

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 completely 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 straight line 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) straight line
*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 frequency 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]