Exampro GCSE Chemistry

C2 Chapter 3 Higher

Name:

Class:

Author:

Date:

Time: 75

Marks: 75

Comments:

Q1. The label shows the ingredients in a drink called Cola.

Cola

Ingredients:

Carbonated water
Sugar
Colouring
Phosphoric acid
Flavouring
Caffeine

(a) (i) The pH of carbonated water is 4.5.

The pH of Cola is 2.9.

Name the ingredient on the label that lowers the pH of Cola to 2.9.

.....

(1)

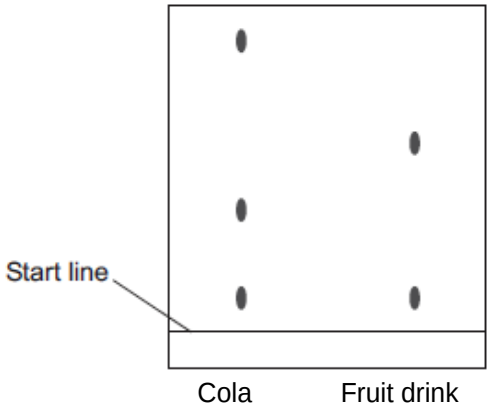
(ii) Which ion causes the pH to be 2.9?

.....

(1)

(b) A student investigated the food colouring in Cola and in a fruit drink using paper chromatography.

The chromatogram in the figure below shows the student's results.



(i) Complete the sentence.

The start line should be drawn with a ruler and ..... .

Give a reason for your answer.

.....

.....

(2)

(ii) Suggest **three** conclusions you can make from the student's results.

.....

.....

.....

.....

.....

.....

(3)

(c) Caffeine can be separated from the other compounds in the drink by gas chromatography.

Why do different compounds separate in a gas chromatography column?

.....

.....

(1)

(d) Caffeine is a stimulant.

Large amounts of caffeine can be harmful.

(i) Only **one** of the questions in the table **can** be answered by science alone.

Tick (✓) **one** question.

Question	**Tick** (✓)
Should caffeine be an ingredient in drinks?	
Is there caffeine in a certain brand of drink?	
How much caffeine should people drink?	

(1)

(ii) Give **two** reasons why the other questions **cannot** be answered by science alone.

Reason 1 .....

.....

Reason 2 .....

.....

(2)

(Total 11 marks)

Q2. Some students investigated magnesium oxide.

(a) Magnesium oxide has the formula MgO.

(i) Calculate the relative formula mass (M_r) of magnesium oxide.

Relative atomic masses: O = 16; Mg = 24.

.....

.....

Relative formula mass = ...

(2)

(ii) Calculate the percentage by mass of magnesium in magnesium oxide.

.....

.....

Percentage by mass of magnesium in magnesium oxide = ...%

(2)

(iii) Calculate the mass of magnesium needed to make 25 g of magnesium oxide.

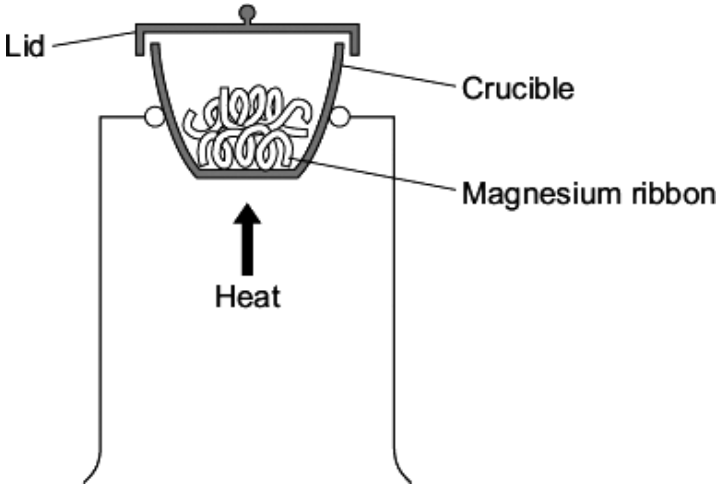
.....

