Past Papers Advanced Higher Chemistry

2009 Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	(/125)	%	
A	+86	69%	26.0%
B	+72	58%	26.2%
C	+58	46%	25.6%
D	+51	41%	7.4%
No award	<51	<41%	14.8%

Section:	Multiple Choice	Extended Answer	Investigation
Average Mark:	24.2 /40	32.7 /60	15.5 /25

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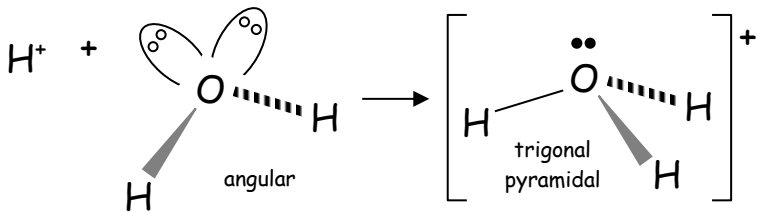
MC Qu	Answer	% Pupils Correct	Reasoning
1	D	88	☒A lines created from the energy released as electrons move down to a particular energy level ☒B electrons moving up absorb energy and do not release energy corresponding to a line ☒C visible light has a wavelength range of 450nm to 700nm ☑D the energy released when an electron drops down to a lower energy level is converted into electromagnetic radiation of a very particular wavelength
2	D	70	☒A Electronegativity: C=2.5 and H=2.2 difference = 0.3 ☒B Electronegativity: Na=0.9 and H=2.2 difference = 1.3 ∴ least covalent character ☒C Electronegativity: N=3.0 and H=2.2 difference = 0.8 ☑D Electronegativity: P=2.2 and H=2.2 difference = 0 ∴ most covalent character
3	A	74	
4	C	49	No. of electron pairs = $\frac{\text{no. of outer electrons in central atom + no. of bonds - charge}}{2}$ $= \frac{7+2-(-1)}{2} = \frac{10}{2}$ = 5 electron pairs (trigonal bipyramidal)
5	A	75	☑A n-type semiconductors are doped with group 5 elements. Non-bonded electrons can migrate across semiconductor ☒B semiconductors are covalent and there are no ions present ☒C p-type semiconductors are doped with group 3 elements with positive holes which migrate ☒D n-type have electrons and p-type have positive holes
6	C	29	☒A LiCl is ionic and dissolves in water ☒B $MgCl_2$ is ionic and dissolves in water ☑C PCl_3 reacts with water to release fumes of white $HCl_{(g)}$ ☒D CCl_4 is non-polar (due to tetrahedral shape) and will not mix of water
7	D	65	☒A basic oxides react with acids but not bases ☒B acidic oxides react with bases bit not acids ☒C neutral oxides do not react with acids or bases ☑D amphoteric oxides react with both acids and bases
8	B	46	tetraammine dichlorid copper (II) o 4 x NH_3 ligands | 2xCl^- ligands | Cu^{2+} central ion ∴ $[Cu(NH_3)_4Cl_2]$
8	B	46	Tetraamminedichloridocopper(II) 4 ligands; NH_3 ligand; 2 ligands; chloride ion ligand; metal ion name; Charge on metal ion complex Complex Formula = $[CuCl_2(NH_3)_4]$ • Ligands are listed alphabetically in both formula and name and can be different order for the same complex. • In a ligand, the element which donates the pair of electrons is listed first e.g. OH_2 • Complex has no overall charge due to Cu^{2+} ions being balanced by 2xCl^- ligands.
9	D	58	☒A no of mol = **v** x **c** = 0.5x0.1 = 0.05mol $(Na^+)_2SO_4^{2-}$ f.u. ∴ 0.05mol SO_4^{2-} ions ☒B no of mol = **v** x **c** = 0.25x0.12 = 0.03mol $Ba^{2+}(Cl^-)_2$ f.u. ∴ 0.06mol Cl^- ions ☒C no of mol = **v** x **c** = 0.3x0.15 = 0.045mol K^+I^- f.u. ∴ 0.045mol I^- ions ☑D no of mol = **v** x **c** = 0.4x0.1 = 0.04mol $Zn^{2+}(NO_3^-)_2$ f.u. ∴ 0.08mol NO_3^- ions

10 C 64

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

	1mol	1mol	1mol
But equilibrium concentration of PCl_5 = 0.5 mol	0.5mol	0.5mol	0.5mol

