**Y11 Combined Chemistry 1**

**PPE 2 - Higher**

**For each topic, there are questions in the Revision Guide that will help you choose what to revise. The page numbers you need are listed below.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Topic** | **Questions**Page Title  | **Support**Pages | **☺** | **😐** | **☹** |
| Development of the atomic model | 111 | Electronic Structure… | 103-106 |  |  |  |
| Group 7 | 111 | Groups of the Periodic Table | 107-110 |  |  |  |
| Ionic bonding | 122 | Ions and Ionic Compounds | 112-114 |  |  |  |
| Graphite | 122 | Covalent substances | 115-118 |  |  |  |
| Graphenes and fullerenes | 122 | 115-118 |  |  |  |
| Concentrations of solutions | 137 | Concentrations of Solutions | 128 |  |  |  |
| Use of amount of substance | 137 | Mole and Equations | 123-127 |  |  |  |
| Strong and weak acids | 137 | Acids and their Reactions | 129-131 |  |  |  |
| RPA – Making a salt | 137 | Acids and their Reactions | 131 |  |  |  |
| RPA – Energy Transfer | 141 | Exothermic and Endothermic Reactions | 139 |  |  |  |

**Exam Practice**

The following pages contain past exam questions that should attempt.

The grade for each question is indicated by:



Remember: to get Grade 7, 8 or 9 you still have to be able to answer the 4-5 questions!

**Models of the Atom**

**Q1.**

**Figure 1** shows two models of the atom.

**Figure 1**

****

(a)  Write the labels on **Figure 1**

Choose the answers from the box.

|  |  |  |
| --- | --- | --- |
| **atom** | **electron** | **nucleus** |
| **neutron** | **orbit** | **proton** |

**(4)**

(b)  Explain why the total positive charge in every atom of an element is always the same.

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**(2)**

(c)  The results from the alpha particle scattering experiment led to the nuclear model.

Alpha particles were fired at a thin film of gold at a speed of 7% of the speed of light.

Determine the speed of the alpha particles.

Speed of light = 300 000 000 m/s

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Speed = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s

**(2)**

(d)  **Figure 2** shows two atoms represented as solid spheres.

**Figure 2**

****

A hydrogen atom has a radius of 2.5 × 10−11 m

Determine the radius of a magnesium atom.

Use measurements from **Figure 2**

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Radius = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ m

**(2)**

**(Total 10 marks)**

**Group 7, The Halogens**

**Q2.**

This question is about the halogens.

(a)  Write the state symbol for chlorine at room temperature.

Cl2 (\_\_\_\_\_\_)

**(1)**

(b)  The diagram below represents one molecule of fluorine.

Complete the dot and cross diagram on the diagram above.

You should show only the electrons in the outer shells.



**(2)**

(c)  A fluorine atom can be represented as 

What is the total number of electrons in a fluorine molecule (F2)?

Tick **one** box.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 9 |  | 14 |  | 18 |  | 38 |  |

**(1)**

(d)  Aluminium reacts with bromine to produce aluminium bromide.

Complete the balanced chemical equation for this reaction.

\_\_\_\_\_\_Al + \_\_\_\_\_\_Br2 ⟶ 2\_\_\_\_\_\_\_\_\_\_

**(2)**

****(e)  When chlorine reacts with potassium bromide, chlorine displaces bromine.

Cl2 + 2 KBr ⟶ Br2 + 2 KCl

Explain why chlorine is more reactive than bromine.

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**(3)**

**(Total 9 marks)**

**Ionic Bonding
Q3.**

****This question is about fluorine.

(a)     **Figure 1** shows the arrangement of electrons in a fluorine atom.



(i)      In which group of the periodic table is fluorine?

Group \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(ii)     Complete the table below to show the particles in an atom and their relative masses.

|  |  |
| --- | --- |
| **Name of particle** | **Relative mass** |
| Proton |   |
| Neutron | 1 |
|   | Very small |

**(2)**

(iii)    Use the correct answer from the box to complete the sentence.

|  |  |  |
| --- | --- | --- |
| **alkalis** | **alloys** | **isotopes** |

Atoms of fluorine with different numbers of neutrons are

called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(b)     Sodium reacts with fluorine to produce sodium fluoride.

