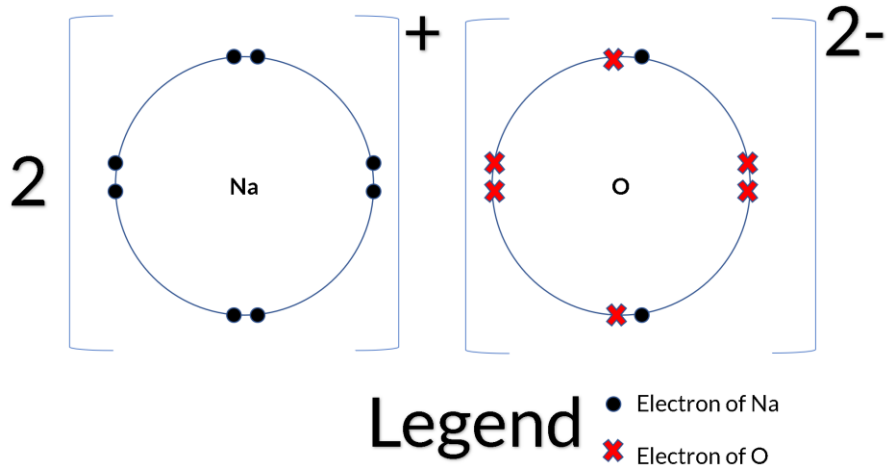
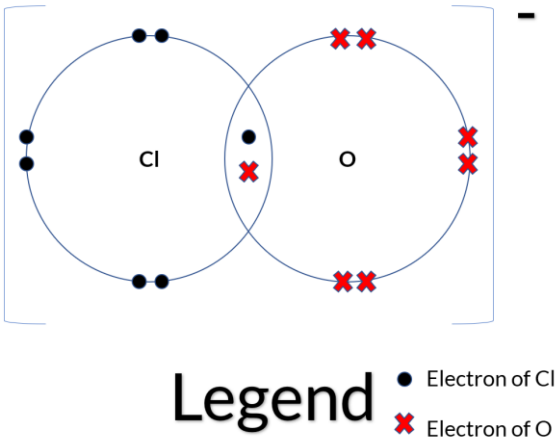
O LEVEL CHEMISTRY 2019 PAPER 2 ANSWERS

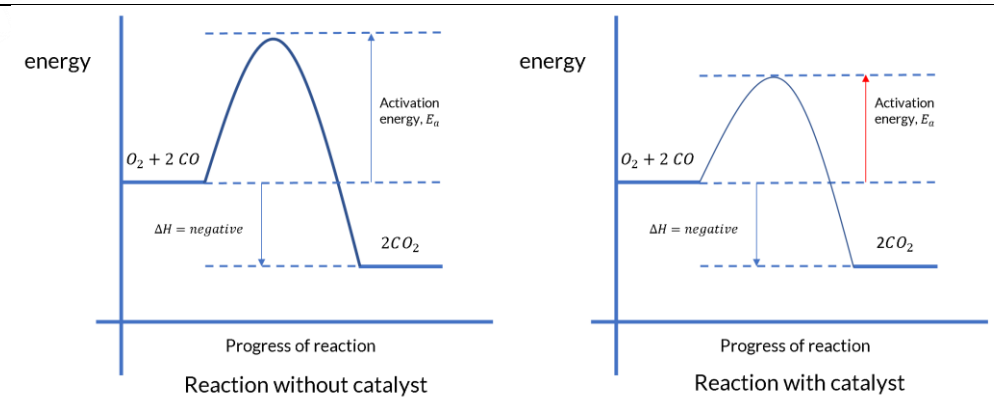
A1	
a)	D and G
b)	A and E
c)	C
d)	G
e)	A
A2	
a)	All contains **16 protons** but have differing number of neutrons from **13, 14 and 15**.
b)	All have 6 protons on the outer shell, suggesting that all isotope will gain 2 electrons to form anion.
c)	
i.	X: Sulfur Y: Oxygen Z: Zinc
ii.	Y, X and Z Sulfur and oxygen exist as diatomic molecules. Since sulfur has a larger molecular size than oxygen, the extensiveness of weak intermolecular forces of attraction between sulfur molecules is more than oxygen molecules thus sulfur has a higher melting point than oxygen. Zinc is a metal and there are strong electrostatic forces of attraction between cation layers and the sea of mobile electrons which requires a large amount of heat to overcome.
iii.	Element Z. Zinc is a moderately reactive metal and it is able to react with acids to form a salt and liberate hydrogen gas.
A3	
a)	Gold is an unreactive metal while lead is a moderately reactive metal that can react with nitric acid.
b)	When dilute hydrochloric acid or sulfuric acid reacts with lead, a tough, insoluble and protective layer of lead (II) chloride or lead (II) sulfate respectively which **prevents further reaction** between lead and the acid thus the removal will not be completed.

