Paper 1 Answers

*Indicate questions with less than 50% correct answers
**Indicate questions with more than 75% correct answers

No	Answer	Explanation
1	A	As sodium carbonate is also soluble, titrating the mixture at the same time with hydrochloric acid will not determine the volume of carbonate present.
2	A	Sulfur dioxide is an acidic, soluble gas and is denser than air. It will react with KOH when bubbled through it.
3*	D	Energy is absorbed from points 1 and 2. As temperature increases 3-4, KE increases. The state of the substance at 3 - 4 is liquid.
4*	B	Note that all the compounds consist of ionic compounds. Ca^{2+} O^{2-} 2.8.8 , 2.8 K^{+} Cl^{-} 2.8.8 , 2.8.8 Li^{+} F^{-} 2 , 2.8 Na^{+} S^{2-} 2.8 , 2.8.8
5*	C	positive ion : protons > electrons isotope : same number of protons , different number of neutrons
6	D	keywords: liquid, mobile electrons indicate that the substance is a metallic element
7	D	Boron nitride is a covalent compound of giant molecular structure. It's properties are similar to graphite.
8*	C	If there is complete combustion, $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ from the mole ratio, we determine that O_2 is the limiting reactant. Hence there will be incomplete combustion and CO will be the pollutant produced. H_2O is not a gas at room temperature.
9	D	No. of moles of Na_2CO_3 = 0.025 mol No. of moles of HCl = 0.01 mol Hence, HCl is the limiting reactant. Using mole ratio: HCl : CO_2 , the theoretical volume of CO_2 produced = 120 cm^3 Hence % yield = 96 / 120 x 100 = 80%
10	A	Use the info in table 1 to determine the colour of solution at the respective pH

solution	W	X	Y	Z
pH (colour)	3 (yellow)	5 (yellow)	7 (green)	9 (blue)

11*	C	The source of error occurs at step 3 as rinsing conical flask with NaOH will increase the concentration of NaOH before titration. This will lead to higher burette readings than expected, and the mole of NaOH calculated will be higher than expected.
12*	C	Reactions of acid with metal / carbonate / base. Calcium oxide neutralises HCl. Ammonium salts react with alkali to give ammonia gas. Copper is an unreactive metal which doesn't react with HCl.
13	A	$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$, 1g of solid will produce 0.193 dm^3 $PbCO_3 + H_2SO_4 \rightarrow PbSO_4 + H_2O + CO_2$, reaction will not be to completion $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$, 1g of solid will produce 0.226 dm^3
14*	B	Increasing ease to lose electrons means to arrange in increasing metallic property X is a non-metal as its oxide is an acidic oxide Y is a metal as its oxide is a basic oxide Z is a metal as its oxide is an amphoteric oxide Y is more metallic than Z as it is likely to be from Group 1 / 2 (hence lose electrons more easily)
15	D	It has similar properties to ammonia, hence is alkaline in nature. It will react with hydrogen chloride (acidic).
16	C	No visible change occurs because both solutions are colourless and neutralisation occurs. The test showed the presence of nitrate ions.
17**	A	P contains Cu^{2+} as it is a blue solution. Q is CO_2 due to limewater test. R contains SO_4^{2-} due to precipitation with Ba^{2+}
18	B	NaI is similar to KI - hence it is a reducing agent. When an oxidising agent ($KMnO_4$) is added, I^- in KI is oxidised to give I_2, hence the colour changes from colourless to brown in solution and purple in organic solvent.
19	C	Reaction 1: OS of Ag in Ag_2O decreases from +1 to 0 in Ag hence H_2O_2 is a reducing agent. Reaction 2: OS of I in KI increases from -1 to 0 in I_2 hence H_2O_2 is a oxidising agent. Reaction 3: OS of Mn in $KMnO_4$ decreases from +7 to +2 in $MnSO_4$ hence H_2O_2 is a reducing agent.
20	C	Calculate the OS of Cr in each compound $(NH_4)_2Cr_2O_7$ +6 Cr_2O_3 +3 Na_2CrO_4 +6 $Cr_2O_7^{2-}$ +6 Cr^{3+} +3
21	B	T is a coloured solution hence must be copper(II) nitrate As the solution turns colourless as electrolysis proceed, Cu^{2+} ions from the electrolyte has been discharged and there is no replenishing of ions if the anode is graphite
22	D	magnesium is the anode (-ve electrode). Hence it will decrease in size as magnesium oxidises more readily. Reduction occurs at the cathode (+ve electrode) and Cu^{2+} from the solution gain electrons to form Cu deposited at the copper electrode.
23*	B	Work backwards using mole ratio and writing the correct half equations. $2O^{2-} \rightarrow O_2 + 4e$ 6dm^3 of oxygen = 0.25 mol hence no. of moles of electrons = 1 mole For the same mole of electrons in the electrolysis, M ion is reduced to give