****(i)      Complete the word equation for this reaction.

sodium     +     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_     →     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

****(ii)     Complete the sentence.

Substances in which atoms of two or more different elements are chemically

combined are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(iii)    The relative formula mass (*M*r) of sodium fluoride is 42.

Use the correct answer from the box to complete the sentence.

|  |  |  |
| --- | --- | --- |
| **ion** | **mole** | **molecule** |

The relative formula mass (*M*r), in grams, of sodium fluoride is one

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the substance.

**(1)**

(iv)     **Figure 2** shows what happens to the electrons in the outer shells when a sodium atom reacts with a fluorine atom.

The dots (•) and crosses (×) represent electrons.



****Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when sodium reacts with fluorine to produce sodium fluoride.

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**(4)**

(v)     Sodium fluoride is an ionic substance.

What are **two** properties of ionic substances?

|  |  |
| --- | --- |
| Tick (✔) **two** boxes. |  |
| Dissolve in water |  |
| Gas at room temperature |  |
| High melting point |  |
| Low boiling point |  |

**(2)**

 **(Total 13 marks)**

**Graphite and Nanotubes**

**Q4.**

Carbon atoms are used to make nanotubes.



© Denis Nikolenko/Hemera/Thinkstock

Carbon atoms in a nanotube are bonded like a single layer of graphite.

The figure below shows the structure of a single layer of graphite.



© Evgeny Sergeev/iStock/Thinkstock

(a)     Suggest why carbon nanotubes are used as lubricants.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(b)     Explain why graphite can conduct electricity.

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**(2)**

**(Total 4 marks)**

**Graphene**

**Q5.**

Scientists have recently developed a method to produce large sheets of a substance called graphene.
Graphene is made from carbon and is a single layer of graphite just one atom thick.

|  |  |
| --- | --- |
| The properties of graphene include: |  |
| •    it conducts electricity |
| •    it is transparent since it is only one atom thick |
| •    it is strong and durable. |
| These properties make it suitable to overlay a monitor screen to make it a touchscreen. |

The photograph below shows the structure of graphene.



                                                   Photographs supplied by iStockphoto/Thinkstock

Use your knowledge of the bonding in graphite and the photograph of the structure to help you to explain, as fully as you can:

(a)     (i)      why graphene is strong;

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(3)**

(ii)     why graphene conducts electricity.

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**(2)**

(b)     Suggest why a sheet of graphite which has a large number of carbon layers would not be suitable for the touchscreen.

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**(1)**

**(Total 6 marks)**

**Concentration**

**Q6.**

**Figure 1** shows a reactor used to produce titanium from titanium(IV) chloride.

**Figure 1**

****

The chemical equation for the reaction of titanium(IV) chloride with sodium is:

          TiCl4                    +        4Na                     Ti           +           4NaCl

titanium(IV) chloride      +      sodium             titanium      +      sodium chloride

(a)     For one reaction:

•      1615 kg titanium(IV) chloride reacted completely with 782 kg sodium

•      1989 kg sodium chloride was produced.

Calculate the mass of titanium produced from this reaction.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Mass of titanium = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kg

**(1)**

(b)     The table below shows the solubility of sodium chloride in 100 cm3 of aqueous solution at different temperatures.

|  |  |
| --- | --- |
| **Solubility of sodium chloride in g per 100cm3** | **Temperature in °C** |
| 35.72 | 10 |
| 35.89 | 20 |
| 36.09 | 30 |
| 37.37 | 40 |
| 36.69 | 50 |
| 37.04 | 60 |

On **Figure 2**:

•      plot this data on the grid

•      draw a line of best fit.

**Figure 2**

****

**(3)**

(c)     The product sodium chloride is dissolved in water to separate it from titanium.

At 30 °C the solubility of sodium chloride is 36 kg per 100 dm3.

Calculate the minimum volume of water in dm3, at 30 °C, needed to dissolve 1989 kg sodium chloride.

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Volume of water = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ dm3

**(2)**

****(d)     Calculate the percentage by mass of titanium in titanium(IV) chloride (TiCl4).

Give your answer to 3 significant figures.