c)	
i.	Aqueous ammonia when added dropwise to the ore will form a white precipitate with lead, zinc and aluminium ions. However, in excess aqueous ammonia, only the white precipitate formed with zinc will dissolve while the other white precipitate formed with lead and aluminium will persist. Thus, only zinc can be identified.
ii.	The addition of dilute hydrochloric acid will form a white precipitate with lead ions but not with aluminium ions.
iii.	Addition of dilute NaOH, aluminium foil to the solution that could possibly contain nitrate ions and warm. If nitrate ions are present, ammonia gas will be liberated which turns moist red litmus paper blue.
A4	
a)	$NH_3(g) + HCl\,(g) \rightarrow NH_4Cl\,(s)$
b)	
i.	$M_r\ of\ NH_3 = 17$ $M_r\ of\ HCl = 36.5$
ii.	Yes, since HCl has a higher M_r than NH_3, it has a slower rate of diffusion thus the formation of solid NH_4Cl will be nearer to the cotton wool that is soaked with concentrated hydrochloric acid.
c)	The formation of the solid NH_4Cl will still be nearer to the cotton wool soaked in concentrated hydrochloric acid but in experiment B, a lower temperature results in a lower rate of diffusion which consequently indicates a longer time taken for the formation of the solid NH_4Cl.
A5	
a)	Experiment using sodium forms sodium oxide which is a basic oxide, which upon dissolving in water, forms NaOH. This caused red litmus solution to turn blue due to presence of OH- ions Experiment using sulfur forms sulfur dioxide which is an acidic oxide, which upon dissolving in water, forms H_2SO_4. However, red litmus solution remains red as OH- ions are absent.

b)	
c)	
i.	$2Na + H_2O \rightarrow Na_2O + H_2$ $no.\ of\ mol\ in\ 0.50\ g\ of\ Na = \frac{0.50}{23} = 0.02174$ According to the equation, 2 mol of Na produced 1 mol of Na_2O $no.\ of\ mol\ of\ Na_2O\ to\ be\ produced\ theoretically = \frac{0.02174}{2}$ $= 0.01087$ $= \mathbf{0.0109}\ (\boldsymbol{to\ 3\ s.f.})$
ii.	$Mass\ of\ Na_2O\ formed = 94.82 - 94.50 = 0.32\ g$ $Theoretical\ mass\ of\ Na_2O\ formed = 0.0109\ \times (23\ \times 2 + 16) = 0.6739g$ $Percentage\ yield\ of\ Na_2O = \frac{0.32}{0.6739} = 47.48\%$ $= \mathbf{47.5\%}\ (\boldsymbol{to\ 3\ s.f.})$
iii.	Sodium may not have fully combusted due to insufficient oxygen thus the yield of sodium oxide is not 100%.
A6	
a)	Magnesium is a more reactive metal than iron that is found in steel thus it will be preferentially oxidized and corrode over iron rusting. $Mg\ (s) \rightarrow Mg^{2+}\ (aq) + 2e^-$

b)	
i.	Oil and paint act as a barrier that prevents the contact of oxygen and water with iron found in steel thus preventing rusting.
ii.	Oil and paint stop acting as a barrier when it is not fully coating the steel pipe. However, since it is an underground pipe surrounded by soil, the pipe has to be unearthed for oil or paint to be reapplied which can be a hassle.
A7	
a)	Voltages generated in a simple cell is proportional to **the differences in reactivity between the two metals used as electrodes.** Metals with a bigger difference in reactivity will generate a higher voltage while metals with a smaller differences in reactivity will generate a lower voltage.
b)	Copper|Iron: *values should be greater than 0.6 V but smaller than 1.10 V* Silver|Magnesium: *values should be greater than 1.56V*
B8	
a)	Chlorate (I) ion is an anion that contains oxygen.
b)	
i.	$NH_2Cl + NaOCl \rightarrow NHCl_2 + NaOH$ $NHCl_2 + NaOCl \rightarrow NCl_3 + NaOH$
ii.	Oxidation state of N in NH_2Cl = -1 Oxidation state of N in $NHCl_2$ = +1 Oxidation of N in NH_2Cl increases from -1 to +1 in N of $NHCl_2$ thus NH_2Cl was oxidized to $NHCl_2$ in the presence of sodium chlorate (I), showing that sodium chlorate (I) is an oxidising agent. Oxidation state of N in NCl_3 = +3 Oxidation of N in $NHCl_2$ increases from +1 to +3 in N of NCl_3 thus $NHCl_2$ was oxidized to NCl_3 in the presence of sodium chlorate (I), showing that sodium chlorate (I) is an oxidising agent.