Final volume = 0.5mol PCl_5 remaining + 0.5 mol PCl_3 produced + 0.5mol Cl_2 produced = 1.5mol gas

11 D 28

☒A Temperature increases gradually and not at one time
☒B Reaction stops at 25cm^3 NaOH and will not increase in temperature after this
☒C Alkali added after 25cm^3 cools down mixture as there is no further reaction
☑D Alkali added after 25cm^3 cools down mixture as there is no further reaction

12 D 80

☒A removal of NO_2 product increases forward reaction
equilibrium constant remains same as NO_2 is replaced
☒B increase in pressure favours pressure-reducing reverse reaction
decrease in products decreases the equilibrium constant
☒C decrease in temp favours exothermic (reverse) reaction
decrease in products decreases the equilibrium constant
☑D increase in temp favours endothermic (forward) reaction
increase in products increases the equilibrium constant

$$K = \frac{[NO_2]^2}{[N_2O_4]}$$

13 A 70

☑A Recrystallisation of benzoic acid from water involves one phase only
☒B Gas-liquid chromatography involves two phases as part of the process
☒C Paper chromatography involves the two phases as part of the process
☒D Solvent extraction involves the two phases as part of the process

14 A 33

no. of mol X in water = **v** x **c** = 0.02 x 0.05 = 0.001mol in water layer
no. of mol X in chloroform = **v** x **c** = 0.0133 x 0.05 = 0.000665mol in chloroform layer

$$K = \frac{[X]_{chloroform}}{[X]_{water}} = \frac{0.000665\text{mol per } 25cm^3}{0.001\text{mol per } 25cm^3} = 0.665$$

15 B 72

☒A boric acid is a weak acid in a solution of one of its salts ∴used as buffer
☑B nitric acid is a strong acid and <u>cannot</u> be used to make a buffer
☒C benzoic acid is a weak acid in a solution of one of its salts ∴used as buffer
☒D propanoic acid is a weak acid in a solution of one of its salts ∴used as buffer

16 C 33

Salt	sodium fluoride	sodium benzoate	sodium propanoate	sodium methanoate
Weak acid to make salt	hydrofluoric acid	benzoic acid	propanoic acid	methanoic acid
pK_a of acid	3.5	4.2	4.9	3.8

The higher the pK_a value the weaker the acid
The weaker the acid the more alkaline the pH of a salt of this acid

17 A 84

☑A ΔG° is always negative ∴ reaction is always feasible
☒B When ΔG° is positive the reaction is not feasible
☒C When ΔG° is positive the reaction is not feasible
☒D When ΔG° is positive the reaction is not feasible

18 A 52

☑A ΔH is positive (endothermic) and ΔS is positive (increase in disorder)
☒B evaporation increases disorder ∴ ΔS is positive
☒C evaporation is an endothermic process ∴ ΔH is positive
☒D evaporation is an endothermic process ∴ ΔH is positive

19 D 64

$\Delta G^\circ - \Delta H^\circ$ is approx zero ∴ $T\Delta S^\circ$ is approx zero (rearrange equation $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$)
∴ ΔS° is approx zero
∴ little change in disorder if ΔS° is approx zero
☒A $CO_2(g)$ released increases disorder greatly
☒B $CO(g)$ and $H_2(g)$ released increases disorder greatly
☒C $H_2(g)$ released increases disorder greatly
☑D Solid formed replaces solid which reacted so similar levels of disorder

20 B 84

Rate = $k[NO][Cl_2]$ ∴ Rate = $k \times [NO]^1 \times [Cl_2]^1$

Reactant	NO	Cl_2
Order	1	1

∴ Overall order = 1+1 = 2

21 B 85

Run	Change	Effect on Rate	Order of reactant
2+3	[X] x2	x2	$[X]^1$
1+2	[Y] x2	x2	$[Y]^1$
1+4	[X] x2 and [Z] x2	x2	if $[X]^1$ then $[Z]^0$

Rate = $k \times [X]^1 \times [Y]^1 \times [Z]^0$ ∴ Rate = $k[X]^1[Y]^1[Z]^0$ ∴ Rate = k[X][Y]

