Paper 1 Chemistry

6 Mark Questions

(Higher Triple)

N.B: The level of each question has been given to show you the difficulty. The level 3 questions will require you to think outside the box and use your knowledge in possibly unseen circumstances. Generally speaking, level 2 questions make up the first half of the paper and level 3 questions make up the second half of the paper.

Index:

C1 & 2 Atomic Structure and the Periodic Table

Q1. Level 2

In the 1860s scientists were trying to organise elements.

Figure 2 shows the table published by John Newlands in 1865.
The elements are arranged in order of their atomic weights.

Figure 2

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co,Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce,La	Zr	Di,Mo	Ro,Ru
Pd	Ag	Cd	U	Sn	Sb	Te

Figure 3 shows the periodic table published by Dmitri Mendeleev in 1869.

Figure 3

H							
Li	Be	B	C	N	O	F	
Na	Mg	Al	Si	P	S	Cl	
K Cu	Ca Zn	? ?	Ti ?	V As	Cr Se	Mn Br	Fe Co Ni
Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	? I	Ru Rh Pd

Mendeleev's table became accepted by other scientists whereas Newlands' table was not.

Evaluate Newlands' and Mendeleev's tables.

You should include:

- a comparison of the tables
- reasons why Mendeleev's table was more acceptable.

Use **Figure 2** and **Figure 3** and your own knowledge.

(6)

Top tips for planning:

Evaluate - Students should use the information supplied, as well as their knowledge and understanding, to consider evidence for and against when making a judgement.

Students often overlook the similarities between the two models e.g. they are ordered by atomic weight. Students usually refer to the fact that spaces are left but then don't refer back to the fact that new elements were discovered which fit those gaps. From the two bullet points given above, these ideas must be incorporated to help formulate your answers, along with your own knowledge of how Mendeleev arranged

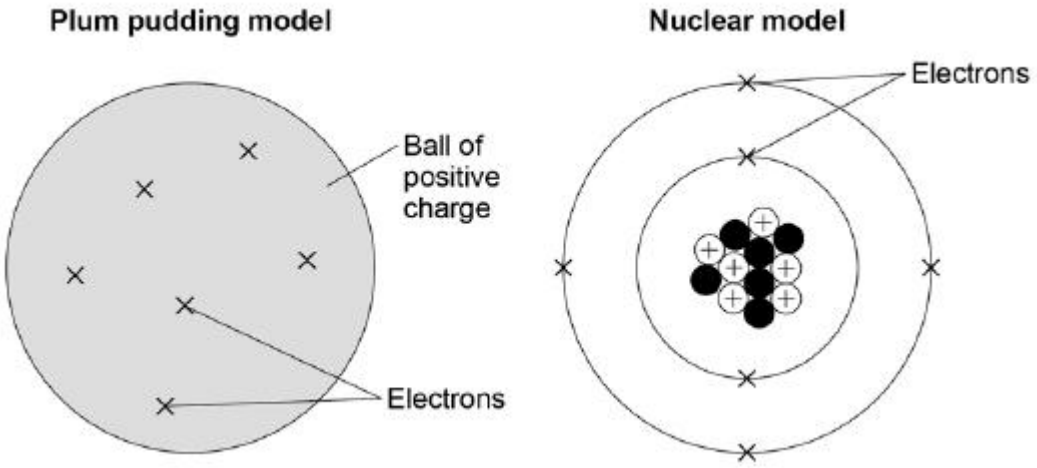
Sample Student Answer

FROM THE FIGURES ABOVE, IT IS SEEN THAT BOTH SCIENTISTS ORDERED THE ELEMENTS BY INCREASING ATOMIC WEIGHT AND THAT THERE ARE SOME SIMILARITIES IN GROUPING THE ELEMENTS E.G. SOME OF THE HALOGENS. IT IS ALSO SHOWN IN SOME INSTANCES THAT THERE IS MORE THAN ONE ELEMENT IN EACH BOX.

THE REASON WHY MENDELEEV'S MODEL WAS MORE WIDELY ACCEPTED IS BECAUSE HE CHANGED SOME OF THE ORDERS OF ELEMENTS TO FIT THE CHEMICAL REACTIVITY RATHER THAN MASS E.G. TELLIRIUM AND IODINE. HE ALSO LEFT GAPS FOR UNDISCOVERED ELEMENTS WHICH WERE LATER FILLED BY NEW ELEMENTS WHICH FIT THE EXPECTED PROPERTIES.

the elements.

