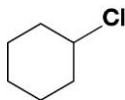


## 6.3 Halogenoalkanes and alcohols

### Answers to Exam practice questions

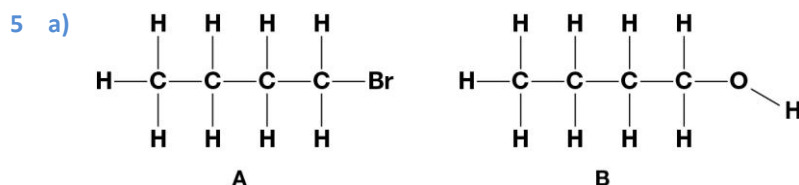
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#### Pages 222–223 Exam practice questions

- 1 a) Heat **W** under reflux [1] with an excess of a solution of potassium dichromate(VI) [1] in dilute sulfuric acid. [1]  
b)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$  [1]  
Use the same reagent but distil off the aldehyde from the reaction mixture as it forms. [1]  
c) Heat **W** [1] with a mixture of red phosphorus and iodine. [1]
- 2 a) Halogenoalkanes do not mix with aqueous reagents. [1]  
Halogenoalkanes do dissolve in ethanol and the solution then mixes with aqueous reagents. [1]  
b) Ethanol is highly flammable so it is much safer to heat it in hot water than with a flame. [1]  
c) The halogenoalkane hydrolyses producing halide ions – in this instance bromide ions which precipitate as  $\text{AgBr}$ . [1]  $\text{AgBr}$  is cream coloured. It is soluble in concentrated ammonia [1], unlike  $\text{AgI}$ , which is a brighter yellow.  
d) The compound is a bromoalkane. [1]
- 3 a)  $(\text{CH}_3)_2\text{C}=\text{CH}_2$  [1]  
b)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$  [1]  
c)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$  [1]  
d)  $\text{HOOCCH}_2\text{CH}_2\text{COOH}$  [1]  
e) 
- 4 a) *From bromoethane:*  
Step 1:  $\text{KCN}$  [1] reflux in ethanol [1]  
 $\text{CH}_3\text{CH}_2\text{Br} + \text{KCN} \rightarrow \text{CH}_3\text{CH}_2\text{CN} + \text{KBr}$  [1]  
Step 2:  $\text{H}_2$  [1] with  $\text{Ni}$  catalyst to  $150^\circ\text{C}$  [1]  
 $\text{CH}_3\text{CH}_2\text{CN} + 2\text{H}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$  [1]  
*From 1-bromopropane:*  
Step 1: excess [1]  $\text{NH}_3$  [1] in ethanol [1]  
 $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + 2\text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 + \text{NH}_4\text{Br}$  [1]  
b) Disadvantage of two-step route:  $\text{KCN}$  toxic.  
Disadvantage of one-step route: further reaction may occur because the product amine can act as a nucleophile.

## 6.3 Halogenoalkanes and alcohols

### Answers to Exam practice questions



b) Step 1: sodium hydroxide [1]; warm, aqueous [1]; nucleophilic substitution [1]

Step 2: acidified potassium dichromate(vi) [1]; reflux [1]; oxidation [1]

6 a) Reaction 1: KOH [1] aqueous; warm [1]

Reaction 2: KBr [1] and conc. sulfuric acid [1]

Reaction 3:  $\text{H}_3\text{PO}_4$  [1]; hot [1]

Reaction 4: steam [1];  $\text{H}_3\text{PO}_4$  catalyst [1]

Reaction 5: KOH [1]; hot ethanolic [1]

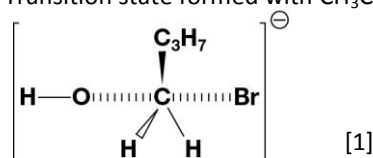
Reaction 6: conc. HBr [1]

b) **Either:** In Reaction 4 [1], the major product would be propan-2-ol rather than propan-1-ol. [1]

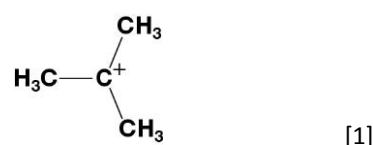
**Or:** In Reaction 6 [1], the major product would be 2-bromopropane rather than 1-bromopropane. [1]

Because, in both cases, the reaction would proceed via the more stable secondary carbocation. [1]

7 a) Transition state formed with  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$  is:



Intermediate carbocation formed with  $(\text{CH}_3)_3\text{CBr}$  is:

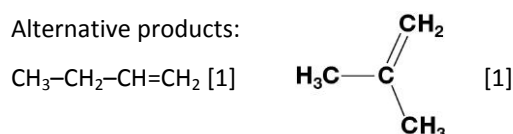


For tertiary compound, three  $\text{CH}_3$  groups hinder attack by  $\text{OH}^-$ /steric hindrance inhibits formation of intermediate (trigonal bipyramidal). [1]

