A-Level Chemistry

Organic

Practical Questions

Mark Scheme

Time available: 122 minutes
Marks available: 99 marks

1. (a) **M1** Tollens' reagent or ammoniacal silver nitrate

M2 silver mirror

M3 no reaction / no (visible) change / colourless

Alternative

M1 *sodium*

M2 *no reaction / no (visible) change*

M3 *fizzing / bubbles / effervescence*

OR

M1 Fehling's solution

M2 orange/brick/red solid/precipitate

M3 no reaction / no (visible) change

Do not allow acidified potassium dichromate(VI)

*If no reagent or incorrect reagent in **M1**, then no marks can score in **M2/3***

*Allow name or formula of suitable reagent for **M1**. Penalise incorrect formula of correct reagent in **M1** (even if correct name also given) but mark on for **M2/3***

*For Tollens': ignore $AgNO_3$ or $[Ag(NH_3)_2]^+$ or silver mirror test or "Tollings' reagent" on their own, but mark on for **M2/3.** Allow silver/black precipitate/solid/deposit for **M2**.*

*For Fehling's (or Benedict's): ignore $Cu^{2+}(aq)$ or $CuSO_4$ or "Fellings" on their own, but mark on for **M2/3***

Ignore "nothing (happens)" / "no observation"

3

(b) **M1** bromine (water) / Br_2 / Br_2(aq)

M2 orange/yellow / no reaction / no (visible) change

M3 colourless / decolourised

Alternative

M1 *acidified potassium manganate(VII) / $KMnO_4/H^+$*

M2 *no reaction / no (visible) change / purple*

M3 *colourless / decolourised*

*If no reagent or incorrect reagent in **M1**, then no marks can score in **M2/3***

*Allow name or formula of suitable reagent for **M1**. Penalise incorrect formula of correct reagent in **M1** (even if correct name also given) but mark on for **M2/3**.*

*Allow brown-red or brown for **M2**. (Ignore red)*

*Ignore clear for **M3***

3

(c) **M1** H = 1.0078

M2 C = 12.0096

M3 M_r= (6 × M1) + (6 × M2) = 78.1044

M2 *Allow ECF from **M1***

M3 *Allow ECF from **M1** and **M2***

Penalise not giving answers to 4dp once only (on the first occasion it would score otherwise)

(providing answers are given to at least 2dp)

3

[9]

2. (a) Use H_2SO_4

Allow HCl / H_3PO_4

Ignore conc / dilute

1

(b) M1 Cool test 2

warm (water bath)

Allow heat / hot

M2 Gas is tested with lighted splint in test 3

Bubble into limewater

Allow no test on gas needed

2

(c) M1 J and M

M2 Test 1 (Orange solution goes) green

M3 M

M4 Test 2 (Blue solution gives a brick) red precipitate
Allow (Brown-red/orange/orange-red)

M5 J and L

M6 Test 3 (Colourless gas that turns) limewater cloudy
Allow M6 Test 3 fizz / effervescence

M7 K

M8 Test 4 (Orange solution goes) colourless
Allow (Brown/Brown-red/yellow/yellow-orange)
Allow decolorises bromine

