Paper 1 B

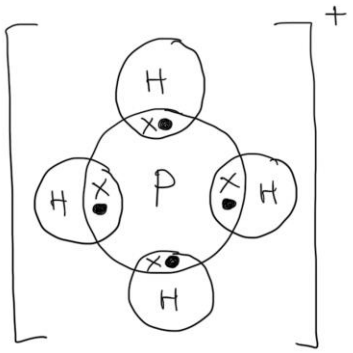
1-5		**6-10**		**11-15**		**16-20**		**21-25**		**26-30**	

Section A

Qn	Answer	Marks	Remarks
1a	$Al(NO_3)_3$	1	Common mistake: $Zn(NO_3)_2$
b	NO_2	1	
c	PbO	1	Common mistake: MgO
d	PbO / NO_2	1	Poorly done, lack awareness of amphoteric oxides reactions.
e	Na_2SO_4	1	
2a	R_f = 4/8 = 0.5	1	
b	Frozen spinach is less fresh compared to spinach from the market. Frozen spinach **contains phaeophytin** which means the chlorophyll is 'older' compared to spinach from the market which does not have this compound.	1 1	Well done
c	The extract from frozen spinach contains a total of 4 components. The unknown component is the most soluble / Xanthophyl is the least soluble / (students can also list the components in increasing/decreasing order of solubility)	1 1	1st marking point was largely missed out by students even though the question stated the requirement explicitly. **Students did not answer the question.** Reject: the components have different solubilities (too simplistic) Common mistake for 2nd marking point: The extract from frozen spinach is most/very soluble
3a	• Lack of a central positive nucleus. / the positive charges are scattered in the atoms instead of localized in a nucleus. • Absence of protons • Absence of neutrons. • Electrons should orbit in electron shells around the nucleus. Any 3 points above. Accept any other logical answers.	3	Generally well done with a variety of expressions accepted as long as concept of atomic structure is shown.

Qn	Answer	Marks	Remarks
b	The positive ion formed should have **10 electrons instead of 11 electrons**. The ion should have **11 protons instead 10 protons** since the original neutral atom has 11 electrons.	1 1	Many students misinterpreted the question and missed the highlighted words in the question which emphasized that this is an ION **formed by the atom in Fig 3.1.** Which means that there is nothing wrong with the charge of the ion. However, credit is still given if the student presents a clear argument of how the number of protons and electrons in Fig 3.2 should give rise to a negative charge. Several wrong answers treated the ion as an atom and wrong stated that the number of electrons and protons should be the same. Several students **again did not answer the question** which stated clearly that the argument should be on the number of subatomic particles. So these students described how the arrangement and placement of the electrons and protons are wrong, which is a repeat of 3(a) and no marks are awarded.
c	X is negatively charged because it is attracted to the positive plate. Y has no charge/is neutral because it is not affected by the positive and negative plates / remained in the straight path of motion. Z is positively charged because it is attracted to the negative plate.	1 1 1	Well done.
4a	**<u>Bonding:</u>** Both white and black phosphorus consist of **strong covalent** bonding between the atoms. OR 1 phosphorus atom is covalently bonded to 3 other phosphorus atoms. **<u>Structure:</u>**	1	Quite well done. Students should avoid using giant lattice structure for giant covalent structure to avoid confusion with giant ionic lattice.

<table>
<tr><th>Qn</th><th>Answer</th><th>Marks</th><th>Remarks</th></tr>
<tr><td></td><td>White phosphorus exists as simple covalent molecules with weak intermolecular forces of attraction between the molecules.
However, black phosphorus exists as a giant covalent structure.</td><td>1

1</td><td></td></tr>
<tr><td>bi</td><td>Correct sharing of electrons with 4 hydrogens
Correct representation of an ion (square brackets with correct charge)
 
</td><td>1
1</td><td>Some students drew 2 separate ions and did not draw a parallel from the familiar NH_4^+ ion.</td></tr>
<tr><td>bii</td><td><table><tr><th></th><th>true</th><th>false</th></tr><tr><td>Sodium phosphide is likely to be insoluble in water.</td><td></td><td>✓</td></tr><tr><td>Phosphorus trioxide is likely to be a poor conductor of electricity.</td><td>✓</td><td></td></tr><tr><td>Phosphine is likely to be a gas at room temperature</td><td>✓</td><td></td></tr></table>
3 correct – 2m
2 correct – 1m</td><td>2</td><td>Quite well done.</td></tr>
<tr><td>5ai</td><td>Any alkali. Eg NaOH, KOH, aq ammonia</td><td>1</td><td>Quite well done.

