A-Level Chemistry

Physical Practical Questions

Mark Scheme

Time available: 77 minutes
Marks available: 63 marks

1. (a) ANY THREE

Ignore apparatus changes

Record all masses (accurately to 2 decimal places)

Weigh by difference / wash the solid from weighing container into the beaker / add solid directly to volumetric flask (via a funnel) and dissolve in approximately 100 cm^3 of distilled water.

Wash the beaker into the flask after the solution is transferred to the volumetric flask / wash the stirring rod into the flask after use / wash beaker and transfer washings to the volumetric flask.

(Use a dropper when adding close to the graduation mark to) ensure the bottom of the meniscus is on the graduation mark

Mix thoroughly the final solution in the volumetric flask / invert the flask several times (after making the solution up to the graduation mark).

3

(b) $\frac{0.20}{250} \times 100 = 0.080$ %

1

[4]

2. (a) **M1** measure the mass of the weighing boat (or similar) and solid

1

M2 Add the solid to a beaker (or other suitable container) and then reweigh the weighing boat (and subtract to find the mass of solid added.)

1

OR

M1 Place weighing boat on a balance and zero the balance

M2 Add the solid to a beaker (or other suitable container), wash out weighing boat and transfer washing to the beaker.

M1 place (an empty) beaker on balance and zero
M2 add the solid to the beaker and record the mass

OR

M1 place (an empty) beaker on balance and measure its mass
M2 add the solid to the beaker and subtract mass of empty beaker from the total mass

(b) **M1** M_r citric acid = 192.0

1

M2 Amount of citric acid = Mass / M_r
= 0.834 / 192
= 0.0043438 (mol)

M2 conseq on M1

1

M3 Concentration = moles / volume
= 0.0043438 / 0.5
= 0.00869 (mol dm^{-3})

M3 conseq on M2

1

Alternative Method

M1 Concentration (g/dm^3) = 0.834 / 0.50 = 1.668

M2 M_r citric acid = 192.0

M3 Concentration (mol/dm^3) = M1/M2 = 0.00869

(c) This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.

Level 3 Three stages are covered and the explanation of each stage is generally correct and virtually complete Answer is well structured with no repetition or irrelevant points. Accurate and clear expression of ideas with no errors in use of technical terms.	5-6 marks
Level 2 Three stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete Answer shows some attempt at structure. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. Some minor errors in use of technical terms.	3-4 marks
Level 1 Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete. Answer includes isolated statements but these are not presented in a logical order or show some confusion. Answer may contain valid points which are not clearly linked to an argument structure. Errors in the use of technical terms.	1-2 marks
Level 0 Insufficient correct chemistry to gain a mark.	0 marks

Use best three of these four stages

Stage 1

a. Problem – using a measuring cylinder
b. Explanation – large uncertainty / not accurate enough
c. Improvement – use a (volumetric) pipette (Not dropping pipette)

Stage 2

a. Problem – too much indicator
b. Explanation – may react and affect the endpoint reading
c. Improvement – use a smaller volume (2-6 drops)

Stage 3

a. Problem – rinsing the burette with distilled or deionised water
b. Explanation – will slightly dilute the alkali solution
c. Improvement – rinse the burette with alkali solution

Stage 4

a. Problem – adding alkali solution until the indicator "just" changes colour
b. Explanation – acid may not have fully reacted (as mixture not swirled)
c. Improvement – add alkali solution until a permanent colour change is seen.

6

(d) Calculates the titres for each of 1,2,3 as

1	2	3
22.95	23.10	22.90

1

Averages concordant titres:
(22.95 + 22.90) ÷ 2 = 22.93 cm^3

Allow 22.9(25) cm^3

1

(e) (0.15 / 22.95) × 100 = 0.65%

0.15 / (Their Run 1) × 100

1

[14]

3. (a) 111(.1)

Allow an answer to a finite number of sig figs (that is correctly rounded)

Allow 110

Do not allow answers with recurring dot above number (ignore dots after the final number)

1

(b) temperature

1

(c) Measure the temperature at the start and end of the reaction and find the mean/average

Measure the temperature at regular intervals during the reaction and find the mean/average

