

5.1 Atomic structure and the periodic table

Trilogy Higher Topic Test Markscheme

Mark scheme 01

26

1

30

1

26

1

Must be in this order

[3 marks]

Mark scheme 02

$$\frac{(203 \times 30) + (205 \times 70)}{100}$$

or

$$\frac{6090 + 14\,350}{100}$$

1

= 204.4

Ignore units

1

[2 marks]

Mark scheme 03.1

Any **one** from:

- So elements / iodine / tellurium were in groups with similar properties
- Iodine has similar properties to Br / Cl / F / Group 7
Allow corresponding argument in terms of tellurium
- Iodine has different properties to Se / S / O / Group 6
Allow corresponding argument in terms of tellurium
Ignore reference to atomic structure
Ignore references to Cr, Mn and Mo

[1 mark]

Mark scheme
03.2

Mendeleev had predicted properties of missing elements

1

Elements were discovered (that filled the spaces / gaps)

1

Properties (of these elements) matched Mendeleev's predictions

Allow atomic weights (of these elements) fitted in the spaces / gaps

1

*If no other mark awarded, allow **1** mark for in previous versions of the periodic table the pattern of similar properties broke down*

Ignore reference to atomic structure

[3 marks]

Mark scheme
03.3

C. Relative atomic mass

[1 mark]

Mark scheme
03.4

(Increasing) atomic / proton number

Ignore (increasing) electron number

*Do **not** accept relative atomic / proton number*

[1 mark]

Mark scheme
03.5

Any **two** from:

- Flame

Allow burns

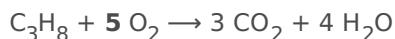
- (White) solid forms

Allow (white) smoke forms

- Colour of gas / chlorine disappears / fades

[2 marks]

Mark scheme 04



Allow multiples

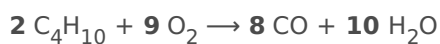
[1 mark]

Mark scheme 05



[1 mark]

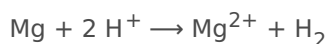
Mark scheme 06



Allow correct multiples / halves

[1 mark]

Mark scheme 07



[1 mark]

Mark scheme
08.1

Any **three** from: (nuclear model)

- Mostly empty space
Allow the plum pudding model has no empty space
Allow the plum pudding model is solid
- The positive charge is (all) in the nucleus
Allow in the plum pudding model the atom is a ball of positive charge (with embedded electrons)
*Do **not** accept reference to protons*
- The mass is concentrated in the nucleus
Allow in the plum pudding model the mass is spread out
*Do **not** accept reference to neutrons*
- The electrons and the nucleus are separate
Allow in the plum pudding model the electrons are embedded
Allow in the nuclear model the electrons are in orbits

[3 marks]

Mark scheme
08.2

Electrons orbit the nucleus

Allow electrons are in energy levels around the nucleus

or

Allow electrons are in shells around the nucleus

1

Electrons are at specific distances from the nucleus

1

*Do **not** accept reference to protons / neutrons*

[2 marks]

Mark scheme
08.3

Atomic number is the number of protons

1

(And) protons were not discovered until later

Ignore electrons / neutrons were not discovered until later

1

[2 marks]

Mark scheme 09

$$\frac{4 \times 10^{-7}}{2400}$$

1

$$= 1.66666 \times 10^{-10}$$

1

$$= 1.67 \times 10^{-10} \text{ (m)}$$

Allow 0.000 000 000 167 (m)

Allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the values in the question

1

[3 marks]

Mark scheme
10.1

(neutron) 1 0

Both needed

Allow (neutron) 1 neutral

1

proton 1 (+1)

Both needed

1

[2 marks]

Mark scheme
10.2

Number of protons plus neutrons

Allow number of protons and neutrons

Ignore protons and neutrons unqualified

*Do **not** accept references to mass or relative mass of protons and / or neutrons*

[1 mark]

Mark scheme 11

Between 69.5 and 70.0.

[1 mark]

Mark scheme 12

2,8

Allow diagram or description

1

(So) stable arrangement of electrons

or

(So) full outer shell

1

[2 marks]

Mark scheme 13

(Caesium has) more energy levels

or

(Caesium has) more shells

1

(So the) outer electron / shell is further from nucleus

or

Outer electron / shell is more shielded

1

(So) weaker attraction between nucleus and outer electron / shell

1

(So) outer electron is more easily lost

Allow (so) less energy needed to remove outer electron

1

Allow converse for sodium

[4 marks]

Mark scheme 14

(The) molecules get larger going down the group

1

(So the) forces between the molecules increase

or

(So the) intermolecular forces increase

1

(So the) boiling points increase going down the group

or

(So the) boiling points increase with increasing relative atomic mass

Allow (so) more energy is needed to separate the molecules

1

Allow converse explanation in terms of boiling point

[3 marks]

5.2 Bonding, structure and the properties of matter

Trilogy Higher Topic Test Markscheme

Mark scheme 01

Any **two** from:

- (Very) hard
Allow strong
- (Very) high melting point
- Does not conduct electricity

Allow high thermal conductivity
Ignore shiny

[2 marks]

Mark scheme 02

(aq)

Allow aq
Ignore aqueous
Ignore formulae

[1 mark]

Mark scheme 03

Any **one** from:

- Not to scale
Allow size of atoms incorrect
- Not 3 dimensional / D
- Incorrect arrangement in space
Allow atoms are separated
- Electrons / shells not shown

Ignore properties of water

[1 mark]

Mark scheme 04

Sodium (atom) loses

Allow moves / transfers for loses

*Do **not** accept sodium ion loses*

1

One (outer shell electron)

1

Chlorine (atom) gains

*Do **not** accept chloride*

1

One (electron)

1

*Transfer of 1 electron from chlorine to sodium **max 2** marks*

*Reference to sharing or covalent bonding **max 3** marks*

[4 marks]

Level	Description	Marks
2	Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	4-6
1	Relevant features are identified and differences noted.	1-3
	No relevant content	0

Indicative content

- (Both) carbon dioxide and silicon dioxide are made up of atoms
- (But) magnesium oxide is made up of ions
- (Both) silicon dioxide and magnesium oxide are giant structures
- (But) carbon dioxide is small molecules
- With weak intermolecular forces
- All three compounds have strong bonds
- (Both) carbon dioxide and silicon dioxide are formed from two non-metals
- (So) bonds formed are covalent
- (So) electron (pairs) are shared (between atoms)
- (But) magnesium oxide is formed from a metal and a non-metal
- (So) bonds in magnesium oxide are ionic
- (So) electrons are transferred
- From magnesium to oxygen
- Two electrons are transferred
- Bonds in silicon dioxide are single bonds
- (Where) each silicon forms four bonds
- (And) each oxygen forms two bonds
- (But) in carbon dioxide the bonds are double bonds
- (Where) carbon forms two double bonds
- (And) oxygen forms one double bond

Ignore properties e.g. melting point, electrical conductivity

[6 marks]

Mark scheme 06

Any **two** from:

- Hydrogen is not shown as H_2 / molecules
- Particles are shown as spheres
- Particles are shown as solid
- Does not show the (weak) forces (between particles)
- Does not show the movement / speed (of particles)
- Is only two-dimensional

[2 marks]

Mark scheme 07

Caesium atom loses one electron

1

(And) oxygen atom gains two electrons

1

(So) two caesium atoms react with one oxygen atom

Allow (to produce) Cs_2O

1

Any **one** from:

- (To form) Cs^+ and O^{2-}
- (To form) caesium ion(s) and oxide ion(s)
- (To form) ions with full outer shells / levels

1

Max 3 marks if reference to incorrect particles / bonding / structure

[4 marks]

Mark scheme 08

(Ammonia has) small molecules

Allow (ammonia has) a simple molecular (structure)

1

(Ammonia has) weak intermolecular forces

Allow (ammonia has) weak intermolecular bonds

*Do **not** accept weak covalent bonds*

1

(So) little energy is needed to overcome the intermolecular forces

Allow (so) little energy is needed to break the intermolecular bonds

Allow (so) little energy is needed to separate the molecules

*Do **not** accept references to breaking covalent bonds*

1

[3 marks]

Mark scheme 09

Each carbon / atom forms 3 (covalent) bonds.

