *element*.

....

.... [1]

(b) The table shows the composition of four atoms or ions, **A**, **B**, **C** and **D**.

	number of protons	number of neutrons	number of electrons
A	10	10	10
B	10	12	10
C	12	10	10
D	13	14	10

(i) What is the atomic number of **A**?

.... [1]

(ii) What is the nucleon number of **B**?

.... [1]

(iii) Which of **A**, **B**, **C** and **D** are isotopes of each other?

.... [1]

(iv) Which of **A**, **B**, **C** and **D** are atoms?

.... [1]

(v) Which of **A**, **B**, **C** and **D** are positive ions?

.... [1]

(c) Complete the table.

	number of protons	number of electrons
Na		
S^{2-}		
Cl_2		

[3]

17. May 2018 V1 – Q1a

Substances can be classified as elements, compounds or mixtures.

(a) What is meant by the term *compound*?

....

....

.... [2]

18. May 2018 V1 – Q2

Flerovium, F*l*, atomic number 114, was first made in research laboratories in 1998.

(a) Flerovium was made by bombarding atoms of plutonium, Pu, atomic number 94, with atoms of element **Z**.

- The nucleus of **one** atom of plutonium combined with the nucleus of **one** atom of element **Z**.
- This formed the nucleus of **one** atom of flerovium.

Suggest the identity of element **Z**.

.... [1]

(b) In which period of the Periodic Table is flerovium?

.... [1]

(c) Predict the number of outer shell electrons in an atom of flerovium.

.... [1]

(ii) Complete the table to show the number of protons, neutrons and electrons in the atoms of the isotopes shown.

isotope	number of protons	number of neutrons	number of electrons
^{286}Fl			
^{289}Fl			

[2]

19.May 2018 V2 – Q3

Complete the following table.

particle	number of protons	number of electrons	number of neutrons	number of nucleons
$^{23}_{11}Na$	11	11	....	23
$^{37}_{17}Cl^{-}$	....	....	20	....
$^{56}_{26}$............	26	24	30	56

[6]

20. May 2018 V3 - Q2a

(a) ^{29}Al is a radioactive isotope of aluminium. The only non-radioactive isotope of aluminium is ^{27}Al.

(i) Describe, in terms of protons, neutrons and electrons, how the isotopes ^{29}Al and ^{27}Al are similar and how they are different.

how they are similar ....

how they are different ....

[2]

(ii) Complete the table to show the number of nucleons, neutrons and electrons in an $^{27}_{13}Al^{3+}$ ion.

	number in $^{27}_{13}Al^{3+}$
nucleons	
neutrons	
electrons	

[3]

21. Nov 2018 V1 - Q2

The table gives some information about four different particles, **A**, **B**, **C** and **D**.

particle	number of electrons	number of neutrons	number of protons	electronic structure	charge on particle
A	11	12	11	2,8,1	0
B		14	11	2,8,1	0
C	18	20		2,8,8	0
D	18	20	17		

(a) Complete the table. The first row has been done for you. [4]

(b) Give **two** particles from the table which are isotopes of each other.

.... [1]

(c) Element **Z** is in the same group of the Periodic Table as **A** and is less reactive than **A**.

State the identity of element **Z**.

.... [1]

(d) **C** is unreactive.

Use information from the table to explain why.

.... [1]

22.Nov 2018 V2 – Q2a,b

Magnesium, calcium and strontium are Group II elements.

(a) Complete the table to show the arrangement of electrons in a calcium atom.

shell number	1	2	3	4
number of electrons				

[1]

(b) Describe how the arrangement of electrons in a strontium atom is:

(i) similar to the arrangement of electrons in a calcium atom

....

....

(ii) different from the arrangement of electrons in a calcium atom.

....

.... [2]

23.March 2019 V2 – Q2

(a) The table gives information about some atoms or ions, **A**, **B** and **C**.

Complete the table.

	number of protons	number of electrons	electronic structure	charge
A	11	10	2,8	
B		18		0
C		10	2,8	–1

[4]

(b) **(i)** Carbon is an element.

Define the term *element*.

....

.... [1]

(ii) ${}^{12}_{6}C$, ${}^{13}_{6}C$ and ${}^{14}_{6}C$ are isotopes of carbon.

Complete the table.

	number of protons	number of neutrons
${}^{12}_{6}C$		
${}^{13}_{6}C$		
${}^{14}_{6}C$		

[2]

24. May 2019 V1- Q1

This question is about the structures of atoms and ions.

(a) Define the term *proton number*.

....

.... [2]

(b) (i) Complete the table to show the number of protons, neutrons and electrons present in atoms of $^{24}_{12}Mg$ and $^{26}_{12}Mg$.

	number of protons	number of neutrons	number of electrons
$^{24}_{12}Mg$			
$^{26}_{12}Mg$			

[2]

(ii) What term is used to describe atoms of the same element, such as $^{24}_{12}Mg$ and $^{26}_{12}Mg$?

.... [1]

(iii) Explain why the chemical properties of $^{24}_{12}Mg$ and $^{26}_{12}Mg$ are the same.

....

.... [2]

(c) Complete the table to identify the atoms and ions which have the following numbers of protons, neutrons and electrons.

	number of protons	number of neutrons	number of electrons
$^{23}_{11}Na^{+}$	11	12	10
	4	5	4
	17	20	18

[4]

(d) State the electronic structure of the following atom and ion.

A*l* ....

S^{2-} ....

[2]

25. May 2019 V2 – Q2a

(a) $^{22}_{11}Na$, $^{23}_{11}Na$ and $^{24}_{11}Na$ are isotopes of sodium.

(i) Describe how these sodium isotopes are the same and how they are different in terms of the total number of protons, neutrons and electrons in each.

same ....

....

different ....

....

[3]

(ii) Why do all **three** isotopes have an overall charge of zero?

....

.... [1]

(iii) Why do all **three** isotopes have the same chemical properties?

....

.... [2]

(iv) Why do sodium ions have a charge of +1?

....

.... [1]

26. May 2019 V3 – Q1

Atoms contain particles called electrons, neutrons and protons.

(a) Complete the table.

particle	where the particle is found in an atom	relative mass	relative charge
	orbiting the nucleus	$\frac{1}{1840}$	
			+1
	in the nucleus		

[3]

(b) How many electrons, neutrons and protons are there in the ion shown?

$$^{44}_{20}Ca^{2+}$$

number of electrons ....

number of neutrons ....

number of protons ....

[3]

27. May 2019 V3 – Q2a,b

Magnesium exists as three isotopes, $^{24}_{12}Mg$, $^{25}_{12}Mg$ and $^{26}_{12}Mg$.

(a) State, in terms of the total numbers of electrons, neutrons and protons, **one** difference and **two** similarities between these magnesium isotopes.

difference ....

similarity 1 ....

similarity 2 ....

[3]

(b) All isotopes of magnesium react with dilute hydrochloric acid to make hydrogen and a salt.

(i) Why do all isotopes of magnesium react in the same way?

....

....

.... [2]

28. Nov 2019 V1 – Q2a,b

(a) Sulfur exists as a number of different isotopes.

What is meant by the term *isotopes*?

....

....

.... [2]

(b) A sulfide ion has the symbol shown.

$$^{34}_{16}\mathrm{S}^{2-}$$

(i) How many neutrons are contained in this sulfide ion?

.... [1]

(ii) How is a sulfide ion, S^{2-}, formed from a sulfur atom?

.... [1]

(iii) Which element forms an ion with a 2+ charge that has the same number of electrons as a S^{2-} ion?

.... [1]

29. Nov 2019 V3 – Q1

(a) Atoms are made of smaller particles called electrons, neutrons and protons.

Complete the table.

particle	relative charge	relative mass
electron		$\frac{1}{1840}$
neutron		
proton	+1	

[2]

(b) The table gives information about atoms and ions **A**, **B** and **C**.

Complete the table.

	number of electrons	number of neutrons	number of protons	symbol
A		14	13	$^{27}_{13}Al$
B			12	$^{25}_{12}Mg^{2+}$
C	10	10	9	

[6]

30. May 2020 V1 - Q1

This question is about elements **X**, **Y** and **Z**.

(a) An atom of element **X** is represented as $^{34}_{16}\mathbf{X}$.

