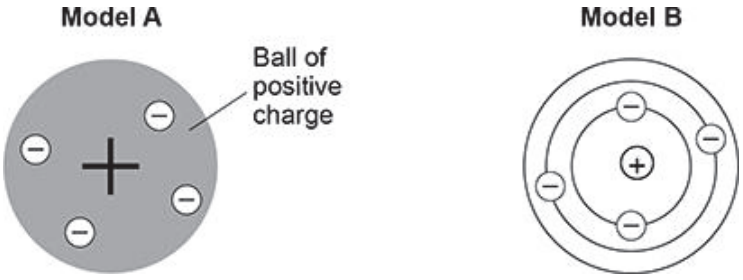
Q1.

This question is about models of the atom.

The figure below shows two early models of the atom.



(a) Name the models of the atom shown in above figure.

Model **A** 'Plum pudding' (or Thompson) model

Model **B** 'Bohr' (or nuclear / Rutherford - Bohr) model

(2)

(b) Compare model **A** with the model of the atom used today.

Use the figure above.

Similarities:

Both contain electrons

Both are overall neutral

Differences:

Model A	Model B
No nucleus	Has a nucleus
Has no protons	Has protons
Has no neutrons	Has neutrons
Positive charge spread throughout the atom	Positive charge concentrated in the centre of atom
electrons distributed randomly	electrons confined to energy levels / shells
Mass spread throughout the atom	Mass concentrated in the centre of atom
No empty space	Mostly empty space

(4)

(c) Chadwick's experiments showed the existence of neutrons in an atom.

This led to an understanding of isotopes.

Define the term 'isotopes'.

Refer to subatomic particles in your answer.

Isotopes are atoms with the same number of protons, but with different numbers of neutrons.

(2)

(Total 8 marks)

Q2.

This question is about atoms.

Atoms contain three types of particle:

- electrons
- neutrons
- protons.

(a) Which particle has no electrical charge?

Tick (✓) **one** box.

Electron	☐
Neutron	☑
Proton	☐

(1)

(b) Which particles have the same relative mass?

Tick (✓) **one** box.

An electron and a neutron	☐
An electron and a proton	☐
A neutron and a proton	☑

(1)

(c) The formula of a compound is N_2O

How many of each type of atom are in one molecule of N_2O?

Nitrogen 2

Oxygen 1

(2)

An atom of element **Z** contains:

- 3 electrons
- 4 neutrons
- 3 protons.

Key						
relative atomic mass **atomic symbol** name atomic (proton) number						
7 **Li** lithium 3	9 **Be** beryllium 4					
23 **Na** sodium 11	24 **Mg** magnesium 12					
39 **K**	40 **Ca**	45 **Sc**	48 **Ti**	51 **V**	52 **Cr**	

(d) Give the name of element **Z**.

Use the periodic table.

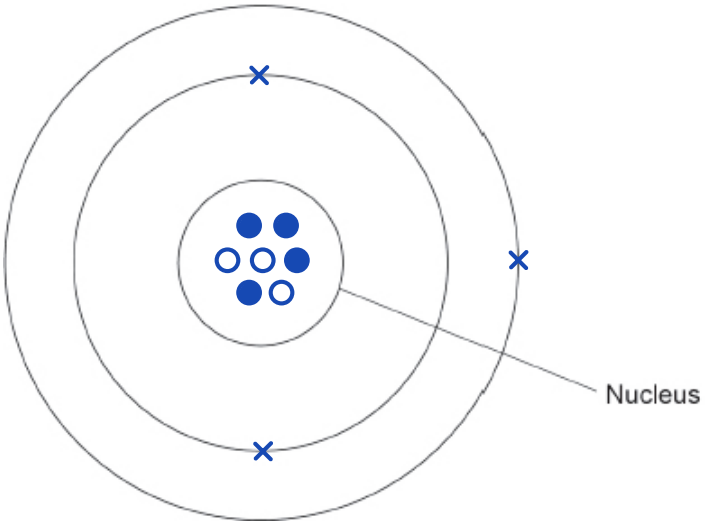
Lithium

(1)

(e) Complete the figure below to show the position of the particles in an atom of element **Z**.