Allow idea of doing the reaction in a water bath

1

(d) **M1** suitable vertical scale

***M1** should use more than half the axis to cover the four points given and the point for 67°C (if plotted)*

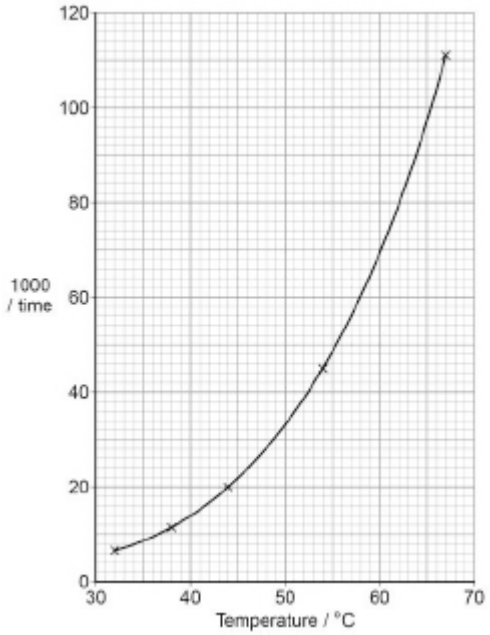
1

M2 points plotted correctly (±½ small square per point)

***M2** allow ECF for plotting of point found in part (a) (if no value found in part (a) allow graph that omits this)*

1

M3 best fit line drawn (within one small square of each point and should be a smooth curve)



***M3** allow ECF for a line based on their plotted points, but only where the line continues to rise throughout the temperature range*

1

(e) $\text{Time} = \frac{1000}{\text{value from graph at 60°C}}$

Answers should be at least 2 sf

Working needs to be shown that includes a value from the graph at 60 °C and/or construction line(s) showing 1000/t at 60 °C on the graph

Use the value their line shows at 60 °C (±½ small square)

1

(f) **M1** many more particles/ions have (energy ≥) activation energy

***M1** need the idea that it is many / much more particles; allow reference to atoms / molecules instead of particles / ions*

1

M2 more successful collisions per unit time / greater frequency of successful collisions

***M2** allow higher proportion of the collisions are successful*

1

[9]

4. (a) **M1** High**er**/**est** concentration of / more H_2O_2 / particles / molecules / reactants

1

M2 More frequent successful collisions

1

Alternative approach

***M1** Low**er**/**est** concentration of / fewer particles / molecules / reactants as time goes on*

***M2** Less frequent successful collisions (look for both ideas even if separated)*

***Ignore** 'chance' / 'probability'*

(b) **M1** Suitable tangent drawn

***M1** Tangent must be drawn with ruler and touch line at 0.05 mol dm^{-3} (± 1 square) and not cross the curve (if white seen between lines it crosses)*

1

M2 **−**0.00120 to –0.00155 (mol dm^{-3} s^{-1})

***M2 Ignore** units*

***Allow** ecf from unsuitable tangent i.e if M1 not awarded*

***Ignore** sign of gradient*

1

(c) **M1** $[H_2O_2]_{initial}$ = 0.083 mol dm^{-3}

***Allow** 0.082 − 0.084*

1

M2 $[H_2O_2]_t$ = 0.0664 (mol dm^{-3})

***Allow** 0.0656 − 0.0672 (scores 2/2)*

2SF minimum

***Allow** ecf from **M1** (M2 = M1 × 0.8)*

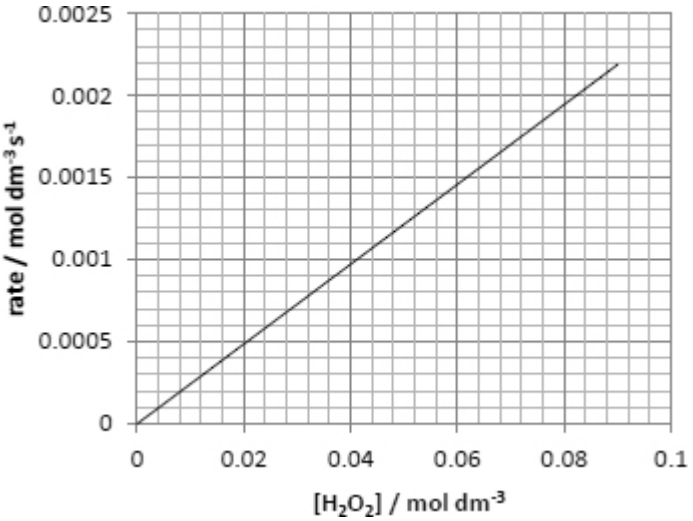
1

(d) **M1** Points plotted

M1 *allow each point (± 1/2 square)*

1

M2 best fit straight line drawn



M2 *line should be drawn with a ruler and cover the five points given going within 1 square of each point, no doubles no kinks. The line does not need to be extended to the origin*