(i) Name the different types of particles found in the nucleus of this atom of **X**.

....

.... [2]

(ii) What is the term for the total number of particles in the nucleus of an atom?

.... [1]

(iii) What is the total number of particles in the nucleus of an atom of $^{34}_{16}\mathbf{X}$?

.... [1]

(iv) What is the electronic structure of the ion $\mathbf{X}^{2-}$?

.... [1]

(v) Suggest the formula of the compound formed between aluminium and **X**.

.... [1]

(b) **(i)** What term is used to describe atoms of the same element with different numbers of particles in the nucleus?

.... [1]

(ii) Identify the atom against which the relative masses of all other atoms are compared.

.... [1]

31. May 2020 V3 - Q3a

Chlorine is in Group VII of the Periodic Table.

(a) Two isotopes of chlorine are chlorine-35 and chlorine-37.

(i) State why these two isotopes of chlorine have the same chemical properties.

....

....

.... [2]

(ii) Complete the table to show the number of electrons, neutrons and protons in each atom and ion.

	number of electrons	number of neutrons	number of protons
$^{35}_{17}Cl$			
$^{37}_{17}Cl^{-}$			

[3]

32. Nov 2020 V3 - Q2

The table gives information about five particles, **A**, **B**, **C**, **D** and **E**.

particle	number of electrons	number of neutrons	number of protons
A	10	13	11
B	18	20	18
C	18	18	18
D	10	12	8
E	10	10	10

(a) State the atomic number of **A**.

.... [1]

(b) State the nucleon number of **B**.

.... [1]

(c) Write the electronic structure of **C**.

.... [1]

(d) Give the letters of all the particles which are:

(i) atoms .... [1]

(ii) positive ions .... [1]

(iii) negative ions .... [1]

(iv) isotopes of each other. .... [1]

33. Feb 2021 V2 - Q1

The table shows the numbers of protons, neutrons and electrons in particles **A** to **I**.

particle	protons	neutrons	electrons
A	1	0	0
B	6	6	6
C	6	8	6
D	10	10	10
E	16	16	18
F	17	18	17
G	18	22	18
H	19	20	19
I	20	20	18

Answer the following questions about particles **A** to **I**. Each letter may be used once, more than once or not at all.

(a) State which of the particles **A** to **I**:

(i) is an anion .... [1]

(ii) are cations .... and .... [2]

(iii) are noble gas atoms .... and .... [2]

(iv) is a halogen atom .... [1]

(v) is a Group I atom .... [1]

(vi) have the same nucleon number .... and .... [1]

(vii) causes acidity in aqueous solutions .... [1]

(viii) is used to define the relative atomic mass of elements. .... [1]

(b) Explain why **B** and **C** are isotopes of the same element.

....

.... [2]

34. May 2021 V1 - Q2

Complete the table to:

- deduce the number of protons, electrons and neutrons in the magnesium atom and copper ion shown
- identify the atom or ion represented by the final row.

	number of protons	number of electrons	number of neutrons
$^{25}_{12}Mg$	12	=	
$^{65}_{29}Cu^{2+}$			36
	17	18	20

[Total: 5]

35. May 2021 V2 - Q2a

Silver has an atomic number of 47.

(a) Naturally occurring atoms of silver are ^{107}Ag and ^{109}Ag.

(i) State the name given to atoms of the same element with different nucleon numbers.

.... [1]

(ii) Complete the table to show the number of protons, neutrons and electrons in each atom and ion of silver shown.

	$^{107}_{47}Ag$	$^{109}_{47}Ag^{+}$
protons		
neutrons		
electrons		

[3]

(iii) Complete this definition of relative atomic mass.

Relative atomic mass is the .... mass of naturally occurring atoms of an element on a scale where the .... atom has a mass of exactly .... units.

[3]

36. May 2021 V3 - Q2

Complete the table to:

- deduce the number of protons, electrons and neutrons in the boron atom and chloride ion shown
- identify the atom or ion represented by the final row.

formula	number of protons	number of electrons	number of neutrons
$^{11}_{5}B$		5	
$^{35}_{17}Cl^{-}$	17		
	24	21	30

37. Nov 2021 V1 - Q2a

[Total: 5]

This question is about copper and its compounds.

(a) Copper has two different naturally occurring atoms, ^{63}Cu and ^{65}Cu.

(i) State the term used for atoms of the same element with different nucleon numbers.

.... [1]

(ii) The atomic number of copper is 29.

Complete the table to show the number of protons, neutrons and electrons in the particles of copper shown.

	^{63}Cu	$^{65}Cu^{2+}$
protons		
neutrons		
electrons		

[3]

(iii) Relative atomic mass is the average mass of naturally occurring atoms of an element.

The percentage of the naturally occurring atoms in a sample of copper is shown.

^{63}Cu	^{65}Cu
70%	30%

Deduce the relative atomic mass of copper in this sample.

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

relative atomic mass = ... [2]

38. Nov 2021 V2 - Q2a

Atoms contain protons, neutrons and electrons.

(a) Complete the table to show the relative mass and the relative charge of a proton, a neutron and an electron.

	relative mass	relative charge
proton		
neutron		
electron	$\frac{1}{1840}$	

[3]

(b) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

atom or ion	number of protons	number of neutrons	number of electrons
$^{32}_{16}S$			
$^{39}_{19}K^+$			
	35	44	36

[5]

39. Nov 2021 V3- Q4a

Carbon is an important element.

(a) Carbon exists as the isotopes $^{12}_{6}C$ and $^{13}_{6}C$.

Complete the table.

isotope	number of protons in one atom	number of electrons in one atom	number of neutrons in one atom
$^{12}_{6}C$			
$^{13}_{6}C$			

[2]

40. May 2022 V1 - Q2

(a) Atoms are made of protons, neutrons and electrons. Atoms of the same element are known as isotopes.

(i) Complete the table.

particle	relative charge	relative mass
electron		$\frac{1}{1840}$
neutron		
proton	+1	

[2]

(ii) $^{24}_{12}Mg$ and $^{25}_{12}Mg$ are isotopes of magnesium.

Complete the table to show the numbers of electrons, neutrons and protons in these isotopes of magnesium.

isotope	number of electrons	number of neutrons	number of protons
$^{24}_{12}Mg$			
$^{25}_{12}Mg$			

[2]

(iii) Explain why magnesium ions have a charge of 2+.

....

.... [1]

(b) Mg^{2+} ions have the electronic structure 2,8.

Give the formula of the following particles which have the same electronic structure as Mg^{2+} ions.

- a cation (positive ion)

....

- an anion (negative ion)

....

- an atom

....
[3]

41. May 2022 V2 - Q3a

Transition elements are found in the middle block of the Periodic Table.

(a) Chromium has several isotopes. Manganese has only one isotope.

(i) State what is meant by the term *isotopes*.

....

.... [2]

(ii) State the nucleon number of manganese.

.... [1]

(iii) Complete the table to show the number of protons, neutrons and electrons in a $^{52}_{24}Cr^{3+}$ ion.

protons	neutrons	electrons

[3]

42. May 2022 V3 - Q2a

(a) $^{32}_{16}S$ and $^{33}_{16}S$ are isotopes of sulfur.

Use your knowledge of protons, neutrons and electrons to answer the following questions.

(i) Describe how these isotopes of sulfur are the same and how they are different.

same ....

....

different ....

.... [3]

(ii) Explain why each of these isotopes have an overall charge of zero.

....

.... [1]

(iii) Explain why both isotopes have the same chemical properties.

....

.... [1]

(b) Sulfide ions, S^{2-}, have the electronic structure 2,8,8.

(i) Explain why sulfide ions have a charge of 2–.

....

.... [1]

(ii) Give the formula of:

- an anion which has the same electronic structure as S^{2-}

....

- a cation which has the same electronic structure as S^{2-}.

....

[2]

43. Feb 2023 V2 - Q2c

Lithium has two naturally occurring types of atoms, ^{6}Li and ^{7}Li.

(i) State the name given to atoms of the same element with different nucleon numbers.

.... [1]

(ii) Complete Table 2.1 to show the number of protons, neutrons and electrons in the atom and ion of lithium shown.