8

(d) M1 S - Fractionating column
M1 Allow beads

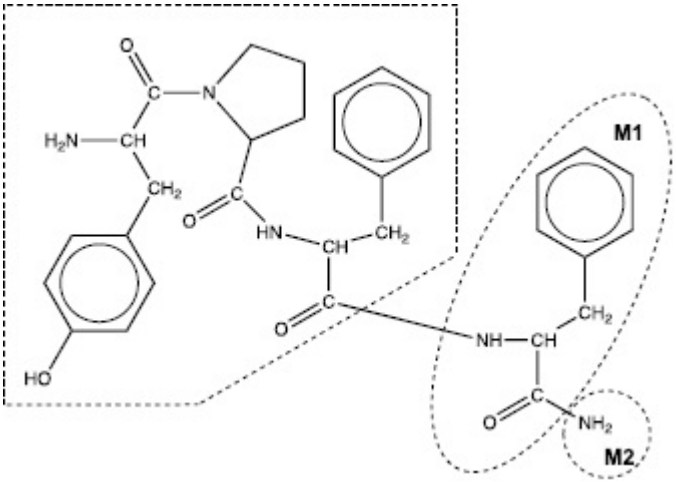
M2 Both T - Water out AND U - Water in

M3 Liquids K and M are likely to have similar boiling points

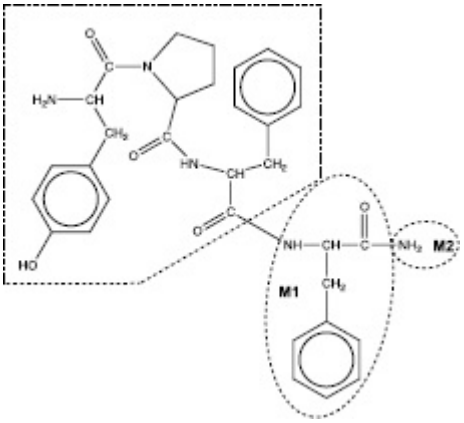
3

[14]

3. (a)



Alternative form

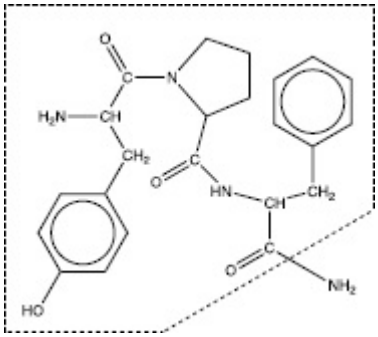


M1 Phe structure drawn with correct peptide link

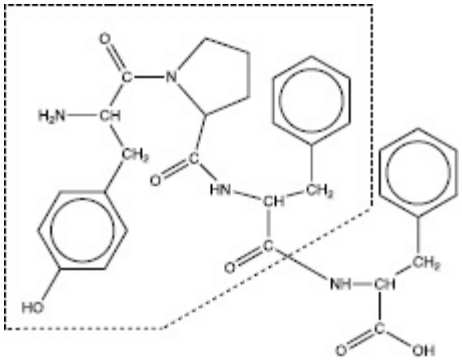
M2 amide group shown on end

M1 *if Phe drawn with COOH or* $CONH_2$

M2 ALLOW *if no Phe drawn i.e. if* NH_2 *only attached directly to C=O on diagram*



*Scores **M2** for ending in amide group*

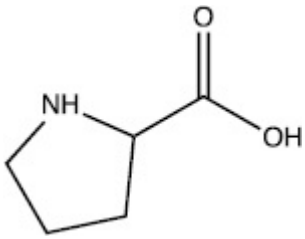


*Scores **M1** for Phe group*

***M1** H needed on N of peptide link drawn unless C-CH-CH_2 drawn skeletal*

2

(b)



***ALLOW** zwitterion*

***ALLOW** -NH_2^+ and/or COO^-*

***ALLOW** with C shown in COOH group*

***ALLOW** without H on N*

***ALLOW** N-H*

***NOT** N-*

1

(c) **M1** (aqueous) HCl/hydrochloric acid

Name or formula of any strong acid or alkali

M2 reflux/heat

***ALLOW** warm / hot / high temperature for heat*

***NOT** T>200°C*

***IGNORE** conc as condition with acid/alkali*

***IGNORE** pressure*

Alternative

***M1** protease/(poly)peptidase/peptase/named protease*

***IGNORE** enzyme*

***M2** warm*

***NOT** hot / high temperature / T>50°C*

2

(d) **M1** lid/cover (on beaker)

Then any 2 from these 3

- prevents escape of vapour (from beaker) / evaporation of solvent (from beaker)
- so atmosphere in beaker is saturated with solvent vapour owtte
- to reduce evaporation from the plate

ALLOW *(for bullet point 3) so solvent can rise up plate*

ALLOW *(for bullet point 3) to avoid plate drying out*

3

(e) Difference in the balance between solubility in solvent/mobile phase and attraction to/retention on stationary phase

ALLOW *difference between (relative) affinity/attraction for solvent and stationary phase*