Question asked for a name but some students gave a chemical formula. No</td></tr>
</table>

<table>
<tr><th>Qn</th><th>Answer</th><th>Marks</th><th>Remarks</th></tr>
<tr><td></td><td></td><td></td><td>deduction this time but it may result in deduction in O'levels.</td></tr>
<tr><td>aii</td><td>The revealer which is an alkali, requires water for ionization to produce hydroxide ions which gives alkaline properties.
Without the presence of hydroxide ions released, the pH will start to drop below 10, causing the indicator to revert back to colourless.</td><td>1

1</td><td>Very poorly done. Only one student remembered that water is required for ionization of alkali.</td></tr>
<tr><td>bi</td><td>
<table>
<tr><th>ink number</th><th>invisible ink</th><th>revealer</th><th>reason for choice</th></tr>
<tr><td>1</td><td>potassium iodide</td><td>lead(II) nitrate</td><td>lead(II) iodide which is yellow in colour is formed.</td></tr>
<tr><td>2</td><td>potassium iodide</td><td>aqueous chlorine</td><td>aqueous iodine which is brown in colour is formed</td></tr>
</table>
Correct pair (revealer and ink can be interchanged)– 1m
Correct reason – 1m</td><td>2</td><td>Poor understanding of the importance of solubility caused errors here.

Many wrongly selected insoluble solids which cannot be used as invisible ink and revealer.

Many wrongly selected sodium hydroxide to pair with copper(II) oxide thinking there will be an exchange of ions to produce a blue precipitate of copper(II) hydroxide. But copper(II) oxide is insoluble. It can't release ions for reaction with sodium hydroxide. There is no reaction between a base and an alkali.</td></tr>
<tr><td>bii</td><td>$2KI + Pb(NO_3)_2 \rightarrow PbI_2 + 2KNO_3$
OR
$2KI + Cl_2 \rightarrow 2KCl + I_2$

Correct formula
Correct balancing</td><td>

1
1</td><td>Quite well done.</td></tr>
<tr><td>6a</td><td>Yttrium
Sc is in period 4 and Y is in period 5.
That means Y has one more electron shell than Sc which gives it a slightly large atomic size.

Note: Award 1m for answers that deduce the size from atomic size trend down the Group. However, this answer alone cannot EXPLAIN why Y has a bigger atom size than Sc.</td><td>
1
1</td><td>All can answer that Yttrium has a bigger size but several reasons led to this question being not well done.

<u>Phrasing issues:</u>
• 'Down the period' is a strange phrasing. We usually say 'down a Group' or</td></tr>
</table>

Qn	Answer	Marks	Remarks
			'across a period' because a period is a horizontal row of elements. • It is wrong to say 'Yttrium has one more valence shell than scandium.' Because **EVERY ELEMENT HAS ONLY ONE VALENCE (outermost) SHELL** **Conceptual issues:** • Many students attributed the increase in atomic size to the increase in the size of nucleus due to the higher number protons and neutrons. However, the size needs to include the electron shells too which are not mentioned in their answers. • Several students also attributed the increase in atomic size to the increase in number of electrons. However, electrons are so tiny, how can their numbers alone account for a change in atom size?
b	Good conductor of electricity Good thermal conductor Silvery Any 2 of above or any other reasonable answers.	1 1	Students should take note that metals are not merely conductors of electricity. A better answer would be: They are GOOD conductors of electricity. → not penalized this time.
ci	Redox reactions	1	Poorly done with wrong answers such as oxidation, combustion etc.
cii	Cerium oxide **lowers the activation energy** of the reactions by providing an alternative pathway of reaction. More **frequent effective collisions** occur between reactant particles, leading to a higher rate of reaction.	1 1	Generally well done.
ciii	The crushed cerium oxide reduces particle size to expose **more surface area** for reaction to take place even faster.	1	Well done.