Q2. Level 2



The plum pudding model of the atom was replaced by the nuclear model.

The nuclear model was developed after the alpha particle scattering experiment.

Compare the plum pudding model with the nuclear model of the atom.

(4)

Top tips for planning:

Compare - describe the similarities and/or differences between things, not just write about one.

Begin by talking about the plum pudding model and then state how the nuclear model is different e.g. where the electrons are in each model.

Sample Student Answer

THE PLUM PUDDING MODEL SUGGESTS THAT THE ATOM IS A BALL OF POSITIVE CHARGE WITH ELECTRONS SPREAD WITHIN IT, WHEREAS THE NUCLEAR MODEL HAS A POSITIVE CHARGE AT THE CENTRE ON THE ATOM AND THE ELECTRONS ORBIT AROUND THE OUTSIDE. THE PLUM PUDDING MODELS MASS IS SPREAD THROUGHOUT THE ATOM WHERES THE NUCLEAR MODEL PUTS THE MASS IN THE CENTRE OF THE ATOM (NUCLEUS). THERE IS EMPTY SPACE BETWEEN THE CENTRE OF THE ATOM AND THE OUTER ELECTRONS IN THE NUCLEAR MODEL, HOWEVER THE PLUM PUDDING MODEL DOESN'T HAVE AREAS OF EMPTY SPACE.

C3 Structure and Bonding

Q3. Level 2

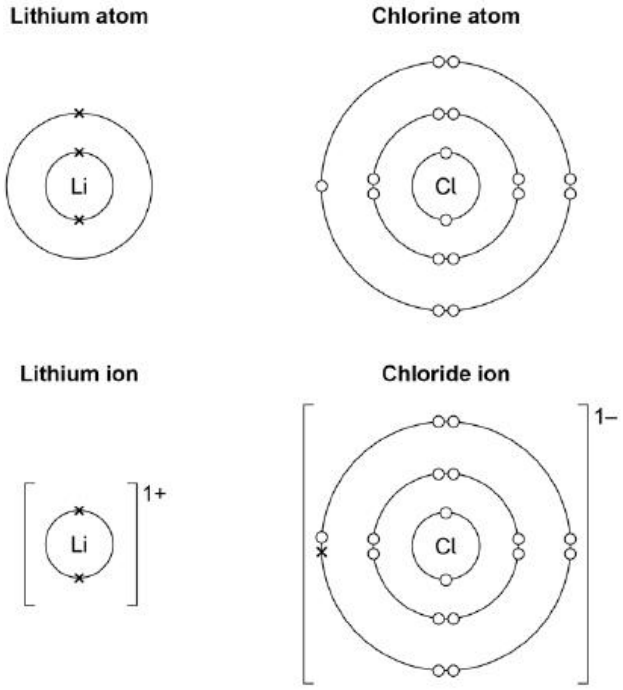
This question is about metal compounds.

Lithium reacts with chlorine to produce lithium chloride.

When lithium atoms and chlorine atoms react to produce lithium chloride, lithium ions and chloride ions are formed.

The diagram shows the electronic structures of the atoms and ions.

The symbols **o** and **x** are used to represent electrons.



Describe what happens when a lithium atom reacts with a chlorine atom.

Answer in terms of electrons.

(4)

Top tips for planning:

Describe - recall process of events

Identify which group each element is from to understand how many outer electrons is has started with, then think about how many it needs to gain or lose to become a full shell. Describe the movement of electrons as a 'transfer' and give the specific number of electrons being transferred to gain maximum marks.

Sample Student Answer

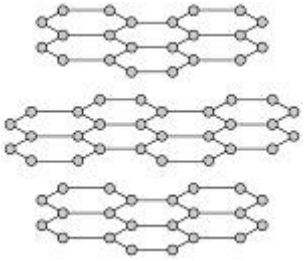
THE LITHIUM ATOM LOSES 1 ELECTRON WHICH IS TRANSFERRED TO CHLORINE TO FORM A POSITIVE ION WITH A +1 CHARGE. THE CHLORINE ATOM GAINS THIS ONE ELECTRON AND BECOMES A NEGATIVELY CHARGED ION WITH A -1 CHARGE.

Q4. Level 3

Graphene is a single layer of graphite.

Figure 2 represents part of the structure of graphite.

Figure 2



Graphite is used as a contact in electric motors because graphite:

- conducts electricity
- is slippery

Explain why graphite has these properties.