Mass of magnesium = ... g

(1)

(b) The students calculated that if they used 0.12 g of magnesium they should make 0.20 g of magnesium oxide.

They did this experiment to find out if this was correct.



- The students weighed 0.12 g of magnesium ribbon into a crucible.
- They heated the magnesium ribbon.
- They lifted the lid of the crucible slightly from time to time to allow air into the crucible.
- The students tried to avoid lifting the lid too much in case some of the magnesium oxide escaped.
- When all of the magnesium appeared to have reacted, the students weighed the magnesium oxide produced.

The results of the experiment are shown below.

Mass of magnesium used in grams	0.12
Mass of magnesium oxide produced in grams	0.18

(i) The mass of magnesium oxide produced was lower than the students had calculated.
They thought that this was caused by experimental error.

Suggest **two** experimental errors that the students had made.

.....

.....

.....

.....

(2)

(ii) The students only did the experiment once.

Give **two** reasons why they should have repeated the experiment.

.....

.....

.....

.....

(2)

(Total 9 marks)

Q3. (a) The table gives information about two isotopes of hydrogen, hydrogen-1 and hydrogen-2.

	Hydrogen-1	**Hydrogen-2**
Atomic number	1	1
Mass number	1	2

An atom of hydrogen-1 is represented as: $^{1}_{1}\mathrm{H}$

Show how an atom of hydrogen-2 is represented.

(1)

(b) (i) Calculate the relative formula mass (M_r) of water, H_2O

Relative atomic masses: H = 1; O = 16.

.....

.....

Relative formula mass (M_r) = ...

(1)

(ii) Simple molecules like water have low boiling points.

Explain why, in terms of molecules.

.....

.....

.....

.....

(2)

(c) Molecules of heavy water contain two atoms of hydrogen-2 instead of two atoms of hydrogen-1.

Explain why a molecule of heavy water has more mass than a normal water molecule. You should refer to the particles in the nucleus of the two different hydrogen atoms in your answer.

.....

.....

.....

.....

.....

(2)
(Total 6 marks)

Q4. Iron is an essential part of the human diet. Iron(II) sulfate is sometimes added to white bread flour to provide some of the iron in a person's diet.

(a) The formula of iron(II) sulfate is $FeSO_4$

Calculate the relative formula mass (M_r) of $FeSO_4$

Relative atomic masses: O = 16; S = 32; Fe = 56.

.....

.....

The relative formula mass (M_r) = ...

(2)

(b) What is the mass of one mole of iron(II) sulfate? Remember to give the unit.

.....

(1)

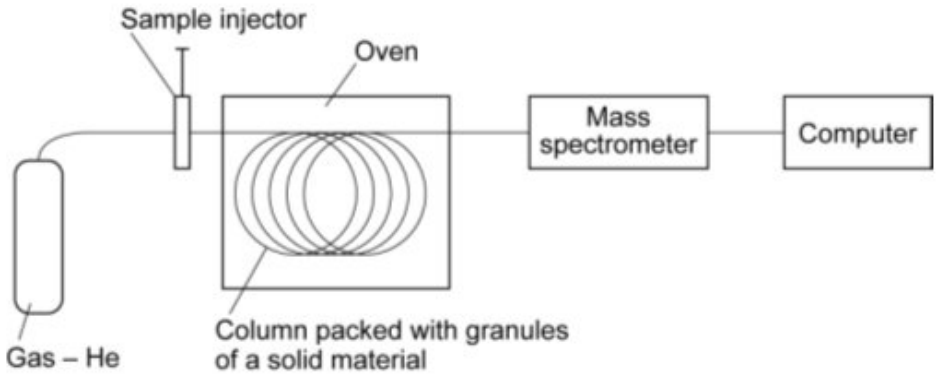
(c) What mass of iron(II) sulfate would be needed to provide 28 grams of iron?

Remember to give the unit.

.....

(1)
(Total 4 marks)

Q5. The diagram shows the main parts of an instrumental method called gas chromatography linked to mass spectroscopy (GC-MS).



This method separates a mixture of compounds and then helps to identify each of the compounds in the mixture.

(a) In which part of the apparatus:

(i) is the mixture separated? .....