c)	
d)	$M_r\ of\ Ca(ClO)_2 = 40 + [(35.5 + 16) \times 2]] = 143$ $Percentage\ by\ mass\ of\ chlorate\ (I) ions\ in\ Ca(ClO)_2$ $= \frac{[(35.5 + 16) \times 2]}{143} \times 100$ $= 72.02$ $= \mathbf{72.0\%}\ (\boldsymbol{to\ 3s.f.})$ $M_r\ of\ NaClO = 23 + (35.5 + 16) = 74.5$ $Percentage\ by\ mass\ of\ chlorate\ (I) ions\ in\ NaClO$ $= \frac{(35.5 + 16)}{74.5} \times 100$ $= 69.12$ $= \mathbf{69.1\%}\ (\boldsymbol{to\ 3\ s.f.})$
e)	CaO_2
f)	Hypochlorite bleaches release $NaOH$ which is corrosive while hydrogen peroxide bleaches release H_2O which is neutral and not likely to cause any adverse reactions.
B9	
a)	Stage 2: Carbon monoxide molecules adsorb onto the surface of the catalyst. Stage 3: Adsorbed carbon monoxide molecules are brought close to the with adsorbed oxygen atoms and new bonds are formed, resulting in the production of carbon dioxide molecules. Stage 4: Carbon dioxide molecules then desorbed from the palladium catalyst surface.

<table>
<tr><td>b)</td><td> 
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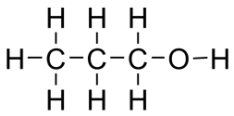
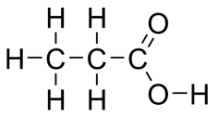
<tr><td>c)</td><td>The palladium catalyst provides an alternative pathway to reduce the activation energy of the reaction. This increases the proportion of reactants that possess energy that is more than or equal to the activation energy, consequently increasing the frequency of effective collisions. This increases the rate of the reaction.</td></tr>
<tr><td>B10
Either</td><td></td></tr>
<tr><td>a)</td><td>Potassium manganate (VII) and Potassium dichromate (VI)</td></tr>
<tr><td>b)</td><td></td></tr>
<tr><td>i.</td><td>
<table>
<tr><td>Name of series</td><td>Alcohols</td><td>Carboxylic acids</td></tr>
<tr><td>Name of third member</td><td>Propanol</td><td>Propanoic acid</td></tr>
<tr><td>Displayed formula of third member</td><td>  </td><td>  </td></tr>
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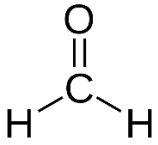
<tr><td>ii.</td><td>  </td></tr>
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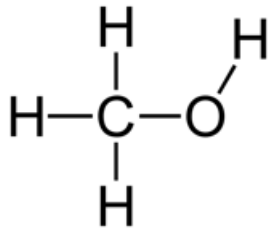
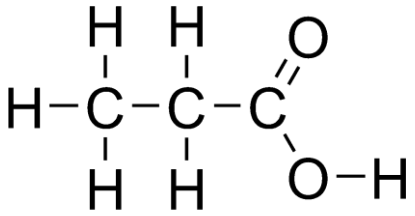
c)	
i.	$CH_3OH + CO \rightarrow CH_3COOH$
ii.	HI is the catalyst. It is chemically unaltered at the end of the reaction.
d)	
i.	This will decrease the yield of ethanoic acid as there will be less available CO to react with CH_3OH.
ii.	H_2 could be use for Haber Process to react with N_2 to form NH_3.
B10 OR	
a)	Isomer 1 and 2 contains the carboxylic acid functional group. As it is a weak acid, it partially dissociates to release H^+ ions that caused the universal indicator to change colour to red. Isomer 3 contains the ester functional group. It is unable to release H^+ ions and thus it is neutral and caused universal indicator to change colour to green.
b)	Methanol  Propanoic acid 

c)

i.

elements	C	H	O
Percentage by mass (%)	62.1	10.3	100 – 62.1 – 10.3 = 27.6
A_r of elements	12	1	16
No. of mole	5.175	10.3	1.725
Molar ratio	$\frac{5.175}{1.725}$ $= 3$	$\frac{10.3}{1.725}$ $= 5.9$ $\approx 6\ (to\ nearest\ whole\ number)$	$\frac{1.725}{1.725}$ $= 1$

Empirical formula of R is $\boldsymbol{C_3H_6O}$

ii. $C_5H_{11}COOH$