		0 333 mol of metal M Hence since the ratio is 1 3, M is likely aluminium
24	C	In order of increasing reactivity in Group 2 . Mg , Ca, Sr, Ba Hence barium will react most vigorously with acid.
25	A	Both reactions show increase in final mass, hence displacement reaction has taken place. Since solutions are added in excess, increase in mass is due to the presence of deposit of the less reactive metal from its solution
26	C	From the observations Q is most reactive, followed by R and S. Hence R cannot protect Q but can protect S All molten metal oxides can be electrolysed
27	C	From the formula of M oxide ion of M has a charge of +2. Since Mg is more reactive than M, hence it will displace M from its solution as shown in C.
28	D	Remember important keywords - exothermic More energy released to form bonds , energy of products lower than energy of reactants endothermic more energy absorbed to break bonds , energy of products higher than energy of reactants
29*	C	The profile diagram shows exothermic reaction of the forward reaction. $N_2 + 3H_2 \rightarrow 2NH_3$ $\Delta H = -92$ kJ/mol Hence Ea for reverse reaction (decomposition) = 119 + 92 and energy absorbed for 1 mole of NH_3 is 92 / 2 = 46 kJ
30	B	$\Delta H = +413 + 839 + 413 + 2(+432) + (-347) + 6(-413)$ $= +2529 - 2825 = -296$ kJ/mol
31	A	Since no more solid is observed at the end of both reactions, the metal is the limiting reactant and acid is in excess Increasing concentration will increase the rate of reaction but not the volume of gas produced
32	D	Rate of reaction can be seen in a steeper gradient at t = 40s. Graph shows the relationship in D clearly.
33	C	All types of fuels do contribute to pollution although of different severity. Hence it is not one of the reason why biofuels are important.
34	B	X must be an alkane as it does not decolourise bromine X must have 34 hydrogen atoms in the molecule has 17 moles of H_2O is produced
35	C	Y has C=C functional group as it undergoes addition polymerisation It mush have -OH group as it reacts with acid to give ester (sweet-smelling product).
36	D	ethyl methanoate - C_2H_5OOCH ethanoic acid - CH_3COOH methyl propanoate - $CH_3OOCC_2H_5$ butanol - C_4H_9OH
37	B	There are 3 -COOH carboxylic groups in the structural formula Hence it will ionised 3 moles of H^+ ions to neutralise 1 mole of NaOH There will be 2 moles of NaOH unreacted
38	D	More polyunsaturated = more C=C bonds → more addition reaction will take place and more decolourisation of bromine occurs
39	A	nylon as the amide linkage -CONH- in the polymer Removing -H from the diamine and remove -OH from the dicarboxylic acids will produce water The number of carbons within the molecule (excluding the functional group at the ends) remain the same.
40*	C	CFC - affects ozone layer and unburnt hydrocarbons causes greenhouse effect which leads to global warming. SO_2 is an acidic gas from burning of fossil fuels which causes acid rain

Paper 2 Section A

1 (a) (i) E

(ii) D

(iii) B and F or D and F

(iv) F

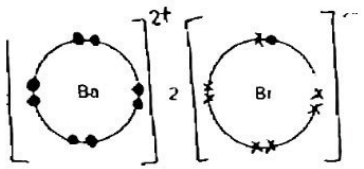
(v) C

(b) When the syringe is placed into hot water the HCl molecules gain **energy** [1] at higher temperature Thus, the HCl molecules **move further away from each other** / are **more spread out** / the **space between molecules increases** [1], increasing the volume *(idea of particle moving apart)*
Reject: particles gain heat (no energy); volume of gas increases, particles occupy more space, explanations about volume increase to accommodate pressure changes

2 (a) (i) protons 56 neutrons 85 electrons 56 [1]

(ii) proton number: 36
identity of unknown atom A **Kr/Krypton** [1]

(b)