1

One electron per carbon / atom is delocalised

1

(So) these electrons carry charge through the graphite

Ignore carry current / electricity

or

(So) these electrons move through the structure.

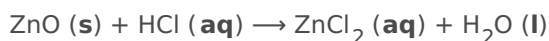
1

Allow free electrons for delocalised electrons

If no other mark scored, allow 1 mark for delocalised / free electrons

[3 marks]

Mark scheme 10



Allow 1 mark for 2/3 correct state symbols

[2 marks]

Mark scheme 11

Sulfur (formed)

Allow S (formed)

1

(Which is a) precipitate

Allow (which is a) solid

Allow (which is) insoluble

1

[2 marks]

Mark scheme 12

Dissolved (in water) **or** aqueous

Allow in solution

1

Molten / liquid

1

So ions are mobile **or** free moving

1

Max 2 for incorrect reference to particles or bonds

[3 marks]

Level	Description	Marks
2	Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4-6
1	Relevant features are identified and differences noted.	1-3
	No relevant content	0

Indicative content

	sodium chloride	hydrogen chloride
differences in bonding	ionic	covalent
	metal & non-metal	two non -metals
	transferring electrons	sharing electrons
	ions (Na^+ and Cl^-)	molecules
	charged particles	neutral or no overall charge
differences in structure	giant structure or lattice	small / simple / discrete molecules
	electrostatic	intermolecular forces
	(electrostatic forces) are strong	(intermolecular forces) are weak
	act in all directions	random or between the molecules
	regular	irregular / random
similarities in bonding	full shells or stability	full shells or stability
	(transferring) electrons	(sharing) electrons
	strong bonds	strong (covalent) bonds
	act in all directions	random or between the molecules
similarities in structure	(electrostatic) forces	(intermolecular) forces

Ignore properties e.g. melting points, conduct electricity

To access **Level 2** there must be a comparison of the structure **and** bonding **and** magnitude of both sodium chloride **and** hydrogen chloride

[6 marks]

5.3 Quantitative chemistry

Trilogy Higher Topic Test Markscheme

Mark scheme 01

(Total) mass before = 156.76 (g)

and

(Total) mass after = 156.76 (g)

Allow $78.26 + 78.50 = 156.76$

and

$108.22 + 48.54 = 156.76$

or

Increase in mass of beaker **A** and contents = 29.96 (g)

and

Decrease in mass of beaker **B** and contents = 29.96 (g)

Allow $108.22 - 78.26 = 29.96$

and

$48.54 - 78.50 = -29.96$

1

(So) the mass of products equals the mass of the reactants

or

(So) there is no change in mass during the reaction

Allow (so) no atoms were lost or made during the reaction

1

[2 marks]

Mark scheme 02

3×16 **or** 48

1

$\frac{48}{80} (\times 100)$

1

60 (%)

1

*An answer of 60 (%) scores **3** marks*

*An answer of 20 (%) scores **2** marks for:*

$\frac{16}{80} (\times 100) (1)$

= 20 (%) (1)

[3 marks]

Mark scheme 03

$$\frac{50}{1000} \text{ (dm}^3\text{)}$$

1

$$= 0.05 \text{ (dm}^3\text{)}$$

1

$$\left(\frac{3.2}{0.05}\right) 64 \text{ (g per dm}^3\text{)}$$

1

Alternative approach:

$$\frac{3.2}{50} \text{ (1)}$$

$$= 0.064 \text{ (1)}$$

$$(\times 1000) = 64 \text{ (g per dm}^3\text{) (1)}$$

Alternative approach:

$$\frac{1000}{50} \text{ (1)}$$

$$= 20 \text{ (1)}$$

$$(\times 3.2) = 64 \text{ (g per dm}^3\text{) (1)}$$

*An answer of 64 (g per dm³) scores **3** marks*

*An incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

*An answer of 0.16 / 0.064 / 0.64 / 6.4 / 6.4×10^{-5} (g per dm³) gains **2** marks*

[3 marks]

Level	Description	Marks
3	The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5-6
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
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

- Weigh test tube
- Add metal carbonate
- Weigh test tube and metal carbonate

- Heat
- Allow to cool
- Weigh test tube and metal oxide
- Repeat (heat, cool and weigh) until no change in mass

- Determine mass of metal carbonate used
- Determine mass of carbon dioxide produced

- Repeat with different metal carbonate(s)

An alternative method can be based on any mass of metal carbonates and at end divide by this mass to find mass carbon dioxide per gram metal carbonate

Level 3 change in mass is determined for at least one other carbonate

[6 marks]

Mark scheme 05

$$M_r \text{ CaO} = 56$$

1

$$(M_r \text{ CaSO}_3 =) 120$$

1

$$\frac{7}{56} \times 120$$

1

$$= 15(.0 \text{ g})$$

1

Alternative approach A

$$(M_r \text{ CaO} =) 56 \text{ (1)}$$

$$\frac{7}{56} = 0.125 \text{ (moles) (1)}$$

$$(\text{Mass CaSO}_3 =) 0.125 \times 120 \text{ (1)}$$

$$= 15(.0 \text{ g}) \text{ (1)}$$

Alternative approach B

$$M_r \text{ CaO} = 56 \text{ (1)}$$

$$\frac{56}{7} = 8 \text{ (factor) (1)}$$

$$M_r \text{ CaSO}_3 = 120 \text{ (1)}$$

$$\frac{120}{8} = 15(.0 \text{ g}) \text{ (1)}$$

Alternative approach C

$$M_r \text{ CaO} = 56 \text{ (1)}$$

$$M_r \text{ CaSO}_3 = 120 \text{ (1)}$$

$$\frac{120}{56} = 2.14235714 \text{ (factor) (1)}$$

$$2.14235714 \times 7 = 15(.0 \text{ g}) \text{ (1)}$$

An answer of 15(.0 g) scores 4 marks

In all approaches allow a correct calculation using an incorrectly calculated M_r

[4 marks]

Mark scheme 06

A gas is produced

Allow carbon dioxide is produced

*Do **not** accept an incorrect gas*

1

(Which) escapes

1

Max 1 mark if evaporation mentioned

[2 marks]

Mark scheme 07

$$2.0 \times 10^3 \text{ moles}$$

[1 mark]