Table 2.1

	^{6}Li	$^{7}Li^{+}$
protons		
neutrons		
electrons		

[3]

(iii) Table 2.2 shows the relative abundance of the two naturally occurring atoms of lithium.

Table 2.2

atom	^{6}Li	^{7}Li
relative abundance	10%	90%

Calculate the relative atomic mass of lithium to **one** decimal place.

relative atomic mass = ... [2]

44. May 2023 V1 - Q2b

(b) Boron, B, has two isotopes.

(i) State the meaning of the term isotopes.

....

.... [2]

(ii) Table 2.1 shows the relative masses and the percentage abundances of the two isotopes of boron.

Table 2.1

relative mass of isotope	percentage abundance of isotope
10	20
11	80

Calculate the relative atomic mass of boron to **one** decimal place.

relative atomic mass = ... [2]

45. Nov 2023 V1 - Q2

Boron and aluminium are Group III elements.

(a) Boron has only two naturally occurring isotopes, ^{10}B and ^{11}B.

Complete Table 2.1 to show the numbers of protons, neutrons and electrons in an atom of ^{11}B.

Table 2.1

number of protons	number of neutrons	number of electrons

[2]

(b) The relative atomic mass of boron to one decimal place is 10.8.

(i) Determine the relative abundance of ^{10}B present in boron. Give your answer as a percentage.

.... % [1]

46. Nov 2023 V2 - Q2

Cobalt and copper are transition elements.

(a) Copper has two naturally occurring isotopes, ^{63}Cu and ^{65}Cu. Cobalt has only one naturally occurring isotope, ^{59}Co.

(i) Complete Table 2.1 to show the number of protons, neutrons and electrons in the ^{59}Co atom and the $^{65}Cu^{2+}$ ion.

Table 2.1

	^{59}Co	$^{65}Cu^{2+}$
protons		
neutrons		
electrons		

[3]

(ii) Table 2.2 shows the relative abundance of the two naturally occurring isotopes of copper.

Table 2.2

isotope	^{63}Cu	^{65}Cu
relative abundance	70%	30%

Calculate the relative atomic mass of copper to **one** decimal place.

relative atomic mass = ... [2]

47. Nov 2023 V3 - Q2

Table 2.1 gives information about particles **A**, **B**, **C**, **D**, **E** and **F**.

Table 2.1

particle	number of electrons	number of neutrons	number of protons
A	5	6	5
B	10	11	10
C	10	14	13
D	18	17	16
E	18	17	17
F	15	16	15

(a) Give the letters of **all** the particles which are:

(i) atoms

.... [1]

(ii) ions with a charge of 2–

.... [1]

(iii) cations.

.... [1]

(b) State the atomic number of **A**.

.... [1]

(c) Determine the number of nucleons in **D**.

.... [1]

(d) State the electronic configuration of **D**.

.... [1]

(e) State the group number of **F**.

.... [1]

(f) State the period number of **B**.

.... [1]

48. Specimen 2023 Q2

Magnesium, calcium and strontium are Group II elements.

(a) Complete Table 2.1 to show the electronic configuration of a calcium atom.

Table 2.1

shell	1st	2nd	3rd	4th
number of electrons				

[1]

(b) Describe how the electronic configuration of a strontium atom is:

(i) similar to the electronic configuration of a calcium atom

....

.... [1]

(ii) different from the electronic configuration of a calcium atom.

....

.... [1]

49.March 2024 V2 - Q1f

(f) Both iron(III) oxide and aluminium oxide contain metal ions with a 3+ charge.

(i) Write the electronic configuration of an Al^{3+} ion.

.... [1]

(ii) Deduce the number of protons and electrons in an Fe^{3+} ion.

protons	electrons

[2]

50. May 2024 V1 - Q2

Complete Table 2.1.

Table 2.1

atom or ion	number of protons	number of electrons	number of neutrons
$^{37}_{17}Cl$		17	
$^{63}_{29}Cu^{+}$			34
	16	18	17

[5]

51.Nov 2024 V1 - Q2

This question is about atomic structure and the Periodic Table.

(a) Define the term nucleon number.

.... [1]

(b) State the connection between the number of occupied electron shells in an atom and the period number of that element.

.... [1]

(c) Write the electronic configuration of the following atom and ion.

$^{28}_{14}Si$ ....

$^{37}_{17}Cl^{-}$ ....

[2]

(d) Complete Table 2.1.

Table 2.1

atom or ion	number of protons	number of neutrons	number of electrons
$^{23}_{11}Na$	11		
$^{19}_{9}F^{-}$	9	10	
	31	38	28

[5]

(e) A sample of thallium, T*l*, contains two isotopes, ^{203}Tl and ^{205}Tl.

(i) Define the term isotopes.

....

.... [2]

(ii) The relative abundance of $^{203}Tl : ^{205}Tl$ is in the ratio 3 : 7.

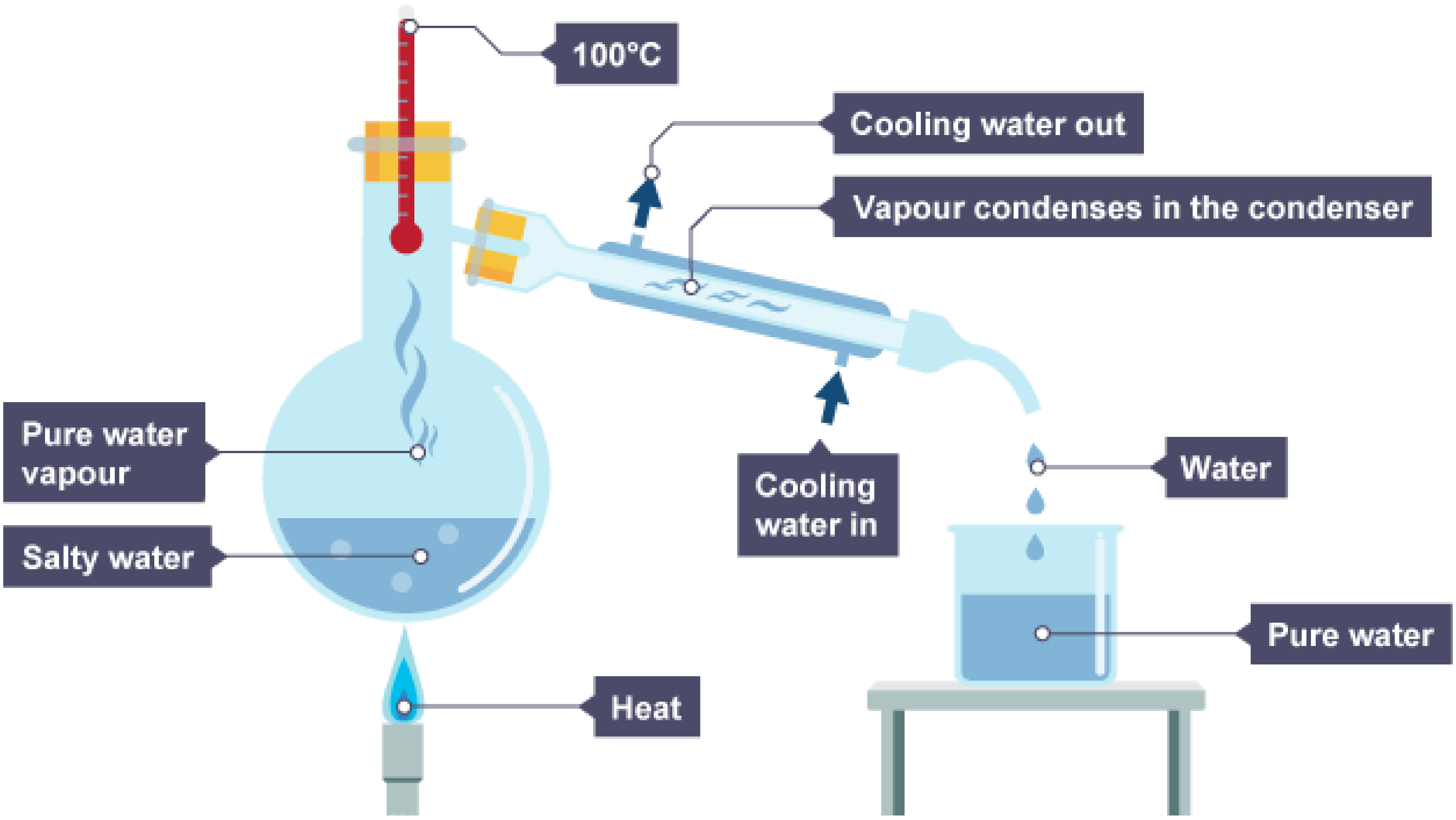
Calculate the relative atomic mass of thallium in the sample to **one** decimal place.

relative atomic mass = ... [2]

(iii) Suggest why these two isotopes have identical chemical properties.