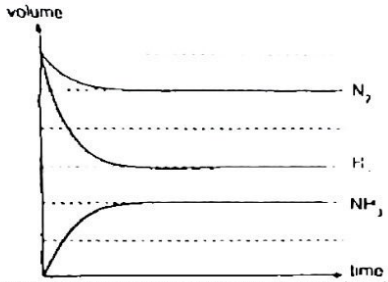


1m – correct number of electrons, showing electron from barium in bromide
1m – correct charges (+2 or 2+ ok), ratio of ions

(c) (i) Add H_2SO_4(aq)/any soluble sulfate salt to $Ba(NO_3)_2$(aq)/$BaCl_2$(aq), stir [1]
Filter and collect the **residue**/ $BaSO_4$.
Wash the residue with a small amount of cold distilled water, dry between pieces of filter paper.[1] *(mark independently)*
Reject: barium hydroxide (not very soluble)

(ii) It is an insoluble salt.

(a)

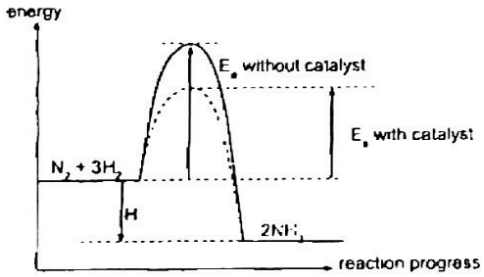


Does not matter where the line starts to become horizontal, but should be a curve

(b) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

ΔH = bond breaking – bond formation
$-92 = 944 + 3(436)$ [1] $- 2(3x)$
$6x = 2344$
$x = 390.66$
$x = 391$ kJ/mol *(no need sign, no need 3sf)* [1]
If x is negative or a fraction, penalize 1 mark

(c)



1m – correct position and formulae of reactants and products (showing balanced equation) and shapes of graphs (show exothermic)
1m – correct direction and labelling of both activation energies
1m – correct direction and labelling of enthalpy change *(just ΔH, no need value)*

If endothermic is drawn, max [1m] for the labeling of two Ea.
Reject - drawn arrow is not touching the peak of the curve or dotted line or drawing double arrowheads

(a) Caesium has a **giant metallic structure**, with **strong electrostatic forces of attraction / metallic bonds** between the metal ions and its sea of mobile/ delocalised electrons
Bromine has a **simple molecular structure / simple molecules**, with **weak intermolecular forces of attraction/ weak forces of attraction between the molecules**.

Larger amount of **energy** is needed to overcome the strong metallic bonds in caesium than the weak intermolecular forces between bromine molecules. Hence caesium has a **higher boiling point** than bromine.

[1] for both structures
[1] for bonding and particles
[1] for more / less energy to overcome the forces upon comparing boiling point
Reject- simple covalent structure, intermolecular bonds, weak covalent bonds. Cs has giant ionic crystal lattice structure.

(b) Bromine is the oxidising agent [1]
Bromine is reduced as the oxidation state of bromine decreases from 0 in Br_2 to -1 in Br^- / caesium is oxidised as its oxidation state increases from 0 in Cs to +1 in Cs^+ [1, *mark for just the OS*]
OR Bromine is reduced as it gains electrons to form bromide/Br and caesium is oxidised as it loses electrons to form Cs^+
no need to state the number of electrons gained or lost but penalize for wrong number of electrons

(c) (i) Redox / oxidation and reduction / displacement [1]

(ii) colourless to red-brown/brown [1]

(iii) Rate of reaction will be faster with fluorine than chlorine as fluorine is more reactive than chlorine or vice versa[1]
Penalize if use chloride or fluoride of Cl2 or F2 for reactivity
Accept higher oxidising power / gain electrons more readily for reactivity

5 (a) Graph for H_2SO_4 has steeper gradient and total volume of CO_2 of 200 cm^3 [1]
Graph for CH_3CO_2H has a gentler gradient with total volume of CO_2 of 100 cm^3. [1]
ignore wrong formula given for acid

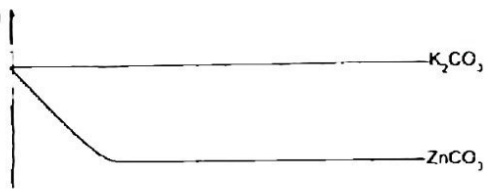
(b) CH_3COOH **partially dissociates / ionizes** in water / **is a weak acid** while HCl/H_2SO_4 **completely dissociates / ionizes** in water / **is a strong acid**, thus CH_3COOH reacts slower than HCl or H_2SO_4.
HCl is a monobasic while H_2SO_4 is a dibasic acid, thus HCl reacts slower than H_2SO_4.
The **higher the concentration of H+ ions / particles**, the higher the **frequency of effective collisions.**