Use the symbols:

× = electron
● = neutron
○ = proton



(4)

(Total 9 marks)

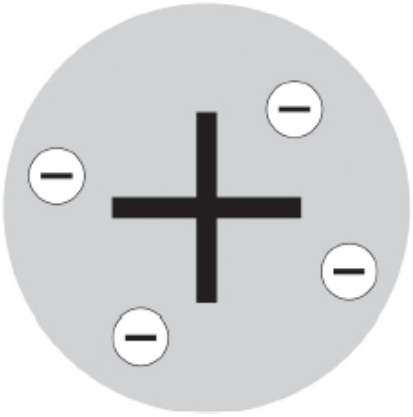
Q3.

Discoveries in chemistry led to a better understanding of atomic structure.

(a) Atoms were originally thought to be tiny spheres that could not be divided.

The plum pudding model of the atom was then developed.

The figure below represents the plum pudding model of the atom.



Describe the plum pudding model of the atom.

The plum pudding model represents the atom as a ball of positive charge with negative electrons embedded.

(2)

(b) Atoms contain electrons, neutrons and protons.

Write these three particles in order of their discovery.

Earliest electrons

protons

Latest neutrons.

(1)

7

19 F fluorine 9
35.5 Cl chlorine 17
80 Br bromine 35
127 I iodine 53
[210] At astatine 85
[293] Ts tennessine 117

Very few atoms of the element tennessine (Ts) have ever been identified.

The atomic number of tennessine is 117

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

Give **one** reason for your answer.

Use the periodic table.

Number of outer shell electrons 7

Reason Tennessine is in Group 7

(2)

(d) Tennessine was first identified by a small group of scientists in 2010.

Suggest **one** reason why tennessine was **not** accepted as a new element by other scientists until 2015.

Time was needed for peer review.

(1)

(e) The discovery of isotopes explained why some relative atomic masses are not whole numbers.

Element **R** has two isotopes.

The table below shows the mass numbers and percentage abundances of the isotopes of element **R**.

Mass number	Percentage abundance (%)
6	7.6
7	92.4

Calculate the relative atomic mass (A_r) of element **R**.

Give your answer to 1 decimal place.

Relative atomic mass $= \frac{\text{Sum of (Mass} \times \%\text{) for each isotope}}{100}$

$A_r = \frac{(6 \times 7.6) + (7 \times 92.4)}{100} = 6.924$

Relative atomic mass (1 decimal place) = 6.9

!!

(3)

(Total 9 marks)

$A_r = \frac{(6 \times 7.6) + (7 \times 92.4)}{100}$

$A_r = \frac{(45.6) + (646.8)}{100}$

$A_r = \frac{692.4}{100}$

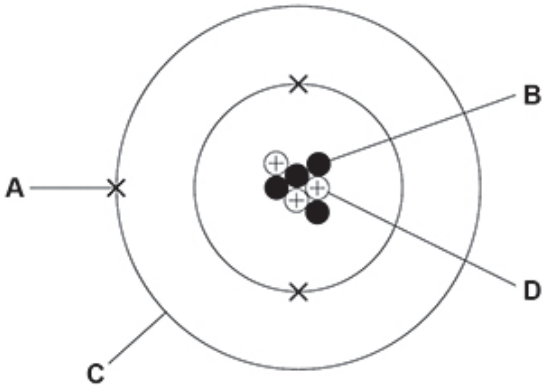
$A_r = 6.924$

$A_r = 6.9 \quad (1 \text{ d.p.})$

Q4.

This question is about atoms.

(a) The figure below represents an atom of an element.



Draw **one** line from each name to the correct label.

Name	Label
Neutron	B
Proton	D

(2)

(b) An atom of element **Y** has:

- an atomic number of 9
- a mass number of 19.

Atom is neutral: N° electrons = N° protons
(−) (+)

Give the number of electrons and the number of neutrons in this atom.

Choose answers from the box.

1	9	10	19	28

Number of electrons 9 (same as protons)

Number of neutrons (19 − 9) = 10

Mass N° = p + n

n = Mass N° − p

(2)

Atomic number = N° protons

Atomic mass = N° protons + neutrons

The table below shows information about two isotopes of element **Z**.

	Mass number	Percentage abundance (%)
Isotope **A**	39	93.3
Isotope **B**	41	6.7

(c) Calculate the relative atomic mass (A_r) of element **Z**.

Use the table above and the equation:

$$A_r = \frac{\text{(mass number} \times \text{percentage) of isotope A + (mass number} \times \text{percentage) of isotope B}}{100}$$

Give your answer to 3 significant figures.