(1)

(ii) is the relative molecular mass of each of the compounds in the mixture measured?

.....

(1)

(b) (i) Athletes sometimes take drugs because the drugs improve their performance. One of these drugs is ephedrine.

Ephedrine has the formula:

$$C_{10}H_{15}NO$$

What relative molecular mass (M_r) would be recorded by GC-MS if ephedrine was present in a blood sample taken from an athlete?

Show clearly how you work out your answer.

Relative atomic masses: H = 1; C = 12; N = 14; O = 16.

.....

.....

.....

.....

Relative molecular mass = ...

(2)

(ii) Another drug is amphetamine which has the formula:

$$C_9H_{13}N$$

The relative molecular mass (M_r) of amphetamine is 135.

Calculate the percentage by mass of nitrogen in amphetamine.

Relative atomic mass: N = 14

.....

.....

Percentage of nitrogen = ... %

(2)

(c) Athletes are regularly tested for drugs at international athletics events.

An instrumental method such as GC-MS is better than methods such as titration.

Suggest **two** reasons why.

.....

.....

.....

.....

(2)

(d) When a blood sample is taken from an athlete the sample is often split into two portions. Each portion is tested at a different laboratory.

Suggest why.

.....

.....

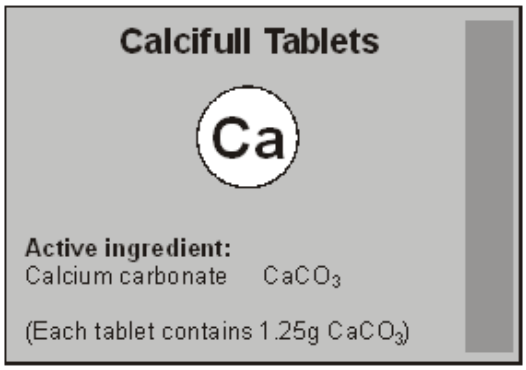
.....

.....

(2)

(Total 10 marks)

Q6. Calcium carbonate tablets are used to treat people with calcium deficiency.



(a) Calculate the relative formula mass (M_r) of calcium carbonate.

Relative atomic masses: C = 12; O = 16; Ca = 40.

.....

.....

Relative formula mass = ...

(2)

(b) Calculate the percentage of calcium in calcium carbonate, $CaCO_3$.

.....

.....

Percentage of calcium = ... %

(2)

(c) Calculate the mass of calcium in each tablet.

.....

.....

Mass of calcium = ... g

(2)

(d) An unwanted side effect of this medicine is that it can cause the patient to have 'wind' (too much gas in the intestine).

The equation below represents the reaction between calcium carbonate and hydrochloric acid (the acid present in the stomach).

$$CaCO_3\ (s) + 2HCl\ (aq) \rightarrow CaCl_2\ (aq) + H_2O\ (l) + CO_2\ (g)$$

Suggest why the patient may suffer from 'wind'.

.....

.....

(1)

(Total 7 marks)

Q7. The two carbon atoms represented below are isotopes.

ISOTOPE 1		ISOTOPE 2
14 C	← mass number →	12 C
6	← proton number →	6

(a) Describe **two** ways in which the isotopes are similar.

.....

.....

(2)

(b) Describe as fully as you can **one** way in which they are different.

.....

.....

.....

(2)

(Total 4 marks)

Q8. The information on the Data Sheet will be helpful in answering this question.

(a) Calculate the formula mass (M_r) of the compound iron (III) oxide, Fe_2O_3.

(Show your working.)

.....

.....

.....

.....

.....

(3)

(b) Calculate the mass of iron produced when 32g of iron (III) oxide is completely reduced by aluminium.

The reaction is shown in the symbol equation:

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$$

(Show your working.)

.....

.....

.....

.....

Answer = ... grams

(3)

(Total 6 marks)

Q9. The picture shows a painting which was painted in a cave in France about 17 000 years ago.

By Carla Hufstedler [CC-BY-SA-2.0], via Wikimedia Commons

One of the pigments in this painting contains:

70 % of iron (Fe) and 30 % of oxygen (O)

Calculate the simplest (empirical) formula of this substance.