[1] direct strength comparison needed, weak and strong acid for CH_3COOH and HCl / H_2SO_4
Reject weaker / stronger for strength
[1] direct basicity comparison needed, dibasic and monobasic for H_2SO_4 and HCl comparison
[1] number of H+ per unit volume / concentration of H+ and freq of effective collisions
Ignore award 1 students gave the correct idea of the factors such as strength / basic %

No ecf from graph
accept particles for H+ to discuss freq of effective collisions

(c) The third experiment was carried out at a **lower temperature** / using **larger lumps / larger pieces of K_2CO_3**. [1]

(d)



Ignore wrong formula. Can write chemical name. Proportion not important. Need to heat until constant mass (straight line for zinc carbonate at the end)
Reject if heat to zero mass

6 (a) (i) zinc hydroxide [1]

(ii) zinc [1]

(iii) zinc sulfate [1]
Penalise 1 mark for chemical formula
Ignore (II) in zinc

(b) $Zn^{2+}(aq) + 2OH^-(aq) \rightarrow Zn(OH)_2(s)$ *ecf based on cation in (a)*
[1] for correct balanced equation
[1] state symbols (consequential)

(c) Let the mass of sulfur and oxygen be 2.0 g each

	sulfur	oxygen
Mass/ g	2.0	2.0
No. of moles/ mol	$\frac{2.0}{32} = 0.0625$	$\frac{2.0}{16} = 0.125$
÷by smallest no.	$\frac{0.0625}{0.0625} = 1$	$\frac{0.125}{0.0625} = 2$
Simplest ratio		2
Empirical formula	SO_2	

1m – correct number of moles for each element using any equal masses of S and O
1m – correct empirical formula
Ignore header, no need tabulate. No working but identify SO, correctly – give 1m max

(d) Bubble gas into test-tube containing **acidified potassium manganate(VII) / $KMnO_4$** solution
Purple $KMnO_4$ solution turns colourless / decolourises. [1]

(a) R, Cu, P, Q [1]
(P = Sn, Q = Zn, R = Ag)

(b) **1.00 V** [1]
Accept 1 V

(c) *Reduction of oxide of R with carbon / coke/ hydrogen* [1]
Accept if heat silver oxide to obtain silver metal

(d) *Metal* **P decreases in size / mass** [1]
Copper metal **increases in size/mass** or **red-brown/pink/brown solid deposited** on copper electrode and **blue solution** of copper(II) sulfate **fades/turns colourless** [1]

(e) Coating of **Q prevents oxygen in the air and water / sacrificial protection/ corrode in place** from coming into contact with iron, thus preventing rusting [1] from taking place;
As Q is more reactive than iron or Q will lose electrons more readily [1] than iron, thus giving sacrificial protection.

8 (a) (i) **As the air : fuel ratio increases**, the amount of oxygen in excess increases, and the relative level **emission of carbon monoxide and hydrocarbons decreases** [1]

(ii) **High air fuel ratio allows the complete combustion of fuel which releases a large amount of energy / exothermic.**[1]

The higher temperature results in **more nitrogen reacting with oxygen to form nitrogen oxides** [1]

(b) (i) The counter electrode acts as the **cathode**
Reduction occurs at the working electrode / **O_2 gains hydrogen to form H_2O / electrons are gained / oxidation state of oxygen decreases from 0 in O_2 to -2 in H_2O** [1]
Reject H^+ are gained or H^+ flowed in

(ii) $CO + H_2O \rightarrow CO_2 + 2H^+ + 2e^-$ *(accept if twice the moles)* [1]

(c) (i) overall PSI is the **maximum value** out of the calculated values of the five pollutants.
Hence the overall PSI is **218**. [1]

(ii) I would advise the PE teacher to **conduct the lesson indoor / avoid all outdoor lessons / wear N95 mask** [1]
Reject avoid strenuous outdoor activities (without mentioning mask or stay indoors)

(d) There will be **higher concentrations** of all **five pollutants.**[1]
(PM10, ozone) **NO_2 and SO_2 cause breathing difficulty** [1]
Reject respiratory problems
CO prevents transportation of oxygen in the blood / is toxic / is poisonous [1]

9 (a) The current used is **directly proportional** to the mass of copper formed at the cathode / the mass of the copper deposited **increases** when the current used **increases.** [1]
From experiments 1 and 4, when the current passing through the solution is doubled (from **9.7 A to 19.4 A**), the mass of copper deposited is also doubled (from **0.643 g to 1.29 g**) [1]

(b) Using data from Experiment 1 of the table,
Mass of silver produced in 50 s = 0.643/2 = 0.3215 g [1]
Mass of silver produced using 4.85 A = 0.3215/2 = **0.161** [1] g
Reject answer not in 3 s.f.

