01. 0620_w21_ms_43 Q: 6

Question	Answer	Marks
(a)	**M1** (a substance that) speeds up a reaction / increases the rate of a reaction (1) **M2** unchanged chemically at the end (1)	**2**
(b)(i)	oxygen gas escapes	**1**
(b)(ii)	**M1** rate decreases **OR** rate / reaction is fastest at the start (1) **M2** reaction stops **or** rate = zero (1)	**2**
(c)(i)	**M1** (particles) have more kinetic energy / particles move faster(1) **M2 more** collisions per unit time (1) **M3 more** particles have energy greater than or equal to activation energy **OR** **more** particles have sufficient energy to react **OR** A greater percentage or greater proportion or greater fraction of collisions have sufficient energy to react **OR** A greater percentage or greater proportion or greater fraction of collisions have energy greater than or equal to activation energy **OR** A greater percentage or greater proportion or greater fraction of collisions are successful (1)	**3**
(c)(ii)	**M1** steeper gradient from start (1) **M2** levels off **at the same mass** (1)	**2**

02. 0620_s20_ms_42 Q: 4

(a)	substance that speeds up a reaction / increases rate (1) unchanged (chemically) at the end **OR** not used up **OR** lowers activation energy **OR** provides alternative pathway (1)	**2**
(b)	rate decreases (1) particles further apart / less particles per unit volume (1) fewer collisions per unit time / lower collision frequency (1) reaction stops because all hydrogen peroxide is used up	**4**
(c)	steeper gradient (1) reaches same volume of oxygen (1)	**2**
(d)	particles gain kinetic energy / particles move faster (1) greater number of collisions with activation energy (or more) / greater number of particles with activation energy (or more) / greater number of particles with energy required for reaction (1) more collisions are successful / more collisions are fruitful / more collisions lead to reaction (1)	**3**
(e)	**M1** moles of oxygen $= \frac{48.0}{24\,000}$ or moles of oxygen = 0.002 (1) **M2** moles of hydrogen peroxide = **M1** $\times 2$ or moles of hydrogen peroxide = 0.004 (1) **M3** concentration = **M2** $\times 40 = 0.16$ mol / dm^3 (1) allow ECF	**3**
(f)	$2KClO_3 \rightarrow 2KCl + 3O_2$ **ALL** formulae correct (1) balancing (1)	**2**

03. 0620_w18_ms_42 Q: 4

(a)(i)	Gradient gets less	1
(a)(ii)	Concentration of HC*l* is decreasing	1
(a)(iii)	120 seconds	1
(b)	M1 New line steeper than printed line and starts at origin M2 New line reaches same final volume as printed line	2

(c)	M1 **Time** taken is less M2 (particles) have more energy M3 (particles) move faster M4 More collisions (of particles) occur per second / per unit time M5 More (of the) particles / collisions have energy greater than activation energy **or** More (of the) particles / collisions have sufficient energy to react **or** A greater percentage / proportion / fraction of collisions (of particles) are successful	5

04. 0620_w18_ms_43 Q: 5

(a)	**M1** volume of gas **M2** time	2
(b)	**M1** rate decreases / reaction gets slower **M2** concentration of acid decreases **M3** fewer collisions per unit time	3

(c)	**M1** particles have **more** kinetic energy **M2** particles move fast**er** **M3 more** collisions **per unit time** **M4 more** of the particles have energy greater than or equal to activation energy / **more** of the collisions have energy greater than or equal to activation energy **OR** **more** of the particles have sufficient energy to react / **more** of the collisions have sufficient energy to react **OR** A greate**r** percentage or greate**r** proportion or greate**r** fraction of collisions are successful	**4**
(d)	**ANY TWO FROM:** □ increase concentration of hydrochloric acid □ decrease particle size of calcium carbonate / increase surface area of calcium carbonate □ (add)catalyst	**2**

05. 0620_s17_ms_41 Q: 5

(a)	(stop-) watch **AND** syringe	**1**
(b)	graph starts at **X** and is a curve with a decreasing gradient	**1**
	graph hits zero rate at 114 □ 6 seconds	**1**
(c)	**M1** moles of carbon dioxide = 180 / 24 000 = 0.0075	**1**
	M2 molar mass of barium carbonate = 197	**1**
	M3 mass of barium carbonate = **M1** □ **M2** = 1.48 (g)	**1**
(d)	curve starts from (0,0) and has a lower gradient than the original curve	**1**
	because lumps have a lower surface area	**1**