Relative atomic masses: O = 16; Fe = 56.

.....

.....

.....

.....

.....

.....

.....

.....

(4)
(Total 4 marks)

Q10. Lead compounds have been used for thousands of years as colours in paint.

Johannes Vermeer [Public domain], via Wikimedia Commons

(a) A sample of a red oxide used in paint was found to contain 6.21 g of lead and 0.64 g of oxygen.

Calculate the empirical (simplest) formula of this compound.

You **must** show all your working to gain full marks.

Relative atomic masses: O = 16; Pb = 207.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

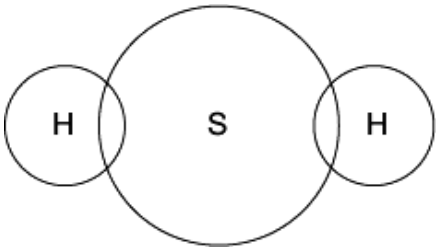
(4)

(b) A problem with lead compounds is that they slowly react with hydrogen sulfide in the air. This produces lead sulfide which is black.

(i) Hydrogen sulfide has the formula H_2S. The bonding in a molecule of hydrogen sulfide can be represented as:

H–S–H

Complete the diagram below to show the arrangement of the outer electrons of the hydrogen and sulfur atoms in hydrogen sulfide.
Use dots (●) and crosses (x) to represent the electrons.
You need only show the outer shell electrons.
(Atomic numbers: H = 1; S = 16.)



(1)

(ii) Hydrogen sulfide has a low boiling point.

Explain why.

.....

.....

.....

.....

(2)

(iii) Lead white is also used in paint. The white colour slowly darkens when lead sulfide is produced.

The painting can be restored with hydrogen peroxide. This converts the black lead sulfide into white lead sulfate.

Balance the equation for the reaction between lead sulfide and hydrogen peroxide (H_2O_2).

$$PbS(s) + ...H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$$

(1)
(Total 8 marks)

Q11. Aspirin tablets have important medical uses.

(a) Aspirin is made when salicylic acid reacts with ethanoic anhydride.

The equation for this reaction is:

$$\underset{\text{salicylic acid}}{C_7H_6O_3} + C_4H_6O_3 \rightarrow \underset{\text{aspirin}}{C_9H_8O_4} + CH_3COOH$$

Calculate the maximum mass of aspirin that could be made from 100 g of salicylic acid.

Show clearly how you work out your answer.

The relative formula mass (M_r) of salicylic acid ($C_7H_6O_3$) is 138.
The relative formula mass (M_r) of aspirin ($C_9H_8O_4$) is 180.

.....

.....

.....

.....

Maximum mass of aspirin = ... g

(2)

(b) (i) In an experiment a chemist calculated that the maximum yield of aspirin is 400 g.

The chemist did the experiment but only made 250 g of aspirin.

Calculate the percentage yield of aspirin for this experiment.

Show clearly how you work out your answer.

.....

.....

.....

.....

Percentage yield of aspirin = ... %

(2)

(ii) Suggest **one** possible reason why the chemist did **not** have a percentage yield of 100%.

.....

.....

(1)

(c) The use of a catalyst might reduce costs in the industrial production of aspirin.

Suggest how.

.....

.....

(1)
(Total 6 marks)

M1. (a) (i) (phosphoric) acid

allow phosphoric

1

(ii) H^+ / hydrogen (ion)

if ion symbol given, charge must be correct

1

(b) (i) pencil

1

so it will not run / smudge / *dissolve*

ignore pencil will not interfere with / affect the results

or

because ink would run / smudge / *dissolve*

ignore ink will interfere with / affect the results

1

(ii) any **three** from:

*reference to spots / dots = max **2***

allow colouring for colour

- *3* colours in Cola

*allow more colours in cola **or** fewer colours in fruit drink*

- *2* colours in Fruit drink
- one of the colours is the same
- two of the colours in Cola are different
- one of the colours in Fruit drink is different

allow some of the colours in the drinks are different

- *one of the colours in Cola is the most soluble*

accept one of the colours in Cola has the highest R_f value

3

(c) different substances travel at different speeds **or** have different retention times

accept different attraction to solid

ignore properties of compounds

1

(d) (i) Is there caffeine in a certain brand of drink?