.... [1]

Topic 14



100°C
Cooling water out
Vapour condenses in the condenser
Pure water vapour
Salty water
Cooling water in
Water
Pure water
Heat

1. Nov 2016 V1 - Q1

1 The table gives some information about five substances.

substance	melting point / °C	boiling point / °C	solubility in water	electrical conductivity when molten	electrical conductivity when solid
F	–97	65	very soluble	does not conduct	does not conduct
G	1600	2230	insoluble	does not conduct	does not conduct
H	801	1413	soluble	conducts	does not conduct
I	–57	126	insoluble	does not conduct	does not conduct
J	1085	2562	insoluble	conducts	conducts

(c) Name a method you could use to separate a mixture of substance **J** and water.

.... [1]

(d) Name a method you could use to obtain substance **F** from a mixture of substance **F** and water.

.... [2]

(e) Describe how you could obtain a solid sample of substance **H** from a mixture of substance **H** and substance **G**.

....

....

....

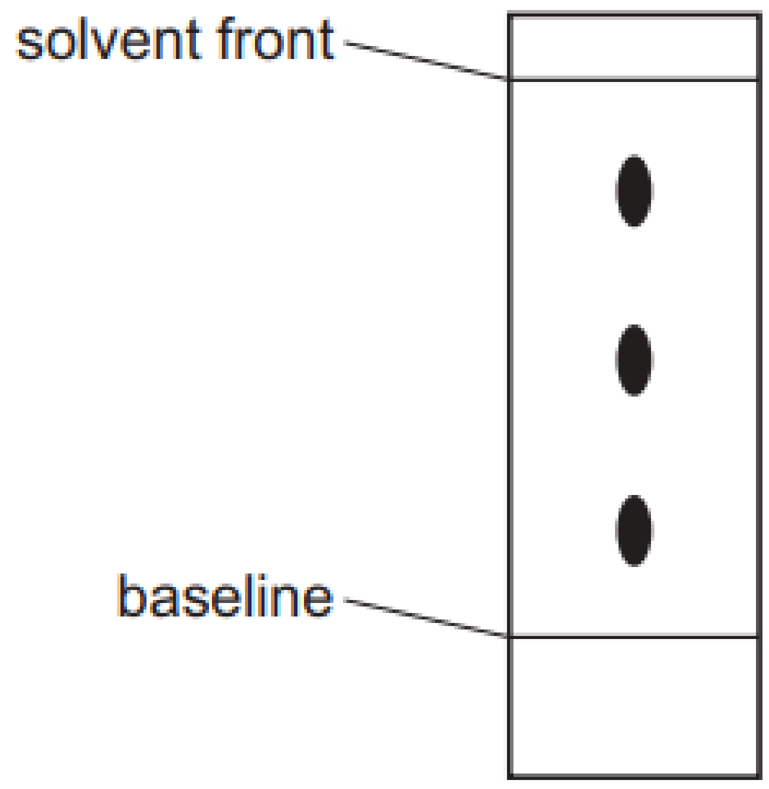
....

....

.... [3]

2. Nov 2016 V2 - Q7c

(c) A colourless mixture of amino acids was separated by chromatography.
Amino acid **X** has an R_f value of 0.8.
The chromatogram of the mixture after treatment with a locating agent is shown.



(i) How is an R_f value calculated?

R_f =

[1]

(ii) On the diagram put a ring around the spot caused by amino acid **X**. [1]

(iii) Describe how you would perform a chromatography experiment to produce the chromatogram shown in **(c)**. Assume you have been given the mixture of amino acids and a suitable locating agent. You are provided with common laboratory apparatus.

....

....

....

....

....

.... [3]

3. Nov 2016 V3 - Q6cii

(ii) Starting with a sample of protein, describe how to produce, separate, detect and identify the monomers which make it up.

Your answer should include
- the name of the process used to break down the protein into its monomers,
- the name of the process used to separate the monomers,
- the method used to detect the monomers after they have been separated,
- the method used to identify the monomers after they have been separated.

....

....

....

....

.... [4]

4. May 2017 V2 - Q1a

(a) State the name of the process that is used to

(i) separate oxygen from liquid air,

.... [1]

(ii) separate the individual dyes in ink,

.... [1]

(iii) produce ethanol from simple sugars,

.... [1]

(iv) obtain water from aqueous sodium chloride,

.... [1]

(v) separate the precipitate formed when aqueous silver nitrate is added to aqueous sodium chloride.

.... [1]

5. Feb 2018 V2 - Q5e

(e) Chromatography can be used to identify simple sugars in a mixture.

A student analysed a mixture of simple sugars by chromatography. All the simple sugars in the mixture were colourless.

(i) What is the name given to the type of substance used to identify the positions of the simple sugars on the chromatogram?

.... [1]

(ii) The student calculated the R_f value of a spot on the chromatogram.

Complete the expression for the R_f value of the spot.

R_f =

[1]

(iii) How could a student identify a simple sugar from its R_f value?

....

.... [1]

(iv) Sometimes not all the substances in a mixture can be identified from the chromatogram produced.

Explain why this may happen.

.... [1]

6. May 2018 V1 - Q1b,c

(b) Mixtures can be separated by physical processes.

A sequence of physical processes can be used to separate common salt (sodium chloride) from a mixture containing sand and common salt only.

Give the order and the correct scientific term for the physical processes used to separate the common salt from the mixture.

1 ....

2 ....

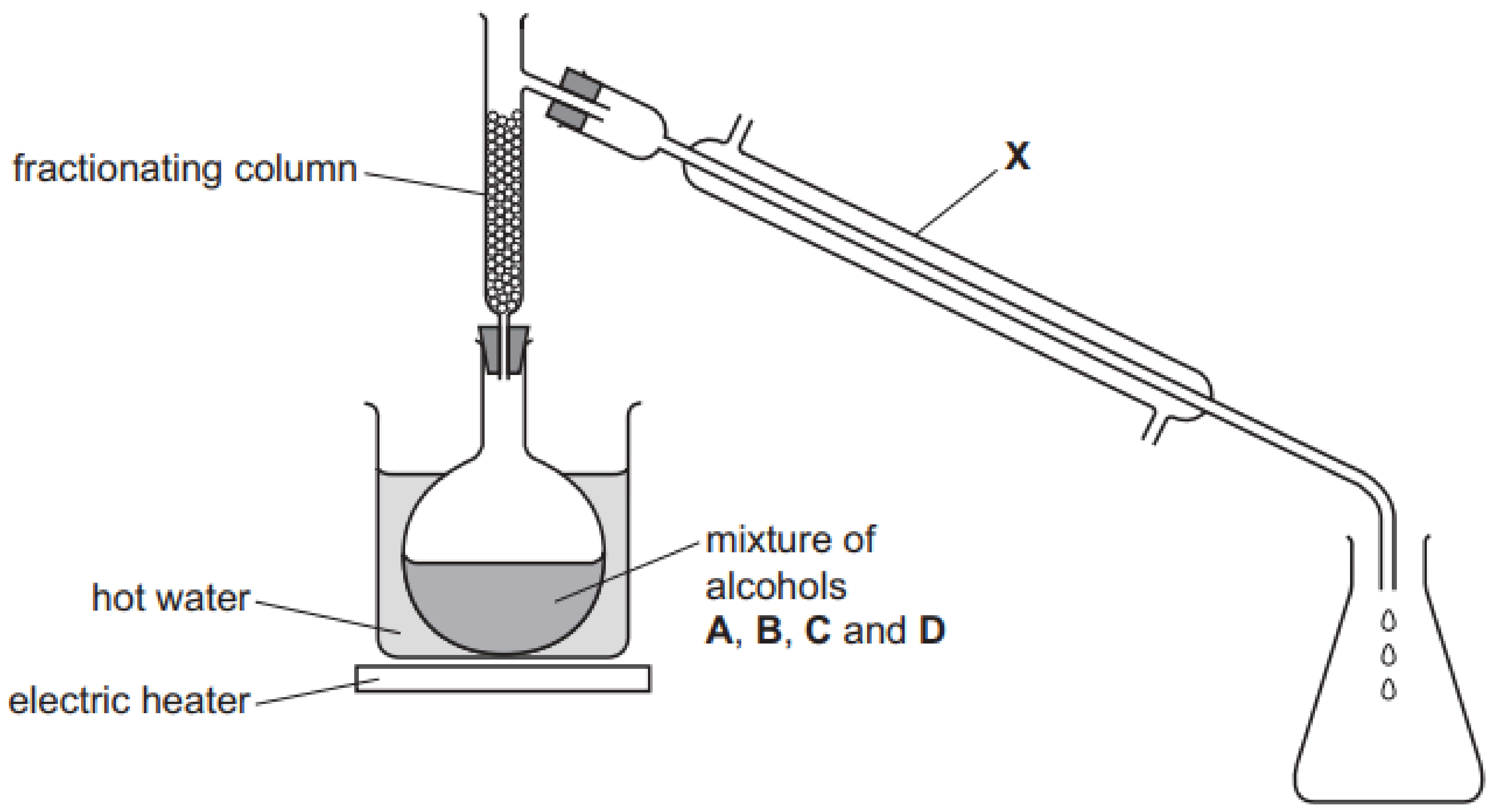
3 ....

