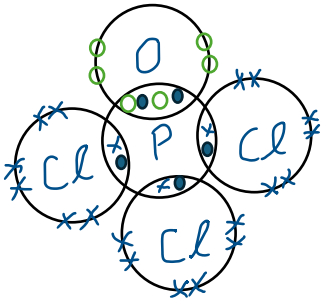
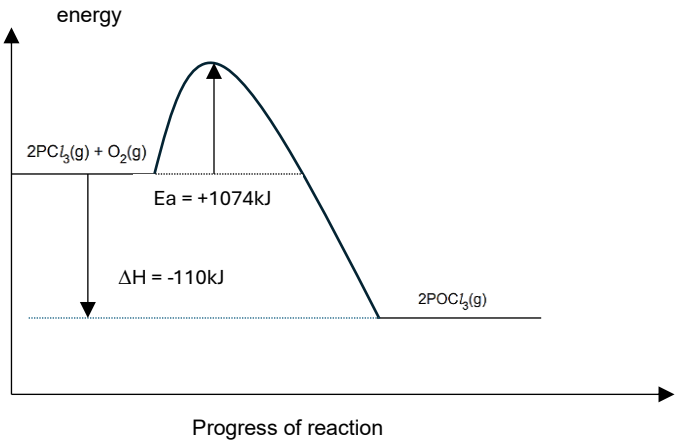
Answers to Sec 4 Pure Chem Preliminary Exam P2 2024

<table>
<tr><td>1(a)</td><td>The solid dissolves/disappears/becomes smaller.</td><td>[1]</td></tr>
<tr><td>(b)</td><td>Carbonic acid</td><td>[1]</td></tr>
<tr><td>(c)</td><td>Barium ethanoate or $(CH_3COO)_2Ba$</td><td>[1]</td></tr>
<tr><td>(d)</td><td>$Ba + 2H_2O \rightarrow Ba(OH)_2 + H_2$</td><td>[1]</td></tr>
<tr><td>(e)(i)</td><td>$CaCO_3$ decomposes first. $CaCO_3$ has a <u>lower thermal stability</u> as <u>calcium is less reactive than barium.</u></td><td>[1]
[1]</td></tr>
<tr><td>(ii)</td><td>$BaCO_3 \rightarrow BaO + CO_2$</td><td>[1]</td></tr>
<tr><td>2(a)</td><td>The ionic radius decreases from P to Cl. As you move across the Period from P to Cl, the <u>nuclear charge increases</u> (OR number of protons increases), the <u>electrons are more closely attracted to the nucleus</u> (attraction between protons and electrons increases).</td><td>[1]
[1]</td></tr>
<tr><td>(b)(i)</td><td>
<table>
<tr><td>Ion</td><td>chlorate</td><td>perchlorate</td><td>hypochlorite</td><td>chloride</td></tr>
<tr><td>formula</td><td>ClO_3^-</td><td>ClO_4^-</td><td>ClO^-</td><td>Cl^-</td></tr>
<tr><td>oxidation state of chlorine</td><td>+5</td><td>+7</td><td>+1</td><td>-1</td></tr>
</table>
</td><td>2m- all correct