Mark scheme 08

$$\frac{1}{40} \times 6.02 \times 10^{23}$$

or

$$0.025 \times 6.02 \times 10^{23}$$

1

$$1.51 \times 10^{22}$$

Allow 1.505×10^{22}

1

An answer of 1.51×10^{22} scores 2 marks

[2 marks]

Mark scheme 09

(Unit conversion)

$$30.0 \text{ cm}^3 = 0.030 \text{ dm}^3$$

or

$$0.500 \text{ dm}^3 = 500 \text{ cm}^3$$

1

$$(\text{moles} = \frac{30}{500} \times 0.1 =) 0.006$$

or

$$(\text{moles} = \frac{0.030}{0.50} \times 0.1 =) 0.006$$

Allow correct use of incorrect / no unit conversion

1

$$\text{Mass} = 0.006 \times 159.5$$

Allow correct use of incorrect value for number of moles

1

$$= 0.957 \text{ (g)}$$

Allow 0.96 (g)

1

[4 marks]

Mark scheme 10

$$(\text{moles Au} = \frac{0.175}{197} \Rightarrow) 0.000888$$

1

$$(\text{moles Cl}_2 = 0.000888 \times \frac{3}{2} \Rightarrow) 0.00133$$

Allow a correct calculation using an incorrectly calculated value of moles of gold

1

$$(\text{Mass Cl}_2 \Rightarrow) 0.00133 \times 71$$

Allow a correct calculation using an incorrectly calculated value of moles of chlorine

1

$$= 0.0946 \text{ (g)}$$

1

$$= 94.6 \text{ (mg)}$$

Allow a correct conversion using an incorrectly calculated mass of chlorine

1

Alternative approach:

(From equation 2 moles of Au reacts with 3 moles of Cl₂)

(So) 394 g Au reacts with 213 g Cl₂ (1)

1 g Au reacts with ($\frac{213}{394} \Rightarrow$)

$$0.54 \text{ g Cl}_2 \text{ (1)}$$

Allow a correct calculation using an incorrectly calculated value of mass of gold and / or chlorine

0.175 g Au reacts with

$$0.54 \times 0.175 \text{ g Cl}_2 \text{ (1)}$$

Allow a correct calculation using an incorrectly calculated value of mass of gold and / or chlorine

$$= 0.0946 \text{ (g) (1)}$$

$$= 94.6 \text{ (mg) (1)}$$

Allow a correct conversion using an incorrectly calculated mass of chlorine

[5 marks]

Mark scheme

11.1

To make sure all of the oxide (of copper) has reacted

or

To make sure all water (produced) is removed

Ignore to ensure complete reaction unqualified

Ignore to make sure all of the hydrogen has reacted

[1 mark]

Mark scheme
11.2

To prevent hydrogen escaping (into the air)

1

(Because) hydrogen is explosive

Ignore hydrogen is flammable

1

[2 marks]

Mark scheme
11.3

(Mass of copper) 8.66 (g)

1

(Mass of water) 2.45 (g)

1

[2 marks]

Moles Cu = 0.04

or

$$\frac{2.54}{63.5} = 0.04$$

1

Moles H₂O = 0.04

or

$$\frac{0.72}{18} = 0.04$$

1

Ratio = 1:1 so equation 2 is correct

1

Alternative approach A

(Calculating mass of water from copper)

moles Cu = 0.04 **or** $\frac{2.54}{63.5} = 0.04$ (1)

$0.02 \times 18 = 0.36$ (g of water for equation 1) (1)

$0.04 \times 18 = 0.72$ (g of water) so equation 2 is correct (1)

Alternative approach B

(Calculating mass of copper from water)

moles H₂O = 0.04 **or** $\frac{0.72}{18} = 0.04$ (1)

$0.08 \times 63.5 = 5.08$ (g of copper for equation 1) (1)

$0.04 \times 63.5 = 2.54$ (g of copper) so equation 2 is correct (1)

Alternative approach C

(Mass ratio)

(copper : water for equation 1)

$127 : 18 = 7.06 : 1$ (1)

(copper : water for equation 2)

$63.5 : 18 = 3.53 : 1$ (1)

$2.54 : 0.72 = 3.53 : 1 = 63.5 : 18$

So equation 2 is correct (1)

[3 marks]

5.8 Chemical analysis

Trilogy Higher Topic Test Markscheme

Mark scheme 01

Air - Mixture

1

Carbon dioxide - Compound

1

Oxygen - Element

1

If more than one line is drawn from any one substance and not crossed out, no mark is given for that substance. The other marks can be awarded.

[3 marks]

Mark scheme 02.1

17 : 3

[1 mark]

Mark scheme 02.2

C. Formulation

[1 mark]

Mark scheme 03

1.20 g = 1200 mg

or

700 mg = 0.700 g

1

$$\frac{700}{1200} \times 100 \text{ or } \frac{0.700}{1.20} \times 100$$

Allow correct use of incorrectly or not converted values from step1

1

= 58.3 (%)

Allow 58.3333333 (%) correctly rounded to at least 2 significant figures

1

*An answer of 58.3333333 (%) correctly rounded to at least 2 significant figures scores
3 marks*

[3 marks]

Mark scheme 04

C. The R_f value would stay the same

[1 mark]

Mark scheme 05

Glowing splint

1

Relights

1

[2 marks]

Mark scheme 06

Boil (water)

Ignore heat

*Do **not** accept filter*

*Do **not** accept incorrect test*

1

(Boils) at 100°C

1

Alternative approach

Freeze (water) (1)

(Freezes) at 0°C (1)

*Allow boils at 100°C for **2** marks*

*If no other mark awarded, allow **1** mark for evaporate or distil water **and** no solid left*

[2 marks]

Mark scheme
07.1

(Bubble gas through) lime water

Allow (bubble gas through) calcium hydroxide (solution)

1

Turns milky / cloudy / white

or

White precipitate forms

1

MP2 is dependent upon correct response in MP1

[2 marks]

Mark scheme
07.2

Burning / lit splint

Allow flame

*Do **not** accept glowing splint*

1

Burns with a (squeaky) pop sound

Allow pops

1

MP2 is dependent upon correct response in MP1

[2 marks]

Mark scheme 08

$$\frac{23.3}{265.5 + 23.3 + 3.0 + 1.5} (\times 100)$$

Allow $\frac{23.3}{293.3} (\times 100)$

1

7.9 (%)

Allow 7.944084555 (%) rounded correctly

1

*An answer of 7.9 (%) scores **2** marks*

[2 marks]

Mark scheme
09.1

Start line drawn in ink

Allow start line should have been drawn in pencil

1

(So) ink dissolves

or

Ink runs in solvent / water

(As) pencil does not dissolve

or

Pencil does not run in solvent / water

1

Water used (as solvent)

or

Water in beaker

Allow ethanol not used

1

(So) colours will not dissolve / move

1

[4 marks]

Mark scheme
09.2

Any **two** from:

- The flowers have no colours in common.
Allow the flowers are not the same colour
- A / B contain one colour.
- C contains two colours.
Allow C is a mixture of colours
- (The colour in) B is most soluble.
Allow (the colour in) B has the highest R_f value
Allow one of the colours in C is the least soluble

[2 marks]

Mark scheme 10

Run known dyes and food colouring (as a chromatogram)