(e)	curve starts from (0,0) and has a steeper gradient than the original curve	**1**
	finishes at the same volume of gas	**1**
	because there are more particles per unit volume / dm^3 / cm^3	**1**
	because there are more collisions per second / unit time **OR** a greater collision rate	**1**
(f)	360 (cm^3)	**1**

06. 0620_w17_ms_41 Q: 7

(a)(i)	more particles (of acid) in a given volume / dm^3 / cm^3	**1**
	more collisions per second / unit time **OR** greater collision rate	**1**

(a)(ii)	particles have more energy / particles move faster / more collisions per second / more collisions per unit time / greater collision rate	**1**
	more (of the) particles / collisions have energy greater than the activation energy / more particles have sufficient energy to react / more collisions have sufficient energy to react / a greater percentage of collisions are successful	**1**
(b)(i)	0.075 If full credit is not awarded, allow 1 mark for M_r of CuO = 80	**2**
(b)(ii)	0.05	**1**
(b)(iii)	4 (g) **M1** moles copper(II) oxide that reacted = (0.05 / 2) = 0.025 mol **M2** mass copper(II) oxide = ((0.075 – 0.025) □ 80) = 4 g	**2**
(c)	$CI_2CuH_4O_2$ **M1** 41.52 / 35.5; 37.43 / 64; 2.34 / 1; 18.71 / 16 **OR** 1.17 : 0.58 : 2.34 : 1.17 **M2** appropriate scaling to give whole number ratios	**2**

07. 0620_p16_ms_40 Q: 3

(a) (i) 6e between two nitrogen atoms; note: can be any combination of dots or crosses [1]
1 lone pair on each nitrogen atom; [1]

(ii)

	solid	gas	
pattern:	regular / lattice	random / irregular / no pattern;	[1]
distance:	close	far apart / spread out;	[1]
movement:	vibrate / fixed position	moving;	[1]

note: comparison must be made

(b) particles have more energy / move faster; [1]
collide harder / collide more frequently / more collisions / collide with more force; [1]
allow: molecules instead of particles

(c) (i) nitrogen has smaller M_r; [1]
nitrogen (molecules) move faster (than chlorine molecules) / ora; [1]
note: comparison must be made

(ii) (at higher temperature) molecules move faster / have more energy [1]

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08. 0620_w16_ms_41 Q: 8

(a)(i)	any 4 from: slowed down acid became less concentrated **OR** fewer particles per unit volume fewer collisions per second **OR** lower collision rate (then the reaction) stopped all the hydrochloric acid reacted	**4**
(a)(ii)	any 4 from: faster (reaction) (powder has) larger surface area more collisions per second **OR** higher collision rate same volume of gas amount / moles hydrochloric acid is not changed	**4**
(b)	any 5 from: temperature increased particles have more energy (particles) move faster more collisions per second **OR** higher collision rate more particles have sufficient energy to react / activation energy more of the collisions are successful	**5**

09. 0620_s13_ms_31 Q: 3

(a) (i) pieces have (same) surface area [1]
same amount / mass / quantity / volume / number of moles of carbonate [1]

(ii) no more bubbles / carbon dioxide **or** piece disappears / dissolves [1]

(b) experiment 1 Ca^{2+} + CO_2 + H_2O [1]

(c) (i) more concentrated **or** higher concentration (of acid) (in experiment 1) [1]
accept: arguments based on collision theory

(ii) ethanoic acid is a weak acid **or** hydrochloric acid is a strong acid [1]
accept: stronger or weaker

ethanoic acid less ionised / dissociated / lower / smaller concentration of hydrogen ions [1]
accept: less hydrogen ions and vice versa argument but not dissociation of ions

(iii) lower temperature (particles) have less energy [1]
moving more slowly [1]
fewer collisions / lower collision rate [1]
or
lower temperature (particles) have less energy [1]
fewer particles collide [1]
with the necessary energy to react [1]
note: less energy fewer successful collisions gains all 3 marks

[Total: 10]

10. 0620_s13_ms_33 Q: 2

(a) (i) large / high surface area [1]

high collision rate / collide more / many collisions [1]
(between oxygen molecules and aluminium atoms)
NOT faster collisions