1

(ii) any **two** from:

- cannot be done by experiment
- based on opinion / *lifestyle choice*
- ethical, *social* or economic issue

accept caffeine has different effects on different people

2

[11]

M2. (a) (i) 40

*correct answer with or without working **or** incorrect working*
*if the answer is incorrect then evidence of 24 + 16 gains **1** mark*
ignore units

2

(ii) 60

*correct answer with **or** without working or incorrect working*
*if the answer is incorrect then evidence of 24/40 **or** 24/(i) gains **1** mark*
ecf allowed from part(i)
ie 24/(i) ×100
ignore units

2

(iii) 15

ecf allowed from parts(i) and (ii)
24/(i) × 25 or (ii)/100 × 25
ignore units

1

(b) (i) any **two** from:

ignore gas is lost

- error in weighing <u>magnesium</u> / <u>magnesium oxide</u>
  allow some magnesium oxide left in crucible
- loss of magnesium oxide / magnesium
  allow they lifted the lid <u>too much</u>
  allow loss of reactants / products
- not all of the magnesium has reacted
  allow not heated enough
  allow not enough oxygen / air

2

(ii) any **two** from:

ignore fair test

- check that the result is not anomalous
- to calculate a mean / average
  allow improve the accuracy of the mean / average
- improve the reliability
  allow make it reliable
- <u>reduce</u> the effect of errors

2

[9]

M3. (a)

2 and 1 must be on the left

2 must be above half-way on the H and the 1 below half-way

accept diagram with 2 <u>different</u> particles in centre and 1 particle on circle

1

(b) (i) 18

ignore working

ignore units

1

(ii) forces (of attraction) between molecules **or**
bonding between molecules **or**
intermolecular forces /intermolecular bonds

1

are weak **or** not much energy needed to break them **or** easily overcome

must be linked to first mark

*if no other mark awarded allow <u>small</u> molecules / small M_r for **1** mark*

*allow forces / bonds are weak for **1** mark*

*do **not** allow covalent bonding is weak*

1

(c) *any reference to <u>more</u> protons = **0** marks*

H-2 atoms have 1 proton and 1 neutron

*allow H-2 has more neutrons / particles for **1** mark*

1

H-1 atoms have one proton

*allow H-2 has two particles and H-1 has one particle for **1** mark*

or

H-2 atom has one neutron (1)

*allow H-2 atom has one more neutron for **2** marks*

H-1 atom has no neutrons (1)

***NB** heavy water (molecule) has 2 <u>more</u> neutrons = **2** marks*

*heavy water (molecule) has <u>more</u> neutrons / particles = **1** mark*

*if no other mark awarded then heavy water molecule has **M_r** of 20 = **1** mark*

ignore reference to electrons

1

[6]

M4. (a) 152 correct answer with **or** without working = **2 marks**
56 + 32 + (4 ×16) gains **1** mark
ignore any units

2

(b) 152g(rams)
ecf from the answer to (a) and g
must have unit g / gram / gramme / grams etc
*accept g / mol **or** g per mole **or** g mole^{-1} **or** g/mol **or** g per mol **or** g mol^{-1}*
*do **not** accept g m*
*do **not** accept G*

1

(c) 76(g)
ecf from their answer to (a) or (b) divided by 2
ignore units

1

[4]

M5. (a) (i) column

1

(ii) mass spectrometer

1

(b) (i) 165
*if answer is not correct then evidence of correct working gains **one** mark.*
e.g. (10 × 12) + 15 + 14 + 16

2

(ii) 10.37%
accept 10 / 10.4 / 10.37.....
*if answer is not correct then evidence of correct working gains **one** mark.*
e.g. minimum evidence would be 14/135

2

(c) any **two** from:

- faster
- more accurate
- detects smaller amounts

2

(d) to avoid bias

accept to check / compare the result

1

to improve reliability

1

[10]