$A_r = \frac{(39 \times 93.3) + (41 \times 6.7)}{100}$

$A_r = 39.134$ 3 sig. fig = 39.1

A_r (3 significant figures) = 39.1

(3)

(d) Suggest the identity of element **Z**.

Use the periodic table.

Element **Z** Potassium, K

39 **K** potassium 19	4 **C** calc 2

(1)

(e) Complete the sentence.

Choose the answer from the box.

electrons	**neutrons**	**protons**

Isotopes of the same element have different mass numbers because the isotopes have different numbers of neutrons.

(1)

(Total 9 marks)

Q5.

This question is about elements, compounds and mixtures.

(a) Which type of substance is hydrogen?

Tick (✓) **one** box.

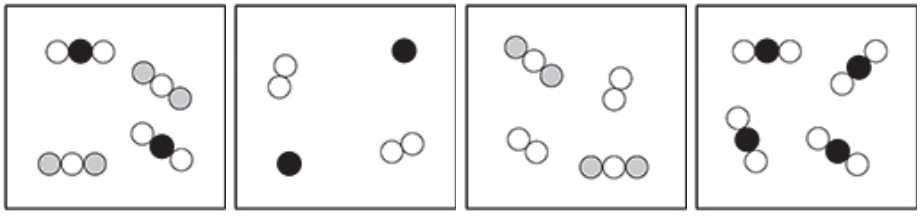
Element	☑
Compound	☐
Mixture	☐

(1)

The diagrams in **Figure 1** represent different substances.

○ ● and ○ represent atoms of three different elements.

Figure 1



A **B** **C** **D**

Use **Figure 1** to answer parts (b) and (c).

(b) Which diagram represents a mixture of compounds?

A ☑ **B** ☐ **C** ☐ **D** ☐

(1)

(c) Which diagram represents a mixture of elements?

A ☐ **B** ☑ **C** ☐ **D** ☐

(1)

Substances can be separated from mixtures by using different methods.

(d) Complete the sentence.

Sand can be separated from a mixture of sand and water by

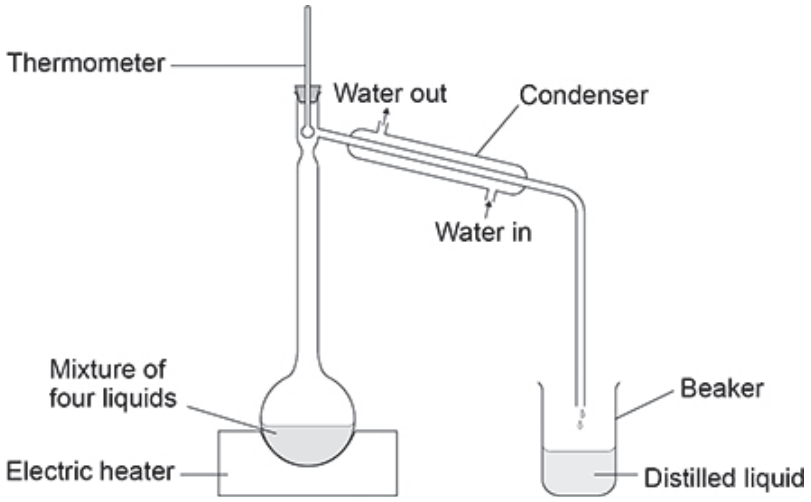
filtration.

(1)

A mixture of four liquids was fractionally distilled.

Figure 2 shows the apparatus used.

Figure 2



The table below shows the boiling points of the four liquids in the mixture.

Liquid	Boiling point in °C
A	97
B	138
C	78
D	118

Lowest b.p.!

(e) Which liquid in the table would distil and be collected in the beaker first?

Liquid C

(1)

(f) Suggest what would happen to the temperature of the water as the water flows through the condenser.

Water flowing through the condenser will increase in temperature

(1)

(g) Describe how to obtain sodium chloride crystals from sodium chloride solution by crystallisation.

Heat the solution until the crystallisation point is reached. (Volume of solution reduces due to evaporation and crystals start to form). Then leave the solution to cool and crystallise.

(2)

(Total 8 marks)

Q1.

This question is about elements in the periodic table.

(a) Argon has the atomic number 18

Explain why argon does **not** form compounds.

Answer in terms of electrons.