[4]

The boiling points of four different alcohols, **A**, **B**, **C** and **D**, are shown.

alcohol	A	B	C	D
boiling point / °C	56	78	122	160

(c) A student suggested that the apparatus shown could be used to separate the mixture of alcohols.



(i) Apparatus **X** needs to have cold water flowing through it.

- Draw an arrow on the diagram to show where the cold water enters apparatus **X**.
- Name apparatus **X**.

.... [2]

(ii) Part of the fractionating column is missing. This means that the experiment will not work.

- Draw on the diagram the part of the fractionating column which is missing.
- Explain why the experiment will **not** work with this part of the fractionating column missing.

....

.... [2]

(iii) Suggest why a Bunsen burner is **not** used to heat the flask.

.... [1]

(iv) A hot water bath cannot be used to separate alcohols **C** and **D**.

Explain why.

....

....

.... [2]

7. May 2018 V2 - Q1

Give the name of the process that is used:

(a) to obtain water from aqueous sodium chloride

.... [1]

(b) to produce lead from molten lead(II) bromide

.... [1]

(c) to separate an insoluble solid from a liquid

.... [1]

(d) to separate the components of petroleum

.... [1]

(e) to separate a mixture of coloured dyes.

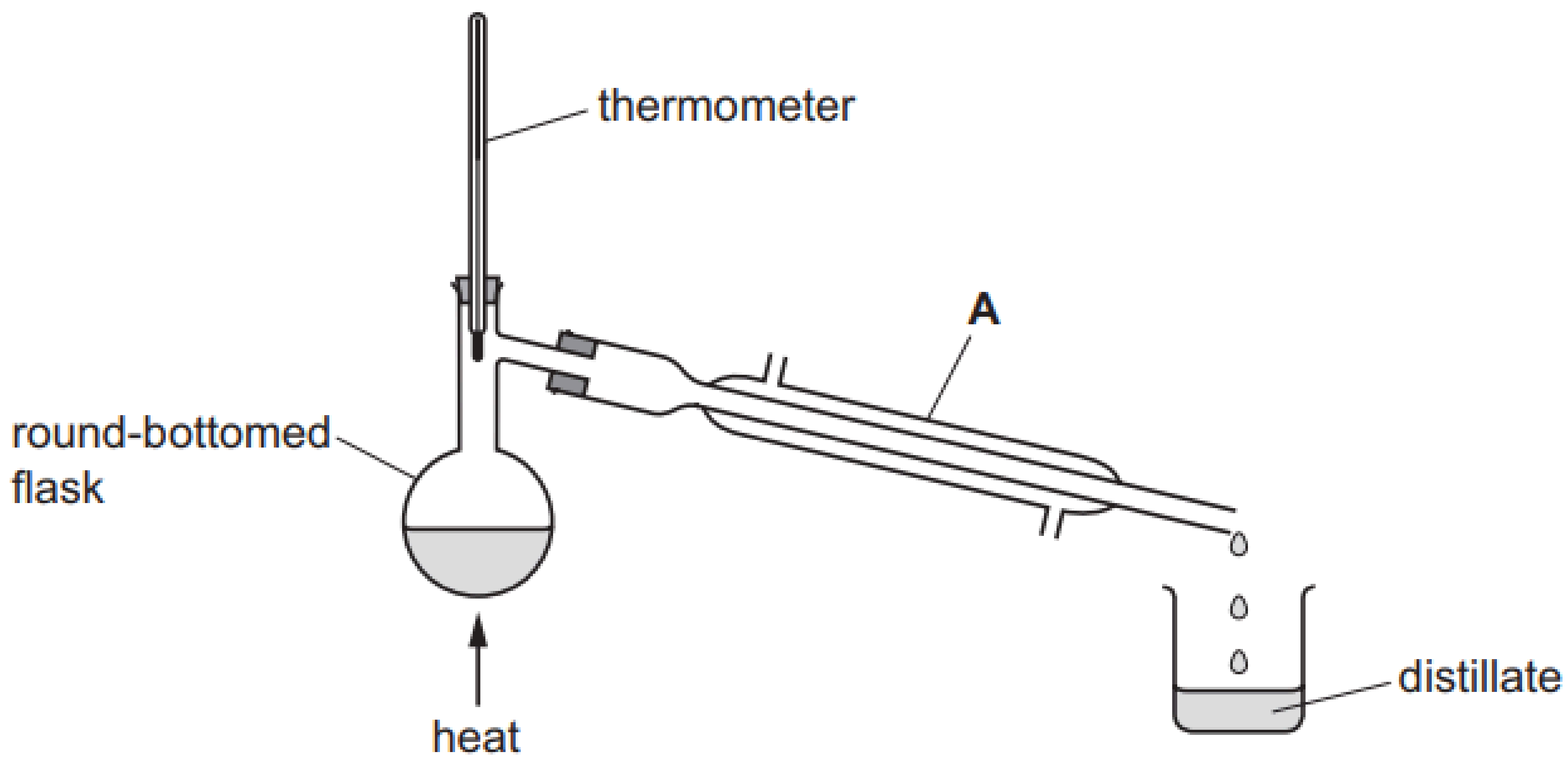
.... [1]

8. May 2020 V1 - Q5c

(c) Alcohols can be partially oxidised to form aldehydes.

Aldehydes are a homologous series of organic compounds.

Partial oxidation is achieved by reacting an alcohol with the oxidising agent in distillation apparatus as shown.



(i) Name apparatus **A**.

