Mark schemes

Q1.

(a) Electrophilic substitution both words needed

Allow minor spelling errors e.g. electrophillic or subsitution

Ignore nitration

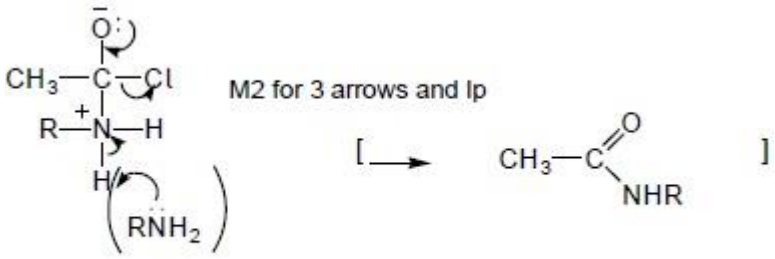
1

(b) + $3H_2$ ..... + $2H_2O$

Allow 6 [H]

1

(c)



M1 *for structure of ion including 2 charges (+ on N must be correct in both cases if drawn twice)*

M2 *for 3 arrows and lp on O - may be scored in two steps*

Ignore use of RNH_2 to remove H^+ in ***M2****, but penalise use of Cl^-*

2

(d) Corrosive **OR** forms strong acid/HCl (fumes) **OR** vulnerable to hydrolysis **OR** dangerous (to use)

Allow anhydride is less corrosive ***OR*** *does not form strong acid fumes* ***OR*** *less vulnerable to hydrolysis*

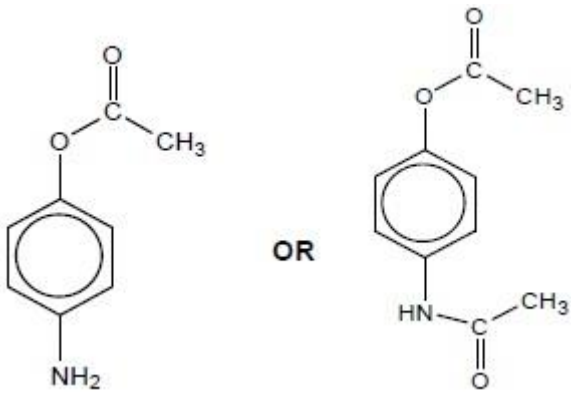
OR *ethanoyl chloride is more expensive*

Allow reacts violently / extremely exothermic / extremely vigorous

Ignore toxic / harmful / hazardous

1

(e)



1

(f) + CH_3COONH_4 ..... + $2H_2O$

Allow CH_3COO^- / $CH_3CO_2^-$ and NH_4^+

Allow NH_4CH_3COO

1

(g) *Via moles*

M1 M_r paracetamol = 151(.0)

M1

M2 Amount paracetamol = 250 × 10^3 / 151.0 = 1655.6 mol
OR (250 × 10^3) / **M1**

(= amount hydroquinone used)

M2

M3 Mass hydroquinone = 1655.6 × 110.0 = 182119 g = 182 kg
OR correct answer to **M2** × 110.0 / 1000

M3

OR via mass
M1 *M_r paracetamol = 151(.0)*
So 110 g hydroquinone forms 151 g paracetamol
M2 *Mass hydroquinone needed 250 × 110 / 151.0*
OR *250 × 110 /* ***M1***
= 182 kg

Min 2sf
If Mr values used wrong way round can score ***M2***

[10]

Q2.

C

[1]

Q3.

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 the explanation of each stage is generally correct and virtually complete. Answer communicates the whole process coherently and shows a logical progression from stage 1 and stage 2 to stage 3. Completely correct use of sign and language in Stage 3.
Level 2 3-4 marks	All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete. Answer is mainly coherent and shows a progression through the stages. Some steps in each stage may be incomplete. Some errors in use of sign and language in Stage 3.
Level 1 1-2 marks	Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR only one stage is covered but the explanation is generally correct and virtually complete. Answer includes some isolated statements but these are not presented in a logical order or show confused reasoning.
Level 0 0 marks	Insufficient correct chemistry to gain a mark.

