**1.** (a) k = rate / $[A]^2$ or $\frac{3.3\times10^{-6}}{(4.2\times10^{-3})^2}$

1

= 1.87 or 1.9

*Answer scores 2*

*1.90 scores first mark only (incorrect rounding)*

1

mol $^{1}$dm$^{3}$s $^{1}$

*Any order and independent of calculation*

1

(b) Expt 2 rate = 1.167 × 10 $^{4}$ 1.2 × 10 $^{4}$ (mol dm $^{3}$ s $^{1}$)

*If answers in table are not those given here, check their value of k in part (a) or use of alternative k.*

1

Expt 3 [A] = 9.7 × 10 $^{3}$ 9.8(1) × 10 $^{3}$ (mol dm $^{3}$)

*If their k is incorrect in part (a) mark this part consequentially e.g. if k = 7.9 × 10 $^{3}$ due to lack of squaring in (a)*

Using alternative value for *k*

*expt 2 4.9 × 10 $^{7}$*

Expt 2 rate = 1.4(4) × 10 $^{4}$ (mol dm $^{3}$ s $^{1}$)

*expt 3 1.5 ×10 $^{1}$* ✓

Expt 3 [A] = 8.85 × 10 $^{3}$ (mol dm $^{3}$)

*(expt 2 6.24 × 10 $^{5}$ × their k)*

*(expt 3 0.0134 / k)*

1

(c) Slow step or rds involves only A

***OR***

B does not appear in the slow step or the rds

***OR***

B only appears after the slow step or the rds

*Not B has no effect on the rate or B is not in the rate equation*

*Allow "it" for B*

1

**[6]**

→

**2.** (a) propyl methanoate;

$HCOOC_3H_7 + OH^- \rightarrow HCOO^- + C_3H_7OH$

1

OR

$HCOOC_3H_7 + NaOH \rightarrow HCOONa + C_3H_7OH$;

1

(b) order wrt A = 1;

1

order wrt NaOH = 1;

1

Initial rate in Exp 4 = 2.4 × $10^{-3}$;


1

2

(c) (i) r(ate) = k[A]
OR
r(ate) = k[A][NaOH]$^0$;
*(penalise missing [ ] but mark on)*
*(penalise missing [ ] once per paper)*
*(if wrong order, allow only units mark conseq on their rate eqs)*
*(penalise $k_a$ or $k_w$ etc)*

1

(ii) $k = \frac{9.0 \times 10^{-3}}{0.02}$;

1

= 0.45;

1

$s^{-1}$;

1

(iii) (large) excess of $OH^-$ or $[OH^-]$ is large/high;

1

$[OH^-]$ is (effectively) constant
OR
[A] is the limiting factor *(Q of L mark)*

1

**[11]**

**3.** (a) (i) $k = \frac{8.4 \times 10^{-5}}{(4.2 \times 10^{-2})^2 \times 2.6 \times 10^{-2}}$ **OR** $\frac{8.4 \times 10^{-5}}{(1.76 \times 10^{-3}) \times 2.6 \times 10^{-2}}$

*Mark is for insertion of numbers into a correctly rearranged rate equ , k = etc.*
*If upside down, score only units mark from their k*
*AE ( 1) for copying numbers wrongly or swapping two numbers*

1

= 1.8(3)

1

$mol^{-2}$ $dm^{+6}$ $s^{-1}$
*Any order*
*If k calculation wrong, allow units consequential to their k = expression*

1

(ii) $5.67 \times 10^{-4}$ (mol $dm^{-3}$ $s^{-1}$) ***OR*** their $k \times 3.1 \times 10^{-4}$
*Allow $5.57 \times 10^{-4}$ to $5.7 \times 10^{-4}$*

1

(b) (i) 2 or second or $[D]^2$

1

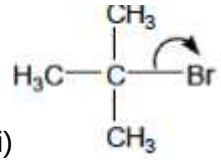
(ii) 0 or zero or $[E]^0$

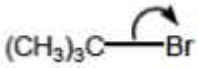
1

(c) (i) Step 1 or equation as shown

*Penalise Step 2 but mark on*

1



(ii) 

Ignore correct partial charges, penalise full / incorrect partial charges

*If Step 2 given above, can score the mark here for*

*allow: OH (must show lp)*

*If $S_N2$ mechanism shown then no mark*

*(penalise involvement of :OH in step 1)*

*Ignore anything after correct step 1*

1

**[8]**

**4.** (a) (i) An appropriate alkene; $CH_3CH_2CHCH_2$ or $(CH_3)_2CCH_2$

1

Isomer 1

1

Isomer 2

1

Position isomerism

1

Mechanism
electrophilic attack and electron shift to Br (Unless $H^+$ used)