(c) In sample 1, **pink / red-brown / brown solid was observed.** Blue solution turns **colourless/decolourises** [1] **Magnesium is more reactive than copper** [1], so it **displaces copper (not copper ion)** / reduces copper(II) ions from the solution to form copper metal. Magnesium also reacted with water to give hydrogen gas.

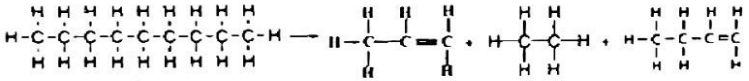
In sample 2, **effervescence** [1] was observed and gas gave a pop sound with lighted splint. After electrolysis, **hydrochloric acid was formed** [1] in the electrolyte, which reacted with the magnesium metal to give hydrogen gas

(d) When electricity passes through the platinum electrode, the **mobile** delocalised **electrons** are able to move [1] to conduct electricity

When electricity is passed through the solution, the **mobile ions** are able to move [1] and to conduct electricity.

10 (a) Cracking **produces shorter chain hydrocarbons / smaller molecules** [1] like propene which are important starting materials **to make fuels / plastics/ to produce hydrogen.** [1]
Reject
- smaller substances
- more useful/higher demand without mentioning a specific use

(b) (i)



(accept but-2-ene)

1m for butene, 1 mark for both propene and ethane

Accept ethene (2 moles)
Reject Not full structural formula (award 1m if all correct)

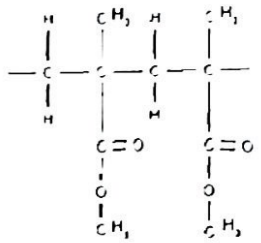
(ii) Add **aqueous Br_2** [1] to separate test-tubes containing propene and ethane respectively
Test-tube containing **propene** will turn **brown/red-brown Br_2 colourless** whilst Br_2 **remains brown/red-brown** for the test-tube containing **ethane** [1].

(c) Product 1 is an isomer of nonane but product 2 is not [1]
The **molecular formula of product 1 is the same** as nonane but with **different structural formula**. The **molecular formula of product 2 is not the same** / has 2 H atoms lesser. [1]
Reject chemical / empirical / general formula

(d) (i) C=C / carbon-carbon double bond, -COO / ester *(BOD)* [1]

Reject C – C double
Ignore C - C single

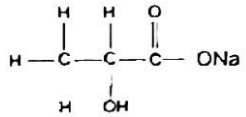
(ii)



Accept
Full structural formula
With brackets and n

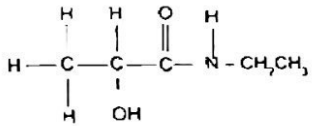
Reject
Unclear bonding

11 (a)



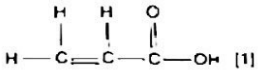
Accept -ONa
Reject -NaO / -O-Na

(b)



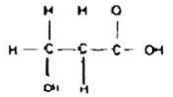
[1]

(c)



[1]

(d) Y



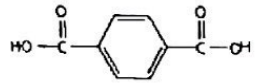
[1]

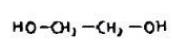
reagent and condition **acidified potassium manganate(VII) / $KMnO_4$ and heat/warm** [1]

(e) (i) depolymerisation / acid hydrolysis / deesterification [1]

Reject reverse polymerisation

(ii)





[1] each

(f) To separate samples of malonic acid and PET, add sodium carbonate or Na metal (any named **carbonate or reactive metal**) [1] **Effervescence** observed that gave white ppt with limewater acid (for sodium carbonate) / gave a 'pop' sound with lighted splint (for Na metal) observed for malonic **No effervescence observed with PET [1]**

Paper 3 Marking Scheme

Question 1 (13 marks)

(a) Refer to the table below.