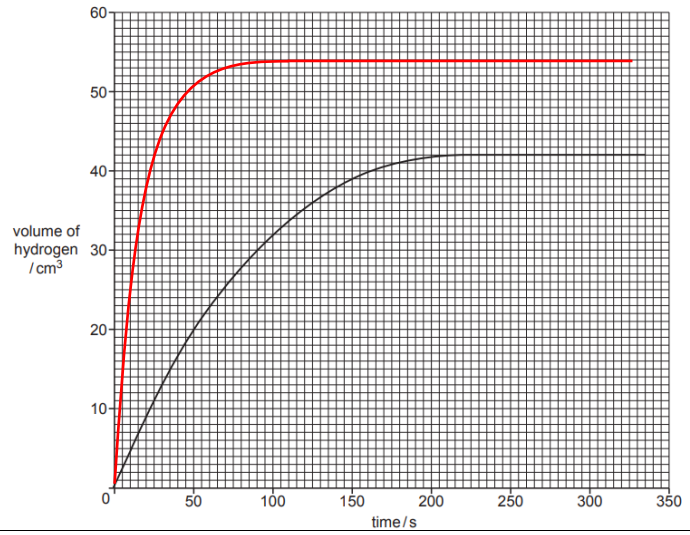
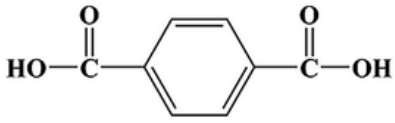
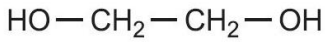
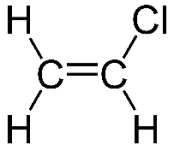
1m-2 or 3 correct</td></tr>
<tr><td>(ii)</td><td>Oxidation state of chlorine increases from +5 in $KClO_3$ to +7 in $KClO_4$. Chlorine is oxidised. (accept if $KClO_3$ oxidised)
Oxidation state of chlorine decreases from +5 in $KClO_3$ to -1 in KCl, Chlorine is reduced. (accept if $KClO_3$ reduced)
Since chlorine is both oxidised and reduced, it is a disproportionation reaction.</td><td>[1]

[1]</td></tr>
<tr><td>(c)</td><td>
<table>
<tr><td>test</td><td>observation</td></tr>
<tr><td>addition of a few drops of $Br_2(aq)$</td><td><u>Solution remains reddish brown</u></td></tr>
<tr><td>addition of a few drops of $AgNO_3(aq)$</td><td><u>White precipitate</u></td></tr>
</table>
</td><td>[1]

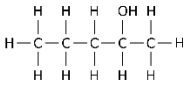
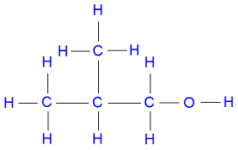
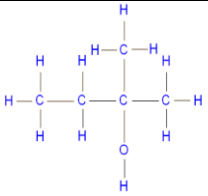
[1]</td></tr>
</table>

3(a)	Covalent bonding, simple covalent (molecular) structure	[1]-both answers
(b)		[1-bonding electrons between O & P, O electrons] [1-bonding electrons between Cl & P, electrons of Cl]
(c)	Enthalpy change for bond breaking in reactants = 2(289) + 496 = +1074 kJ Enthalpy change for bond formation in products = - (2 x 592) = -1184 kJ Enthalpy change for reaction = + 1074 – 11 84 = -110 kJ	 [1] [1]
(d)		[1- exo + labelling of reactants & products [1-Ea labelling & value] [1-ΔH & value]
4(a)	Similarity: At the anode, iodine is produced. Difference: At the cathode, for molten magnesium iodide, magnesium is produced while hydrogen is produced for concentrated aqueous magnesium iodide.	[1] [1]
(b)	Colourless solution <u>turns brown</u>. <u>Chlorine which is more reactive than iodine displaces iodine from magnesium iodide</u>, producing the brown iodine.	[1] [1]
(c)	The oxidation state of iodine increases from -1 in I^- to 0 in I_2. I^- is oxidised, hence it is acting as the reducing agent.	[1] [1]