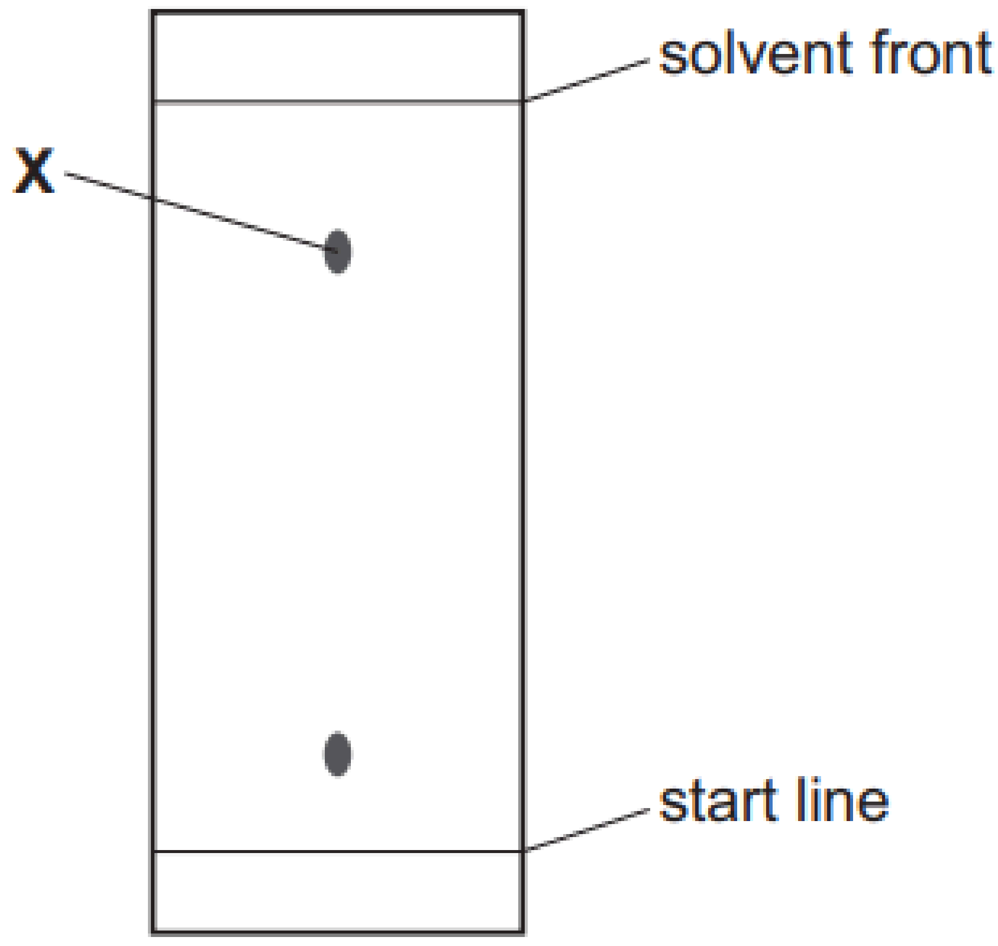
.... [1]

(ii) On the diagram, use **one** arrow to show where water enters apparatus **A**. [1]

9. May 2020 V3 - Q4c

(c) Chromatography can be used to test the purity of substances.

The diagram shows the chromatogram of a coloured substance.



(i) How does this chromatogram show that this substance is **not** pure?

.... [1]

(ii) Draw a circle round the correct R_f value for the spot labelled **X**.

0.2 0.4 0.8 1.2 [1]

(iii) State how a colourless substance can be made visible on a chromatogram.

.... [1]

10. Nov 2020 V1 - Q4b

(b) Oxygen and nitrogen are useful gases that can be obtained from air.

(i) Name the process used to separate oxygen and nitrogen from liquid air.

.... [2]

(ii) State the property of oxygen and nitrogen that allows these gases to be separated using this process.

.... [1]

11. Nov 2021 V2 - Q1d

(d) A solution is a mixture of a solute and a solvent.

(i) Name the process when a solid substance mixes with a solvent to form a solution.

.... [1]

(ii) Name the type of reaction when two solutions react to form an insoluble substance.

.... [1]

12. Nov 2022 V1 - Q4c

(c) The student continues to add calcium carbonate until it is in excess. The student then removes the excess calcium carbonate by filtration and collects the aqueous calcium nitrate.

State the general term given to a solution collected from filtration.

.... [1]

13. Nov 2022 V2 - Q4

(c) The excess magnesium is removed by filtration.

State the general name given to a solid separated from a solution by filtration.

.... [1]

(d) The aqueous magnesium sulfate is heated until crystals begin to appear.

(i) Suggest the name for a solution in which no more solute can dissolve.

.... [1]

(ii) Suggest why more crystals of magnesium sulfate appear on cooling.

.... [1]

14. Nov 2022 V3 - Q6c

(iii) Amino acids are colourless.

A sample containing a mixture of amino acids is separated. Each amino acid is detected and identified.

- Name the process used to separate the amino acids.

....

- Name the type of substance used to detect the amino acids.

....

- Give the symbol of the value used to determine the identity of each amino acid after separation and detection.

....
[3]

15. May 2024 V3 - Q1

Name the process used to:

(c) separate an insoluble solid from a mixture of an insoluble solid and a solution

.... [1]

(e) identify the components of a mixture of soluble coloured substances

.... [1]

(f) separate a mixture of several liquids with different boiling points

.... [1]

16. Nov 2024 V1 - Q6e,f

(e) A mixture of the three amino acids, **A**, **B** and **C**, can be separated and the amino acids identified using paper chromatography.

Complete the equation for R_f.

R_f =

[2]

(f) A sample of the mixture of the three amino acids, **A**, **B** and **C**, is placed onto the baseline and a chromatogram is allowed to develop as shown in Fig. 6.5.

The finished chromatogram is shown in Fig. 6.6.

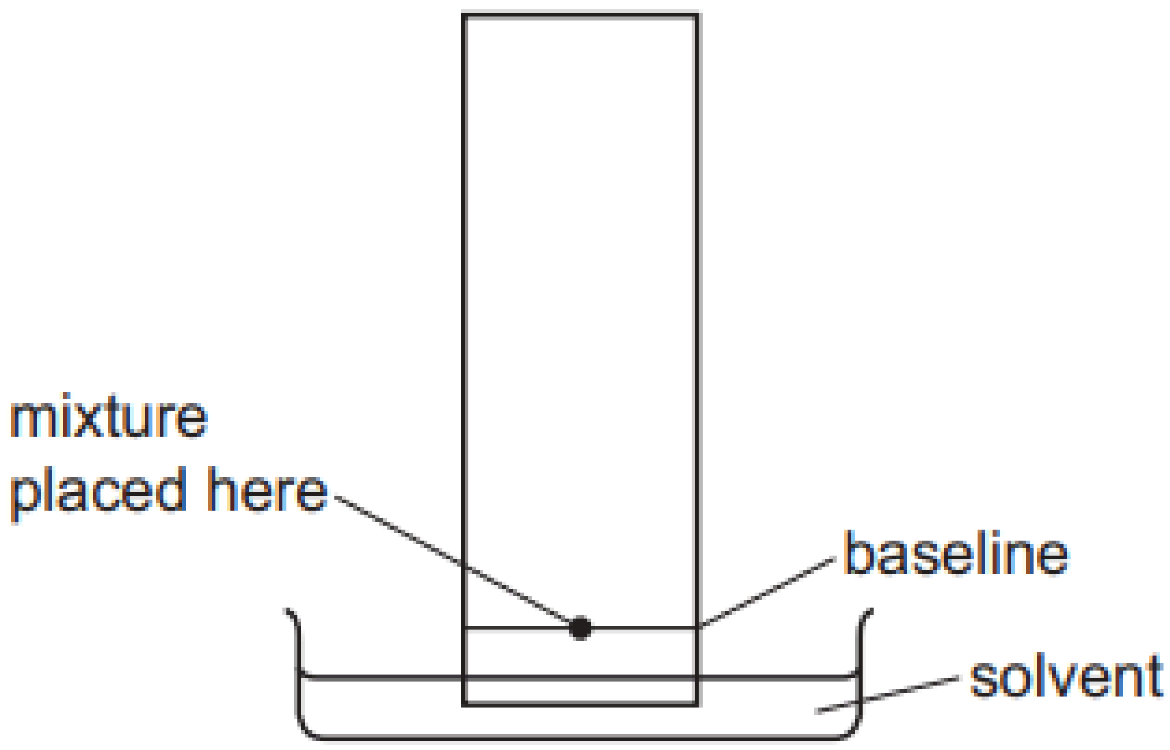


Fig. 6.5

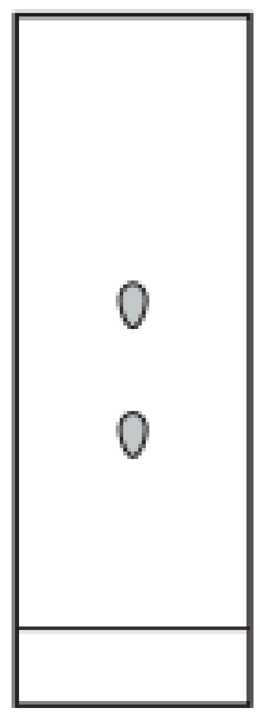


Fig. 6.6

The amino acids, **A**, **B** and **C**, are colourless. Water is used as the solvent.