Test	Observations
Test 1 Put 1 cm depth of solution S in a clean test-tube. Add 2 cm depth of potassium iodide solution and shake the mixture well. Filter the contents of the test-tube into a clean test-tube. Rinse the residue with a little deionised water. Then, add a few drops of starch solution to the filtrate slowly with shaking until no further change is seen.	The residue / ppt. is white / cream / light brown / pale brown **[1]** and *Reject brown for residue* filtrate is brown / red brown / orange brown **[1]** Reject yellow-brown, brown-yellow for filtrate Filtrate turned black / blue-black. **[1]** Reject purple / dark brown / dark blue ppt / dark purple / dark blue / purple black
Test 2 Put 2 cm depth of solution S in a clean test-tube. Add an equal depth of aqueous barium nitrate with shaking, then	A <u>white ppt</u> in pale blue solution is seen **[1]**
add dilute nitric acid slowly until no further change is seen.	*No visible change/ ppt insoluble in acid / white ppt remained Reject white ppt formed
Test 3 Put 2 cm depth of solution S in a clean test-tube. Add an equal depth of aqueous silver nitrate with shaking, then	A <u>white ppt</u> in pale blue solution is seen. **[1]**
add dilute nitric acid slowly until no further change is seen	*No visible change/ ppt insoluble in acid / white ppt remained [*both correct for test 2 and 3 **[1]**. Reject white ppt formed
Test 4 Put 1 cm depth of solution S in a clean boiling tube. Add 3 cm depth of aqueous sodium hydroxide slowly with shaking. **Gently** heat the contents of the boiling tube until no further change. **<u>Keep the final solution for use in Test 5</u>**	Blue ppt seen. [1] *Accept light blue ppt* *Reject: dark blue ppt* *Penalize other wrong observations such as testing for O_2 / H_2 / NH_3 gas produced* On heating **<u>blue ppt turned black/ black solid formed</u>** [1]
Test 5 To the mixture from **Test 4**, add 1 piece of aluminium foil and **gently** warm the mixture	No visible change / moist red litmus paper remains red OR

	Effervescence. Moist red litmus paper turns blue. Gas is ammonia. [1] *Reject: Effervescence that gives hydrogen or oxygen gases*

[9]

(b) cation Cu^{2+}

anions SO_4^{2-} and Cl^- or NO_3^- *(depends on last 5 results)*
[any two correct: 1; all correct: 2; apply ecf for nitrate ions; reject names]

(c) Oxidising agent / oxidises KI solutions [1; reject S is reduced]

Solution S oxidised iodide ions / potassium iodide into brown iodine [1; no ecf for explanation if role is wrong]

Question 2 (15 marks)

(a) Refer to the table below.

	experiment 1 / Q_1	experiment 2 / Q_2	experiment 3 / Q_3
final burette reading/cm^3			
initial burette reading/cm^3			
volume of P /cm^3			

Results Table

Write initial reading, final reading and volume added with correct headings and units in a titration table *(Reading)* [1]
Reject: initial / final volume or amount, or use of short form, vol.
Accept: change in volume of P / headings given in horizontal row instead of vertical and ignore order of heading
Ignore: 'best titration' if given

Record all burette readings for all accurate titres in titration table are recorded to nearest 0.05 cm^3 *(Reading)* [1]
Reject if final reading is lower than initial reading

Titration results
Accuracy (Accuracy) [3]

Q_1	Q_2	Q_3
24.00 to 24.50 cm^3	12.00 to 12.30 cm^3	5.90 to 6.30 cm^3

1 mark each for Q1, Q2 and Q3 respectively if reading falls within the range above.

For multiple / repeated readings, only 1st reading is taken into consideration for marking

(b) No sharp colour change to detect end point / no clear end point / too many colour change before end point / colour change is too wide for end-point, so end-point (key word) must be mentioned [1; *answer should link to idea of 'difficult to see end point'*]
Reject: the range of pH for colour change is too wide, cannot detect colour change clearly, colours keep changing, colour change is too fast / neutralisation point

(c) Experiment Q3 (needed smallest volume) and (Experiment) Q1 (needed largest volume). [1; apply ecf from (a)]
Reject: if amount of (Q) sodium hydroxide is kept constant; apply ecf from (a)
Accept: 'The higher volume of P used, the higher the concentration of Q'
No mark for (c)(ii) IF order of concentration is wrong

most concentrated Q1 [1]
Q2
least concentrated Q3

(d) mole of acid P = 0.02 X *24.20 (student's Q1 reading)* / 1000
= 0.000484 [1]

mole of P = mole of NaOH

concentration of NaOH = 0.000484 / 0.025
= 0.01936 mol / dm^3
= 0.0194 mol / dm^3 [1; to 3 s.f.; no e.c.f. within part]