ALLOW *absorption/adsorption for retention on stationary phase*

1

(f) **M1** ninhydrin

M2 amino acids are colourless / to make the amino acids visible

ALLOW *iodine*

IGNORE *UV*

IGNORE *stated final colour e.g. "turns the amino acids purple" is not enough on its own*

IGNORE *clear*

2

(g) 0.54

ALLOW *0.53 - 0.55 (to min two sig figs)*

1

[12]

4. (a)

This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.	
Level 3 **5-6 marks**	**All stages are covered and each stage is generally correct and virtually complete** (6 v 5) Answer is well structured, with no repetition or irrelevant points, and covers all aspects of the question. Accurate and clear expression of ideas with no errors in use of technical terms.
Level 2 **3-4 marks**	**All stages are covered but stage(s) may be incomplete or may contain inaccuracies OR two stages are covered and are generally correct and virtually complete** (4 v 3) Answer has some structure and covers most aspects of the question. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. If any, only minor errors in use of technical terms.
Level 1 **1-2 marks**	**Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR only one stage is covered but is generally correct and virtually complete** (2 v 1) Answer includes statements which are presented in a logical order and/or linked.
Level 0	Insufficient correct chemistry to gain a mark.

Stage 1
Anti-bumping granules
1a no anti-bumping granules / add anti-bumping granules
1b to create smaller bubbles / to prevent large bubbles / to prevent mixture jumping into condenser

Stage 2
Open system with no thermometer
2a system should be closed (above flask) to prevent gases escaping
2b should be closed with (bung +) thermometer
2c to allow collection of propanone (only) / to prevent distillation of other components / to stay in suitable temperature range

Stage 3
The water direction in the condenser
3a water flows in wrong direction through condenser / change water direction
3b condenser not cool enough / not full of water
3c product may not condense / comes through as gas

6

(b) **M1** mass of propan-2-ol = 2.0 x 0.786 (= 1.572 g to at least 2sf)

M2 amount of propan-2-ol = $\frac{1.572}{60.0}$ (= 0.0262 to at least 2 sf) mol

M3 mass of propanone expected = 0.0262 x 58.0 (= 1.52 g to at least 2sf)

M4 % yield = $\left(\frac{0.954}{1.52} \times 100\right)$ = 63% (2sf only)

Alternative for M3/4

M3 *amount of propanone formed =* $\frac{0.954}{58.0}$ *(= 0.0164) mol*

M4 *% yield =* $\left(\frac{0.0164}{0.0262} \times 100\right)$ *= 63% (2sf only)*

Allow ECF at each step

4

(c) **M1** propan-2-ol: tetrahedral and 109.5°

M1 *allow 104–110°*

1

M2 propanone: trigonal planar and 120°

M2 *allow 115–123°*

Any two correct boxes scores one mark

1

(d) **M1** propan-2-ol has stronger intermolecular forces

*Penalise **M1** and **M2** for any reference to breaking covalent bonds, (but **M3** could score)*

1

M2 propan-2-ol has hydrogen bonds between molecules

*For **M2** ignore reference to dipole-dipole forces in propan-2-ol*

1

M3 propanone has dipole-dipole forces and/or van der Waals' forces

1

[15]

5. (a) **M1** flask not clamped

allow *<u>only</u> the condenser is clamped*

1

M2 sealed system / bung in condenser

allow *explanation of effect of bung being there e.g. pressure build up*

not *reference to incorrect water direction*

1

(b) sulfuric acid needs adding

allow *hydrochloric / nitric / phosphoric*

ignore *conc/dil*

not *just acid/H^+*

1

(c) **M1** direction of water flow through condenser

allow *reference to water direction from answer to (a)*

1

M2 thermometer not needed

allow *references to safety issue(s) if* ***not*** *given in (a)*

ignore *reference to position of thermometer*

1

(d) to prevent 'bumping'

allow *prevent large bubbles / ensure small bubbles*

not *increases rate*

1

(e) **M1** (fractional) distillation

1

M2 $\frac{6.5}{60}$ mol propan-1-ol (= max $\frac{6.5}{60}$ mol propanoic acid) (0.108)

M2 $\frac{6.5}{60}$ *mol propan-1-ol (= max* $\frac{6.5}{60}$ *mol propanoic acid)*

