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Past Papers Advanced Higher Chemistry

2005 Marking Scheme

Grade Awarded	Mark Required (/125)	Mark Required %	% candidates achieving grade
A	90+	72%	21.9%
B	74	59%	28.7%
C	59	47%	24.7%
D	51	41%	10.8%
No award	<51	<41%	13.9%

Section:	Multiple Choice	Extended Answer	Investigation
Average Mark:	25.9 /40	32.1 /60	15.3 /25

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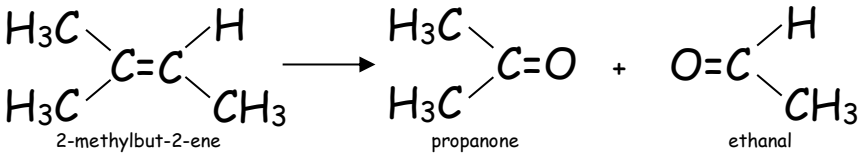
MC Qu	Correct Answer	% Correct	Reasoning
1	C	92	☒A s-block is group 1 → group 2 ☒B p-block is group 3 → group 0 ☑C d-block is then transition metals ☒D f-block is the Actinide and Lanthanides rows at the bottom of the Periodic Table
2	A	79	Group 3 elements have a low 3rd ionisation energy as losing the 3rd electron achieves the stable outer electron shell. Group 3 elements have a high 4th ionisation energy as losing the 4th electron breaks into a stable outer electron shell.
3	D	80	☒A In *atoms* in the ground state, 4s orbital fills before the 3d orbitals ☒B In *atoms* in the ground state, 4s orbital fills before the 3d orbitals ☒C In *atoms* in the ground state, 4s orbital fills completely fill before the 3d orbitals ☑D 4s orbitals fill completely before 3d orbitals start to fill before 3d fills according to Hund's Rules
4	B	48	☒A Absorbing blue visible light would result in the light appearing yellow (red+green mixed) ☑B When electrons drop down electron levels, light is emitted with a particular wavelength ☒C Emitting blue light would appear blue to the eye. ☒D Absorbing red visible light would result in the light appearing cyan (blue+green mixed)
5	C	67	Possible electron transitions between n=4 and n=1 4→3 | 4→2 | 4→1 | 3→2 | 3→1 | 2→1
6	C	76	☒A same wavelength of radiation is absorbed regardless of concentration of ion in solution ☒B same frequency of radiation is absorbed regardless of concentration of ion in solution ☑C A calibration curve of concentration against the level of radiation absorption is set up. ☒D radiation is absorbed not emitted.
7	A	87	Diagrams B+C+D are resonance structures of the carbonate CO_3^{2-} ion.
8	D	75	Least ionic character ∴ electronegativity difference is low ☒A KCl: Electronegativity difference = 3.0 - 0.8 = 2.2 ☒B CaO: Electronegativity difference = 3.5 – 1.0 = 2.5 ☒C BH_3: Electronegativity difference = 2.2 – 2.0 = 0.2 ☑D PH_3: Electronegativity difference = 2.2 – 2.2 = 0