(d)(i)	Iodine -123 and iodine-131 have the same number of 7 valence electrons, hence will have similar chemical properties.	[1]
(ii)	$^{32}_{15}P \rightarrow {}^{32}_{16}S + {}^{0}_{-1}\beta$	[1]
5(a)	No of moles of $S_2O_3^{2-}$ = 0.0200 x 20.10/1000 = 0.000402 mol Mole ratio I_2: $S_2O_3^{2-}$ = 1: 2 = 0.000402/2 : 0.000402 mol No of moles of I_2 = 0.000402/2 = 0.000201 mol	[1]
(b)	Mole ratio I_2: Cu^{2+} = 1: 2 = 0.000201: 0.000201 x 2 No of moles of Cu^{2+} = 0.000402 mol No of moles of Cu^{2+} in original piece of ore = 100/25 x 0.000402 = 0.001608 mol	[1] [1]
(c)	Mass of copper in ore = 0.001608 x 64 = 0.1029 g % of copper in ore = 0.1029/0.567 x 100% =18.15% = 18.2 % (3sf)	[1] [1]
(d)	Alloy of copper is harder than pure copper as the atoms in the alloy have different sizes, which disrupts the orderly layered arrangement of copper atoms, making it harder for the layers of atoms to slide past one another.	[1] [1]
6(a)	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$	[1]
(b)	Mr of SO_4^{2-} = 32 + 4(16) = 96 Ar of Ba^{2+} = 137 SO_4^{2-} has a smaller Mr, hence will diffuse faster, so they will meet and react nearer to barium nitrate at X.	[1- calculation of Ar & Mr] [1m for explanation]
(c)	Observation: white ppt and blue ppt	[1]
(d)(i)	Volume of CO_2 = 42 cm^3 No of moles of CO_2 = 42/24000 = 0.00175 mol Mole ratio CO_2: H_2SO_4 = 1:1 No of moles of H_2SO_4 = 0.00175 mol	[1] [1]
(ii)	No of moles of H_2SO_4 = 0.00175 = 0.0500 x V Volume of H_2SO_4 = 0.00175/0.0500 = 0.035 dm^3 = 35 cm^3	[1]
(iii)	No of moles of H_2SO_4 = 0.0643 x 0.035 = 0.002251 mol Mole ratio CO_2: H_2SO_4 = 1:1 No of moles of CO_2 = 0.002251 mol Volume of CO_2 = 0.002251 x 24 = 0.054 dm^3 = 54 cm^3	[1] [1]
(iv)	At higher concentrations, there are more particles per unit volume. Frequency of effective collisions increases, rate of reaction increases.	[1] [1]

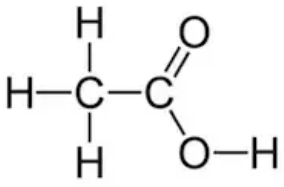
(v)		[1- vol of gas = 54 cm^3 & steeper curve]
7(a)	Plastics are made from <u>non-renewable petroleum,</u> hence it is not environmentally sustainable. As <u>greehouse gases</u> are produced in the plastic production process, it is harmful to the environment as green house gases cause <u>global warming</u>, causing polar ice caps to melt, resulting in flooding.	[1] [1]
(b)	Physical method: The plastic is melted, cooled and made into pellets. Chemical method: The plastic is cracked or depolymerised.	[1] [1]
(c)(i)	Monomers of PET:  and  Monomer of PVC 	[1] [1]
(ii)	Addition polymer: PVC Condensation polymer: PET	[1]
(iii)	Any one:	

<table>
<tr><td></td><td>In condensation polymerisation, there is removal of small molecules but in addition polymerisation, there is no removal of small molecules.

The monomers in addition polymerisation are unsaturated while in condensation polymerisation, the monomers have different functional groups.</td><td>[1]</td></tr>
<tr><td>8(a)</td><td>Isomerism</td><td>[1]</td></tr>
<tr><td>(b)</td><td>
<table>
<tr><th>Alcohol</th><th>P</th><th>Q</th><th>R</th></tr>
<tr><td>Structural formula</td><td>  </td><td>  </td><td>  </td></tr>
<tr><td>Class of alcohol</td><td>Secondary(2⁰)</td><td>Primary (1⁰)</td><td>Tertiary (3⁰)</td></tr>
<tr><td>Name</td><td>Pentan-2-ol</td><td>2-methylpropan-1-ol</td><td>2-methylbutan-2-ol</td></tr>
</table>
</td><td>Every 2 correct 1m

[2]</td></tr>
<tr><td>(c)</td><td>Accept any value between 75 to 130
As molecule T has <u>two hydroxyl groups</u>, there will be <u>more/stronger hydrogen bonding</u>,
<u>requiring more energy to overcome</u>, hence higher boiling point than ethanol.</td><td>[1]

[1]

