C7bD Alcohols, Carboxylic Acids and Polymers: Exam Drill

Total Marks

AQA 8464 · Calculator allowed · about 90 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Name the functional group present in alcohols.

(Total for Question 1 is 1 mark)

---

2 Write the condensed structural formula for ethanol.

(Total for Question 2 is 1 mark)

---

3 State the products when ethanol burns completely in oxygen.

(Total for Question 3 is 1 mark)

---

4 Ethanol can be oxidised to ethanoic acid using oxygen. Balance the symbol equation for this oxidation:

C2H5OH + O2 -> C2H4O2 + H2O

(Total for Question 4 is 2 marks)

---

5 When a carboxylic acid dissolves in water it partially ionises. State the two ions produced when ethanoic acid ionises in water.

(Total for Question 5 is 1 mark)

6 A student titrates 20.00 cm3 of an ethanoic acid solution with 0.100 mol/dm3 sodium hydroxide. The volume of NaOH required to reach the end point is 25.00 cm3.

Calculate the concentration of the ethanoic acid solution in mol/dm3. The reaction is CH3COOH + NaOH -> CH3COONa + H2O.

(Total for Question 6 is 3 marks)

---

7 Name the ester formed when ethanol reacts with ethanoic acid.

(Total for Question 7 is 1 mark)

---

8 A polyester is made by condensation polymerisation of ethane-1,2-diol (HO-CH2-CH2-OH) and butanedioic acid (HOOC-CH2-CH2-COOH).

a) State the two monomers used (give each name). (2 marks)

b) Write the condensed formula for the repeating unit of the polyester, using -[...] - to show the repeat. Use simple text (no structural diagrams). (1 mark)

(a) State the two monomers used (give each name). **(2)**

(b) Write the condensed formula for the repeating unit of the polyester, using -[...] - to show the repeat. **(1)**

(Total for Question 8 is 3 marks)

9 In the condensation polymerisation above, each ester linkage formed produces one molecule of water. Calculate the number of water molecules produced when 0.150 mol of ester linkages are formed. Give your answer to 3 significant figures.

Use Avogadro constant = 6.02×10^{23} mol^{-1}.

(Total for Question 9 is 3 marks)

---

10 Compare, with reasons, the environmental persistence of a typical addition polymer such as poly(ethene) and a typical condensation polyester (for example a polyester made from a diol and a dicarboxylic acid). Your answer should refer to chemical structure and the types of bonds present. (3 marks)

(Total for Question 10 is 3 marks)

---

11 During a titration practical a student rinses the inside of a burette with deionised water only before filling it with 0.100 mol/dm3 NaOH. Describe one systematic effect this mistake would have on the titre volumes and explain how it affects the calculated concentration of the acid being titrated. (3 marks)

(Total for Question 11 is 3 marks)

12 Explain how to prepare ethyl ethanoate (an ester) from ethanol and ethanoic acid in a school laboratory, including reagents, conditions, role of any catalyst, how you would purify the product, and why each major step is needed. (6 marks)

(Total for Question 12 is 6 marks)

---

13 Calculate the relative molecular mass (Mr) of the repeating unit -[O-CH2-CH2-O-CO-CH2-CH2-CO]- (use atomic masses: C = 12.0, H = 1.0, O = 16.0). Show substitution and give the Mr with units. (3 marks)

(Total for Question 13 is 3 marks)

---

14 Stretch question: A student prepares ethyl ethanoate and obtains 15.0 g of product. The theoretical yield based on the limiting reagent is 18.5 g.

Calculate the percentage yield and give one realistic reason (experimental) why the yield might be less than 100%. (3 marks)

(Total for Question 14 is 3 marks)

Mark scheme · C7bD Alcohols, Carboxylic Acids and Polymers: Exam Drill

Question 1

- **B1** the hydroxyl group -OH, cao
- **Answer: Hydroxyl group -OH**

Question 2

- **B1** C2H5OH or CH3CH2OH cao
- **Answer: CH3CH2OH**

Question 3

- **B1** carbon dioxide and water (CO2 and H2O) cao
- **Answer: Carbon dioxide and water**

Question 4

- **M1** correctly balances oxygen by adding coefficients (recognises 1 O2 is needed)
- **A1** C2H6O + O2 -> C2H4O2 + H2O cao
- **Answer: C2H6O + O2 -> C2H4O2 + H2O**

Question 5

- **B1** hydrogen ions H+ and ethanoate ions CH3COO- (or CH3COO minus), cao
- **Answer: H+ and CH3COO-**