9	D	57	PF_5: no. of electron pairs = $^{(\text{no. of electrons on central atom + no. of bonds})}/_2$ = $^{(5+5)}/_2$ = $^{10}/_2$ = 5 electron pairs ∴ trigonal bipyraminal PF_3: no. of electron pairs = $^{(\text{no. of electrons on central atom + no. of bonds})}/_2$ = $^{(5+3)}/_2$ = $^{8}/_2$ = 4 electron pairs (3 bonding) ∴ (trigonal) pyramidal
10	B	94	☒A The electronegativity difference makes the substance ionic but doesn't decide the arrangement of the ions in the salt. ☑B The size of the ionic radii decides the arrangement of the ions (either 6:6 NaCl or 8:8 CsCl) ☒C electrode potentials are not important in solid ionic substances. ☒D Ionisation energies are important in the formation of the salt but not the ion arrangement in the salt
11	D	35	☒A Silver ions would not precipitate with nitrate ions in sodium nitrate due to solubility ☒B Barium carbonate is insoluble and therefore cannot be used in the gravimetric analysis of silver ions ☒C Silver ions would not fully precipitate with sulphate ions in potassium sulphate due to solubility ☑D Ammonium chloride is fully soluble and the silver chloride precipitate would form for analysis
12	C	25	**n**o. of mol of $CaCl_2$ = **v**olume x **c**oncentration = 0.025 litres x 0.2 mol l^{-1} = 0.005mol $CaCl_2$ f.u. But 2 Cl^- ions per f.u. ∴ **n**o of mol Cl^- ions = 0.01mol $\text{volume} = \frac{\text{no of moles}}{\text{concentration}} = \frac{0.01 \text{ mol}}{0.1 \text{ mol } l^{-1}} = 0.1 \text{ litres} = 100 cm^3$ But 25cm^3 of water already present ∴ <u>75cm^3</u> of water added to make up volume to 100cm^3
13	D	88	☒A No change in pressure from reactants to products ∴ no change to concentration of products ☒B Forward reaction increases pressure ∴external increase in pressure will reduce concentration of products ☒C Forward reaction increases pressure ∴external increase in pressure will reduce concentration of products ☑D Forward reaction decreases pressure ∴increase in pressure will increase concentration of products
14	B	66	Increase in temperature (630°C → 850°C) decreases the equilibrium constant (3300→21) ∴ Increase in temperature *decreases the concentration of products* by favouring reverse reaction ∴ reverse reaction must be endothermic reaction and forward reaction must be *exothermic*