22 C 46

☒A Initiation: No free radicals at start - free radicals are created during initiation
☒B Termination: No free radicals at end – free radicals join together during termination
☑C Propagation: Free radical used up and new free radical created during propagation
☒D $H^\bullet$ free radicals are not formed in this mechanism ($CH_3^\bullet$ and $Cl^\bullet$ are formed)

23 A 61

☑A C-Br bond undergoes heterolytic fission to form $(CH_3)_3C^+$ and Br^- ions
☒B S_N1 reactions produce carbocations which have a positive charge
☒C S_N2 mechanism & OH^- ions are negative so complex would have negative charge
☒D This is S_N2 mechanism: 2 particles is involved in mechanism $(CH_3)_3CBr$ and OH^-

24 C 63

Electrophile: Species attracted to centres of negative charge

$OH^- + CO_2 \rightarrow HCO_3^-$	CO_2 is attracted to –ve charge of OH^-
$C_2H_4 + Br_2 \rightarrow C_2H_4Br^+ + Br^-$	Br_2 is attracted to electrons in C=C double bond

25 B 56

Number of corners = number of carbons = 17
- Each carbon has 4 bonds (be careful with C=C double bonds)
- Count the number of bonds not used up at each carbon. These must contain a hydrogen

Number of bonds not bonded to carbons = number of bonds to hydrogen = 14

26 D 69

Bond		C - C	C = C	C ≡ C	C - H
Sigma	σ	1	1	1	1
Pi	π	0	1	2	0

6xC-H + 2xC-C + 1xC=C + 1xC≡C
= (6σ) + (2σ) + (1σ+1π) + (1σ+2π)
= 10σ + 3π

27 D 59

☒A Chlorine must be added first so 2 iodines cannot add across C=C double bond
☒B This is not the only product as I^- ions complete with Cl^- ions in step 2
☒C Iodine cannot be added to C_1 as C=C is between C_2 and C_3 in but-2-ene
☑D As I^- ions compete with Cl^- ions to complete step 2
2,3-dichlorobutane and 2-chloro-3-iodobutane are <u>both</u> formed

28 A 52

☑A sodium reacts with alcohols: $2Na + 2C_2H_5OH \rightarrow 2C_2H_5O^-Na^+ + H_2$
☒B metal oxides do not react with alcohols
☒C sodium chloride does not react with alcohols
☒D alkalis do not react with alcohols

29 C 78

☒A ethoxyethane $C_2H_5OC_2H_5$ is very flammable
☒B ethoxyethane and butan-1-ol both have the molecular formula $C_4H_{10}O$
☑C hydrogen bonding in butan-1-ol gives it a higher boiling point than ethoxyethane
☒D ethoxyethane is an ether and is a solvent for many organic compounds

30 C 68

☒A 2-methylpropan-2-ol is produced ∴ tertiary alcohol is produced
☒B methanol is produced ∴ primary alcohol is produced
☑C propan-2-ol is produced ∴ secondary alcohol is produced
☒D 2-methylpropan-1-ol is produced ∴ primary alcohol is produced

31 B 72

☒A Propanal: aldehydes oxidise to carboxylic acids
☑B Propanoic acid: carboxylic acids do not oxidise.
☒C Propan-1-ol: primary alcohols oxidise to aldehydes then carboxylic acids
☒D Propan-2-ol: secondary alcohols oxidise to ketones

32 C 35

☒A propan-2-ol: alcohols do not react with alkalis
☒B propene: alkenes do not react with alkalis
☑C methylethanoate: esters hydrolyse in the presence of alkalis
☒D methoxyethane: ethers do not react with alkalis

33 C 51

☒A all alkanes are non-planar
☒B cyclohexane is non-planar as ring of 6 carbons zigzag in a hexagonal shape
☑C chlorobenzene is planar as chlorine is in same plane as flat benzene ring
☒D Methyl group make flat benzene molecule non-planar