1

M3 $\frac{6.5 \times 74}{60}$ = 8.02 g (i.e. M2 x 74)

M3 $\frac{3.25}{74}$ *mol propanoic acid formed*

1

M4 $\frac{3.25 \times 100}{8.02}$ = 40.5 %

M4 $\frac{3.25/74}{6.5/60} \times 100$ *= 40.5 %*

1

(f) **M1** add sodium carbonate/hydrogencarbonate

1

M2 effervescence / bubbles

not *gives off* (CO_2) *gas*

1

M3 no (visible) change/reaction

not *nothing / no observation*

allow *acidified sodium/potassium dichromate*

no visible change / stays orange

orange to green

allow *named alcohol + sulfuric acid plus sweet smell and no change/reaction*

allow *named carboxylic acid + sulfuric acid plus no change/reaction and sweet smell*

not *pH measurement*

incorrect reagent = 0/3

incomplete reagent – mark on

1

[13]

6.

(a) **M1** (Re)weigh the empty boat

1

M2 In order to calculate the (exact) mass of salicylic acid added to the reaction mixture

1

(b) 10 cm^3 measuring cylinder (if volume given – allow between 10 to 50 cm^3)
Or a 10 cm^3 pipette

Or burette / graduated pipette

Or 10 cm^3 syringe

1

(c) Corrosive

Allow skin burn / permanent eye damage

Ignore irritant / toxic

1

(d) LHS + $(CH_3CO)_2O$ RHS + CH_3COOH

1

(e) **M1** Amount salicylic acid = $^{6.01}/_{138}$ = 4.36×10^{-2} mol

Allow conseq from wrong mole ratio in (d)

Must show and state that ethanoic anhydride is in excess

1

M2 Mass $(CH_3CO)_2O$ = 10.5 × 1.08 = 11.34 g

1

M3 Amount $(CH_3CO)_2O$ = $^{11.34}/_{102}$ = 1.11×10^{-1} mol

For M4/M5 ecf from M1/M3

1

M4 $(CH_3CO)_2O$ is in excess

1

M5 Mass aspirin = M1 × 0.841 × 180 = 6.59 g

Allow 2 sf or more.

1

(f) **M1** Value lower

1

M2 Range of values

For M2 allow mpt not sharp or a larger range of melting points

1

(g) **M1** (Ethanol is flammable so) use a water bath to heat / do not use a Bunsen burner

Must give practical step, not just state hazard

1

M2 Heat to temp below bp (so ethanol does not boil away)

Allow use min vol solvent

1

(h) To remove any soluble impurities

Allow To avoid aspirin dissolving (small amount cold solvent used)

Allow To remove/(wash away) any ethanolic solution on the product.

1

(i) Pure product will have (larger) crystals / needle-like crystals / lighter in colour

Allow whiter, less grey, more crystalline, less powdery, shinier, single colour

Must be tied to pure product

Allow opposite points tied to the crude product

1

[16]

7. (a) **M1** Moles of cyclohexanol = (10 × 0.96)/100.0 = 0.096

Correct answer scores all 3 marks

1

M2 Max mass of cyclohexene = 0.096 × 82.0 = 7.87(2)

= M1 × 82.0 (process mark)

1

M3 % yield = (5.97 / 7.87) × 100 = 76% (Allow range 75.8 – 76)

= (5.97 / M2) × 100 (process mark)

1

Alternative method

M1 Moles of cyclohexanol = (10 × 0.96)/100.0 = 0.096

M2 Moles of cyclohexene = 5.97/82.0 = 0.0728

M3 % yield = 0.0728 / 0.096 × 100 = 76% (allow range 75.8 – 76)

= (M2 / M1) × 100

Allow 1/3 for 62(.2)%

(b) Add bromine (water)

If M1 not correct then only allow M2 if reagent involves bromine (water)

1

Would turn (from orange to) colourless / decolourise

Do not allow incorrect starting colour, but allow brown/red/yellow

Not discolour.

