Practice Paper 1C

Section A

1	C	6	B	11	C
2	B	7	B	12	D
3	B	8	A	13	D
4	D	9	D	14	C
5	B	10	A	15	A

Section B

16 a) i) $Ba_{(g)} + \frac{1}{2}O_{2(g)}$ ✓

   ii) $Ba^+_{(g)} + \frac{1}{2}O_{2(g)} + e^-$ ✓

b)   1st electron affinity (of oxygen) ✓

c)   Energy is required to overcome the repulsion between the electron and a negative ion ✓

d) $\Delta H = -770 - -141 - 248 - 965 - 503 - 180 + -548$ ✓
   $\Delta H = -3073$ kJ mol⁻¹ ✓

e)   Larger as it requires more energy to remove an electron from strontium than from barium ✓
   Because strontium has fewer shells / is smaller AND has less shielding ✓

17 a)

LEVEL OF RESPONSE QUESTION	
Level 3: (5–6 marks)	Comprehensive practical account given in a logical fashion. Almost all key equipment included.
Level 2: (3–4 marks)	Account that covers most of the practical steps, in a mostly logical fashion. Some of the key equipment is included.
Level 1: (1–2 marks)	A few of the practical steps included, but with little sense of order. One or two key pieces of equipment included.
0 marks	No creditworthy response.

Indicative Content (IGNORE references to specific quantities)
- Measure equal volumes of acid from each insect using suitable apparatus (pipette or micro-syringe)
- Add to a volumetric flask, and add distilled water to the volumetric flask until it almost reaches the line
- Make up to the fixed amount using a teat pipette to bring the bottom of the meniscus to the measuring line
- Invert the volumetric flask repeatedly to mix the solution
- Use a pipette to extract a known quantity of solution and add to a conical flask / other suitable piece of named glassware
- Add an indicator

b) i) $[H^+] = 10^{-pH} = 10^{-2.54} = 2.88 \times 10^{-3}$ ✓

   ii) $K_a = 10^{-pKa} = 10^{-3.75} = 1.778 \times 10^{-3}$ ✓
   $[HCOOH] = \frac{[H^+]^2}{K_a} = \frac{[2.88 \times 10^{-3}]^2}{[1.778 \times 10^{-3}]}$ ✓ ALLOW ECF from incorrect values above
   $[HCOOH] = 0.0468$ mol dm⁻³

   iii)   Negligible dissociation means that the concentration of H⁺ ions formed from dissociation can be ignored ✓
   So that $[H^+] = [HCOO^-]$ AND $[H^+] \times [HCOO^-] = [H^+]^2$ ✓

c) i) (A solution) that acts to minimise a change in pH ✓ (DO NOT ALLOW 'STOPS')
When small quantities of acid or base are added ✓

ii) Adding an **excess** of the weak acid to NaOH ✓

d) $[H^+] = \dfrac{[HCOOH] \times K_a}{[HCOO^-]} = \dfrac{0.125 \times 1.778 \times 10^{-3}}{0.100}$ ✓   ALLOW use of concentrations as given in question
$[H^+] = 2.22(2) \times 10^{-4}$ ✓
$pH = -\log_{10}[H^+] = -\log_{10}(2.222 \times 10^{-4}) = 3.7$ to 1 d.p. ✓

18 a) Correct dot-and-cross diagram ✓ (IGNORE inner electrons)
Shape is non-linear / bent ✓
Bond angle is <120° and >115° ✓
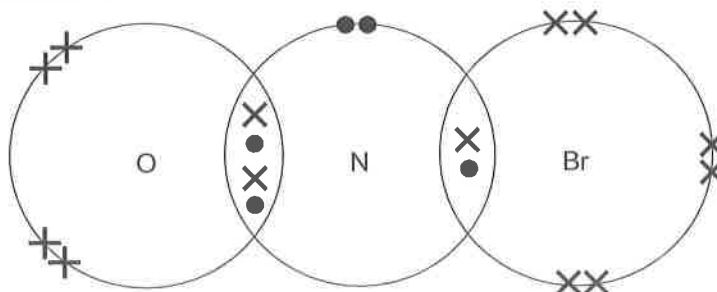
b) i) Record volume of gas produced against time ✓
Plot graphs of volume against time for different temperatures ✓
Draw tangents to the curves at t = 0 and compare the gradients of the tangents ✓

ii) It is not a closed system ✓

c) $K_c = \dfrac{[NO]^2 \times [Br_2]}{[NOBr]^2}$ ✓

	NOBr	**NO**	**Br₂**
Moles (initial)	Y	0.00	0.00
Moles (eqm)	Y − 0.089	0.089	0.0445
Concentration (eqm)	$\dfrac{Y - 0.089}{2}$	$\dfrac{0.089}{2}$	$\dfrac{0.0445}{2}$
Concentration (eqm)	$\dfrac{Y - 0.089}{2}$	0.0445	0.02225