[1]</td></tr>
<tr><td>(d)(i)</td><td>V represents C-O bond
W represents C-H bond
X represents O-H (in carboxylic acids)
Y represents C=O</td><td>Every 2 correct 1m
[2]</td></tr>
<tr><td>(ii)</td><td>Z is a carboxylic acid</td><td>[1]</td></tr>
<tr><td>(iii)</td><td>Z is ethanoic acid.
  </td><td>[2]</td></tr>
<tr><td>(iv)</td><td>Ethanol and acidified potassium manganate (VII) or oxygen</td><td>[1]</td></tr>
<tr><td>9(a)(i)</td><td>Metallic bonding exists in magnesium. Magnesium has <u>giant metallic lattice structure</u>. There are <u>strong electrostatic forces of</u></td><td>[1- description of ionic</td></tr>
</table>

<table>
<tr><td></td><td>attraction between positive metal ions and the sea of delocalized electrons which require a lot of energy to overcome, hence high mpt.
Iodine is a covalent molecule with simple covalent/molecular structure. There are weak intermolecular forces of attraction between the molecules which require little energy to overcome, hence low mpt.</td><td>bonding & structure] [1- description of bonding & structure] [1- energy]</td></tr>
<tr><td>(ii)</td><td>Each carbon atom in graphite has one valence electron not used up in bonding, hence there are mobile electrons between the layers of atoms which act as mobile charge carriers to conduct electricity.
Iodine exists as molecules, absence of mobile charge carriers/ions or electrons, hence unable to conduct electricity.</td><td>[1]
[1]</td></tr>
<tr><td>(b)</td><td><table><tr><td></td><td>P</td><td>O</td><td>Cl</td></tr><tr><td>No of moles</td><td>20.2/31 = 0.652</td><td>10.4/16 =0.65</td><td>69.4/35.5 =1.95</td></tr><tr><td>Mole ratio</td><td>0.652/0.65 = 1</td><td>0.65/0.65 = 1</td><td>1.95/0.65 = 3</td></tr></table>Empirical formula = $POCl_3$</td><td>[1]
[1]</td></tr>
<tr><td>(c)(i)</td><td>Potential difference = +1.36 – 0.77 = 0.59V</td><td>[1]</td></tr>
<tr><td>(ii)</td><td>Green solution turns reddish brown</td><td>[1]</td></tr>
<tr><td>(iii)</td><td>Test using moist blue litmus paper. If the litmus paper is not bleached, the chlorine is fully used up.</td><td>[1]</td></tr>
<tr><td>10 (a)</td><td>Mr of $C_6H_{12}N_4$ = 140
Mr of $C_{10}H_8$ = 128
Energy density of hexamine = 1/140 x (- 4200) = -30kJ/g
Energy density of naphthalene = 1/128 x (-5133) = 40.1 kJ/g</td><td>[1]
[1]</td></tr>
<tr><td>(b)</td><td>Naphthalene has a higher energy density and it has a lower mass, so it is better to bring moth balls than solid fuel for camping as it gives more energy per gram of fuel.</td><td>[1]</td></tr>
<tr><td>(c)</td><td>Air pollutant: nitrogen dioxide
Effect of air pollutant: Nitrogen dioxide dissolves in rain water to form acid rain which corrodes limestone and metal structures/harms aquatic plants & animals</td><td>[1]
[1]</td></tr>
<tr><td>(d)(i)</td><td>Student A: The solid dissolves
Student B: The solid dissolves or white precipitate</td><td>[1-both correct] [1]</td></tr>
</table>

	Explanation: Aluminium is an amphoteric oxide, so it reacts with both hydrochloric acid and potassium hydroxide.	
(ii)	Aluminium oxide has a giant ionic crystal lattice structure which has strong electrostatic forces of attraction between oppositely charged ions, requiring a lot of energy to overcome, hence has high mpt and so exists as a solid. Nitrogen dioxide has a simple molecular structure and has weak intermolecular forces of attraction between the molecules which require little energy to come, hence low mpt and exist as a gas.	[1- descirption of ionic bonding & structure] [- description of bonding & structure] [1- energy]