15	A	72	In a aqueous neutral solution: $[H^+] = [OH^-]$. For acidic or alkaline solutions: $[H^+] \neq [OH^-]$
16	B	45	☒A Salt made from strong acid (HCl) and strong alkali (LiOH) ∴ salt pH = 7 in water (neutral) ☑B Salt made from weak acid (CH_3COOH) and strong alkali (KOH) ∴ salt pH > 7 in water (alkaline) ☒C Salt made from strong acid (H_2SO_4) and strong alkali (NaOH) ∴ salt pH = 7 in water (neutral) ☒D Salt made from strong acid (HNO_3) and weak alkali (NH_4OH) ∴ salt pH < 7 in water (acidic)
17	A	55	Buffers are made by adding a salt made from neutralisation of a weak alkali (NH_4Cl) to the weak alkali (Ammonia solution). Buffers can also be made by adding a salt made from neutralisation of a weak acid to the weak acid.
18	A	51	$pH = pK_{In} = 5.2$ (from question) $pK_{In} = -\log_{10}K_{In} = 5.2$ $\log_{10}K_{In} = -5.2$ $K_{In} = 10^{-5.2} = 6.3 \times 10^{-6}$
19	B	89	❶ $C + O_2 \longrightarrow CO_2$ $\Delta H^o = -394$ kJ mol^{-1} ❷x-1 $CO_2 \longrightarrow CO + \frac{1}{2}O_2$ $\Delta H^o = +284$ kJ mol^{-1} Add ❶+❷′ $C + \frac{1}{2}O_2 \longrightarrow CO$ $\Delta H^o = -110$ kJ mol^{-1}
20	B	76	Positive ΔS^o value → increase in disorder ☒A decrease in disorder as 2 different gases become a more ordered single product gas ☑B Increase in disorder as solid and liquid react to become a gas ☒C decrease in disorder as gas and solution becomes a more ordered solid and liquid ☒D Decrease in disorder as two reactants (one a gas) becomes a more ordered single liquid product
21	A	52	☑A When $\Delta G=0$, the forward reaction becomes feasible and equilibrium is established ☒B Dynamic equilibrium can exist and values well above K=1 and well below K=1 ☒C Activation energies for forward and reverse reaction would only be equal where $\Delta H = 0$ ☒D ΔH for forward and reverse reactions would only be equal where $\Delta H = 0$
22	C	86	$\Delta G^o = \Delta H^o - T\Delta S^o$ $= 2.5 - (298 \times {}^{-6.7}/_{1000})$ $= 2.5 - (-1.9966)$ $= 4.4966 \approx 4.5$
23	A	80	$\Delta H^o = +240$kJ mol^{-1} : endothermic reactions have ΔH^o with a positive value $\Delta G^o = -92$ kJ mol^{-1} : reactions are thermodynamically feasible when $\Delta G^o < 0$
24	B	49	☒A As electrons are moving from Y to X, $Cu \rightarrow Cu^{2+} + 2e^-$ must be supplying e^- in the circuit. So Cu^{2+} blue colour in Y will become more intense as concentration of Cu^{2+} ions increases ☑B Mass of electrode Y decreases as $Cu \rightarrow Cu^{2+} + 2e^-$ and copper atoms in the electrode break off and become copper ions in the solution. ☒C As electrons are move from Y→X, Cu^{2+} ions in X must be accepting electrons ($Cu^{2+}+2e^-\rightarrow Cu$) So Cu^{2+} ions are used up and concentration of solution in X will decrease. ☒D Electrons flow from Y to X through the wires. Ions, not electrons, move through the salt bridge to balance the movement of charge in the cell.
25	C	57	☒A faster catalysed reactions change of rate constant k. ☒B catalysts give same equilibrium concentrations of reactants and products so same value of K ☑C catalysts provide an alternate route for a chemical reaction mechanism ☒D catalyst lower the activation energy for both the forward and reverse reactions
26	D	79	Propanoic acid is an carboxylic acid and propan-1-ol is a primary alcohol Oxidation: primary alcohol → carboxylic acid ∴ Reduction: carboxylic acid → primary alcohol
27	B	77	☒A Termination Step: 2 Free radicals joining up ☑B Propagation Step: Free radical chain reaction (one free radical as reactant and one as product) ☒C Termination Step: 2 Free radicals joining up ☒D Initiation Step: 2 Free radicals formed
28	A	59	Tertiary halogenalkanes tend to form stable intermediate carbocations by S_N1 mechanism Primary & Secondary halogenalkanes tend to proceed by S_N2 mechanism