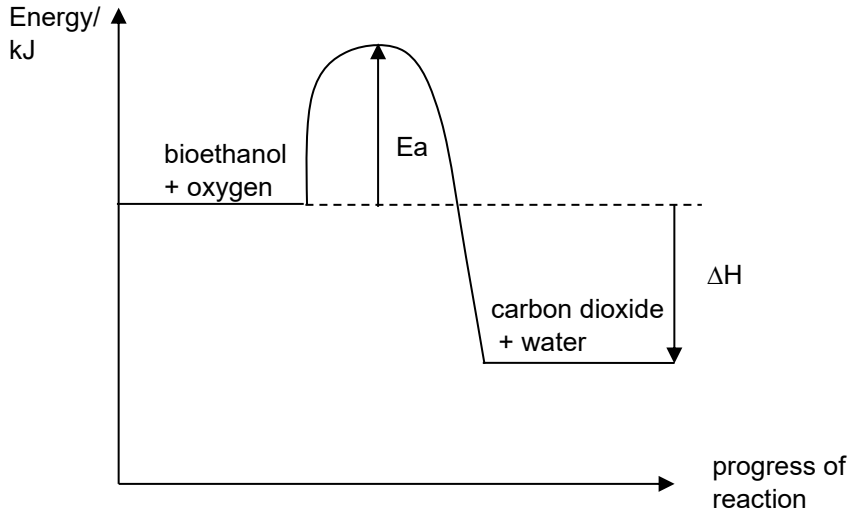
<table>
<tr><th>Qn</th><th>Answer</th><th>Marks</th><th>Remarks</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>7a</td><td>
<table>
<tr><th>element</th><th>oxidation state in $NaAu(CN)_2$</th></tr>
<tr><td>carbon</td><td>+2</td></tr>
<tr><td>gold</td><td>+1</td></tr>
<tr><td>nitrogen</td><td>−3</td></tr>
<tr><td>sodium</td><td>+1</td></tr>
</table>
3 correct = 2m
2 correct = 1m</td><td>2</td><td>A group of students strangely obtained +4 for oxidation state of carbon.</td></tr>
<tr><td>b</td><td>Na^+, Au^+, H^+</td><td>1</td><td>Quite some students missed out H^+

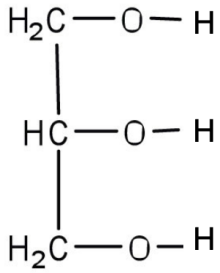
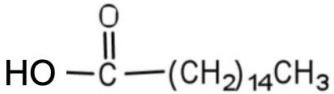
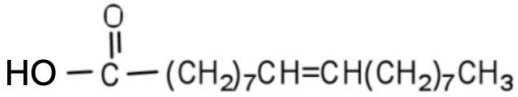
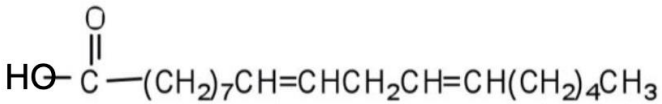
A few students did not take into account that C in part (a) does not exist alone in the solution. It is part of CN^-</td></tr>
<tr><td>ci</td><td>$Au^+(aq) + e \rightarrow Au(s)$</td><td>1</td><td>Generally well done.</td></tr>
<tr><td>cii</td><td>Gold is the lowest in the electrochemical series.
So the ions accept electrons more easily than the ions of other elements.

OR
Gold is very unreactive, so its ion is less stable.
The ion is more easily converted back into the atom compared to the other ions that are more stable.</td><td>1
1</td><td>Quite some students wrongly referred to the metal reactivity series and compared reactivity instead of ion stability which is linked to the electrochemical series.