Argon is in Group 0 and has a full outer shell of electrons, i.e. a stable arrangement.
Therefore Argon does not form compounds.

(2)

(b) Phosphorus (P) is the element below nitrogen in the periodic table.

Predict the formula of the compound formed between phosphorus and hydrogen.

Formula = PH_3

5

Gr 5 ∴ needs 8-5 = 3e⁻

(1)

Each H shares 1e⁻

NH_3 ammonia

14
N
nitrogen
7
31
P
phosphorus
15

(c) Tellurium is the element with atomic number 52

Predict whether tellurium reacts with metals.

Explain your answer.

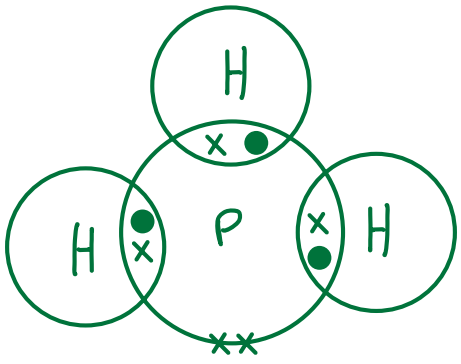
Answer in terms of the position of tellurium in the periodic table.

Yes, tellerium will react with metals as it sits towards the right of the periodic table (Group 6 - same as O and S). So, tellerium is a non-metal, it will gain electrons from a metal.

6

(2)

16
O
oxygen
8
32
S
sulfur
16
79
Se
selenium
34
128
Te
tellurium
52



2

9	
Be	
beryllium	
4	
24	
Mg	
magnesium	
12	
40	
Ca	
calcium	
20	
88	
Sr	
strontium	
38	
137	
Ba	
barium	
56	
[226]	

Barium (Ba) is an element in Group 2 of the periodic table.

Barium reacts with hydrochloric acid.

(d) Suggest **two** observations that could be made when barium reacts with hydrochloric acid.

1 Effervescence / fizzing

2 Barium disappears to form a colourless solution.

(Temp. increases)

(2)

(e) Write a balanced symbol equation for the reaction between barium and hydrochloric acid.

$Ba + 2\,HCl \rightarrow BaCl_2 + H_2$

(3)

(Total 10 marks)

Ba, Group 2, ∴ ⇒ Ba^{2+} H^+Cl^- H^+Cl^-

Ba^{2+} Cl^- Cl^- } $BaCl_2$

H^+ H^+ } H_2

1

Q2.

This question is about groups in the periodic table.

The elements in Group 1 become more reactive going down the group.

Rubidium is below potassium in Group 1.

7 **Li** lithium 3	
23 **Na** sodium 11	r
39 **K** potassium 19	
85 **Rb** rubidium 37	
133 **Cs** caesium 55	
[223] **Fr** francium 87	

Reactivity Increases ↓

(a) Rubidium and potassium are added to water.

Predict **one** observation you would see that shows that rubidium is more reactive than potassium.

Rubidium has a more vigorous bubbling and bigger, brighter flame.

(1)

(b) Explain why rubidium is more reactive than potassium.

Rubidium's outer electron shell is further from the nucleus. Resulting in less electrostatic attraction between the nucleus and outer electron (more shielding). Thus the outer electron is more easily lost (takes less energy to remove) and is therefore more reactive than potassium.

(3)

(c) Complete the equation for the reaction of rubidium with water.

You should balance the equation.

$$2\,Rb + 2\,H_2O \rightarrow 2\,RbOH + H_2$$

(3)

Rb, Group 1 ∴ ⇒ Rb^+

HOH

↙ ↘

H^+ OH^-

acid alkali

neutral

Rb^+ OH^-

H^+ } H_2

H^+ }

Need an extra H^+ to form H_2 gas ∴ 2× H_2O + 2× Rb

The noble gases are in Group 0.

(d) Which is a correct statement about the noble gases?

Tick (✓) **one** box.

The noble gases all have atoms with eight electrons in the outer shell.	☐
The noble gases have boiling points that increase going down the group.	☑
The noble gases have molecules with two atoms.	☐
The noble gases react with metals to form ionic compounds.	☐

Group 0

↓ Group

Bigger atoms
More e⁻
↑ interatomic forces
↑ b.p.

(1)

(e) The table below shows information about the three isotopes of neon.

Mass number	Percentage abundance (%)
20	90.48
21	0.27
22	9.25

Calculate the relative atomic mass (A_r) of neon.