Indicative chemistry content

Stage 1 Bonding
1a) Each C has three (covalent) bonds
1b) Spare electrons (in a p orbital) overlap (to form a π cloud)
1c) delocalisation

Stage 2 Shape
2a) Planar
2b) Hexagon/6 carbon ring/120° bond angle
2c) C–C bonds equal in length / C–C bond lengths between single and double bond

Stage 3 Stability
3a) Expected ΔH^{o} hydrogenation of cyclohexatriene = –360 kJ mol^{-1}
3b) ΔH^{o} hydrogenation benzene (is less exothermic) by 152 kJ mol^{-1}
3c) Benzene lower in energy than cyclohexatriene / Benzene is more stable

6

(b) Value within range –239 to –121

If outside range including positive values CE=0

1

Double bonds separated by one single bond / alternating (or shown in structure)

The wording 'close enough to allow delocalisation' would score M2 and M3

1

Allows some delocalisation/overlap of p orbitals

Ignore reference to hydration here

1

[9]

Q4.

A

[1]

Q5.

(a) $HNO_3 + 2H_2SO_4 \longrightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$

Allow $H_2SO_4 + HNO_3 \longrightarrow NO_2^+ + HSO_4^- + H_2O$

Allow a combination of equations which produce NO_2^+

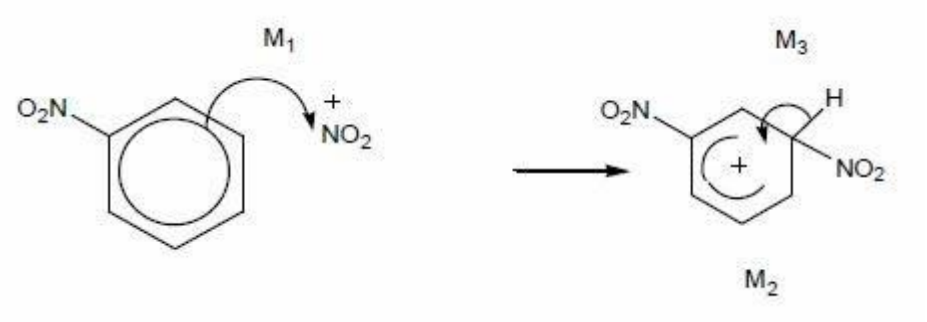
Penalise equations which produce SO_4^{2-}

1

(b) Electrophilic substitution.

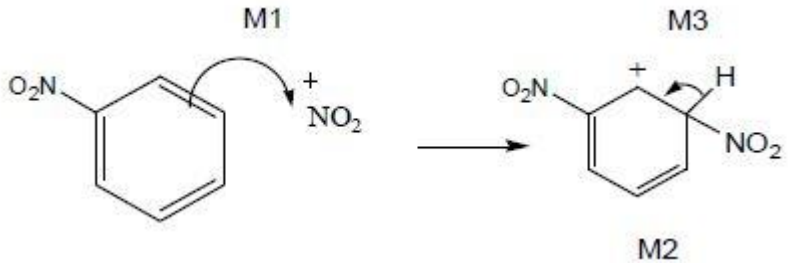
Ignore nitration

1



3

OR Kekule



M1 Arrow from inside hexagon to N or + on N
(Allow NO_2^+)

M2 Structure of intermediate

- *horseshoe centred on C1 and must not extend beyond C2 and C6, but can be smaller*
- *+ in intermediate not too close to C1 (allow on or "below" a line from C2 to C6)*

M3 Arrow from bond into hexagon (Unless Kekule)

- *Allow M3 arrow independent of M2 structure*
- *+ on H in intermediate loses M2 not M3*

(c) D

1

(d) (Balance between) solubility in moving phase and retention by stationary phase

