M1.(a) sulfur / sulphur / S / S(s)

1

(b) as the temperature increases, the rate of reaction increases

allow two correct values for rate quoted (from graph) at different temperatures

1

the rate of increase increases **or** there is an exponential relationship

*accept the rate of reaction increases slowly (from 20 °C to 50 °C) then increases more rapidly for **2** marks*

answer MUST be based on rate / speed of reaction

1

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

- temperature (of the reactants)
- concentration of hydrochloric acid
- volume of hydrochloric acid
- volume of sodium thiosulfate
- the (size / darkness / thickness of the) cross
- total volume of solution.

*if no other marks gained, allow **1** mark for:*

rate of stirring

OR

amount of hydrochloric acid / sodium thiosulfate

OR

volume of solution

2

(ii) (because as the concentration increases) the number of particles per unit volume increases **or** particles are closer together.

idea of more particles in a given space is required for the first mark.

ignore references to area.

1

(therefore) the frequency of (successful) collisions increases

allow increased chance / probability of collisions

number of collisions increases is insufficient here.

***must** mention per unit time or frequency.*

ignore speed of collisions.

if reference to space and time missing from M1 and M2 but they are otherwise correct, then award 1 mark.

1

so the number of particles (per unit volume) doubles **or** (the frequency of) collisions doubles.

*students can score **2** marks for a qualitative explanation; the third mark is for a quantitative explanation.*

1

[8]

M2.(a) (i) the higher the temperature, the greater the rate

or

at 40 °C rate is faster than at 20 °C

accept the higher the temperature, the faster the reaction

1

(ii) 40 °C curve is steeper

accept the 40 °C line becomes horizontal sooner

accept at higher temperatures the reaction finishes sooner

accept reaction finishes sooner at 40 °C

accept at higher temperatures the gas is produced faster

or

correct comparison of data from the graph

1

(iii) 2

1

(b) (i) Concentration of acid

Mass of marble chips

2

(ii) increases rate

*incorrect reference to energy = max **1***

1

(because of) more frequent collisions (between particles)

accept particles are more likely to collide

ignore more collisions

ignore more successful collisions

1

(c) any **one** from:

- increases rate of reaction
- reduces energy required
- lower temperature can be used
- catalyst is not used up.

1

[8]

M3.(a) (i) precipitation

1

(ii) (aq) on left hand side

1

(s) on right hand side

1

(iii) potassium iodide

1

potassium nitrate

1

(iv) filtration

1

(b) (i) diffusion

1

(ii) iodide ions move / diffuse faster than lead ions **or** travel further in the same time

Must be a comparison

Accept converse

1

because the lead iodide forms much closer to the lead nitrate (or **X**) than the potassium iodide (or **Y**).

allow because iodide ions are smaller than lead ions

allow references to potassium iodide and lead nitrate

1

(iii) the particles / ions move / diffuse faster

ignore which particles / ions the student refers to

1

because they have more energy **or** will collide / meet sooner

ignore reference to frequency of collisions

1

[11]

M4.(a) time from when the heating is started until

1

the limewater turns cloudy / milky

1

(b) (i) the temperature was not high enough

accept the copper carbonate had not started to decompose / react

accept it takes time to heat up the copper carbonate

1

the bubbles of gas were air

accept no carbon dioxide produced

1

(ii) the copper carbonate was decomposing / reacting

accept the temperature was high enough to cause decomposition / a reaction

1

so carbon dioxide was produced

allow correct word / symbol equation

1

(iii) copper oxide was produced

allow correct word / symbol equation

1

because the copper carbonate had <u>completely</u> decomposed / reacted

ignore all of the carbon dioxide had been given off

1

[8]

M5.(a) because sulfur / S forms

1

which is insoluble / a solid / a precipitate

1

(b) (i) 32

*correct answer with or without working gains **2** marks*

*accept evidence of 31 + 33 / 2 for **1** mark*

*allow 35 for **1** mark*

2

(ii) reaction rate increases

*if incorrect reference to energy = max **2***

1

because of more particles (per unit volume)

allow because particles are closer together

1

and because there is an increase in frequency of collisions

*accept because particles are more likely to collide **or** higher chance of collision*

ignore more (successful) collisions

1

[7]

M6.(a) (i) a continuous <u>straight line</u> missing anomalous point

allow a line which does not start at zero / origin

1

(ii) any **two** sensible errors eg

*ignore systematic / zero error / weighing error **or** error unqualified*

- timing errors and / or example
- measurement errors and / or example
- apparatus errors and / or example
- human / experimental / reading / random error and / or example

or 'did not do it right'

*could be two from **same** category*
eg two timing errors – watch not started at the same time plus difficulty in deciding when the cross has disappeared.

- temperature fluctuation
- anomalous point

accept outlier / wrong result

- results not recorded correctly
- plotting error
- rate calculated incorrectly

ignore 'not repeated'

2

(b) (i) <u>straight line</u>

*allow as concentration increases the rate goes up **or** converse*
allow numerical example
allow positive correlation
allow same gradient
ignore 'most points near / on line of best fit'

1

(ii) because of an increase in <u>frequency</u> of collisions

*max **1** if incorrect reference to energy **or** if subatomic particle specified*

accept because particles are more likely to collide or higher chance of collision

ignore more (successful) collisions

1

because there are more particles (per unit volume)

allow because particles are closer together

1

[6]

M7. (a) gives out energy **or** heat

1

(b) (i) *accept qualified answers in terms of volume of gas related to time*

fast initially

1

slows down

1

reaction stops

accept reaction is now very slow

1

(b) (ii) 21

1

(iii) 84

*correct answer with or without working = **2** marks*
*allow ecf from (b)(ii) correctly calculated for **2** marks*
*allow evidence of 21/25 **or** (b)(ii)/25 for **1** mark*

2

(c) because they / particles have more energy / move faster

ignore particles move more / vibrate

1

(and so) particles collide more often / more frequently **or** particles more likely to collide

ignore collide faster
ignore more collisions

1

(and) more of the collisions are successful **or** particles collide with more energy / harder **or** more of the particles have the activation energy

accept more successful collisions

1

[10]