Relative atomic masses (*A*r): Cl = 35.5; Ti = 48

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Percentage of titanium by mass = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ %

**(3)**

(e)     Suggest why the reaction is done in an atmosphere of dry argon instead of air containing water vapour.

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**(3)**

(f)     Explain why titanium conducts electricity.

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**(3)**

 **(Total 15 marks)**

**Amount of Substance (Moles)**

**Q7.**

This question is about iron.

Iron reacts with dilute hydrochloric acid to produce iron chloride solution and one other product.

(a)  Name the other product.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(b)  Suggest how any unreacted iron can be separated from the mixture.

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**(1)**

Magnesium reacts with iron chloride solution.

****3 Mg + 2 FeCl3 ⟶ 2 Fe + 3 MgCl2

(c)  0.120 g of magnesium reacts with excess iron chloride solution.

Relative atomic masses (*A*r): Mg = 24 Fe = 56

Calculate the mass of iron produced, in mg

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Mass of iron = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mg

**(5)**

(d)  Explain which species is reduced in the reaction between magnesium and iron chloride.

3 Mg + 2 FeCl3 ⟶ 2 Fe + 3 MgCl2

Your answer should include the half equation for the reduction.

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**(3)**

**(Total 10 marks)**

**Strong and Weak Acids**

**Q8.**

Hydrogen chloride (HCl) is a gas.

(a)     Complete the diagram to show all of the arrangement of the outer shell electrons of the hydrogen and chlorine atoms in hydrogen chloride.



**(1)**

****(b)     Hydrochloric acid is a strong acid.

Ethanoic acid is a weak acid.

Describe a reaction that could be used to show the difference between a weak acid and a strong acid.

You should explain why the weak acid and the strong acid give different results.

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**(6)**

**(Total 7 marks)**

**RPA: Making a Salt**

**Q9.**

A student plans a method to prepare pure crystals of copper sulfate.

The student’s method is:

1.   Add one spatula of calcium carbonate to dilute hydrochloric acid in a beaker.

2.   When the fizzing stops, heat the solution with a Bunsen burner until all the liquid is gone.

The method contains several errors and does not produce copper sulfate crystals.

Explain the improvements the student should make to the method so that pure crystals of copper sulfate are produced.

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**(Total 6 marks)**

**RPA: Energy Transfers**

**Q10.**

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:

•        measured 50 cm3 copper sulfate solution into a glass beaker

•        measured the temperature of the copper sulfate solution

•        added 2.3 g zinc

•        measured the highest temperature

•        repeated the experiment using copper sulfate solution with different concentrations.

The equation for the reaction is:

Zn(s)     +                 CuSO4(aq)                    Cu(s)       +              ZnSO4(aq)

zinc       +      copper sulfate solution        copper      +    zinc sulfate solution

(a)     The thermometer reading changes during the reaction.

Give **one** other change the student could **see** during the reaction.

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**(1)**

(b)     Suggest **one** improvement the student could make to the apparatus.

Give a reason why this improves the investigation.

Improvement \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Reason \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(c)     **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

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

|  |  |  |
| --- | --- | --- |
| **Experiment number** | **Concentration ofcopper sulfatein moles per dm3** | **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.

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**(6)**

**(Total 9 marks)**

Mark schemes

**Q1.**

(a)  electron

**1**

atom

**1**

nucleus

**1**

orbit

**1**

(b)  positive charge is provided by protons

**1**

(every atom of the same element contain the) same number of protons

*do* ***not*** *accept same number of protons and neutrons*

*ignore reference to electrons*

**1**

(c)  

*allow any correct method of determining 7% of 300 000 000*

**1**

v = 21 000 000 (m/s)

*allow 2.1 × 107 (m/s)*

**1**

*an answer of 21 000 000 scores* ***2*** *marks*

(d)  r = 6 × 2.5 × 10−11

*allow a ratio in the range of 5.7−6.3 or measurements that would give this range, correctly substituted*

**1**

r = 1.5 × 10−10 (m)