(i) Explain why the baseline is drawn in pencil.

.... [1]

(ii) State the type of substance used to make the colourless amino acids visible on the chromatogram in Fig. 6.6.

.... [1]

(iii) Explain why in Fig. 6.6 only **two** spots are seen from the mixture of three amino acids.

....

.... [1]

(iv) Suggest how the experiment can be changed to separate all three amino acids.

.... [1]

The Periodic Table of Elements

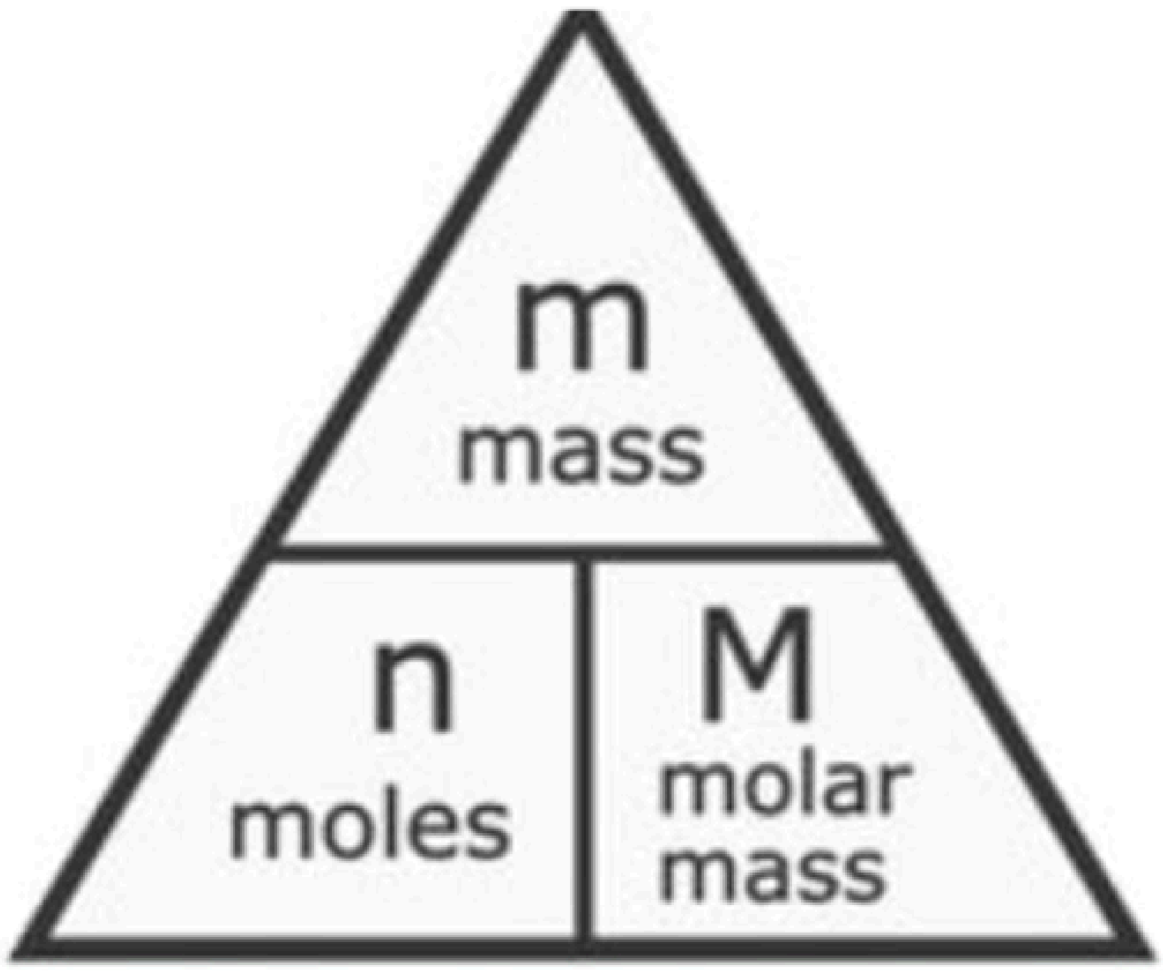
Key

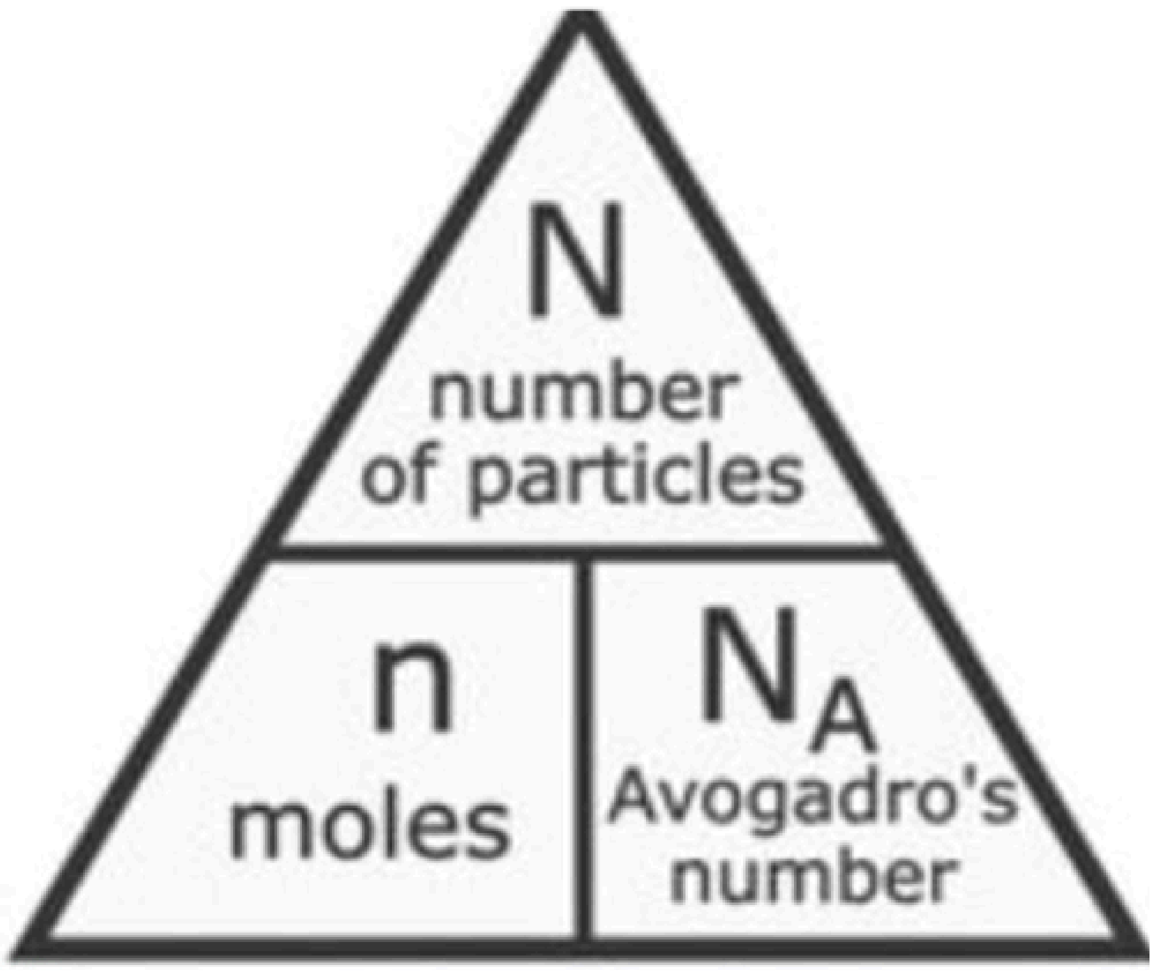
atomic number atomic symbol name relative atomic mass