1

carbocation

1

reaction with carbocation

*[Allow mechanism marks for the alkene $CH_3CHCHCH_3$]*

*[Allow one mark if mechanism for minor product given]*

1

(ii) An appropriate carbonyl; $CH_3CH_2CHO$

1

Mechanism nucleophilic attack and electron shift to O

1

anion intermediate

1

reaction with anion

*[Allow mechanism marks for the carbonyl $(CH_3)_2CO$]*

1

Isomer 1

1

Isomer 2

1

Optical isomerism

*NB* *Isomer structures must be tetrahedral*

*NB* *Penalise "stick" structures once in part (a)*

1

(b) QoL
Large charge on carbonyl carbon atom due to bonding to O and Cl

1

Nucleophiles have electron pairs which can be donated

1

Equation Species

1

Balanced

1

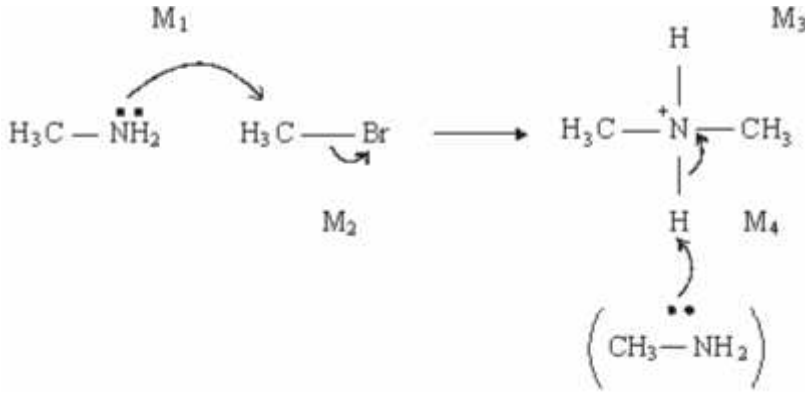
**[18]**

**5.** (a) dimethylamine

1

(b) nucleophilic substitution

1




4

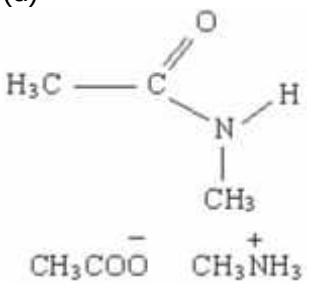
(c) quaternary ammonium salt

1

(cationic) surfactant / bactericide / detergent / fabric softener or conditioner/hair conditioner

1

(d)




*(allow $CH_3COOH$ or $CH_3COO^- NH_4^+$)*

2

**[10]**

**6.** (a) (i) Moles NaOH = mv/1000 = 1.50 × 72.5/1000 = 0.108 to 0.11 **(1)**
Moles of ethanoic acid at equilibrium = moles sodium hydroxide **(1)**
Moles ester = moles water (=moles acid reacted) **(1)**
= 0.200 – 0.108 = 0.090 to 0.092 **(1)**
Moles ethanol = 0.110 – 0.091 = 0.018 to 0.020 **(1)**
$K_c$ = [Ester] [Water]/[Acid] [Alcohol] **(1)**
*Allow if used correctly*
= $(0.091)^2/0.109 \times 0.019$ = 3.7 to 4.9 **(1)**
*Ignore units*
*NB Allow the answer 4 one mark as correct knowledge*

**7**

(ii) Similar (types) of bond broken and made **(1)**
Same number of the bonds broken and made **(1)**
*any number if equal*
*NB If a list given then the total number of each type of bond broken and made must be the same*

**2**

(b) (i) (Weak) dipole-dipole attraction between HCl molecules **(1)**
(Strong) **hydrogen bonds** between $CH_3COOH$ molecules **(1)**
*NB Ignore van der Waals forces*

**2**

(ii) Ethanoic anhydride is
cheap compared to ethanoyl chloride **(1)**
less corrosive than ethanoyl chloride or HCl evolved **(1)**
reaction less violent or vigorous or exothermic or dangerous or safer to use **(1)**
less vulnerable to hydrolysis **(1)**
reaction more easily controlled **(1)**

**Max 2**

**[13]**

**7.** (a) Yes, because it is oxidised to ethanal / $CH_3CHO$
**OR** it is oxidised to a compound that contains $CH_3CO$ group
*Ignore 'primary alcohols are oxidised to aldehydes'.*
*Need 'yes' and an explanation to be awarded the mark.*

**1**

(b) $M_r$ $CHI_3$ = 393.7 **(M1)**
*Allow if clearly shown in a calculation.*
*Allow 394*

**1**

Moles $CHI_3$ = 10 / 393.7 = $2.54 \times 10^{-2}$ **(M2)**
*Allow a consequential answer on an incorrect $M_r$.*
*$2.54 \times 10^{-2}$ scores **M1** and **M2**.*

**1**

Moles $I_2$ = $7.62 \times 10^{-2}$ **(M3)**

*Allow 3 × **M2**.*

1

Mass $I_2$ = 7.62 × 10 $^{-2}$ × 253.8 = 19.34g **(M4)**

*Allow **M3** × 253.8 or **M3** × 254*

1

Scaling 19.34 / 0.832 = 23.2g **(M5)**

*Allow **M4** / 0.832*
*Lose this mark if the answer is not given to 3 significant figures.*
*Answer without working scores **M5** only.*
*Allow any chemically correct alternative method.*
*Calculations which combine several steps in one expression can score the marks for all of these individual steps.*

1

(c) Remove soluble impurities

*Allow 'remove excess sodium hydroxide / iodine'.*
*Allow 'remove excess sodium methanoate / sodium iodide'.*
*Allow 'remove excess reagents'.*

1

(d) Will not dissolve solid / solid is insoluble in water

*Allow 'will not react with solid'.*

→

1

**[8]**

**8.** (a) $Mg + 2C_6H_4(OH)COOH \rightarrow (C_6H_4(OH)COO)_2Mg + H_2$

*Accept multiples, including fractions.*

1

(b) Gas syringe / inverted burette over water / measuring cylinder over water

*Collection apparatus must show graduations or be clearly labelled (eg syringe, burette, measuring cylinder).*

1

**[2]**

**9.** Identification of acid by suitable method eg named indicator, named carbonate, specified reactive metal

*Ignore any reference to the smell of the ester.*

1

with expected results

*Do not allow the use of any instrumental method eg i.r. or n.m.r.; must be a chemical test.*

1

Identification of alcohol by suitable method eg oxidation by acidified potassium dichromate(VI)

1

with expected results

1 **[4]**