1

Compare distances moved

or

Compare Rf values

1

(So) can identify those that move the same distance as known dyes

Allow (so) can identify those that move different distances as unknown dyes

or

(So) can identify those that have the same Rf values as known dyes

Allow (so) can identify those that have different Rf values as unknown dyes

1

[3 marks]

Mark scheme 11

$$(\text{distance moved}) = \frac{3.2}{0.65}$$

1

$$(\text{distance moved}) = 4.9 \text{ (cm)}$$

Allow 4.923076923 (cm) correctly rounded

1

An answer of 4.9 (cm) scores 2 marks

[2 marks]

Mark scheme
12.1

$$0.60 = \frac{5.7}{\text{distance moved by solvent}}$$

1

$$(\text{Distance moved by solvent}) = \frac{5.7}{0.60}$$

1

$$= 9.5 \text{ (cm)}$$

1

[3 marks]

Mark scheme
12.2

Some of the compounds are colourless (in solution)

or

Dyes / compounds have the same R_f values

Allow there are only two compounds that are coloured (in solution)

[1 mark]

Mark scheme
12.3

A. Allow the solvent front to travel further

1

C. Use a different solvent

1

[2 marks]

Mark scheme
12.4

So that the (shade of) green is the same

Allow because the green ink is a formulation

[1 mark]

Mark scheme
12.5

B. The dye is less soluble in the new solvent and more attracted to the new paper

[1 mark]

Mark scheme 13

Damp / moist litmus paper.

Ignore colour of litmus paper

1

Bleaches / goes white

1

[2 marks]

5.5 Energy changes in reactions

Trilogy Higher Topic Test Markscheme

Mark scheme 01

The (minimum) energy needed for particles to react

or

The (minimum) energy needed for a reaction to occur

Allow the (minimum) energy needed to start a reaction

[1 mark]

Mark scheme 02

The activation energy should be from the reactants (line to the peak)

Ignore description of where the activation energy is on the diagram

1

The products (line) should be below the reactants (line)

or

The products should have less energy than the reactants

Allow the product (line) is above the reactants (line)

Allow the products have more energy than the reactants

Allow the profile shows an endothermic reaction

Ignore the arrow for the overall energy change should point downwards

1

[2 marks]

Level	Description	Marks
2	The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	3-4
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**Key steps**

- Add the metals to (dilute) hydrochloric acid
- Measure temperature change
or
Compare rate of bubbling
or
Compare colour of resulting solution

For copper:

- No reaction
- Shown by no temperature change
or
Shown by no bubbles

For magnesium and iron:

- Magnesium increases in temperature more than iron
or
Magnesium bubbles faster than iron
or
Magnesium forms a colourless solution and iron forms a coloured solution

Control variables

- Same concentration / volume of hydrochloric acid
- Same mass / moles of metal
- Same particle size of metal
- Same temperature (of acid if comparing rate of bubbling)

[4 marks]

Mark scheme 04

Level	Description	Marks
3	The design / plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5-6
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
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

[6 marks]

Mark scheme 05

27.4 (°C)

Allow values in the range 27.2-27.5 (°C)

1

(27.4-14.3 =) 13.1 (°C)

Allow correct subtraction of incorrect temperature reading

1

[2 marks]

Mark scheme 06

Temperature increases.

or

Temperature does not decrease.

Allow (because) energy / 'heat' is transferred to the surroundings

Allow energy / 'heat' is given out

Allow energy / 'heat' is not taken in (from the surroundings)

Allow the energy of the products is less than the energy of the reactants

Ignore because it is exothermic

Ignore references to copper

[1 mark]

Mark scheme 07

Polystyrene is a better (thermal) insulator

Allow polystyrene is a poorer (thermal) conductor

1

(So) reduces energy exchange (with the surroundings)

Allow (so) reduces energy / heat loss (to the surroundings)

1

[2 marks]

Mark scheme
08.1

Didn't stir (the solution enough)

Allow measured the temperature before the temperature stopped falling

Allow measured the temperature too soon

[1 mark]

Mark scheme
08.2

The temperature decreases (initially) because energy is taken in (by the reaction from the solution)

Allow temperature decreases (initially) because the reaction is endothermic

1

When 1.5 g (of citric acid) is added the sodium hydrogencarbonate has all reacted

Allow when the temperature reaches 11.6 °C the sodium hydrogencarbonate has all reacted

or

From 1.5 g the citric acid is in excess

Allow after the temperature reaches 11.6 °C the citric acid is in excess

or

When 1.5 g (of citric acid) is added the reaction is complete

Allow when the temperature reaches 11.6 °C the reaction is complete

1

(So) the temperature increases as energy is transferred from the room to the solution

Allow (so) the temperature increases as energy is transferred from the excess citric acid to the solution

1

[3 marks]

Mark scheme
09.1

Temperature (change)

[1 mark]

Mark scheme
09.2

To reach a constant temperature

Allow to reach room temperature

[1 mark]

Mark scheme
09.3

The reaction finished / stopped

Allow maximum temperature has been reached

1

(So) energy is lost to surroundings / atmosphere

or

(So the) solution cools (back to room temperature)

Allow heat for energy

1

[2 marks]

Mark scheme
10.1

Reads levels of reactants (800 kJ) and products (300 kJ)

1

$(800 - 300) = 500 \text{ (kJ)}$

Allow correct subtraction of one incorrect value determined for the energy change

1

*An answer of (-) 500 (kJ) scores **2** marks*

Ignore sign

[2 marks]

(Bonds broken)

$$((4 \times 463) + (2 \times 138) =) \textbf{2128}$$

1

(Bonds made)

$$((4 \times 463) + (496) =) \textbf{2348}$$

1

(Energy change =

Bonds broken - bonds made)

$$(2128 - 2348 =) (-) \textbf{220 (kJ)}$$

Ignore energy change sign

Allow correct calculation using incorrect values from step 1 and / or step 2

1

Alternative approach:

(Bonds broken)

$$(2 \times (\text{O-O}) = (2 \times 138) =) \textbf{276 (1)}$$

(Bonds made)

$$(1 \times (\text{O=O}) =) \textbf{496 (1)}$$

(Energy change =

Bonds broken - bonds made)

$$(276 - 496 =) (-) \textbf{220 (kJ) (1)}$$

*An answer of (-) 220 (kJ) scores **3** marks*

*An incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[3 marks]

Mark scheme 11

(a) (For bonds broken)

$$((12 \times 391) + (3 \times 498) =) \text{ 6186}$$

1

(For bonds made)

$$((2 \times 945) + (12 \times 464) =) \text{ 7458}$$

1

(Overall energy change = 6186-7458 =) (-)1272 (kJ)

Allow correct calculation using incorrectly calculated values from step 1 and / or step 2

1

*An answer of (-)1272 (kJ) scores **3** marks*

(b) 7458 (kJ) (released in making bonds) is greater than 6186 (kJ) (used in breaking bonds)

or

The products have 1272 (kJ) less energy than the reactants

Allow the (overall) energy change is -1272 (kJ)

1

(So) energy is released (to the surroundings)

Dependent on MP1 being awarded

Allow (so) heat is released (to the surroundings)

1

*If no values given, allow **1** mark for more energy released in making bonds than used in breaking bonds*

*Allow ecf from part **(a)***

[5 marks]