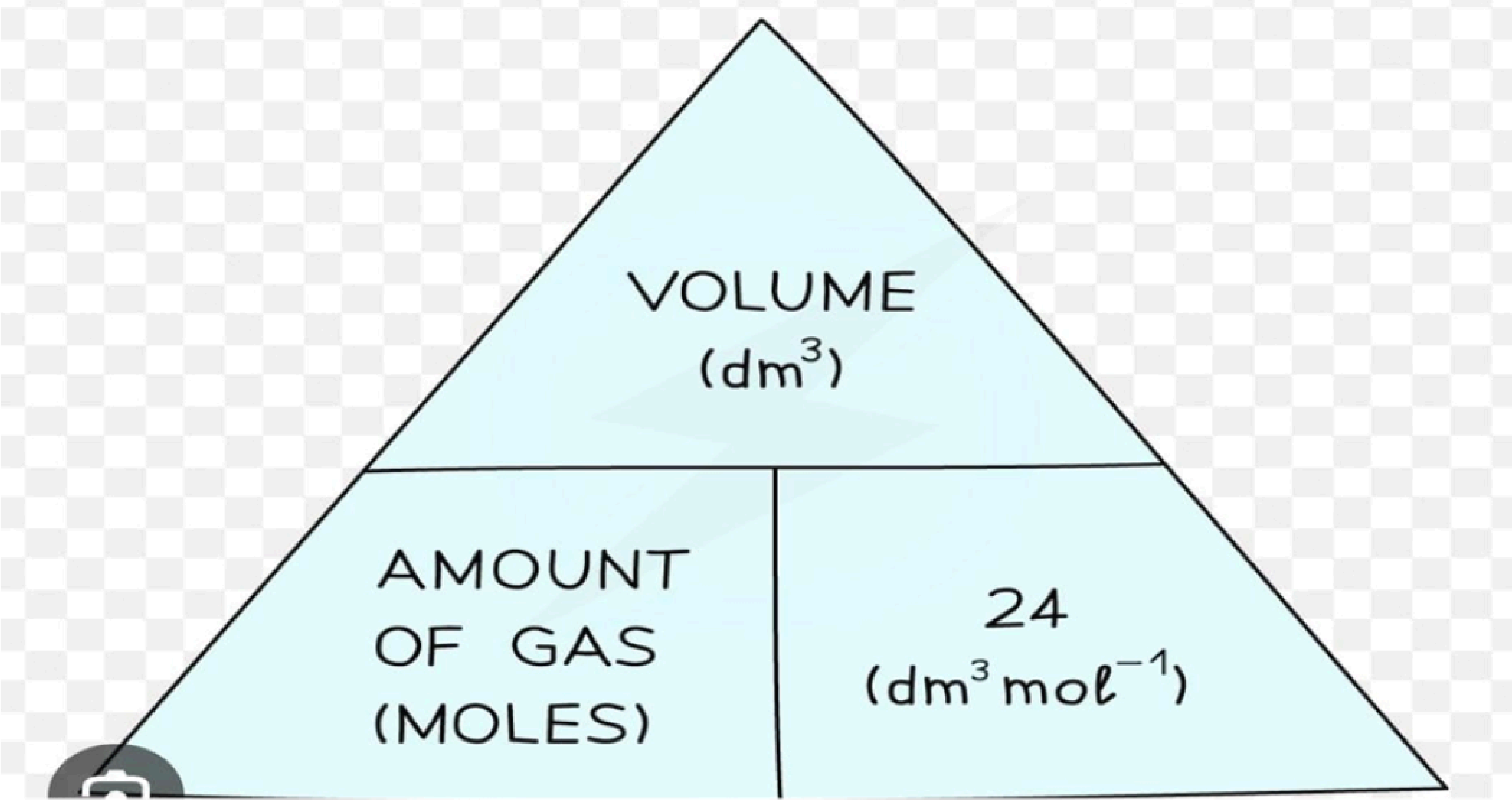
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).







Number of moles = Concentration (mol dm^{-3}) x Volume (dm^3)

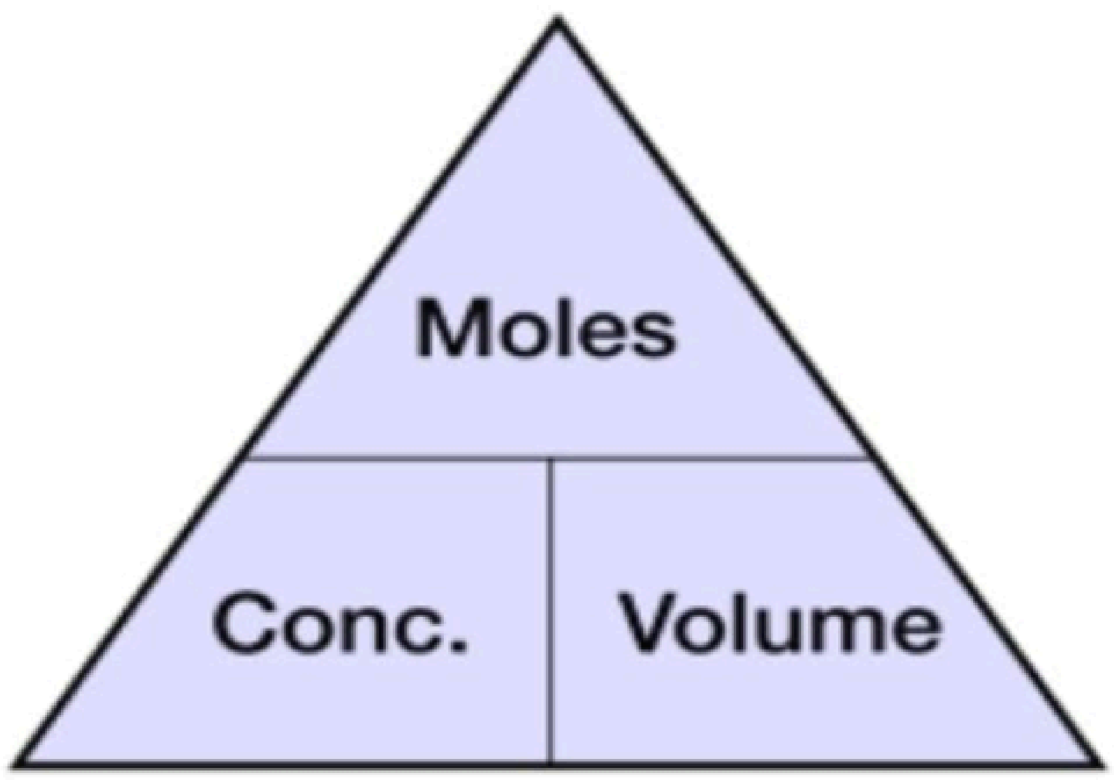


Fig 2. Formula Triangle for Calculating Moles, Concentration and Volume.

$$\text{PERCENTAGE YIELD} = \frac{\text{ACTUAL YIELD}}{\text{THEORETICAL YIELD}} \times 100$$

Valency of Some Simple and Polyatomic Ions

Valency	Simple (+ve) ions	Simple (-ve) ions	Polyatomic ions
1	Copper(I), Cu^+ Hydrogen, H^+ Potassium, K^+ Silver, Ag^+ Sodium, Na^+	Hydride, H^- Chloride, Cl^- Bromide, Br^- Iodide, I^-	Ammonium, NH_4^+ Hydrogencarbonate, HCO_3^- Hydroxide, OH^- Nitrate, NO_3^-
2	Calcium, Ca^{2+} Copper(II), Cu^{2+} Iron(II), Fe^{2+} Lead(II), Pb^{2+} Magnesium, Mg^{2+} Zinc, Zn^{2+}	Oxide, O^{2-} Sulfide, S^{2-}	Carbonate, CO_3^{2-} Sulfate, SO_4^{2-}
3	Aluminium, Al^{3+} Iron(III), Fe^{3+}	Nitride, N^{3-}	Phosphate, PO_4^{3-}

Process	Temperature	Pressure	Catalyst
Haber	450 °C	20 000 kPa/200 atm	Iron
Contact	450 °C	200 kPa/2atm	Vanadium(V) oxide
Photochemical Reaction	X	X	Ultra-Violet light
Catalytic Cracking	550 °C	X	Aluminum Oxide
Addition Of Hydrogen	150 °C	X	Nickel
Hydration	300 °C	6000 kPa/60 atm	Phosphoric Acid
Ester Formation	X	X	Concentrated Sulfuric Acid
Fermentation	25-35 °C	X	Yeast