34	D	65	☒A –NH_2 group reacts with acid but molecule does not react with alkali ☒B –NH_2 group reacts with acid but molecule does not react with alkali ☒C $C_2H_5NH_3^+Cl^-$ will react with alkali but molecule does not react with acid ☑D –NH_2 group reacts with acid and –COOH group reacts with alkali
35	B	41	☒A $Br_2/AlCl_3$ will perform the electrophilic substitution of benzene (Bromination) ☑B Free radical substitution will not substitute Br onto benzene ring ☒C Light catalyses free radical substitution of Br onto alkyl side group but not benzene ☒D SO_3/H_2SO_4 will perform the electrophilic substitution of benzene (sulphonation)
36	A	62	☑A Ethanoic acid has a lower pH than phenol as phenol is a weaker acid than Ethanoic acid (Ethanoic acid pK_a=4.8 and Phenol pK_a=9.9) ☒B Phenol is acidic and ethanol is neutral ☒C Benzoic acid is acidic and ethane-1,2-diol is neutral ☒D Benzoic acid is acidic and methanol is neutral
37	B	16	☒A Primary amines are weaker bases than secondary amines ☑B Secondary amines are stronger bases than primary amines ☒C Benzene ring withdraws lone pair of electrons making base weaker ☒D Benzene ring withdraws lone pair of electrons making base weaker
38	B	71	☒A Need a chiral carbon (carbon with 4 different groups attached) to be optical isomer ☑B Optical isomers: contains chiral carbon and are mirror images of each other ☒C These are geometrical isomers not optical isomers as they have no chiral carbon ☒D These are not optical isomers as there is not chiral carbon (they are same chemical)
39	C	60	☒A Carbon appears much smaller than iodine in X-ray crystallography ☒B Hydrogen appears much smaller than iodine in X-ray crystallography ☑C Iodine is the biggest atom and shows up the biggest in X-ray crystallography ☒D Oxygen appears much smaller than iodine in X-ray crystallography
40	C	91	☒A Agonists cause the same biological response as the body's natural substrate ☒B Receptors are the units that drugs interact with to cause a biological response ☑C Antagonists block the receptor for a chemical to react with ☒D pharmacophores are the shape of a molecule which fits the receptor