You should refer to the structure and bonding of graphite in your answer.

(6)

Top tips for planning:

Explain - give reasons for something happening

First identify what graphite is made of and then think about where it is on the periodic table. What type of bonding will it have? Think about the number of joining bonds and the forces that act on this type of bond. What is significant about it's structure which allows it to be 'slippery' and a good conductor?

Sample Student Answer

GRAPHITE IS MADE FROM CARBON ATOMS WHICH ARE BONDED TOGETHER BY STRONG COVALENT BONDS. EACH CARBON FORMS COVALENT BONDS TO 3 OTHER CARBON ATOMS AND IS ARRANGED IN HEXAGONAL LAYERS HELD TOGETHER BY WEAK INTERMOLECULAR FORCES. THIS ALLOWS THE LAYERS TO SLIDE OVER EACH OTHER. THE DELOCALISED ELECTRON CAN THEN CARRY THE CHARGE THROUGH THE STRUCTURE.

Q5. Level 2

Soluble salts are formed by reacting metal oxides with acids.

Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

(6)

Top tips for planning:

Describe - recall process of events

- *What chemicals will you react together to make magnesium sulfate? What must the metal oxide be? Which acid would you use to make a sulfate?*
- *Write bullet points like you would a method – made up of key points from the practical*
- *What key things happen in the practical which will affect the outcome of the experiment e.g. does it matter if you don't complete the filtration*
- *Write in a logical order e.g. would you be able to filter the product in the final step or would this need to come before?*

Sample Student Answer

ADD MAGNESIUM OXIDE TO WARM SULFURIC ACID IN A BEAKER. STIR THE CONTENTS AND KEEP ADDING MAGNESIUM OXIDE UNTIL NO FURTHER REACTION IS OBSERVED. FILTER THE EXCESS UNREACTED MAGNESIUM OXIDE USING FILTER PAPER AND A FUNNEL. HEAT THE REMAINING SOLUTION IN AN EVAPORATING DISH TO REDUCE THE VOLUME BY HALF. PUT THE SATURATED SOLUTION INTO A PETRI DISH AND LEAVE TO CRYSTALLISE. PAT DRY WITH FILTER PAPER IF NEEDED.

Q6. Level 2

Describe a method to investigate how the temperature changes when different masses of ammonium nitrate are dissolved in water.

You do **not** need to write about safety precautions **(6)**

Top tips for planning:

Describe - recall process of events

This question hasn't given you any indication of what the method might involve. You should be thinking about how you would set up an experiment which looks at temperature change. How will you make sure the thermal energy stays within the beaker rather than leak out into the surroundings. Remember to think about what you will do to control the experiment e.g. use the same volume of water.

Sample Student Answer

ADD 50ML OF WATER TO AN INSULATED BEAKER. RECORD THE INITIAL TEMPERATURE OF THE WATER. THEN ADD 1G OF AMMONIUM NITRATE TO THE BEAKER AND STIR. MEASURE THE FINAL TEMPERATURE OF THE SOLUTION AND RECORD THIS. CALCULATE THE TEMPERATURE INCREASE FOR THIS MASS OF AMMONIUM NITRATE. REPEAT THIS EXPERIMENT AGAIN WITH DIFFERENT MASSES OF AMMONIUM NITRATE AND COMPARE YOUR RESULTS.

Q7. Level 2

Chemical reactions can produce electricity.

The table below shows data about different ways to power electric cars.

	Hydrogen fuel cell	Rechargeable lithium-ion battery
Time taken to refuel or recharge in minutes	5	30
Distance travelled before refuelling or recharging in miles	Up to 415	Up to 240
Distance travelled per unit of energy in km	22	66
Cost of refuelling or recharging in £	50	3
Minimum cost of car in £	60 000	18 000

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.

Use the table above and your own knowledge.

(6)

Top tips for planning:

Evaluate - Students should use the information supplied, as well as their knowledge and understanding, to consider evidence for and against when making a judgement.

Recall your own knowledge about the differences between a battery and a hydrogen fuel cell to help support your evaluation. You may want to make small bullet points to help remind yourself of key information you should mention which supports your judgement. All your arguments should be centred around supporting your overall judgement. There is no right or wrong answer in terms of which option you chose.