(ii) concentration [1]
of reactants decreases [1]

allow one mark **ONLY** *for:*
for reactants used up **or** amount of reactant decreases

(iii) *any three of four from one strand:*

M1	increase in temperature	
M2	molecules move faster **or**	particles have more energy
M3	higher collision rate	
M4	more successful collisions **or**	more particles have enough energy to react/E_a

[3]

(b) (i) flour **or** wood dust **or** coal dust or carbon or sugar [1]

(ii) any three from:
powder and larger pieces / different sized particles use
suitable named solid, e.g. magnesium
suitable named solution, e.g. named acid **or** copper sulfate(aq)
result – powder reacts faster than larger pieces [3]
NOT Cu (with acid); K / Na with anything

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11. 0620_w13_ms_31 Q: 4

(a) (i) (mass at t =0) – (mass at t = 5) [1]
NOTE: must have mass at t = 5 not final mass

(ii) fastest at origin
slowing down between origin and flat section gradient = 0
where gradient = 0
three of above in approximately the correct positions [2]

(iii) 3 correct comments about gradient = [2]
2 correct comments about gradient = [1]
1 correct comment about gradient = [0] [2]

(b) start at origin and smaller gradient [1]
same final mass just approximate rather than exact [1]

(c) **(i)** smaller surface area [1]
lower collision rate [1]

(ii) molecules have more energy [1]
collide more frequently / more molecules have enough energy to react [1]

(d) number of moles of HCl in 40 cm^3 of hydrochloric acid,
concentration 2.0 mol / dm^3 = 0.04 × 2.0 = 0.08 [1]
maximum number of moles of CO_2 formed = 0.04 [1]
mass of one mole of CO_2 = 44 g [1]
maximum mass of CO_2 lost = 0.04 × 44 = 1.76 g [1]

[Total: 15]

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12. 0620_s12_ms_31 Q: 8

(a) **(i)** device which changes chemical energy; [1]
into electrical energy; [1]
OR
produces a voltage / potential difference / electricity; [1]
due to difference in reactivity of two metals; [1]
OR
produces a voltage / potential difference / electricity; [1]
by redox reactions; [1]

(ii) negative / electrode B / right electrode; [1]
accept: anode because it is the electrode which supplies electrons to external circuit
loses ions / iron ions / Fe^{2+} or Fe^{3+}; [1]
electrons move from this electrode; [1]

(iii) change of mass of electrode / mass of rust formed; [1]
time / mention of stop watch / regular intervals; [1]

(iv) to make it a better conductor; [1]

(b) moles of Fe = 51.85/56 = 0.926 (0.93); [1]
moles of O = 22.22/16 = 1.389 (1.39); [1]
moles of H_2O = 16.67/18 = 0.926 (0.93); [1]

if given as 0.9 1.4 0.9
three of the above correct = [2]
two of the above correct = [1]

simplest whole number mole ratio Fe : O : H_2O is 2: 3: 2 / $Fe_2O_3.2H_2O$; [1]
allow: ecf for a formula based on an incorrect whole number ratio

[Total: 12]

(a) (i) A C D B [1]

(ii) speed (or rate) increases as concentration increases / time decreases as concentration increases; [1]
rate or speed or time depends on (concentration) of H^+ or hydrogen ions; [1]
B is slow because propanoic acid is weak or doesn't dissociate or weakly ionises;
or
B is slow because HCl **and** H_2SO_4 are stronger or ionise or dissociate more than propanoic; [1]
D slower than C because C is more concentrated than D / ORA; [1]
A is fast because H^+ concentration high (**note:** this would also score second mark if not already awarded) / H_2SO_4 is diprotic or dibasic or $2H^+$; [1]
time is inversely proportional to rate / owtte / ORA; [1]
max [5]

(b) change 1:
increase temperature / heat (the mixture); [1]
particles/molecules/ions have more energy or move faster; [1]
more (successful) collisions / more particles with E_a; [1]
change 2:
increase surface area / decrease particle size / use powdered (magnesium) / use smaller pieces / crush the magnesium; [1]
more collisions / more particles exposed to reaction; [1]
or
catalyst; [1]
more (successful) collisions; [1]
lowers E_a; [1]
max [5]