Mark scheme 12

$$(\text{Bonds broken} = 4(412) + 193 =) 1841$$

1

$$(\text{Bonds formed} = 3(412) + 366 + \mathbf{X} =) 1602 + \mathbf{X}$$

1

$$-51 = 1841 - (1602 + \mathbf{X})$$

Allow use of incorrectly calculated values of bonds broken and / or bonds formed from steps 1 and 2 for steps 3 and 4

1

$$(\mathbf{X} =) 290 \text{ (kJ/mol)}$$

Allow a correctly calculated answer from use of $-51 = \text{bonds formed} - \text{bonds broken}$

1

OR

Alternative method ignoring the 3 unchanged C-H bonds

$$(412 + 193 =) 605 \text{ (1)}$$

$$366 + \mathbf{X} \text{ (1)}$$

$$-51 = 605 - (366 + \mathbf{X}) \text{ (1)}$$

$$(\mathbf{X} =) 290 \text{ (kJ/mol)} \text{ (1)}$$

*An answer of 290 (kJ/mol) scores **4** marks*

*An answer of 188 (kJ/mol) scores **3** marks*

*An incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[4 marks]

5.6 Rate and extent of chemical reactions

Trilogy Higher Topic Test Markscheme

Mark scheme 01.1

(Gas) syringe

Allow measuring cylinder (and water trough)

Allow balance

1

Stopclock / stopwatch

Allow timer / clock / watch

1

[2 marks]

Mark scheme 01.2

A. More bubbles were produced in the first 10 seconds

1

C. The magnesium was used up more quickly

1

[2 marks]

Level	Description	Marks
3	The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5-6
2	The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3-4
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 a measuring cylinder / pipette / burette to measure 50 cm³ of sodium thiosulfate
- Use a different measuring cylinder / pipette / burette to measure 10 cm³ of hydrochloric acid
- Start the timer when the acid is added
- Record the temperature of the solution after the acid is added
- Stop the timer when the cross is no longer visible
- Record the temperature of the solution at the end of the reaction
- Calculate the mean temperature of the reaction
- Repeat the experiment at different temperatures
- Use the same concentration of sodium thiosulfate and same concentration of hydrochloric acid
- Use the same volume of sodium thiosulfate and the same volume of hydrochloric acid
- Describe how to heat the thiosulfate / acid solutions

[6 marks]

Mark scheme
02.2

(Change in mass of gas =) 0.15

and

(Time =) 2

1

(Rate of reaction =) $\frac{0.15}{2}$

Allow correct use of incorrectly determined values for mass and / or time

1

0.075 (g/min)

1

Ignore signs

[3 marks]

Mark scheme
03.1

Value from graph used to show volume increase.

Must include a time or volume value

1

Values from graph used to show the volume increases less rapidly.

Must include time interval or volume increment

1

Volume **or** time stated when graph line levels off.

*Allow levels off at 60 (cm³) **or** 28 to 30 s*

Allow descriptions in terms of rate of reaction

1

Values must be approximately correct

[3 marks]

Mark scheme
03.2

Draw tangent at 15 s

Allow draw a straight line on the curve at 15 s

1

Calculate gradient

Allow correct description of gradient calculation

Ignore calculations if given

1

[2 marks]

Mark scheme 04

(Because) surface area (of fine manganese dioxide powder) greater

Allow converse for coarse lumps

1

(So) more collisions (with hydrogen peroxide molecules / particles) per unit time

*Do **not** accept references to changes in kinetic energy or speed (of molecules / particles)*

Ignore references to activation energy

1

[2 marks]

Mark scheme 05

(Surface area of each face = $2 \times 2 =$) 4

1

($6 \times 4 =$) 24 (cm²)

Allow $6 \times$ student's value from step 1

1

*An answer of 24 (cm²) scores **2** marks*

[2 marks]

Mark scheme
06.1

Provides different reaction pathway

Allow provides a different mechanism / route

1

(Which has a) lower activation energy

1

Ignore references to collisions

[2 marks]

Mark scheme
06.2

Less energy is needed

Allow reduces the temperature required

Allow reduces costs

Ignore references to pressure

Ignore references to rate or time

[1 mark]

Mark scheme 07

Both reaction profiles start at the same energy level and end at the same energy level

[1 mark]

Mark scheme 08

When a reversible reaction occurs in apparatus which prevents the escape of reactants and products

Allow when a reversible reaction occurs in a sealed system

1

(Equilibrium is reached) when the forward and reverse reactions occur at (exactly) the same rate

1

[2 marks]

Mark scheme 09

Equilibrium shifts to right-hand side

Allow towards the products

Allow in favour of the forward reaction

1

(Because) concentration of SO_3 decreases

This marking point is dependent on first marking point being awarded

Allow pressure decreases

Allow to increase the concentration of SO_3

Allow to re-establish equilibrium

1

[2 marks]

Mark scheme
10.1

Higher temperatures produce a lower (percentage) yield (of ammonia)

Allow converse

Allow correct reference to shift in equilibrium

Ignore references to pressure

[1 mark]

Mark scheme
10.2

Higher yield (of hydrogen or carbon monoxide or product)

Allow converse arguments in terms of higher pressure

Ignore references to rate

Allow more hydrogen or more carbon monoxide or more product

Allow equilibrium moves to the right

Allow equilibrium moves in the forward direction

1

(Because) fewer moles / molecules / particles on left hand side

or

(Because) more moles / molecules / particles on right hand side

Allow (because) the reverse reaction produces fewer moles / molecules / particles

or

Allow (because) the forward reaction produces more moles / molecules / particles

*Do **not** accept fewer / more atoms*

1

[2 marks]

Mark scheme
10.3

No effect (on yield of hydrogen)

Allow position of equilibrium unaffected by pressure

Ignore references to rate of reaction

[1 mark]

Mark scheme
11.1

Becomes (more) red

1

(Because the position of) equilibrium moves to the right

Allow (because) the concentration of FeSCN^{2+} (ions) increases

Allow (because) the forward reaction is favoured

1

(So that) the (increase in the) concentration of thiocyanate (ions) is reduced

Allow (so that) the increase in the concentration of thiocyanate (ions) is counteracted

1

[3 marks]

(The position of) equilibrium moves to the left

Allow the concentration of Fe^{3+} (ions) increases

Allow the reverse reaction is favoured

1

(So that) the (increase in the) temperature is reduced

Allow (so that) the increase in the temperature is counteracted

1

(Therefore) the forward reaction is exothermic

Allow (therefore) the forward reaction releases energy (to the surroundings)

1

[3 marks]

5.7 Organic chemistry

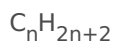
Trilogy Higher Topic Test Markscheme

Mark scheme
01.1



[1 mark]

Mark scheme
01.2



[1 mark]

Mark scheme
02.1

B. Alkane

[1 mark]

Mark scheme
02.2



[1 mark]

Mark scheme 03

Any **two** from:

- High temperature
Ignore heat / hot
Allow a temperature between 400 °C and 900 °C
- Catalyst
Allow aluminium oxide, alumina, porous pot, zeolites
- Steam
- High pressure
- Low oxygen atmosphere

[2 marks]

Mark scheme 04

Stage **A** - Crude oil is heated

Stage **B** - Hydrocarbons evaporate

Stage **C** - Vapours condense

*All correct for **1** mark*

[1 mark]

Mark scheme
05.1

Condenses

[1 mark]

Mark scheme
05.2

A. The fractions have different boiling points.

[1 mark]