(e) relative molecular mass of acid P = 1.26 / 0.02
= 63 [1; *for working and value*]

Acid P is HNO_3 / nitric acid. [1; *for stating acid*]

(f) No effect / change [1]
Both aqueous ammonia and sodium hydroxide solution have the same basicity. / The number of moles of OH present is the same for both aqueous ammonia and sodium hydroxide / Both are monobasic [1; *accept 'acidity for basicity'*]

(g) The titration results / volume of acid / burette reading would be halved.
[1; *accept if student give half the numerical value of P in experiment 1*]

Question 3 (12 marks)
(a) Refer to the table below.

	Number of C atoms	Temperature rise/°C
Methanol	1	7.0
Ethanol	2	13.0
Propanol	3	25.0
Butanol	4	- (ignore value give)
Pentanol	5	37.0

Calculate the temperature rise to 1 d.p.
[1; accept if + is included in answers but reject if — is given]

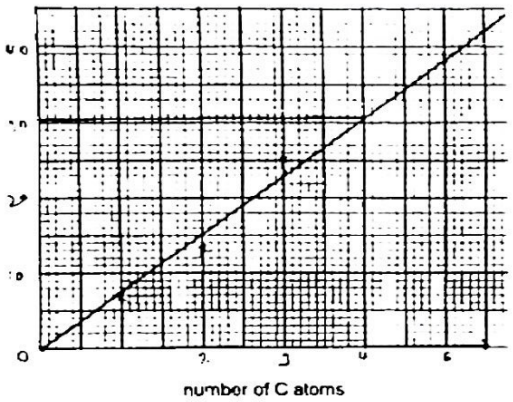
(aii) Plot points correctly (allow 1 error) and labeling axis correctly with unit (Reject if y-axis labelled in short form) [1]

Draw best fit line [1] , if graph did not extend to y-axis or x-axis [penalize]

Use more than half of graph paper and use appropriate scale [1]

Refer to the graph below

temperature rise / °C



(aiii) Shown on grid with line, 31.0 / 31 °C *(based on student's graph)*

[1, answer can be given on grid if line drawn is clearly shown, ignore d.p. here]

(aiv) error Heat loss to surroundings [1]

Accept, if 'error' is written under 'effect'

effect Final temperature / temperature rise will be lower than expected / actual / theoretical / underestimation of the final temperature (or temperature rise) 1]

mark error and effect separately

Reject – initial temperature is different/ bulb of thermometer is at the bottom of boiling tube

(av) No, the graph has a constant gradient, showing that each carbon atom provides the same temperature rise in larger and smaller molecules

accept 'graph is linear'

accept 'temperature rise is directly proportional to number of C atoms if graph passes 0 mark'

If a student drew a curve rather than a straight line in (aii), accept alternative explanations based on the curve drawn , disagree and gradient is decreasing as number of C atoms increase showing that each C atom provides a lower temperature rise

(b) Refer to the table below [1 mark for each chemical/reagent and corresponding observations]

Solution	Chemical / reagent	Observations
Alkene	Aqueous bromine / bromine solution / bromine water	Red-brown / brown bromine decolourises rapidly. *Accept brown but not red for bromine* *The word 'solution / aqueous' can be embedded into observation*
Alcohol	Acidified potassium manganate (VII)	Purple acidified potassium manganate (VII) decolourises.
Carboxylic acid	*A named reactive metal* (magnesium / zinc / iron / sodium etc) OR *A named metal carbonate* (zinc carbonate etc)	Effervescence. Effervescence. *'Do not need to test for gases* *Reject use of esterification for acid*
Water	Anhydrous / dehydrated copper(II) sulfate OR Cobalt(II) chloride paper *Accept cobalt chloride paper* *OR* *Add Ca / Na metal (after eliminating acid)*	White anhydrous / dehydrated copper(II) sulfate turns blue accept 1 (II) is not mentioned Blue paper turns pink. *Effervescence* *'Do not need to test for gases*

Note: Deduct 1 mark overall if students gave reagents / chemicals using formulae, instead of names