Tertiary carbocation is more stable than primary. [1]

b) Rate would increase [1] because the C-I bond is weaker than the C-Br bond. [1]

c) Alternative products:



## 6.3 Halogenoalkanes and alcohols

### Answers to Exam practice questions

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- 8 a) Hydrolysis [1] produces 3-methylbutan-2-ol,  $(\text{CH}_3)_2\text{CHCHOHCH}_3$  [1]  
b) Elimination [1] of HBr produces two alkenes:  
2-methylbut-2-ene [1],  $(\text{CH}_3)_2\text{C}=\text{CHCH}_3$  [1] and  
3-methylbut-1-ene [1],  $(\text{CH}_3)_2\text{CHCH}=\text{CH}_2$  [1]  
c) Nucleophilic substitution [1] produces 2-amino-3-methylbutane [1],  $(\text{CH}_3)_2\text{CHCHNH}_2\text{CH}_3$  [1]  
d)  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{CN}$  [1], 2,3-dimethylbutanenitrile [1]
- 9 The mark for each improvement must be linked with the correct improvement.  
Thermometer bulb should be level with condenser side arm and not in the liquid. [1]  
The temperature of the vapour as it condenses gives the boiling temperature of the liquid distilling. [1]  
The water should flow in at the bottom of the condenser and flow out at the top. [1]  
This ensures all the condenser surface is cooled and improves the efficiency of the condenser. [1]  
The ethanal should be collected in a conical flask (preferably cooled in ice) rather than in an open beaker. [1] (See Figure 6.3.16 for suitable apparatus.)  
The boiling point of ethanal is only just above room temperature and it will easily evaporate from an open beaker. [1]
- 10 This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully sustained line of reasoning. Assess the quality of the answers taking into account both the key points made (*up to 4 marks*) and the logic and coherence of the discussion (*up to 2 marks*).  
Points to make in an answer:
- Separating funnel needed.
  - Sodium hydrogencarbonate added to remove acid.
  - Mixture shaken and tap opened to release any pressure; lower aqueous layer removed.
  - Water added to remove any sodium hydrogen carbonate; after shaking, lower aqueous layer removed.
  - Damp cyclohexene run into conical flask and lumps of anhydrous calcium chloride added.
  - When liquid is clear, dry cyclohexene decanted off or calcium chloride filtered off.
- 11 a) 1 mol propan-2-ol forms 1 mol propanone. [1]  
Separated by distillation [1]  
Amount of propan-2-ol =  $\frac{11 \text{ cm}^3 \times 0.78 \text{ g cm}^{-3}}{60.0 \text{ g mol}^{-1}} = 0.143 \text{ mol}$  [1]  
Mass of pure propanone =  $0.80 \times 0.143 \text{ mol} \times 58.0 \text{ g mol}^{-1} = 6.64 \text{ g}$  [1]

## 6.3 Halogenoalkanes and alcohols

### Answers to Exam practice questions

- b) 1 mol butan-1-ol forms 1 mol 1-iodobutane [1]

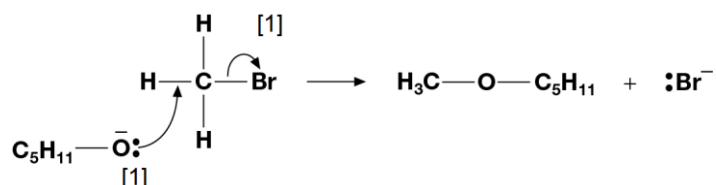
$$\text{Amount of butan-1-ol} = \frac{9.25 \text{ cm}^3 \times 0.81 \text{ g cm}^{-3}}{74.0 \text{ g mol}^{-1}} \quad [1]$$

$$= 0.101 \text{ mol} \quad [1]$$

$$\text{Mass of pure 1-iodobutane} = 0.85 \times 0.101 \text{ mol} \times 183.9 \text{ g mol}^{-1} = 15.8 \text{ g} \quad [1]$$

- 12 a) Q is  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OCH}_3$  [1]


- b) i) Nucleophilic substitution [1]



- ii) Q is an ether for which the strongest intermolecular forces are dipole–dipole interactions. [1] Alcohols such as pentan-1-ol have hydrogen bonding, which is stronger. [1]

- c) i) R is  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_3$  [1]

- ii) P is a strong base [1] so instead of acting as a nucleophile, it can remove a proton from bromoethane [1] in an elimination reaction. [1]

- d) i)  [1]

- ii) A nucleophilic substitution [1] reaction occurs when the oxide ion on one end of the chain acts as a nucleophile and attacks the  $\delta^+$  carbon attached to the bromine at the other end. [1]
- iii) The ring in S has 6 atoms so the internal bond angle is similar to the tetrahedral angle of  $109.5^\circ$ . [1] If 2-bromopentan-1-ol were used instead, the ring would contain only 3 atoms and be unstably strained. [1]
- iv) S is a cyclic ether so will only have dipole–dipole interactions. [1] Pentan-1-ol with hydrogen bonding will have the higher boiling temperature. [1]