29	A	68	Higher number of –OH groups increases degree of hydrogen bonding in compound: a) R has highest boiling point as R has the most hydrogen bonding due to 3x –OH groups b) R has highest viscosity as R has the most hydrogen bonding due to 3x –OH groups and R is thicker as R molecules are closer together.
30	C	45	☒A The solvent's solubility in water would depend on the solute used ☒B A lower boiling point would be desirable but not essential ☑C The extra solute which dissolves when hot will recrystalise on cooling. ☒D Solvents dissolve more solute when hot as there are bigger gaps between the solvent molecules
31	C	52	Phenol C_6H_5OH is (more) acidic but ethanol C_2H_5OH is neutral because the delocalised electron ring pull the electrons in the –OH bond in C_6H_5OH towards the O making the dissociation of H^+ more likely. Phenylamine $C_6H_5NH_2$ is less basic than ethylamine $C_2H_5NH_2$ because delocalised electron ring in phenylamine pulls the lone pair of electrons on the N atom towards the delocalised electrons making the formation of the dative covalent bond in $C_6H_5NH_3^+$ less likely.
32	D	79	☒A Cracking turns longer, less useful alkanes into shorter, more useful alkane/alkene mixture ☒B Partial hydrogenation turns the C≡C bond in alkynes into C=C bonds in alkenes ☒C Dehydration of alkanols forms alkenes e.g. $C_2H_5OH \rightarrow C_2H_4 + H_2O$ ☑D Alkenes are not made by direct combination of the elements carbon and hydrogen
33	C	66	$CH_3I + 2Na + CH_3I \rightarrow C_2H_6$ (ethane) + 2NaI $C_2H_5I + 2Na + CH_3I \rightarrow C_3H_8$ (propane)+ 2NaI $C_2H_5I + 2Na + C_2H_5I \rightarrow C_4H_{10}$ (butane) + 2NaI
34	D	72	 2-methylbut-2-ene propanone ethanal
35	A	66	But-1-ene has structure $\mathbf{C}H_2=\mathbf{C}HCH_2CH_3$. Markovnikov's Rule: Hydrogen will mostly add to the carbon in double bond that has highest number of hydrogen atoms already attached to it. Major product: H adds to carbon C_1 and chlorine adds to carbon C_2 forming 2-chlorobutane Minor product: H adds to carbon C_2 and chlorine adds to carbon C_1 forming 1-chlorobutane
36	C	69	☒A Alkanes have sp^3 bonding and sigma bonds only ☒B Alkenes have sp^2 bonding and a mixture of sigma and pi bonds ☑C Alkanes have sp^3 bonding and all bonds are sigma bonds ☒D Alkanes have no pi bonds (pi bonds are only found in C=C and C≡C bonds)
37	B	63	Esters are formed from a condensation reaction between alcohols and carboxylic acids. Only primary alcohols oxidise into carboxylic acids
38	D	53	☒A Ethanol C_2H_5OH can be oxidised to ethanal CH_3CHO which contains the $CH_3C=O$ group ☒B Propanone CH_3COCH_3 contains the group $CH_3C=O$ group ☒C Butan-2-ol can be oxidised to butanone $CH_3COCH_2CH_3$ which contains the $CH_3C=O$ group ☑D Pentan-3-one $CH_3CH_2COCH_2CH_3$ does not contain the group $CH_3C=O$ group
39	B	61	HCN adds across a C=O bond in aldehydes and ketones but not carboxylic acids. $LiAlH_4$ is a reducing agent which will turn aldehydes into primary alcohols and ketones into secondary alcohols. ☒A While aldehydes will oxidise to an acid, ketones will not. ☑B Aldehydes and ketones both contain a carbonyl group (C=O) ☒C HCN does not add across a C=C bond in alkenes nor do alkenes get reduced by $LiAlH_4$ ☒D It cannot be said **with certainty** that the compound is an alkanone rather than an alkanal
40	C	55	☒A Ethanol would react with the acid COOH group to form an ester ☒B Bromine water would react with the C=C double bond ☑C hot copper (II) oxide will not oxidise this molecule (-COOH group will not oxidise further) ☒D Conc. H_2SO_4/HNO_3 electrophilically substitutes a nitro group ($-NO_2$) onto the benzene ring