✓ (Correct eqm moles)
✓ (Eqm moles / 2)
$K_c = \dfrac{[0.0445]^2 \times [0.02225]}{[\frac{Y-0.089}{2}]^2} = 0.0143$

$[\frac{Y-0.089}{2}]^2 = \dfrac{[0.0445]^2 \times [0.02225]}{0.0143}$

$Y = \left(2 \times \sqrt{\dfrac{[0.0445]^2 \times [0.02225]}{0.0143}} \right) + 0.089$ ✓ (Mark is for correct rearrangement in terms of Y)

$Y = 0.200$ (mol) ✓
Total moles = (0.200 − 0.089) + 0.089 + 0.0445 = 0.2445
Mole fraction of NOBr = (0.200 − 0.089) / 0.2445 = 0.454 ✓

d)   i)   Increase in the number of moles of gases means increase in disorder ✓
           ΔS should be positive ✓ (Must be linked to correct justification)

      ii)   Reaction must be endothermic in the forward direction so ΔH is positive ✓
           Because position of equilibrium shifts in the endothermic direction to oppose the increase in
           temperature (which is the forward reaction) ✓
           $\Delta G = \Delta H - T\Delta S$ AND ΔG must be negative for a reaction to proceed ✓
           Since ΔH is positive for the forward reaction, ΔG can only be favourable if ΔS is also positive ✓

19   a)
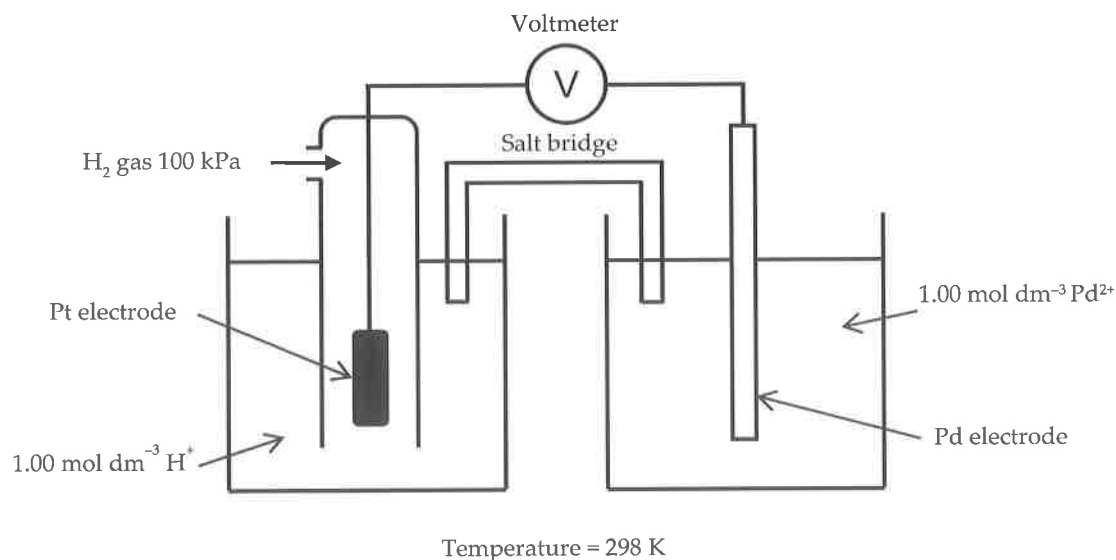
Temperature = 298 K

Inflow of hydrogen AND platinum electrode ✓
$1.00 \ mol \ dm^{-3}$ solutions AND temperature = 298 K AND 100 kPa / 1 bar pressure ✓
Pd electrode AND Pd^{2+} ions in solution ✓
Salt bridge AND voltmeter ✓

   b) $2H^+ + 2e^- \rightleftharpoons H_2$ moves to the left during the reaction AND because E° is less positive ✓
        pH decreases AND because $[H^+]$ increases (must be a reason for this mark to be awarded) ✓
        A different value is given because conditions are no longer standard / concentrations have changed ✓

20 a) Chlorine goes from +1 to -1 AND +5 ✓
Chlorine has been both oxidised and reduced ✓

b) More **frequent** collisions ✓
More of the collisions are above the **activation energy** ✓

c) i)
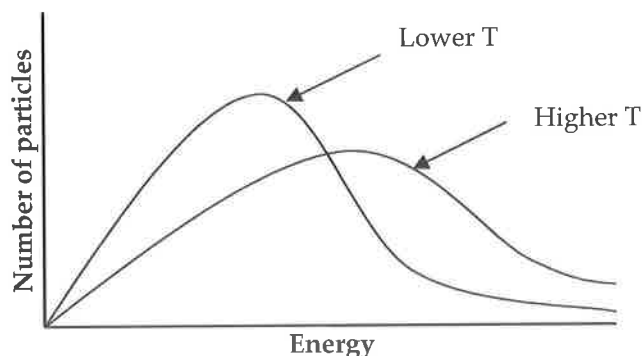
Axes correctly labelled ✓
Correct shape of curve ✓
Labelled higher T curve with a peak lower and to the right of first peak ✓

ii) Area under the curve ✓

d)