OR (relative) affinity for stationary / solid and mobile / liquid / solvent (phase)

(e) Solvent depth must be below start line

Ignore safety

1

(f) 1,2- is more polar **OR** 1,4- is less polar
OR 1,2 is polar, 1,4- is non-polar

1

1,4- (or Less/non polar is) less attracted to (polar) plate / stationary phase / solid
OR (Less/non polar is) more attracted to / more soluble in (non-polar) solvent / mobile phase / hexane

1

M2 dependent on correct M1

If M1 is blank then read explanation for possible M1 and M2

Allow converse argument for 1,2

(g) No CE = 0

Yes - mark on but there is **NO MARK FOR YES**

Mark independently following yes

Solvent (more) polar or ethyl ethanoate is polar

1

Polar isomer more attracted to / more soluble in / stronger affinity to the solvent (than before)

Penalise bonded to mobile phase in M2

1

[12]

Q6.

A

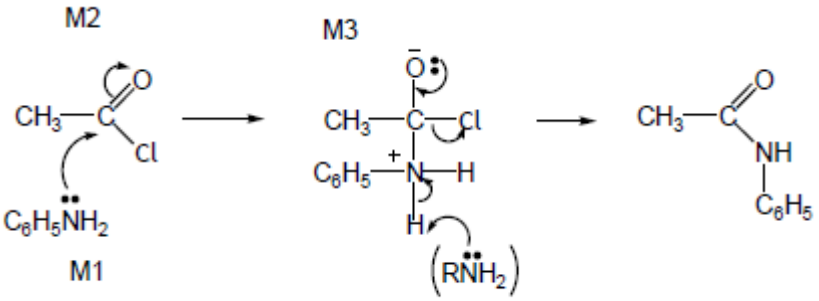
[1]

Q7.

(a) (nucleophilic) addition-elimination

Not electrophilic addition-elimination

1



M4 for 3 arrows and lp

Allow C_6H_5 or benzene ring

Allow attack by :$NH_2C_6H_5$

M2 not allowed independent of M1, but allow M1 for correct attack on C+

M3 for correct structure <u>with charges</u> but lone pair on O is part of M4

M4 (for three arrows and lone pair) can be shown in more than one structure

4

(b) **The minimum quantity of hot water was used:**

To ensure the hot solution would be saturated / crystals would form on cooling

1

The flask was left to cool before crystals were filtered off:

Yield lower if warm / solubility higher if warm

1

The crystals were compressed in the funnel:

Air passes through the sample not just round it

Allow better drying but not water squeezed out

1

A little cold water was poured through the crystals:

To wash away soluble impurities

1

(c) Water

Do not allow unreacted reagents

1

Press the sample of crystals between filter papers

Allow give the sample time to dry in air

1

(d) M_r product = 135.0

1

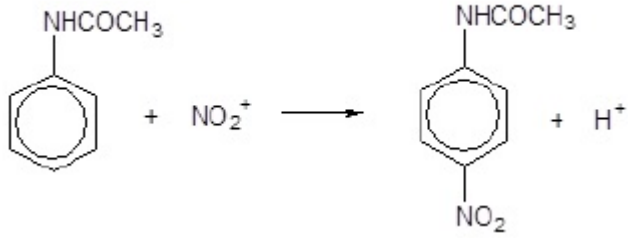
Expected mass = $5.05 \times \frac{135.0}{93.0} = 7.33$ g

1

Percentage yield = $\frac{4.82}{7.33} \times 100 = 65.75 = 65.8(\%)$

Answer must be given to this precision

(e)



OR

$C_6H_5NHCOCH_3 + NO_2^+ \rightarrow C_6H_4(NHCOCH_3)NO_2 + H^+$

1

(f) Electrophilic substitution

1

(g) Hydrolysis

1

(h) Sn / HCl

Ignore acid concentration; allow Fe / HCl

1

[18]