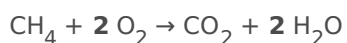
Mark scheme
05.3

Propane

*Do **not** accept propene*

[1 mark]

Mark scheme
05.4



Allow multiples

[1 mark]

Mark scheme 06

Bromine (water)

*Do **not** accept bromide*

1

(Colour change) orange*

1

(To) colourless*

Ignore clear

1

Allow **1 mark for colourless (to) orange*

[3 marks]

Mark scheme
07.1

A temperature between 400 (°C) and 500 (°C) inclusive

Allow a temperature range entirely within 400 (°C) and 500 (°C) inclusive

[1 mark]

Mark scheme
07.2

(Diesel oil has a) lower boiling point / range than heavy fuel oil

1

(But diesel oil has a) higher boiling point / range than kerosene

1

*Allow the boiling range (of diesel oil) is between those of heavy fuel oil and kerosene for **2** marks*

Ignore quoted values for boiling points

Ignore references to melting points

Ignore references to intermolecular forces or chain length

Allow temperature of vaporisation / condensation for boiling points throughout

[2 marks]

Any **two** from:

- (Too) viscous
Allow references to difficulty of flow
- Not (very) flammable
Allow references to difficulty of ignition / burning
*Do **not** accept bitumen takes more energy to burn*
- Boiling point (too) high
Allow not (very) volatile
Ignore references to cost

[2 marks]

Level	Description	Marks
2	Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	4-6
1	Relevant features are identified and differences noted.	1-3
	No relevant content	0

Indicative content

Structure and bonding

- Both are hydrocarbons
- Both contain two carbon atoms (per molecule)
- Ethane contains six hydrogen atoms (per molecule)
- (But) ethene contains four hydrogen atoms (per molecule)
- Both have covalent bonds
- Ethane contains a single C—C bond
- (But) ethene contains a double bond
- Both contain C—H bonds
- Both small molecules

Reactions

- Both react with oxygen in complete combustion reactions
- To produce water and carbon dioxide
- Both react with oxygen in incomplete combustion reactions
- To produce water, carbon monoxide and carbon
- Incomplete combustion is more likely with ethene
- Ethene decolourises bromine water
- (But) ethane does not decolourise bromine water
- Ethene is more reactive (than ethane)
- Ethene can react with hydrogen (to produce ethane)
- Ethene can react with water (to produce ethanol)
- Ethene can react with halogens (to produce halogenoalkanes)
- Ethene can undergo addition reactions
- Ethene can polymerise (to produce poly(ethene))

Ignore physical properties

Ignore references to flammability

[6 marks]

Mark scheme
09.1

The boiling point increases as the number of (carbon) atoms increases

1

(Because the weak) intermolecular forces increase

or

(Because the weak) forces between the molecules increase

1

(And these intermolecular forces increase) as the size of the molecules increases

1

*Max 2 marks for incorrect reference to particles / bonds
Allow converse*

[3 marks]

Mark scheme
09.2

(As number of carbon atoms increase) the time increases

1

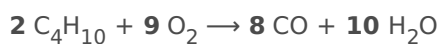
(Because) the viscosity increases

1

MP2 dependent on correct response in MP1

[2 marks]

Mark scheme 10



Allow correct multiples / halves

[1 mark]

Mark scheme 11

Ratio of $O_2 : CO_2 = 5 : 3$

1

(oxygen needed = $\frac{3.60 \times 5}{3}$) = 6.0 (dm³)

Allow correct calculation using an incorrectly determined mole ratio

1

(oxygen unreacted = 7.25 - 6.0) = 1.25 (dm³)

Allow correct subtraction of an incorrectly calculated volume of oxygen

1

(oxygen unreacted = 1.25 × 1000) = 1250 (cm³)

Allow correct conversion to cm³ anywhere in response

1

Alternative approach for MP1 and MP2

Moles $CO_2 = 0.15$

and

Moles $O_2 = 0.25$ (1)

(0.25 × 24 =) 6.0 (dm³ oxygen needed) (1)

An answer of 1250 (cm³ oxygen unreacted) scores 4 marks

[4 marks]

Mark scheme 12

(Add) bromine (water)

*Do **not** accept bromide*

1

(Changes from) orange to colourless

Dependent on correct test in MP1

Allow (changes from) brown to colourless

Ignore clear

1

[2 marks]

Mark scheme 13

Plankton

Allow biomass

Allow (marine) animals / organisms

Ignore plants

1

Buried in mud

Allow compressed under mud

Allow compressed in sedimentary rock

Ignore fossilised

1

Over a long period of time

or

Over millions of years

1

[3 marks]

5.4 Chemical changes

Trilogy Higher Topic Test Markscheme

Mark scheme
01.1

B. Chlorine

[1 mark]

Mark scheme
01.2

A. Copper is less reactive than hydrogen

[1 mark]

Mark scheme
01.3

1.8 (mg)

Allow an answer in range 1.7-1.9

[1 mark]

Mark scheme
01.4

$$\frac{3.02 + 3.01 + x}{3} = 3.06$$

Allow any other suitable method

1

3.15 (mg)

1

*If no other mark awarded allow 9.18 for **1** mark*

*An answer of 3.15 (mg) scores **2** marks*

[2 marks]

Mark scheme 01.5

$$\frac{50}{1000} \text{ or } \frac{1}{20} \text{ or } 0.05$$

1

$$(0.05) \times 300$$

The second mark is dependent on the first mark being scored

1

15 (g)

1

or

$$\frac{300}{1000} \text{ or } \frac{3}{10} \text{ or } 0.03 (1)$$

$$(0.3) \times 50 (1)$$

The second mark is dependent on the first mark being scored

15 (g)

*An answer of 15 (g) scores **3** marks*

*If no other mark awarded allow 150 **or** 15 000 for **1** mark*

[3 marks]

Mark scheme 02

	Mark
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 marks]

Mark scheme 03

Order:

1. magnesium
2. cobalt
3. nickel
4. tin
5. copper
6. silver

Allow 1 mark for magnesium, cobalt, nickel, tin in order at top

Allow 1 mark for copper and silver in order at the bottom

2

Justification:

The higher the (positive) voltage, the more reactive (the metal)

Allow the most reactive (metal) has the highest voltage

1

Silver has a negative voltage because silver is less reactive than copper

1

[4 marks]

Mark scheme 04

Magnesium (atoms) are oxidised because they lose electrons

1

(And) zinc (ions) are reduced because they gain electrons

If no other marks awarded allow 1 mark for magnesium (atoms) lose electrons and zinc (ions) gain electrons

1

[2 marks]

Mark scheme
05.1

(At start) value in range 12-14

1

(At end) value in range 0-3

1

Must be in this order

[2 marks]

Mark scheme
05.2

0.10 mol/dm³

[1 mark]

Mark scheme 06

Dilution by a factor of 100

Allow pH changes by 1 when solution is diluted by factor of 10

or

Allow pH changes by 2

1

(pH =) 5

1

An answer of (pH=) 5 gains 2 marks

[2 marks]

Mark scheme 07

CrO_4^{2-} / chromate ions moved to the positive electrode

Allow anode for positive electrode

Allow yellow (coloured) ions moved to the positive electrode

1

(Because) opposite charges attract

Allow (because) negative ions are attracted to the positive electrode

1

[2 marks]