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Long Qu	Answer	Reasoning
1a(i)	Superconductor A increases in conductivity	At temperatures approaching absolute zero, conductors become superconductors as their resistance reduces to zero. Superconductors achieve zero resistance at temperatures around the temperature of liquid nitrogen.
1a(ii)	Semiconductor B decreases in conductivity	The conductivity of conductors and superconductors decreases with increasing temperature. The conductivity of semiconductors increases with increasing temperature.
1b	n-type (1mark) P atoms has extra outer electron (1mark)	P atoms have 5 electrons per atom. 4 of these electrons are bonded with silicon atoms in the semiconductor and the 5^{th} electron on the P atom (a negative charge) is able to move through the substance.
2a	Amphoteric	Amphoteric oxides can act as acidic oxides or basic oxides
2b	Covalent network	SiO_2 has a very high melting point indicating the presence of a covalent network structure.
2c(i)	Temp below 1750K	Upper line on Ellingham diagram pair reverses. Desired reduction of $Al_2O_3 \rightarrow Al$ line is only the top line at temperatures below 1750K
2c(ii)	Change of state (solid→liquid or liquid→gas)	Melting and boiling of substances changes the entropy of a substance and hence the change of gradient of the line.
3a	Both have electron lone pairs to donate	Ligands are either negatively charged or have lone pairs of electrons which are attracted to the central metal ion.
3b	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$ or $[Ne]\ 3s^2\ 3p^6\ 3d^6$	electron arrangement of Co atoms: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^7$. Co atoms lose 4s electrons before 3d to become Co^{3+} ions → $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$
3c(i)	$2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$	This equation is found on page 11 of the data booklet.
3c(ii)	223.9	❶ $4[Co(H_2O)_6]^{3+} + 4e^- \rightarrow 4[Co(H_2O)_6]^{3+}$ $E^o = +1.81V$ ❷x-1 $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$ $E^o = -1.23V$ Add ❶+❷′ $4[Co(H_2O)_6]^{3+} + 2H_2O \rightarrow 4[Co(H_2O)_6]^{3+} + O_2 + 4H^+$ $E^o = +0.58V$ $\Delta G^o = -nFE^o = -4 \times 96500 \times 0.58 = 223880\ J\ mol^{-1}$ $= 223.9\ kJ\ mol^{-1}$
4a	$Ca^+(g) + e^- + 2H(g)$	ΔH_3 represents the 1^{st} ionisation of gaseous calcium atoms and ΔH_4 represents the 2^{nd} ionisation of gaseous calcium atoms.
4b	-145.6 kJ	From data booklet: $H(g) + e^- \rightarrow H^-(g)$ $\Delta H = -72.8\ kJ\ mol^{-1}$ $\therefore\ 2H(g) + 2e^- \rightarrow 2H^-(g)$ $\Delta H = -145.6\ kJ$
4c	-2412.4	Lattice enthalpy: $Ca^{2+}(g) + 2H^-(g) \rightarrow Ca^{2+}H_2(s)$ $\Delta H = \Delta H_6 - \Delta H_5 - \Delta H_4 - \Delta H_3 - \Delta H_2 - \Delta H_1$ $= (-192) - (-145.6) - 1160 - 596 - 432 - 178$ $= -2412.4\ kJ\ mol^{-1}$
4d	Calcium hydroxide and hydrogen	Hydrides hydrolyse in water to produce an alkali and hydrogen gas: $CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$
5a(i)	Hexachloroplatinumate(IV) or Hexachloroplatinate(IV)	Hexachloroplatinumate(IV) 6 chloride ligand ions; central metal ion; negative complex; valency of Pt
5a(ii)	$K = \frac{[PtCl_6]^{2-}_{(organic)}}{[PtCl_6]^{2-}_{(aq)}}$	$K = \frac{[solute]_{(product\ solvent)}}{[solute]_{(reactant\ solvent)}}$