Simply saying that gold ions have a higher ease of discharge is not explaining the preferential discharge. It’s obvious that it must have a higher ease since it is preferred for discharge. But why is it so?</td></tr>
<tr><td>d</td><td>The concentration of the electrolyte does not change.
This is because, for every mole of gold ion discharged out at the cathode,
An equal mole of gold ion is released from the anode.</td><td>1
1</td><td>Quite many students missed out emphasizing the 1:1 mole discharge and replenishment of gold ions. This is important because the question is about</td></tr>
</table>

Qn	Answer	Marks	Remarks
			concentration, which is specific to the number of moles per unit volume.
e	All the gold ions in the electrolyte have been discharged. Hydrogen is preferentially discharged to form hydrogen gas.	1 1	Students should avoid using the simplistic term 'used up'. *It is used up for what, cooking???* *Chemists talk to chemists like a chemist. You are talking to me (Your chem teacher) in your script. Show me evidence of your learning in your usage of words in communicating scientific ideas.*
8a	Glucose solution from sugarcane is added to **yeast** in a sealed vessel, **keeping air out**. The mixture is kept at **37°C** for some days for **fermentation** to take place. The ethanol is obtained by **fractional distillation** of the reaction mixture. $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$	1 1 2	Poorly done for a simple recall question.
b	The carbon dioxide **released in burning** the fuel is **offset/balanced** by the carbon dioxide **absorbed** by the sugarcane plants **during photosynthesis.**	1	Several students wrongly stated that bioethanol does not produce any harmful/greenhouse gases. The idea that a fuel is renewable/sustainable is NOT an explanation for why it is carbon-neutral. Several students wrongly wrote that the planting of sugarcane does not produce carbon dioxide, forgetting that **all living things respire and will give out carbon dioxide <u>at the same time</u> when photosynthesis takes place.**

Qn	Answer	Marks	Remarks
c	 Correct exothermic profile with reactants and products labelled. Correct indication and label of activation energy. Correct indication and label of enthalpy change.	 1 1 1	Poorly done for a low demand application question. Several students missed out indicating oxygen as a reactant in this combustion reaction. Several students wrongly placed glucose as one of the reactants. This is a reaction of combusting bioethanol. It is not burning of sugar solution.
9a	Degree of unsaturation. As the number of carbon atoms increase from 16 to 17 (larger molecule) in a saturated fatty acid, the melting point only increased by 6.7 ^{o}C. When a 18 carbon fatty acid contain C=C bonds (higher degree of unsaturation), the melting point decreased significantly from 69.6 ^{o}C to -5 ^{o}C instead.	 1 1	**Deduct 1m** if answer does not take reference from the 17 C molecule to show either that melting point is expected to increase when number of C increase, or that adding a carbon atom does not change melting point significantly compared to a change in shape. Question is generally well done with a variety of well argued responses accepted.
b	When molecules are straight, they can pack tightly. The intermolecular forces of attraction is stronger, leading to a higher melting point. When molecules have kinks, they cannot pack tightly. The intermolecular forces of attraction is weaker, leading to a lower melting point.	1 1	**Deduct 1m** if the type of attractive forces is not identified. Quite well done for a challenging question.
c			

Qn	Answer	Marks	Remarks
	structural formula of the triol:  structural formula of one of the carboxylic acids:  OR  OR 	1 1	
d	Coconut oil	1	Well done
e	General formula of a straight chain carboxylic acid = $C_nH_{2n+1}COOH$ When n = 17, the formula of the acid should be $C_{17}H_{35}COOH$. But linolenic acid has 6 H lesser. So number of double bonds = 6/2 = 3 (since 2 H is lost for every C=C bond formed.) OR General formula of a straight chain carboxylic acid = $C_nH_{2n+1}COOH$ There are 29 H in this molecule (excluding the H in the carboxyl group) Every single bonded C needs 2 H except for the one at the end that needs 3H.	 1 1	Poorly done with several strangely attempting to approach the question by calculation of Mr.

Qn	Answer	Marks	Remarks
	Therefore: No. of C – C bonds = (29 – 1) / 2 = 14 But there are 17 C in the molecule and no more H to support single bonding Therefore the extra C must undergo double bonding without H: No. of C=C bonds = 17 – 14 = 3		
f	P/S of beef fat = 3 / 59 = 0.0508 P/S of soybean oil = (50+8) / 14 = 4.14 Healthier substance: soybean oil	1 1 1	Deduct 1m if both P/S values not given to 3sf Not quite well done for a low demand application question. Careless mistakes include: • Not adding the 8% of polyunsaturated fatty acid found in linolenic acid for soybean oil • Not reading the text carefully that the higher the P/S value, the healthier the substance is.