*allow 1.4 × 10−10 to 1.6 × 10−10*

*their ratio × 2.5 × 10−11 correctly calculated scores* ***1*** *mark*

**1**

*an answer in the range 1.4 × 10−10 to 1.6 × 10−10 scores* ***2*** *marks*

**[10]**

**Q2.**

(a)  g

*do* ***not*** *accept upper case (G)*

*do* ***not*** *accept gas*

**1**

(b)



*one shared pair anywhere in overlap between two circles* ***or*** *on intersection*

**1**

*6 other electrons on each atom*

**1**

*allow dots* ***or*** *crosses* ***or*** *mixture for all marks*

*ignore any inner shell electrons*

(c)  18

**1**

(d)  AlBr3

**1**

**2** Al + 3 Br2 (⟶ 2 AlBr2)

**1**

*allow* ***1*** *mark for balancing their equation with an incorrect product*

(e)  chlorine is a smaller atom

**or** has fewer energy levels

**or** outer shell closer to nucleus

*ignore chlorine has fewer electrons*

**1**

chlorine has less shielding

**or**

has the greater attraction between the nucleus and the outer shell **or** incoming electron

**1**

therefore chlorine can gain an electron (into the outer shell) more easily

**1**

*if no other marks awarded allow* ***1*** *mark for correct trend in reactivity in Group 7*

*do* ***not*** *accept reference to incorrect particles e.g. chloride atom*

***max 2*** *if outer shell / level not mentioned*

*‘it’ refers to chlorine*

*allow converse reasons for bromine being less reactive*

**[9]**

**Q3.**

(a)     (i)      7 / seven

**1**

(ii)     1

*do* ***not*** *accept –1*

**1**

Electron

**1**

(iii)     isotopes

**1**

(b)     (i)      (sodium + ) fluorine → sodium fluoride

**1**

(ii)     compounds

**1**

(iii)     mole

**1**

(iv)     sodium (atom) loses

**1**

fluorine (atom) gains

**1**

one electron

**1**

ions formed

**1**

*allow sodium forms positive (ion)* ***or*** *fluorine forms negative (ion)*

*allow form ionic bond*

*allow to gain a full outer shell of electrons*

*allow forms noble gas structure*

***max 3*** *if reference to incorrect particle / bonding*

(v)     Dissolve in water

**1**

High melting point

**1**

**[13]**

**Q4.**

(a)     nanotubes can slide (over each other)

*allow nanotubes can roll (over each other)*

**1**

because no (covalent) bonds between the nanotubes

*accept weak forces between the nanotubes* ***or*** *weak intermolecular forces*

*allow layers for nanotubes throughout*

**1**

(b)     delocalised electrons

*accept free electrons*

**1**

*so (delocalised) electrons* can move through the graphite

*accept so (delocalised) electrons can carry charge through the graphite*

**1**

**[4]**

**Q5.**

(a)      (i)     *ionic / molecules / metallic / (inter)molecular = max* ***2***

because graphene / it has a giant structure / lattice / macromolecular

*accept all / every / each atom is bonded to 3 other atoms*

**1**

because graphene / it has covalent bonds / is covalent

**1**

because in graphene / the bonds are strong **or**a lot of energy needed / hard to break the bonds

**1**

(ii)     there are delocalised / free electrons

**1**

because one (delocalised / free) electron per atom linked to first marking point

*accept because three electrons per atom used (in bonding)*

*accept because one electron per atom not used (in bonding)*

**1**

(b)     opaque (owtte)

*eg could not see through them*

**or** layers slide
**or** layers not aligned

*ignore thick*

**1**

**[6]**

**Q6.**

(a)     408 kg

**1**

(b)     all points correct

*± ½ small square*

**2**

*allow* ***1*** *mark if 5 points correct*

best fit line

**1**

(c)    

**1**

5525 dm3

**1**

(d)     relative formula mass of TiCl4 is 190

**1**

25.26 %

**1**

Answer given to 3 significant figures = 25.3 %

**1**

*25.23% with or without working gains* ***3*** *marks*

(e)     argon is unreactive

**1**

water (vapour) would react with sodium

*allow water (vapour) would react with titanium(IV) chloride*

**1**

and air contains oxygen that would react with reactants

*allow and air contains oxygen that would react with products*

**1**

(f)     (titanium conducts electricity) because electrons in the outer shell of the metal atoms are delocalised