5a(iii) — No change

If more organic solvent is added, more platinum complex would dissolve in the larger organic layer to make the ratio of platinum in each layer the same. K is fixed by the concentrations of the solute in the layer not the number of moles of solute.

5b — Tertiary amine

Primary Amine	Secondary Amine	Tertiary Amine
$H-\underset{\displaystyle H}{\underset{\vert}{N}}-C_3H_7$	$H_3C-\underset{\displaystyle H}{\underset{\vert}{N}}-C_2H_5$	$H_3C-\underset{\displaystyle CH_3}{\underset{\vert}{N}}-CH_3$
1 Carbon attached to the Nitrogen	2 Carbons attached to the Nitrogen	3 Carbons attached to the Nitrogen

6a(i) — 7.6×10^{-4}

no. of mol H_2SO_4 = **v**olume x **c**oncentration = $0.0152 \times 0.05 = 7.6\times10^{-4}$ mol

6a(ii) — 1.52×10^{-2}

$$\underset{2\text{mol}}{2NaOH} + \underset{1\text{mol}}{H_2SO_4} \rightarrow Na_2SO_4 + 2H_2O$$

1.52×10^{-3}mol $\quad$ 7.6×10^{-4}mol

no. of moles NaOH in $25cm^3$ = 1.52×10^{-3}mol

no. of moles NaOH in $250cm^3$ = 1.52×10^{-2}mol

6a(iii) — 0.0098

no. of mol NaOH started with = v x c = 0.025 x 1 = 0.025mol

no. of mol reacted with acid = 0.0152 mol

no. of mol NaOH reacted with aspirin = 0.025mol - 0.0152mol = 0.0098mol

6a(iv) — 0.294g

$$\underset{1\text{mol}}{C_9H_8O_4} + \underset{2\text{mol}}{2NaOH} \rightarrow C_7H_5O_3Na + CH_3COONa + H_2O$$

0.0049mol $\quad$ 0.0098mol

mass = **n**o. of mol x **gfm** = 0.0049mol x 180g mol^{-1} = 0.882g

$\therefore$ 3 tablets of Aspirin = 0.882g

1 tablet = 0.882g x $^1/_3$ = 0.294g

6b — Aspirin in insoluble in water

Back titrations allow all the aspirin to be reacted and into solution. By having an excess of alkali, the unreacted alkali can be quantified by titration with acid and the quantity of aspirin can be calculated.

6c — Check melting point

Melting point apparatus an be used to determine the purity of the aspirin. The closer to the melting point to the data book value for aspirin (137°C) the purer the sample is.

7a — 5 or +5 or V

Oxygen has oxidation number of -2 $\therefore 3O = -6$
Br atom must have oxidation number = +5
} BrO_3^- = (+5) + (3x-2) = -1

7b(i)

Reactant	Order
BrO_3^-	1^{st}
Br^-	1^{st}
H^+	2^{nd}

Experiment	Change	Effect on Rate	Order of reactant
1+2	$[BrO_3^-]$ x2	x2	$[BrO_3^-]^1$
2+3	$[Br^-]$ x2	x2	$[Br^-]^1$
1+4	$[H^+]$ x2	x4	$[H^+]^2$

7b(ii) — $Rate=k[BrO_3^-][Br^-][H^+]^2$

$$Rate = k\,[BrO_3^-]^1[Br^-]^1[H^+]^2 = k\,[BrO_3^-][Br^-][H^+]^2$$

7b(iii) — 8 $l^3mol^{-3}\,s^{-1}$ (1 mark) (1mark)

$$Rate = k\,[BrO_3^-][Br^-][H^+]^2$$

$$k=\frac{rate}{[BrO_3^-][Br^-][H^+]^2} = \frac{5\times10^{-5}\ mol\ l^{-1}\ s^{-1}}{(0.05_{mol\ l^{-1}}) \times (0.05\ mol\ l^{-1}) \times (0.05_{mol\ l^{-1}})^2} = 8\ l^3mol^{-3}\,s^{-1}$$

8a — ClO^-

$$\underset{\text{acid}}{HClO_{(aq)}} + \underset{\text{base}}{H_2O_{(l)}} \rightleftharpoons \underset{\text{conjugate acid}}{H_3O^+_{(aq)}} + \underset{\text{conjugate base}}{ClO^-_{(aq)}}$$

Acid: Substance capable of donating H^+ $\rightarrow$ Conjugate base is formed after loss of H^+

Base: Substance capable of accepting a H^+ $\rightarrow$ Conjugate acid is formed after gain of H^+

8b — $K_a=\frac{[H_3O^+]\,[ClO^-]}{[HClO]}$

$$K_a=\frac{[H_3O^+]^1\,[ClO^-]^1}{[HClO]^1\,[H_2O]^1}$$ But water is also the solvent $\therefore [H_2O] = 1$ $\quad K_a=\frac{[H_3O^+]\,[ClO^-]}{[HClO]}$