Give your answer to 3 significant figures.

$$A_r = \frac{(20 \times 90.48) + (21 \times 0.27) + (22 \times 9.25)}{100}$$

$$A_r = \frac{(1809.6) + (5.67) + (203.5)}{100}$$

$$A_r = \frac{2018.77}{100} = 20.1877$$

Relative atomic mass (3 significant figures) = 20.2

(3)

(Total 11 marks)

All questions are for separate science students only

Ba^{2+} SO_4^{2-}

$BaSO_4$ insoluble white precipitate

Q1.

This question is about sulfuric acid.

(a) Sulfuric acid contains sulfate ions.

Describe the test for the presence of sulfate ions in sulfuric acid.

Give the result of the test. **(chemistry only)**

Test Add barium chloride ($BaCl_2$)

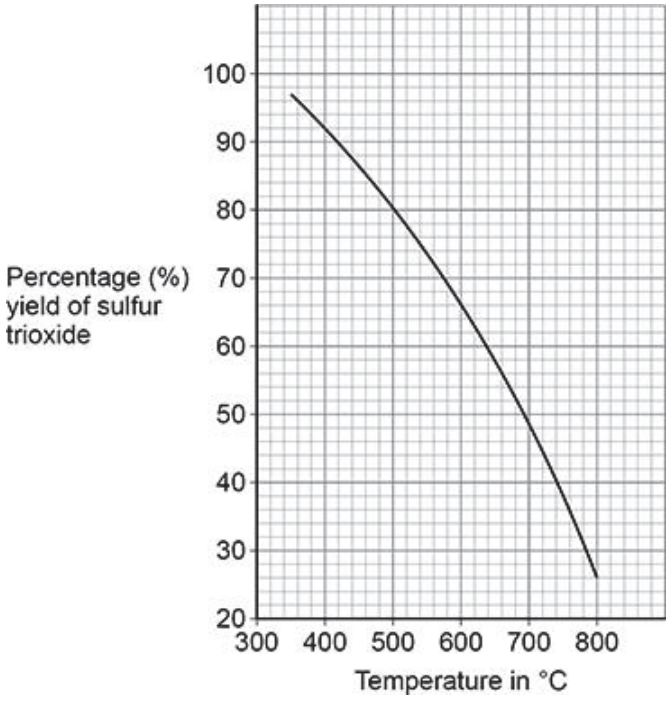
Result White precipitate forms

(2)

One stage in the industrial production of sulfuric acid is the reaction of sulfur dioxide with oxygen to produce sulfur trioxide.

This reversible reaction reaches dynamic equilibrium.

The figure below shows the percentage yield of sulfur trioxide in this reaction at different temperatures.



$2SO_2 + O_2 \rightleftharpoons 2SO_3$

(b) Which statement about the forward reaction is correct?

Use the above figure.

Tick (✓) **one** box.

The yield is greater at higher temperatures because the reaction is exothermic.	☐
The yield is greater at higher temperatures because the reaction is endothermic.	☐
The yield is smaller at higher temperatures ✓ because the reaction is exothermic. ✓	✓
The yield is smaller at higher temperatures ✓ because the reaction is endothermic.	☐

The equation for the reaction is:

$$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$$

3 mol 2 mol

(1)

(c) Explain why the percentage yield of sulfur trioxide in this reaction is greater if the pressure is higher. **(HT only)**

There are more moles of gas on the left, so as pressure increases, to oppose the change, the equilibrium shifts to the right, producing more product and thus a higher yield.

(2)

(d) In industry, the reaction is done at 450 °C and atmospheric pressure.

Under these conditions the yield of sulfur trioxide is 86%.

Suggest **two** reasons why a higher pressure is **not** used.

1 Risk of explosion increases

2 High cost of producing pressure and thicker, stronger reaction vessels.

(2)

Higher income from increased yield is outweighed by the extra expenditure / cost !

(e) This reaction uses a catalyst to increase the rate of the reaction.

The catalyst is a metal oxide.

Which is the most likely metal in the metal oxide catalyst? **(chemistry only)**

Use the periodic table.

Tick (✓) **one** box.

Aluminium (Al)	☐
Barium (Ba)	☐
Potassium (K)	☐
Vanadium (V)	☑ Transition Metal !

(1)

(Total 8 marks)

Transition Metals

45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30