Section B

Qn	Answer	Marks	Comments
10a	When the piece of galvanized iron is scratched, the exposed iron continues to be protected from rusting whereas when paint is scratched off, the exposed iron begins to rust. However, galvanizing iron is more expensive compared to painting over it.	1 1	Poorly done for the first marking point. Students did not link to the concept of sacrificial protection which is commonly used as an industrial application.
b	Under pressure, the fuel has a smaller volume and takes up lesser space.	1	Poorly done. Students did not link to kinetic particle theory in the spatial distribution of the different states of matter.
c	% C in hydrogen = 0 % C in propane = [(3x12) / (3x12+8)] x 100 = (36/44) x 100 = 81.8 % C in butane = [(4x12) / (4x12+10)] x 100	1	Poorly done. The simple concept of % composition is not understood by many who attempted the question. Several students based their arguments without any calculations at all, leaving one

<table>
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<tr><td></td><td>= (48/58) x 100
= 82.8
The London and Rio torches had butane mixed into the fuel which gives it the highest % of C,
resulting in more incomplete combustion to produce a brighter yellow/orange flame.

Correct calculations – 1m
Correct explanation based on calculation – 2m</td><td>

1

1</td><td>to wonder what is the basis of their reasoning.</td></tr>
<tr><td>d</td><td><table><tr><td></td><td>C</td><td>H</td></tr><tr><td>No. of moles</td><td>0.078</td><td>0.080 x 2 = 0.16</td></tr><tr><td>Smallest ratio</td><td>1</td><td>2.0513
= 2 (nearest whole number)</td></tr></table>
Empirical formula of C_xH_y = CH_2

Molecular formula of $(CH_2)n$ = 84g
(12 + 2) x n = 84
n = 6
Molecular formula of C_xH_y = C_6H_{12}</td><td>1

1

1
1</td><td>Poorly done with several students strangely giving final answers with no displayed calculation to support their answers.</td></tr>
<tr><td>11ai</td><td>$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$</td><td>1</td><td>Well done</td></tr>
<tr><td>11aii</td><td>No. of mols of Zn = 0.488 / 65 = 0.0075077
No. of mols of acid used = 0.02 x 2.00 = 0.04

No. of mols of HCl required to react with zinc = 0.0075077 x 2
= 0.01502 (< 0.04)
No. of mols of H_2SO_4 required to react with zinc = 0.0075077 (< 0.04)

Therefore, the limiting reactant is zinc.</td><td>2</td><td>1m for deriving existing/used amount of reactants.

1m for determining the required amount of reactant and hence concluding on the correct limiting reactant.

Many students missed out proof for the other acid, with calculations done only for one.</td></tr>
<tr><td>b</td><td>Curve A.
Sulfuric acid is dibasic and will produce a higher H^+ concentration of 4.00 mol/dm^3.</td><td>1

1</td><td>Common misconception:
Sulfuric is a stronger acid than HCl. But both are strong</td></tr>
</table>

Qn	Answer	Marks	Comments
	Curve A has a steeper gradient, indicating a faster rate of reaction caused by higher hydrogen ion concentration.		Missed out higher concentration as a factor of speed.
ci	Sulfuric acid. The initial rate of reaction is the same as curve A which used sulfuric acid.	1	
cii	Since vol of hydrogen is half of A, mass of Z = 0.488 / 2 = 0.244 g OR (not recommended) Volume of hydrogen = 90cm^3 No. of mols of hydrogen = 0.090 / 24 = 0.00375 Mole ratio of Zn : H_2 = 1:1 No. of mols of Zn = 0.00375 Mass of Zn = 0.00375 x 65 = 0.24375 = 0.244g	1	Generally well done
d	$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$ Some of the zinc reacted to displace copper instead So there is lesser zinc to react with the acid to produce hydrogen	1 1 1	Generally well done