Mark scheme
08.1

The electrode reacts with oxygen

1

The electrode is carbon / graphite

1

(So) carbon dioxide is produced

Allow (so) the electrode / carbon / graphite is used up

Allow (so) the electrode / carbon / graphite is burned away

Ignore (so) the electrode / carbon / graphite is worn away

Ignore (so) the electrode / carbon / graphite is corroded

1

[3 marks]

Mark scheme
08.2

Hydrogen (gas) would be produced (instead of sodium)

1

(Because) sodium is more reactive than hydrogen

1

[2 marks]

Mark scheme 09

Reading of mass at stated time

Allow tolerance of $\pm \frac{1}{2}$ small square

E.g. at 30 minutes value is 5.4 (mg)

1

Factor from time to 24 hours

E.g. $5.4 \times 48 (= \frac{24 \text{ hours}}{30 \text{ minutes}})$

Allow correct calculation using incorrectly read value for mass at time quoted

1

Correct evaluation

E.g. = 259 (mg)

1

Alternative approach:

Calculates the gradient (1)

E.g. $(1.8 \div 10) = 0.18$

Gradient $\times$ time in minutes in 24 hours (1)

E.g. $0.18 \times 24 \times 60$

or

E.g. 0.18×1440

Allow correct use of incorrectly determined gradient

Correct evaluation (1)

E.g. = 259 (mg)

*An incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[3 marks]

Mark scheme
10.1

Use measuring cylinders (instead of test tubes)

Allow use burettes

Allow use (gas) syringes

Allow Hoffmann voltameter

1

(Because) test tubes cannot measure volume.

or

(Because) test tubes have no graduations / scale.

Allow (so that) volume can be measured

1

[2 marks]

Any **three** from:

- The volume of hydrogen collected is directly proportional to the time.
Allow the (volume of) hydrogen is collected at a constant / steady rate
- The rate of collection of hydrogen is $0.45 \text{ (cm}^3\text{/min)}$.
- Up to 8 minutes chlorine is collected at an increasing rate.
Allow any value from 6 to 8 minutes
Allow initially chlorine is collected at an increasing rate
- After 8 minutes the rate of collection of chlorine is the same as that of hydrogen.

or

After 8 minutes the rate of collection of chlorine is $0.45 \text{ (cm}^3\text{/min)}$.

Allow any value from 6 to 8 minutes

Allow after 8 minutes the (volume of) chlorine is collected at a constant / steady rate

*If neither bullet point 3 nor bullet point 4 is awarded allow **1** mark for chlorine is collected slowly up to 8 minutes and then more quickly*
Allow any value from 6 to 8 minutes

[3 marks]

5.9 Chemistry of the atmosphere

Trilogy Higher Topic Test Markscheme

Mark scheme 01

Any **one** from:

- Occurred 4.6 billion years ago
Allow any indication of billions of years
- Limited or no evidence.
Allow limited or no proof

Ignore there was nobody there

[1 mark]

Mark scheme 02

$$\frac{6.0}{4.1} \times 0.0235$$

1

0.0344(kg)

Allow correct rounding
Allow calculator reading

1

If no mark awarded:

Allow 1 mark for 34.4 or 0.344

Allow 2 marks for 34.4 g

An answer of 0.0344(kg) scores 2 marks

[2 marks]

Mark scheme 03.1

High temperatures (in the engine)

1

Enable oxygen and nitrogen (from air) to react

Allow combine / bond for react

1

[2 marks]

Level	Description	Marks
3	A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5-6
2	Some logically linked reasons are given. There may also be a simple judgement.	3-4
1	Relevant points are made. They are not logically linked.	1-2
	No relevant content	0

Indicative content

Examples of relevant points might include:

- Car **C** produces the most CO₂ during manufacture
- Car **A** produces the most CO₂ per km when driving
- Car **C** produces the most CO₂ from manufacture and 40,000 km when driving
- Car **B** produces the most CO₂ from manufacture and 100,000 km when driving

Examples of linked statements might include:

- Car **A** produces least CO₂ during manufacture, but most CO₂ per km
- Car **C** produces most CO₂ during manufacture, but least CO₂ per km
- Car **A** produces least CO₂ during manufacture, but car **C** produces the least CO₂ per km

Examples of judgements might include:

- Overall car **A** has the smallest carbon footprint as it has the smallest CO₂ production during manufacture, the smallest mass of CO₂ after 40,000 km of driving and the smallest mass of CO₂ produced after 100,000 km of driving
- Car **A** eventually (after 157,895 km) will have the largest carbon footprint because the mass of carbon dioxide produced per km is highest

[6 marks]

Mark scheme 04

(Maximum % =) 96 (%)

Allow a value in the range 95 to 97 (%)

1

(Maximum mass =)

$$\frac{96}{100} \times 5.15 \times 10^{18}$$

Allow correct use of incorrectly determined percentage

1

$$= 4.94 \times 10^{18} \text{ (kg)}$$

Allow 4.944×10^{18} (kg)

1

[2 marks]

Mark scheme 05

(Titan has) little / no oxygen

Ignore references to respiration

1

(So) photosynthesis has not occurred (on Titan)

Allow (so) no plants / algae to produce oxygen (on Titan)

1

(Therefore) little / no carbon dioxide present (on Titan)

or

(Therefore) oxygen-using animals cannot have evolved (on Titan)

1

[3 marks]

Mark scheme 06

Wood is renewable

or

(Natural) gas is finite

1

(Burning) wood produces the same amount of carbon dioxide as the trees absorbed

Allow wood is carbon-neutral

Allow wood does not add to global warming

or

(Burning natural) gas increases the amount of carbon dioxide (in the atmosphere)

Allow (burning natural) gas adds to global warming

Allow (burning natural) gas adds greenhouse gases (to the atmosphere)

1

Ignore references to energy / cost

[2 marks]

Mark scheme 07

The amount of carbon dioxide used to produce the ethanol 1

Is the same as the amount of carbon dioxide given off when the ethanol is burned 1

Alternative approach

There is sufficient carbon dioxide (in the atmosphere) (1)

Because carbon dioxide is constantly produced from burning fossil fuels (1)

If no other mark awarded allow for 1 mark burning ethanol produces carbon dioxide

[2 marks]

Mark scheme 08

Methane [1 mark]

Mark scheme
09.1

Incomplete combustion 1

(Because of) insufficient oxygen 1

Max 1 mark if soot wrongly identified

[2 marks]

Mark scheme
09.2

Sulfur reacts with oxygen to form sulfur dioxide
Allow SO₂ for sulfur dioxide
Allow sulfur burns to form sulfur dioxide 1

(So) less sulfur dioxide emitted 1

(So) less acid rain 1

(So less) limestone reacts with acid rain 1

[4 marks]

Mark scheme
09.3

(Car engines work at) high temperatures

1

(So in the engine) nitrogen (from air) reacts with oxygen (from air)

1

[2 marks]

Mark scheme
10.1

Respiratory problems

Allow named respiratory conditions e.g. asthma

Allow breathing problems

or

Acid rain

Allow consequences of acid rain e.g. kills aquatic life

or

Damages limestone buildings

Allow smog

[1 mark]

Mark scheme
10.2

(Increased)

More traffic

Allow more cars

1

(Decreased)

Improved efficiency of car engines

Allow use of catalytic converters

Allow more electric / hybrid cars

Allow lower temperature of car engines

Allow more use of public transport

Allow more people walk / cycle

Ignore better designed engines

1

[2 marks]

Mark scheme
11.1

Incomplete combustion

1

(Because) insufficient / limited oxygen supply

1

[2 marks]

Mark scheme
11.2

Any **two** from:

- Carbon monoxide toxic / poisonous.
Allow description of how carbon monoxide is toxic / poisonous
Ignore carbon monoxide is harmful / dangerous / deadly
- Greater public concern / awareness about pollution.
Ignore comments about the effects of other pollutants
Ignore unspecified comments about carbon monoxide pollution
- More cars so otherwise there would be more carbon monoxide entering atmosphere.
- Improved engine technology.
- Catalytic converters have been introduced.