M6. (a) 100

ignore units

*40 + 12 + (3 × 16) for **1** mark*

1

(b) 40

*(**ecf** from part (a) can get **2** marks)*

$\frac{40}{\text{their (a)}} \times 100$ *for **1** mark*

1

(c) 0.5

*(**ecf** from part (b) can get **2** marks)*

$1.25 \times \left(\frac{\text{their (b)}}{100}\right)$ ***or** other correct working for **1** mark*

2

(d) gas produced **or** carbon dioxide / CO_2 produced

1

[7]

M7. (a) same number/six electrons;
same number/six protons;
react in same way **not** same element or both carbon

any two for 1 mark each

2

(b) different number of neutrons

gains 1 mark

but **or**

$^{14}_{6}C$ has two more neutrons different mass number

gains 1 mark

or

but two mass units bigger

gains 2 marks

$^{14}_{6}C$ has 8 neutrons while $^{12}_{6}C$ has 6 neutrons

gains 2 marks

2

[4]

##

(a) Fe_2 [56 × 2] **or** 112

O_3 [16 × 3] **or** 48

each gain 1 mark

but M_r = 160

gains 3 marks

3

(b) [$Fe_2O_3 + 2A1 \rightarrow 2Fe + A1_2O_3$]

160 → 112 (NB Credit if unworked
(or value (or value but should be totalled)
from (a)) from (a))

gains 1 mark

but
32 g. of Fe_2O_3 → 32/160 × 112

gains 2 marks

but = 22.4

gains 3 marks

3

[6]

M9. 70/56 30/16

division by atomic mass

1

= 1.25 = 1.875

proportion

1

2 3

ratio (accept 1:1.5 / 4:6 / etc)
allow e.c.f from proportion if sensible attempt at step 1

1

Fe_2O_3

formula allow e.c.f from ratio if sensible attempt at step 1
*allow correct formula with no working = **1** mark*

1

[4]

M10. (a)

$\frac{6.21}{207}$ $\frac{0.64}{16}$

***1** mark for dividing mass by A_r*
*max **2** if A_r divided by mass*

1

= 0.03 = 0.04

***1** mark for correct proportions*

1

3 4

***1** mark for correct whole number ratio (allow multiples) can be awarded from correct formula*

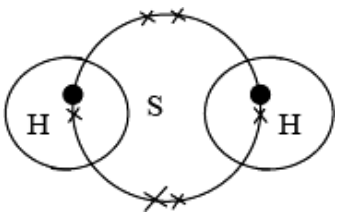
1

Pb_3O_4

***1** mark for correct formula*
ecf** allowed from **step 2 to step 3** and **step 3 to step 4** if sensible attempt at **step 1
*correct formula with no working gains **2** marks*

1

(b) (i)



*allow all dots **or** all crosses **or** e **or** e^-*
ignore inner shells and any inner electrons
allow 4 non-bonded electrons anywhere on shell as long as not in overlap – need not be paired

1

(ii) forces of attraction / bonds between molecules are weak (owtte)

*do **not** accept intramolecular forces / covalent bonds are weak*

*do **not** accept reference to ions*

or

intermolecular forces / bonds are weak (owtte)

or

it is made of small molecules with weak forces of attraction

*if **2** marks not awarded*

*made of small molecules / simple molecular gains **1** mark*

*forces of attraction are weak (without specifying between molecules / intermolecular) gains **1** mark*

(accept easily broken / not much energy needed to break instead of weak)

bonds are weak without specifying intermolecular would not gain a mark and would be ignored

2

(iii) 4

1

[8]

M11. (a) 130.4

accept 130 to 130.43478……

correct answer gains two marks with or without working

*an answer of 131 would gain **one** mark.*

if answer is not correct then:
moles of salicylic acid = 0.7 ..... (1 mark)
or
mass of aspirin = moles of salicylic acid x 180 (1 mark)
or
100 x (180/138) (1 mark)

2

(b) (i) 62.5%

accept 63%

correct answer gains two marks with or without working

if answer is not correct then:

250/400 x 100 (1 mark)

2

(ii) any **one** from:

- reversible reaction
  accept not all of the reactant converted to product
- some of product lost

1

(c) use lower temperatures
or
less energy needed

allow product made faster or more product made in a given time

1

[6]