Ignore clear

1

(c) Na_2CO_3 would neutralise/react with/remove (phosphoric) acid/H_3PO_4/H^+

1

(d) avoid pressure build-up / release pressure / release CO_2/air/gas / prevent stopper blowing out

Ignore explosion

Do not allow an incorrect named gas

Allow idea that build-up of gas/CO_2 would lead to increased pressure/stated effect of increased pressure

1

(e) Does not dissolve in/react with the cyclohexene

Allow remains a solid/is inert in cyclohexene

Allow organic product/organic compound formed/ organic layer/distillate instead of cyclohexene

Do not allow if answer implies cyclohexanol

Do not allow if answer says does not react with products

Ignore references to filtration

Do not allow insoluble/unreactive unless qualified by implied reference to cyclohexene

1

(f) If diagram drawn:

M1 diagram of basic set up to include flask or tube with side-arm/Buchner flask, flat-bottomed funnel/Buchner funnel, filter paper

M2 apparatus should work, flow through, air-tight connection between flask and funnel, arrow/label/description (to vacuum pump)

Do not allow "standard" Y-shaped funnel

1

If description given:

M1 Buchner funnel/flat-bottomed funnel containing filter paper

M2 Buchner flask/side-arm flask connected to vacuum pump

Do not allow just "funnel"

Penalise M2 if described apparatus would not actually work.

1

(g) Cyclohexene is less polar than cyclohexanol / cyclohexanol is more polar than cyclohexene

It = cyclohexene

Allow cyclohexene is non-polar and cyclohexanol is polar

1

Cyclohexene has a greater affinity/attraction for the mobile phase/hexane / cyclohexanol has a greater affinity/attraction for the stationary phase/silica

Allow cyclohexanol held in the stationary phase for longer

Allow cyclohexene is more soluble in the mobile phase/hexane or converse for cyclohexanol

Allow references to hydrogen bonds between cylcohexanol and silica

1

(h) Would be no peak at 3230 – 3550 cm^{-1} due to O—H((alcohol))

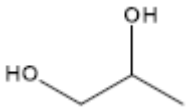
OR

There would be no additional peaks in the fingerprint region compared to a pure sample / fingerprint region exactly matches cyclohexene

Need wavenumber and bond for mark

1

[13]

8. (a) 

Any correct skeletal formula (both OH groups must be shown)

1

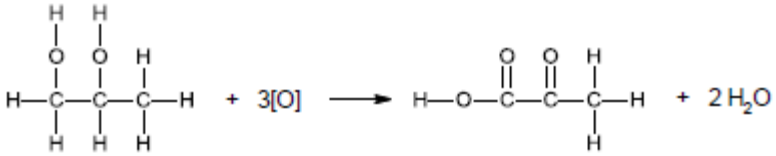
(b) M1 Displayed formula of correct product

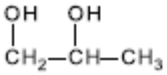
Incorrect organic product CE=0

Must be displayed formula but can be shown separately or in the equation

1

M2 Balanced equation





$CH_2OHCHOHCH_3$

$C_3H_8O_2$

Allow any correct structural formula (or molecular formula $C_3H_4O_3$) for product in balanced equation

Allow any correct formula of propane-1,2-diol (including its molecular formula $C_3H_8O_2$)

1

(c) M1 flask with condenser vertically above it (without gaps between flask and condenser)

Distillation diagram CE = 0

Condenser must have outer tube for water that is sealed at top and bottom; condenser must have two openings for water in/out (that are open, although these openings do not need to be labelled)

Penalise M1 if apparatus is sealed (a continuous line across the top and/or bottom of the condenser is penalised)

1

M2 flask and condenser labelled

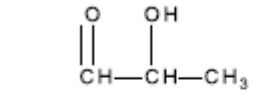
Allow condensing tube for condenser label

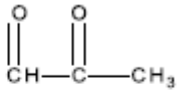
1

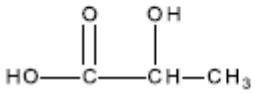
(d) Form small(er) bubbles or prevent large bubbles

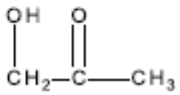
1

(e) Any one of these four structures:









Allow any correct structural / displayed / skeletal formula

For reference:

Carbon 1	Carbon 2
aldehyde	alcohol
carboxylic acid	alcohol
aldehyde	ketone
alcohol	ketone

1

[7]