Sample Student Answer

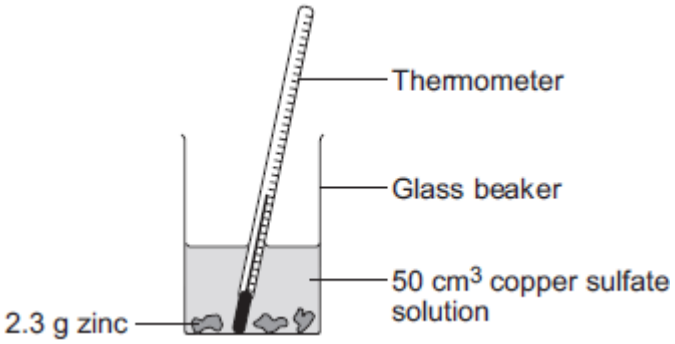
USING THE INFORMATION ABOVE IT IS CLEAR THAT THE LITHIUM-ION CAR COSTS MUCH LESS THAN THE FUEL CELL ALTERNATIVE. IT ALSO REQUIRES LESS MONEY TO RECHARGE ALTHOUGH IT TAKES LONGER TO RECHARGE (25 MINS MORE). ALTHOUGH THE RANGE ISN'T AS GOOD, THE DISTANCE TRAVELLED PER UNIT OF ENERGY IS MUCH BETTER MAKING IT MUCH MORE EFFICIENT. THERE ARE MORE CHARGING POINTS AROUND FOR ELECTRIC CARS RATHER THAN HYDROGEN FUELLED CARS AND HYDROGEN IS FLAMMABLE MAKING THE STORAGE OF IT MORE DIFFICULT. ALSO, THERE ARE NO EMISSIONS PRODUCED. IN CONCLUSION, THE LITHIUM-ION BATTERY IS CURRENTLY THE BETTER OF THE TWO CARS.

Q8. Level 2

A student investigated the temperature change when zinc reacts with copper sulfate solution.

The student used a different concentration of copper sulfate solution for each experiment.

The student used the apparatus shown below.



The student's results are shown in the table below.

Experiment number	Concentration of copper sulfate in moles per dm^3	Increase in temperature in °C
1	0.1	5
2	0.2	10
3	0.3	12
4	0.4	20
5	0.5	25
6	0.6	30
7	0.7	35
8	0.8	35
9	0.9	35
10	1.0	35

Describe **and** explain the trends shown in the student's results.

(6)

Top tips for planning:

Describe - recall process of events

Explain - give reasons for something happening

Look at the table and see if you can find any similarities in there e.g. experiment 7 onwards shows the same temperature. Why is this? What is gradually happening to the temperature in each experiment? Why is this?

Sample Student Answer

AS THE CONCENTRATION OF COPPER SULFATE INCREASES, THE TEMPERATURE INCREASES. THIS IS BECAUSE THE RATE OF REACTION IS INCREASING AS THERE ARE MORE PARTICLES IN THE BEAKER. AS MORE COPPER SULFATE REACTS, MORE ENERGY IS GIVEN OUT AS HEAT ENERGY WHICH IS RECORDED.
AT EXPERIMENT 7 THE TEMPERATURE STOPS INCREASING. THIS SHOWS THAT THE REACTION IS COMPLETE. ADDING MORE COPPER SULFATE WILL NOT CHANGE THE RESULTS BECAUSE IT IS NOW IN EXCESS. NO MORE HEAT WILL BE GIVEN OFF.

Q1.

Level 3 (5-6 marks):
A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

Level 2 (3-4 marks):
Some logically linked reasons are given. There may also be a simple judgement.

Level 1 (1-2 marks):
Relevant points are made. They are not logically linked.

Level 0
No relevant content

Indicative content

comparative points
- both tables have more than one element in a box
- both have similar elements in the same column
- both are missing the noble gases
- both arranged elements in order of atomic weight

advantages of Mendeleev / disadvantages of Newlands
- Newlands did not leave gaps for undiscovered elements
- Newlands had many more dissimilar elements in a column
- Mendeleev left gaps for undiscovered elements
- Mendeleev changed the order of some elements (e.g. Te and I)

points which led to the acceptance of Mendeleev's table
- Mendeleev predicted properties of missing elements
- elements with properties predicted by Mendeleev were discovered
- Mendeleev's predictions turned out to be correct
- elements were discovered which fitted the gaps

6

Q2.

Level 2 (3-4 marks):
Scientifically relevant features are identified; the ways in which they are similar / different is made clear.