LEVEL OF RESPONSE QUESTION	
Level 3: (5–6 marks)	Reasoning for deduction of both the rate equation and the mechanism is clear. Order is correctly calculated. A viable mechanism is deduced.
Level 2: (3–4 marks)	Some reasoning given for both the deduction of the rate equation and the mechanism OR detailed reasoning given for only one of them. Order is correctly calculated. Part of a viable mechanism is given.
Level 1: (1–2 marks)	Little reasoning given for either step. Order is correctly calculated.
0 marks	No creditworthy response.

Indicative Content
Rate equation
- When $[ClO^-]$ is multiplied by 3, rate is multiplied by 9
- This shows rate $\alpha\ [ClO^-]^2$
- Rate is second order with respect to $[ClO^-]$
- Rate = $k[ClO^-]^2$

Mechanism (ALLOW any alternative that fits with equation stoichiometry and rate equation)
- Rate-determining step has 2 ClO^- ions
- $2\ ClO^- \rightarrow 2\ Cl^- + O_2$
- Oxygen is not in the overall equation, so must be used up in the second step
- Second step must have an additional ClO^- as the overall equation involved 3 ClO^-
- $ClO^- + O_2 \rightarrow ClO_3^-$

e)   i)   Starting volume of $ClO^- = \frac{100}{1000} = 0.1 \text{ dm}^3$

Starting moles of $ClO^- = 0.1 \times 0.01 = 0.001$ ✓

Moles of O_2 produced $= \frac{pV}{RT}$

Moles of O_2 produced $= \frac{500 \times 0.00072}{8.314 \times 470}$ ✓

Moles of O_2 produced $= 1.382 \times 10^{-4}$ ✓

Moles of ClO^- reacting by this route $= 2 \times 1.382 \times 10^{-4} = 2.764 \times 10^{-4}$

Moles of ClO^- decomposing to give $ClO_3^- = 2 \times 1.382 \times 10^{-4} = 0.001 - 2.764 \times 10^{-4}$

Moles of ClO^- decomposing to give $ClO_3^- = 7.236 \times 10^{-4}$ ✓

Moles of ClO_3^- produced $= 7.236 \times 10^{-4} \div 3 = 2.41 \times 10^{-4}$ ✓

   ii)   ANY FOUR FROM:

Add an **excess** of $AgNO_{3(aq)}$ ✓

AgCl precipitate forms ✓

Filter precipitate ✓

Wash (and allow to dry) ✓

Weigh precipitate ✓

Use moles $= \frac{Mass}{M_r}$ to work out moles of AgCl, (and hence Cl⁻) ✓

21   a)   Peaks near 59 corresponding to the isotopes of cobalt ✓ (DO NOT ALLOW just 'peak at 59' (could be an isotope of something else) or mention of 'peak furthest right' as there are heavier metals in the sample)

   b)   i) $[Cu(H_2O)_6]^{2+}_{(aq)} + 2NH_{3(aq)} \rightarrow Cu(H_2O)_4(OH)_{2(s)} + 2NH_4^+_{(aq)}$

Left-hand side ✓   Right-hand side ✓   (IGNORE state symbols) (ALLOW representation of complexes without H_2O ligands, but penalise once if the equation doesn't balance)

      ii)   Dark/deep blue solution ✓

$[Cu(NH_3)_4(H_2O)_2]^{2+}$ ✓

   c)   i)   Indication that the metal ion is Cr^{3+} ✓

Indication that the non-metal ion is SO_4^{2-} ✓

Moles Cr^{3+} = moles $Cr(OH)_3 = 0.400 \div 103 = 3.883 \times 10^{-3}$

Moles $Cr_2(SO_4)_3 = 0.5 \times 3.883 \times 10^{-3} = 1.942 \times 10^{-3}$ ✓

Mass of $Cr_2(SO_4)_3 = 1.942 \times 10^{-3} \times 392.3 = 0.7618 \text{ g}$ ✓ ALLOW ECF

Percentage by mass of chromium sulfate in rock $= \frac{0.7618}{10} \times 100 = 7.6(2)$ % ✓ ALLOW ECF

      ii) $[Cr(OH)_3]$ dissolves in / reacts with excess NaOH ✓