Allow *reasonable best fit line if points plotted incorrectly*

1

(e) **M1** 1st order

1

M2 straight line graph through the origin

Ignore *rate is (directly) proportional to* $[H_2O_2]$

Allow *constant gradient line through the origin*

Allow *use of data from line to show e.g. x2 conc = x2 rate*

Allow *if M1 missing*

Not *if M1 wrong*

1

[10]

5. (a)

	Temp/ ^{o}C		Mass /g
Initial		Burner before	
Final		Burner after	
(ΔT)		(Mass heptane burned)	

M1 for Temperature data including units

M2 for Burner mass data including units If either unit missing MAX 1

M1
M2

(b) Any two from:

Glass is a poorer conductor than copper

M1

Tripod and gauze would reduce heat transfer

Tripod and gauze would have a fixed height above the flame

Heat capacity of metal is less than glass or vice versa

M2

(c) Heat loss to surroundings or to copper/calorimeter

M1

Incomplete combustion

M2

(d) Use a wind shield (to reduce heat loss)

Allow use a lid

Insulate the sides of the calorimeter

1

[7]

6. (a) $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^{-}$

*If equations reversed, allow **M1** only.*

1

$Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$

Ignore state symbols.

1

(b) Moles of copper(II) reacted = (100 / 1000) × 0.5 = 0.05

1

Moles of zinc reacted = 0.05

1

Mass of zinc lost = 0.05 × 65.4 = 3.27 g

*Correct final answer without working scores **M3** only.*

1

(c) Allow cell to discharge until $[Cu^{2+}]$ is 0.5

Alternative: Allow cell to discharge completely.

1

Confirmed by colorimetric measurement or other suitable method

Solution colourless or use of chemical test to determine absence of copper(II)

1

Weigh the Zn electrode before and after the experiment

Weigh Zn electrodes before and after and halve the mass change.

1

[8]

7. (a) ($Q = mc\Delta T$)

= 50 × 4.18 × 27.3

If incorrect (eg mass = 0.22 or 50.22 g) ***CE = 0 / 2***

1

= **5706 J** (accept 5700 and 5710)

Accept 5.7 kJ with correct unit. Ignore sign.

1

(b) M_r of 2-methylpropan-2-ol = 74(.0)

For incorrect M_r, lose M1 but mark on.

1

Moles = mass / M_r

= 0.22 / 74(.0)

= **0.00297 moles**

1

ΔH = –5706 / (0.002970 × 1000)

= **–1921 (kJ mol^{-1})**

If 0.22 is used in part (a), answer = –8.45 kJ mol^{-1} scores 3

(Allow –1920, –1919)

If uses the value given (5580 J), answer = –1879 kJ mol^{-1} scores 3

Answer without working scores M3 only.

Do not penalise precision.

Lack of negative sign loses M3

1

(c) ΔH = ΣΔH products – ΣΔH reactants
OR a correct cycle

Correct answer with no working scores 1 mark only.

1

$\Delta H = -(-360) + (4 \times -393) + (5 \times -286)$

M2 also implies M1 scored.

1

ΔH = **–2642** (kJ mol^{-1}) This answer only.

Allow 1 mark out of 3 for correct value with incorrect sign.

1

(d) (–2422 – part (b)) × 100 / –2422

Ignore negative sign.

Expect answers in region of 20.7

If error carried forward, 0.22 allow 99.7

If 5580 J used earlier, then allow 22.4

1

(e) Reduce the distance between the flame and the beaker / put a sleeve around the flame to protect from drafts / add a lid / use a copper calorimeter rather than a pyrex beaker / use a food calorimeter

Any reference to insulating material around the beaker must be on top.

Accept calibrate the equipment using an alcohol of known enthalpy of combustion.

1

(f) Incomplete combustion

1

[11]