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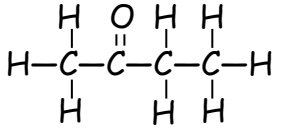
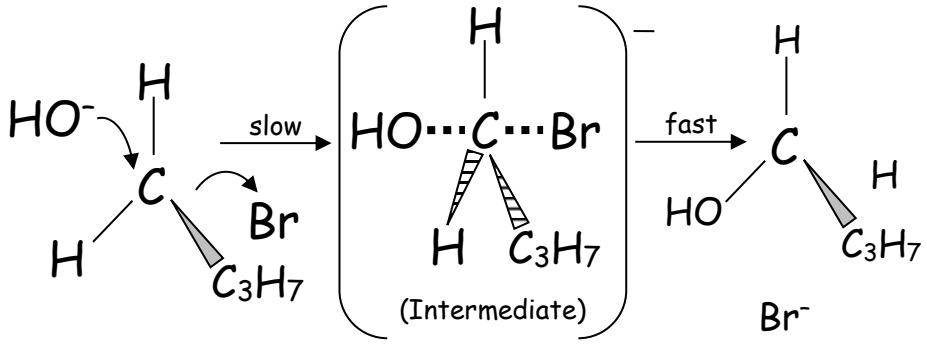
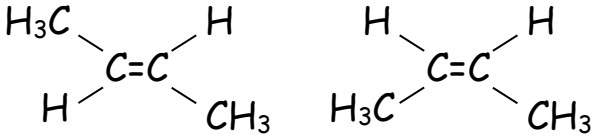
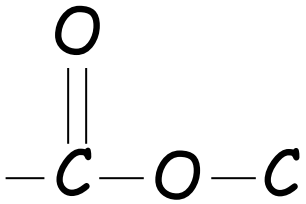
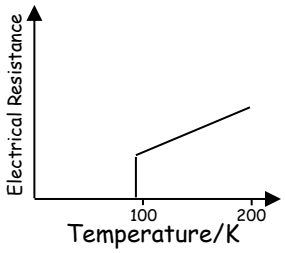
Long Qu	Answer	Reasoning
1a	$1s^2 2s^2 2p^6 3s^2 3p^6$ or [Ne] $3s^2 3p^6$	Atomic Number of Argon = 18 $\therefore$ Argon atoms have 18 electrons s orbitals hold 2 electrons and p orbitals hold 6 electrons
1b(i)	78.3nm	$E = \frac{L \times h \times c}{\lambda} \therefore \lambda = \frac{L \times h \times c}{E} = \frac{6.02\times10^{23}\,mol^{-1} \times 6.63\times10^{-34}\,J\,s \times 3\times10^{8}\,m\,s^{-1}}{1530 \times 1000\,J\,mol^{-1}}$ $= 7.83 \times 10^{-8}$ m = 78.3nm
1b(ii)	$Ar(g) \rightarrow Ar^+(g) + e^-$	1st Ionisation Energy: The removal of one mole of electrons from 1 mole of gaseous atoms
2a	138 J K^{-1} mol^{-1}	$\Delta S^o = \Sigma S^o_{(products)} - \Sigma S^o_{(reactants)}$ $= (2\times27) + (3\times189) - ((1\times90) + (3\times131))$ $= (54 + 567) - (90 + 393)$ $= 621 - 483$ = 138 J K^{-1} mol^{-1}
2b	96kJ mol^{-1}	$\Delta H^o = \Sigma \Delta H_f^o{}_{(products)} - \Sigma \Delta H_f^o{}_{(reactants)}$ $= (2\times0) + (3\times-242) - ((1\times-822) + (3\times0))$ $= (0 - 726) - (-822 + 0)$ $= -726 - (-822)$ = 96 kJ mol^{-1}
2c	696K	The reaction becomes thermodynamically feasible when $\Delta G^o = 0$ $\Delta G^o = \Delta H^o - T\Delta S^o = 0 \therefore T\Delta S^o = \Delta H^o \therefore T = \frac{\Delta H^o}{\Delta S^o} = \frac{96 \times 1000\,J\,mol^{-1}}{138\,J\,K^{-1}\,mol^{-1}} = 696K$
3a	$Mg^{2+}(aq)$	ΔH_2 is the enthalpy of hydration for Mg^{2+}: $Mg^{2+}(g) \rightarrow Mg^{2+}(aq)$
3b	Lattice Enthalpy or Lattice Breaking Enthalpy	lattice breaking enthalpy (ΔH_1) for $MgCl_2$: $Mg^{2+}(Cl^-)_2(s) \rightarrow Mg^{2+}(g) + 2Cl^-(g)$
3c	-728kJ mol^{-1}	ΔH_3 = 2 x enthalpy of hydration for Cl^- = 2x -364kJ mol^{-1} = -728kJ mol^{-1}
3d	-171 kJ mol^{-1}	ΔH_4 = ΔH_1 + ΔH_2 + ΔH_3 Enthalpy of solution = Lattice breaking enthalpy + Enthalpy of hydration for Mg^{2+} + 2x Enthalpy of hydration for Cl^- $= 2477 + (-1920) + (2x-364)$ = -171 kJ mol^{-1}
4a	-241 kJ mol^{-1}	$\Delta H = \Sigma$(bond breaking steps) + Σ(bond forming steps) $= (1x\ H\text{-}H) + (\frac{1}{2}x\ O{=}O) + (2x\ O\text{-}H)$ $= (1\times436) + (\frac{1}{2}\times498) + (2\times-463)$ $= 436 + 249 + (-926)$ = -241 kJ mol^{-1}
4b	Additional energy will be released as $H_2O(g)$ condenses into $H_2O(l)$	The enthalpy of combustion forms H_2O in the liquid state at standard conditions (25°C). The reaction in the question forms H_2O in the gaseous state and this means the energy released as the water condenses has yet to be released.
5a	1mol l^{-1} H^+ ions 298K (25°C) 1 atmosphere pressure	1 mol l^{-1} H^+ ions is found in 1 mol l^{-1} HCl or HNO_3
5b	$2IO_3^- + 12H^+ + 10e^-$ ↓ $I_2 + 6H_2O$	Write down the main species involved in the reaction: $IO_3^- \rightarrow I_2$ Balance all atoms except O and H: $2IO_3^- \rightarrow I_2$ Add H_2O to other side to balance O atoms: $2IO_3^- \rightarrow I_2 + 6H_2O$ Add H^+ ions to other side to balance H atoms: $2IO_3^- + 12H^+ \rightarrow I_2 + 6H_2O$ Add e^- to most positive side to balance charge: $2IO_3^- + 12H^+ + 10e^- \rightarrow I_2 + 6H_2O$