**1**

and so electrons are free to move

*allow the delocalised electrons in the metal carry electrical charge through the metal*

**1**

through the whole structure

**1**

**[15]**

**Q7.**

(a)  hydrogen **or** H2

*allow hydrogen gas*

*ignore H without the 2 subscript*

**1**

(b)  filtration / filter

*allow magnet* ***or*** *decant*

*ignore heating*

**1**

(c)  

*mark is for ÷ by 24*

**1**

****



**1**

(mass Fe) = 0.00333 × 56

*mark is for × 56*

**1**

= 0.1866 (g)

**1**

= 187 (mg)

**1**

*an answer of 280 (mg) scores* ***4*** *marks*

*an answer of 0.280 scores* ***3*** *marks (no ratio from equation)*

*184 scores* ***0*** *[= (3 × 24) + (2 × 56)]*

**OR**

****

(mass of Fe) = 0.00166



= 0.1866 (g) (1)

187 (mg) (1)

**OR**

72 g Mg ⟶ 112g Fe (1)



= 0.1866 (g) (1)

= 187 (mg) (1)

*an answer of 185−190 (mg) scores* ***5*** *marks*

*an answer of 0.185−0.19 scores* ***4*** *marks*

(d)  Fe3+

**1**

(because) reduction is gain of electrons

*allow change in oxidation state / (+)3 to 0*

**1**

Fe3+ + 3e(−) ⟶ Fe

**1**

**[10]**

**Q8.**

(a)     bonded pair of electrons and

6 non-bonded electrons on chlorine

**1**

(b)     **Level 3 (5–6 marks):**

A detailed and coherent explanation of comparative results of a reaction in terms of concentration and ionisation. The response makes logical links between the points
raised and uses sufficient examples to support these links.

**Level 2 (3–4 marks):**

A description of a reaction with results is given but may miss some details. Links are made but may not be fully articulated and / or precise.

**Level 1 (1–2 marks):**

Simple statements are made. The response may fail to make logical links between the points raised.

**0 marks:**

No relevant content

**Indicative content**

Simple statements / descriptions of a reaction

•        correct comparative pH, such as, 0–3 (strong) 4–6 (weak)

•        named reaction, such as, with a reactive metal or a named carbonate

•        comparative results or observations of the named reaction, such as, faster reaction (strong) or greater volume of gas produced in a given time (strong)

Explanations of different results

•        weak acids are only partially ionised in aqueous solution

•        strong acids are completely ionised in aqueous solution / greater
concentration of H+ ions

•        aqueous solutions of acids at the same concentration / same state of division
of metal / powder, same temperature

**6**

**[7]**

**Q9.**

**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**

•   uses sulfuric acid not hydrochloric acid

    **or** sulfuric acid needed

•   uses copper carbonate / oxide not calcium carbonate

    **or** copper carbonate / oxide needed

•   add solid until solid remains **or** is in excess **or** no more reacts / dissolves

    so that most / all of the acid reacts

•   filter

    to remove excess **or** unreacted carbonate / oxide / solid

•   heat gently **or** partially evaporate **or** leave

    until crystals appear **or** to crystallise

for **level 3** the correct chemicals must have been selected

**[6]**

**Q10.**

(a)     any **one** from:

•        solution becomes colourless or colour fades

•        zinc becomes bronze / copper coloured

*allow copper (forms) or a solid (forms)*

•        zinc gets smaller

*allow zinc dissolves*

•        bubbles or fizzing.

*ignore precipitate*

**1**

(b)     improvement:

use a plastic / polystyrene cup or add a lid

*accept use lagging / insulation*

**1**

reason - must be linked

reduce / stop heat loss

**OR**

improvement:

use a digital thermometer

*allow use a data logger*

reason - must be linked

more accurate or easy to read or stores data

*allow more precise or more sensitive*

*ignore more reliable*

*ignore improvements to method, eg take more readings*

**1**

(c)     Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a ‘best–fit’ approach to the marking.

**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

**6**

**[9]**