Level 1 (1-2 marks):
Relevant features are identified and differences noted.

Level 0
No relevant content.

Indicative content

similarities
- both have positive charges
- both have (negative) electrons
- neither has neutrons

differences

plum pudding model	**nuclear model**
ball of positive charge (spread throughout)	positive charge concentrated at the centre
electrons spread throughout (embedded in the ball of positive charge)	electrons outside the nucleus
no empty space in the atom	most of the atom is empty space
mass spread throughout	mass concentrated at the centre

4

Q3.

lithium (atom) loses (one) electron(s)

1

chlorine (atom) gains (one) electron(s)

1

reference to transfer of one electron

1

to form positive and negative ions

allow to form noble gas electronic structures
or
allow to form stable electron arrangements
or
allow to form full outer shells
or
allow reference to ionic bonding

1

Q4.

Level 3: Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

Structure and bonding
- giant structure / lattice
- of carbon atoms
- in layers
- of hexagonal rings
- covalent (bonds)
- strong (covalent) bonds
- where each (carbon) atom bonded to three other (carbon) atoms
- one electron on each atom is delocalised
- delocalised / free electrons

Explanation for conductivity
- delocalised / free electrons
- (which) carry charge through the structure
  or
- (which) move through the structure

Explanation for graphite being slippery
- layers free to slide over each other
- (because) no covalent bonds between layers
  or
  (because) only weak (intermolecular) forces between layers

Q5.

Level 3: The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- use magnesium oxide and sulfuric acid
- add sulfuric acid to a beaker
- warm sulfuric acid
- add magnesium oxide
- stir
- continue adding until magnesium oxide is in excess

- filter
- using a filter paper and funnel
- to remove excess magnesium oxide

- heat solution in an evaporating basin
- to crystallisation point
- leave to crystallise
- pat dry with filter paper

credit may be given for diagrams

[6]

Q6.

Level 3: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.

3–4

Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

Steps

- use a suitable container e.g. test tube
- use insulation
- add water
- measure the initial water temperature (with a thermometer)
- add stated mass e.g. 1g **or** 1 spatula
- stir (to dissolve the solid)
- measure the final (allow lowest or highest) temperature of the solution
- calculate the temperature difference **or** determine graphically
- repeat with different masses

- repeat with the same volume of water

to access level 3 there must be an indication of how the temperature change is determined using different masses dissolved in the same quantity of water

Q7.

Level 3: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

5–6

Level 2: Some logically linked reasons are given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. This is not logically linked.

1–2

No relevant content

0

Indicative content

reasons why fuel cells could be judged as better

from the table	from other knowledge
• time for refuelling a fuel cell is faster than recharging **or** a fuel cell does not need to be recharged • a fuel cell has a greater range	• hydrogen can be renewable if made by electrolysis using renewable energy • lithium-ion batteries can catch fire • produces only water **or** no pollutants produced • lithium-ion batteries may release toxic chemicals on disposal • lithium-ion batteries (eventually cannot be recharged so) have a finite life

reasons why the lithium-ion battery could be judged as better

from the table	from other knowledge
• lithium-ion uses energy more efficiently • cost of lithium-ion car much less • cost of recharging much less than refuelling with hydrogen	• hydrogen is often made from fossil fuels so is not renewable • charging points are more widely available than hydrogen filling stations

	• hydrogen takes up a lot of space **or** is difficult to store • hydrogen can be highly flammable / explosive • no emissions produced • (catalyst in the hydrogen fuel-cell eventually becomes poisoned so) have a finite life

[11]

Q8.

0 marks
No relevant content

Level 1 (1−2 marks)
There is a statement about the results.

Level 2 (3−4 marks)
There are statements about the results. These statements may be linked or may include data.

Level 3 (5−6 marks)
There are statements about the results with at least one link and an attempt at an explanation.

Examples of chemistry points made in the response:

Description:

Statements

Concentration of copper sulfate increases

Temperature change increases

There is an anomalous result

The temperature change levels off

Reaction is exothermic

Linked Statements

Temperature change increases as concentration of copper sulfate increases

The temperature change increases, and then remains constant

After experiment 7 the temperature change remains constant

Statements including data

The trend changes at experiment 7

Experiment 3 is anomalous

Attempted Explanation

Temperature change increases because rate increases

Temperature change levels off because the reaction is complete

Explanation

As more copper sulfate reacts, more heat energy is given off

Once copper sulfate is in excess, no further heat energy produced