5c	-574.2 kJ mol^{-1}	$\Delta G^\circ = -nFE^\circ$ $= -5 \times 96500C\ mol^{-1} \times 1.19V$ $= -574175\ J\ mol^{-1}$ $= -574.175\ kJ\ mol^{-1}$
6a(i)	methanoate ion $HCOO^-$	$HCOOH$ + H_2O $\rightleftharpoons$ $HCOO^-$ + H_3O^+ acid (donates H^+) — base (accepts H^+) — conjugate base — conjugate acid
6a(ii)	$K_a = \frac{[HCOO^-][H_3O^+]}{[HCOOH]}$	$K_a = \frac{[HCOO^-][H_3O^+]}{[HCOOH][H_2O]}$ But $[H_2O] = 1$ as H_2O is also the solvent $K_a = \frac{[HCOO^-][H_3O^+]}{[HCOOH]}$
6b(i)	0.0783 mol l^{-1}	gfm $HCOOH = (2x1) + (1x12) + (2x16) = 2 + 12 + 32 = 46g\ mol^{-1}$ **n**o. of mol = $\frac{\textbf{mass}}{\textbf{gfm}} = \frac{3.6x10^{-3}g}{46g\ mol^{-1}} = 7.83 \times 10^{-5}$ mol **c**oncentration = $\frac{\textbf{n}\text{o. of mol}}{\textbf{v}\text{olume}} = \frac{7.83 \times 10^{-5}\ mol}{0.001\ litres} = 0.0783\ mol\ l^{-1}$
6b(ii)	2.43	$pH = \frac{1}{2}pK_a - \frac{1}{2}\log_{10} c$ $= (\frac{1}{2} \times 3.75) - \frac{1}{2} \times \log_{10}(0.0783)$ $= 1.875 - (-0.553)$ $= 2.428$
7a	Rate=k[CH_3COCH_3][H_3O^+]	The species involved in the rate determining (slow) step are the species involved in the rate equation
7b	H^+ is regenerated during the reaction	H^+ ions are a reactant in the slow step but H^+ ions are products of the 2nd step and H^+ ions are not used up in the reaction.
7c(i)	To neutralise the acid (To quench the reaction)	Sodium hydrogencarbonate will neutralise the H^+ ions required for the slow rate determining step. H^+ removal stops the reaction.
7c(ii)	Starch Indicator blue/black purple → colourless	The Iodine present at the start of the reaction will turn starch indicator blue/black. The Iodine is reacted away so at the end point the mixture becomes colourless.
8a	EDTA	**E**thylene**d**iamine**t**etra**a**cetic acid (**EDTA**) is a hexadentate ligand used in volumetric analysis and complexes with metal ions in a ratio of 1:1
8b	Ni^{2+} ions are green or Ni^{2+} ions absorb visible light	The green colour of Ni^{2+} ions is caused by d→d transitions where certain wavelengths are absorbed and green light is transmitted. Colorimetric analysis determines which wavelengths are absorbed. The higher the concentration of Ni^{2+} ions the higher the absorbance.
8c(i)	It has lone pairs of electrons	Butanedione dioxime has lone (non-bonding) pairs of electrons on the nitrogen atoms in the molecule. These form dative/co-ordinate bonds with the central metal ion.
8c(ii)	4	Ni^{2+} ions forms 4 co-ordinate bonds with the 2 ligand molecules of butanedione dioxime.
8c(iii)	gravimetric analysis	Gravimetric analysis involves the heating of a substance to a constant mass. The roasting of a solid will drive off any water molecules trapped in the structure allowing the measuring of the mass accurately. Once a constant mass has been achieved on heating then the true mass of the substance has been achieved.
8c(iv)	To allow solid to cool with absorbing moisture	Desiccators are sealed containers which contain a chemical like silica gel to remove all the moisture from the desiccator. It is necessary to let the solid cool down before heating and the desiccator prevents the solid absorbing water from the atmosphere as it cools.
9a	Butanone or 	Y reacts with 2,4-dinitrophenylhydrazine ∴ Y is an aldehyde or ketone. Y does not react with Benedict's solution or Tollen's reagent ∴ Y is a ketone as aldehydes do not react with Benedict's orTollen's reagent. Butanone is the only structure of a 4 carbon ketone.