8c — 0.01

$$pH = -\log_{10}[H^+] = 5.4 \therefore \log_{10}[H^+] = -5.4 \therefore [H^+] = 10^{-5.4} = 3.98\times10^{-6}$$

$$K_a=\frac{[H_3O^+]\,[ClO^-]}{[HClO]} \therefore \frac{[ClO^-]}{[HClO]} = \frac{K_a}{[H_3O^+]} = \frac{3.98\times10^{-8}}{3.98\times10^{-6}} = 0.01$$

9a(i) — Sodium metal or group 1 metal

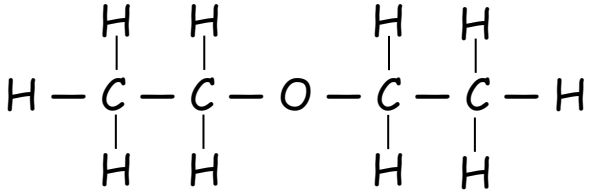
$$\underset{\text{Sodium metal}}{2Na} + \underset{\text{ethanol}}{2C_2H_5OH} \rightarrow \underset{\text{sodium ethoxide}}{2Na^+C_2H_5O^-} + \underset{\text{hydrogen gas}}{H_2}$$

9a(ii) — acidified dichromate or acidified permanganate or hot copper (II) oxide

primary alcohol → aldehyde → carboxylic acid
secondary alcohol → ketone → ✗
tertiary alcohol → ✗

Oxidising Agent	primary alcohol ↓ aldehyde	secondary alcohol ↓ ketone	aldehyde ↓ carboxylic acid
acidified dichromate	✓	✓	✓
acidified permanganate	✓	✓	✓
hot copper (II) oxide	✓	✓	✓
Tollen's Reagent	×	×	✓
Benedict's/ Fehling's Solution	×	×	✓

9b — $CH_3CH_2OCH_2CH_3$ or full structural formula (shown on right)



9c — -169 kJ

Bond Breaking Steps			Bond Forming Steps		
1x C=C	1x 612 =	612kJ	1x C-C	1x 348 =	348kJ
4x C-H	4x 412 =	1648kJ	4x C-H	4x 412 =	1648kJ
1x Cl-Cl	1x 243 =	243kJ	2x C-Cl	2x 338 =	676kJ
		2503kJ			2672kJ

ΔH^o = ∑endothermic steps + ∑exothermic steps
= +2503kJ -2672kJ
= -169kJ mol^{-1}

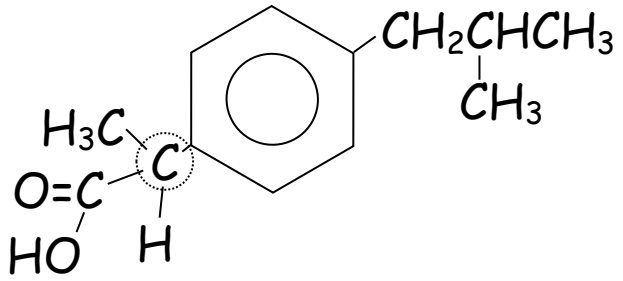
10a — (electrophilic) substitution

$C_6H_6 + CH_3CH(CH_3)CH_2Cl \xrightarrow[AlCl_3]{\text{Electrophillic substitution}} C_6H_5CH_2CH(CH_3)CH_3 + HCl$

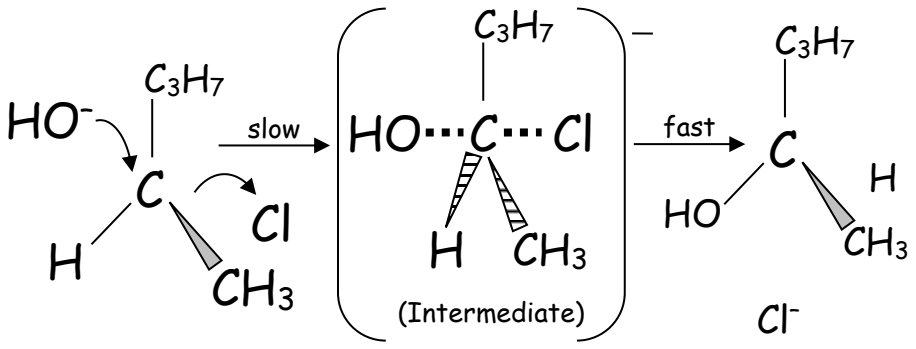
10b — dilute acid

This is (acid) hydrolysis of a nitrile C≡N group

10c — Diagram showing:



11a — Diagram showing:



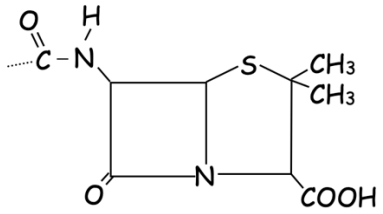
11b — Diagrams showing:

trans-pent-2-ene cis-pent-2-ene

12a — Antagonist due to inhibition of bacterial wall synthesis

Agonists bind with the active site and produce a biological response.
Antagonists bind with the active site and inhibit a biological response.

12b — diagram showing:



13a — Carbonyl C=O

C=O bond within aromatic and alkyl ketones and aromatic carboxylic acids causes an absorption peak at 1685cm^{-1} as the radiation at this wavelength/wavenumber is absorbed and causes a vibration within the bond.

13b — $C_7H_6O_2$

Elements	C	H	O
percentage of element	68.9	4.9	26.2
Divide mass by RAM	$= \frac{68.9}{12}$ = 5.742	$= \frac{4.9}{1}$ = 6.06	$= \frac{26.2}{16}$ = 1.638
Divide through by smallest value	$= \frac{5.742}{1.638}$ = 3.5	$= \frac{6.06}{1.638}$ = 2.99	$= \frac{1.638}{1.638}$ = 1
Multiply through to achieve ratio in whole numbers	3.5 x2 = 7	2.99 x2 =5.98 ≈ 6	1 x2 =2

13c(i) — $C_7H_6O_2$

$C_7H_6O_2 = (7x12)+(6x1)+(2x16) = 84+6+32 = 122$

Heaviest peak on mass spectra is the mass of product = 122

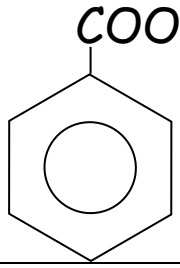
Mass of $C_7H_6O_2$ = 122 ∴ molecular formula = $C_7H_6O_2$ = 122

13c(ii) — $C_6H_5^+$ phenyl group

$^m/_z = {}^{mass}/_{charge}$ = 77 ∴ if charge = 1+ then mass = 77amu

$C_6H_5 = (6x12) + (5x1) = 72 + 5 = 77$amu

13d



Evidence:

a) Substance X must be either an aromatic/alkyl ketone or aromatic carboxylic acid (from IR spectra peak absorption at 1685cm^{-1})

b) Substance X does not react with Brady's Reagent so it cannot be an aldehyde or ketone ∴ substance X is an aromatic carboxylic acid.

c) Molecular formula is $C_7H_6O_2$ but carboxylic acid has formula COOH so structural formula is C_6H_5COOH

13e — 20.176

$$\text{Wavelength } \lambda = \frac{1}{\text{wavenumber}} = \frac{1}{1685\text{cm}^{-1}} = 5.93\text{x}10^{-4}\text{ cm} = 5.93\text{x}10^{-2}\text{m}$$

$$E = \frac{Lhc}{\lambda} = \frac{6.02\text{x}10^{23}\text{mol}^{-1} \text{ x } 6.63\text{x}10^{-34}\text{ J s x } 3\text{x}10^{8}\text{m s}^{-1}}{5.93\text{x}10^{-2}\text{ m}} = 20176\text{ J mol}^{-1}$$

$$= 20.176\text{kJ mol}^{-1}$$