[2 marks]

Mark scheme
11.3

Any **one** from:

- (To reduce) health problems.
Allow (to reduce) specified health problems e.g. breathing difficulties, asthma, lung cancer
- (To reduce) global dimming.
Allow (to reduce) the effects of global dimming e.g. reduced light levels
Allow (to reduce) smog
Allow (to reduce) the formation of particulates
Ignore global warming
*Do **not** accept to reduce soot*

[1 mark]

Any **two** from:

- Acid rain.
Allow specific effects of acid rain
- Respiratory problems.
Allow specific respiratory problems e.g. breathing difficulties, asthma
- Carbon monoxide.
- Global dimming **or** smog.

Max 1 mark if global warming mentioned

[2 marks]

5.10 Using resources

Trilogy Higher Topic Test Markscheme

Mark scheme
01.1

Level	Description	Marks
2	Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	3-4
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

- Choose an appropriate source of fresh water
- Such as rivers, streams, lakes, boreholes
- Pass through filter beds
- (Which) removes undissolved solids
- Sterilise
- Using chlorine / ozone / UV light
- (Which) destroys harmful microbes

[4 marks]

Mark scheme
01.2

$$\frac{260}{1413} \times 100$$

1

$$= 18.40056617 \%$$

1

$$= 18.4 \%$$

Allow an answer correctly calculated to 3 significant figures from an incorrect percentage calculation which uses values in the question

1

[3 marks]

Mark scheme
01.3

Any **one** from:

- The population increased
- More waste water produced
- Less untreated sewage discharged

[1 mark]

Mark scheme
01.4

Any **two** from:

- Increased demand for food (due to increasing population)
Allow more farming
 - Conserves energy / resources
Allow more sustainable
 - Landfill space is running out
Allow more awareness of the negative environmental impacts of landfill
Ignore less sent to landfill
 - Increased demand for organic fertiliser
Allow lifestyle choice for organic food
- Ignore references to cost*

[2 marks]

Mark scheme 02

Level	Description	Marks
3	A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5-6
2	Some logically linked reasons are given. There may also be a simple judgement.	3-4
1	Relevant points are made. They are not logically linked.	1-2
	No relevant content	0

Indicative content

Examples of relevant points might include:

- Car **C** produces the most CO₂ during manufacture
- Car **A** produces the most CO₂ per km when driving
- Car **C** produces the most CO₂ from manufacture and 40,000 km when driving
- Car **B** produces the most CO₂ from manufacture and 100,000 km when driving

Examples of linked statements might include:

- Car **A** produces least CO₂ during manufacture, but most CO₂ per km
- Car **C** produces most CO₂ during manufacture, but least CO₂ per km
- Car **A** produces least CO₂ during manufacture, but car **C** produces the least CO₂ per km

Examples of judgements might include:

- Overall car **A** has the smallest carbon footprint as it has the smallest CO₂ production during manufacture, the smallest mass of CO₂ after 40,000 km of driving and the smallest mass of CO₂ produced after 100,000 km of driving
- Car **A** eventually (after 157,895 km) will have the largest carbon footprint because the mass of carbon dioxide produced per km is highest

[6 marks]

Mark scheme 03

Meets needs of current generation

1

Without compromising needs of future generations

Allow so there are enough resources for future generations

Ignore references to harming / damaging planet / environment

1

[2 marks]

Mark scheme 04

Any **two** from:

- Poly(propene) comes from a non-renewable source.
Allow poly(propene) will run out
- Poly(propene) requires a lot of energy to make.
- Poly(propene) is not biodegradable.
- A wool carpet needs replacing more often.
Must refer to the carpet, not just the fibre
- Wool requires the use of large areas of land (which could be used to grow food crops).
Ignore references to cost
Ignore pollution
Ignore landfill

Allow converse arguments

[2 marks]

Mark scheme
05.1

Dependent

[1 mark]

Mark scheme
05.2

Not all water had been removed from the sample

Allow description of process

1

Heat to constant mass

1

Alternative approach:

Mass included (droplets of) water on the bottom of the evaporating basin (1)

Allow bottom of evaporating basin was wet

Ignore spillages

Ignore weighing errors

Dry the bottom of the evaporating basin (1)

Allow wipe off droplets

[2 marks]

Mark scheme
05.3

(a) $\frac{0.22 + 0.23 + 0.20 + X}{4} = 0.21$

1

(X =) 0.19 (g)

1

(b) C

1

Biggest difference between the maximum and minimum values

Allow calculated range if all ranges are shown A 0.04; B 0.06; C 0.15 and D 0.12

1

Allow ecf from question part (a)

[4 marks]

Mark scheme 06

Growing plants (on low-grade ore)

Allow named plant

1

Plants are burnt (to produce ash)

1

(Ash dissolved in acid to produce) solution of a copper compound

Allow named copper compound

1

Electrolysis (of solution of a copper compound)

or

Displacement (by adding scrap iron to a solution of a copper compound)

Allow addition of scrap iron (to a solution of a copper compound)

1

[4 marks]

Mark scheme
07.1

Any **two** from:

Energy used in:

- Extraction of raw materials
- Processing raw materials
- *Allow energy used to make food plate materials*
- Manufacturing
- Transportation
- Cleaning non-disposable plates
- Disposal
- Recycling

[2 marks]

Mark scheme
07.2

Level	Description	Marks
2	A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	3-4
1	Some logically linked reasons are given. There may also be a simple judgement.	1-2
	No relevant content	0

Indicative content

Raw materials

- Trees are renewable
- Crude oil and clay are finite

Manufacturing and packaging

- Paper plates use the least packaging so conserve raw materials
- Paper plates need less transportation overall as more plates in a 10 dm³ cardboard box

Use and operation

- Paper plates are single use so must be replaced most often
- Ceramic plates last longer than polymer plates so must be replaced less often

Disposal

- Polymer / ceramic plates take up landfill which is running out
- Paper / polymer plates can be used to make new products
- Recycling conserves raw materials

Reasoned judgement

[4 marks]

Mark scheme 08

(Decrease =)
6.7 (billion)

1

(% decrease =)

$$\frac{6.7}{8.0} \times 100$$

Allow correct use of an incorrect value for decrease in plastic bag use

1

= 84 (%)

Allow 83.75 / 83.8 (%)

1

Alternative approach:

(% now used =)

$$\frac{1.3}{8.0} \times 100 (1)$$

= 16.25 (1)

(% decrease =)

84 (%) (1)

Allow 83.75 / 83.8 (%)

[3 marks]