9b	Substitution or Nucleophillic substitution	
9c	Measure melting point and check data tables	The derivatives of carbonyl compounds with 2,4-dinitrophenylhydrazine (Brady's Reagent) are solids with very well defined melting points. By measuring the melting point accurately in melting point apparatus, the original aldehyde or ketone can be determined from data tables.
9d	Both structures required:	 trans-but-2-ene cis-but-2-ene
10a	conc sulphuric acid & conc nitric acid	A mixture of concentrated sulphuric aid and concentrated nitric acid is required to perform the nitration electrophillic substitution reaction
10b	Reduction	Reduction is a decrease in the oxygen : hydrogen ratio
10c	Ethanoic acid	An amide link has formed between the $-NH_2$ group of the aromatic compound and the COOH group of ethanoic acid
11a	$C_4H_8O_2$	Heaviest peak in mass spectrum = 88amu $\therefore$ mass of A= 88amu Emipirical formula C_2H_4O: (2x12) + (4x1) + (1x16) = 24 + 4 + 16 = 44amu $\therefore$ $2x(C_2H_4O) = C_4H_8O_2$ = 88amu
11b(i)	C=O Carbonyl	The IR adsorption peak at 1745cm^{-1} is due to the stretching of the C=O carbonyl group with an ester bond 
11b(ii)	ester	
11c	$C_2H_5CO^+$	$C_2H_5CO^+$ is the fragment which has a mass of 57 (3x12) + (5x1) + (1+16) = 36 + 5 + 16 = 57
11d	methyl propanoate	• $C_4H_8O_2$ is an ester due to the IR absorption peak at 1745cm^{-1} • The carboxylic acid side of the ester has 3 carbons due to the $C_2H_5CO^+$ fragment in the mass spectrum. • the alcohol side of the ester must contain the remaining 1 carbon $\therefore$ name of ester is methyl propanoate
12a	IF_5: I=+5 IF_7: I=+7	IF_5 if F=-1 5xF = -5 $\therefore$ I=+5 IF_7 if F=-1 5xF = -7 $\therefore$ I=+7 Both molecules are neutral so I atom balances the oxidation state of the F atoms combined
12b	trigonal bipyramidal	5 atoms around a central atom is a trigonal bipyramidal arrangement
12c	sp^3d hybridisation or sp^2d^2 hybridisation or spd^3 hybridisation	IF_7 has 7x I-F bonds and sp^3d^3 has 7 electrons for forming 7 bonds. IF_5 has 5x I-F bonds and 5 hybridised orbitals between s, p and d are needed: sp^3d or sp^2d^2 orspd^3 contain 5 hybridised orbitals
12d	Cl atom too small to fit 7 F atoms around it	Iodine is a much larger atom than chlorine and can fit 7 fluorine atoms around the central iodine atom. Chlorine atoms can only fit 5 fluorine atoms around the central atom.

13a



A superconductor behaves in a similar way to conductors at higher temperatures

- the lower the temperature the lower the resistance
- at a critical temperature a superconductor quickly attains zero resistance

A semiconductor behaves oppositely to conductors with temperature

- semiconductor increase in resistance with decreasing temperature

13b(i)

$YBa_2Cu_3O_7$

Element	Y	Ba	Cu	O
%	13.4	41.2	28.6	16.8
No. of moles (divide % by gfm)	$\frac{13.4}{88.9}$ = 0.151	$\frac{41.2}{137.3}$ = 0.301	$\frac{28.6}{63.5}$ = 0.450	$\frac{16.8}{16.0}$ = 1.050
Mole ratio (divide through by smallest value)	$\frac{0.151}{0.151}$ = 1	$\frac{0.301}{0.151}$ = 1.99	$\frac{0.450}{0.151}$ = 2.98	$\frac{1.050}{0.151}$ = 6.95
Round to Whole Number	1	2	3	7

13b(ii)

+2.33

Y		Ba_2		Cu_3		O_7	
1x +3	+	2x +2	+	3X	+	7x -2	= 0
+3	+	+4	+	3X	+	(-14)	= 0
				3X	-	7	= 0
				3X			= +7
				X			= +2.33

13b(iii)

$Y_2Ba_4Cu_6O_{13}$

Element	Y		Ba		Cu		O
Mole Ratio	1		2		3		
Mole ratio x Oxidation No.	1x3		2x2		3x2		-2X = 0
	3	+	4	+	6	+	-2X = 0
					13	+	-2X = 0
							-2X = -13
							X = 6.5
Atom Ratio	1		2		3		6.5
Multiply to Achieve Whole Number	2		4		6		13