Question 6

- **M1** calculates moles NaOH = 0.100 x (25.00 / 1000) = 0.00250 mol
- **A1** uses 1:1 stoichiometry so moles CH3COOH = 0.00250 mol
- **A1** concentration = 0.00250 / (20.00 / 1000) = 0.125 mol/dm3 cao
- **Answer: 0.125 mol/dm3**

Question 7

- **B1** ethyl ethanoate (accept ethyl acetate) cao
- **Answer: Ethyl ethanoate**

Question 8

- (a) **B1** ethane-1,2-diol (also accept ethylene glycol or HO-CH2-CH2-OH)
- (a) **B1** butanedioic acid (also accept succinic acid or HOOC-CH2-CH2-COOH)
- **(a) Answer: Ethane-1,2-diol (ethylene glycol) and butanedioic acid (succinic acid).**
- (b) **B1** repeat unit written as -[O-CH2-CH2-O-CO-CH2-CH2-CO]- or equivalent text string, cao
- **(b) Answer: -[O-CH2-CH2-O-CO-CH2-CH2-CO]-**

Question 9

- **M1** calculates moles H2O = 0.150 mol (1:1 relationship)
- **A1** calculates molecules = 0.150 x 6.02 x 10^{23} = 9.03 x 10^{22}
- **A1** gives answer to 3 s.f. as 9.03 x 10^{22} cao
- **Answer: 9.03 x 10^{22}**

Question 10

- **M1** states that poly(ethene) has only C-C and C-H single bonds (non-polar, strong), making it chemically inert
- **M1** states that condensation polyesters contain ester linkages -CO-O- which are polar and susceptible to hydrolysis
- **A1** concludes that poly(ethene) is more persistent in the environment whereas polyesters can be broken down by hydrolysis (biological or chemical) more readily, cao
- **Answer: Poly(ethene) contains only C-C and C-H bonds which are non-polar and chemically inert so it is very persistent; condensation polyesters contain polar ester linkages (-CO-O-) that can be hydrolysed, so polyesters are generally less persistent and more susceptible to chemical or biological breakdown.**

Question 11

- **M1** identifies that residual water will dilute the NaOH in the burette at the start of the titration (systematic dilution)
- **M1** states the effect: measured titre volumes will be larger than they should be because weaker NaOH needs a greater volume to reach the end point
- **A1** explains consequence: using the nominal NaOH concentration and larger titre leads to overestimation of moles of acid and so the calculated acid concentration will be too high, with reasoning, cao
- **Answer: Residual water dilutes the NaOH so the burette solution is weaker and a larger volume is needed; using the nominal concentration with the larger titre gives too many moles of base, so the calculated acid concentration is too high.**

Question 12

- **Level 3** (5-6): Detailed explanation with required reagents, conditions, catalyst, purification steps and clear chemical reasons. Logical sequence showing understanding of esterification and separation techniques.
- **Level 2** (3-4): Partial description: mentions main reagents and either catalyst or purification with a basic reason, but misses detail or some justification.
- **Level 1** (0-2): Limited reference to reagents or a single step without explanation; lacks clarity about conditions or purification.
- **Indicative content:**
  - Add concentrated ethanoic acid to excess ethanol with a few drops of concentrated sulfuric acid as catalyst to protonate and speed up esterification
  - Heat under reflux gently to reach equilibrium and increase yield
  - Use an excess of one reactant (often ethanol) or remove water to shift equilibrium to products by Le Chatelier and improve yield
  - After reaction, neutralise acid catalyst (wash with sodium carbonate solution) to remove acid and stop reaction
  - Separate organic layer (ester) from aqueous layer by decanting/separating funnel
  - Dry organic layer with anhydrous drying agent (e.g. anhydrous sodium sulfate) and then distil the ester to purify it; give reasoning for each purification step

Question 13

- **M1** counts atoms correctly in repeat unit: O x4, C x6, H x8 (or equivalent atom count) and sets up sum
- **M1** substitutes atomic masses and calculates Mr: (6 x 12.0) + (8 x 1.0) + (4 x 16.0)
- **A1** gives final Mr = 72.0 + 8.0 + 64.0 = 144.0 g/mol cao
- **Answer: 144.0 g/mol**

Question 14

- **M1** calculates percentage yield = (15.0 / 18.5) x 100
- **A1** gives correct percentage yield = 81.1% (to 3 s.f.) or 81.08% rounded to 81.1% cao
- **A1** gives one realistic reason, e.g. incomplete reaction, loss during transfer or purification, side reactions, or evaporation of volatile ester, with brief explanation
- **Answer: 81.1% (possible reason: loss during purification by distillation or incomplete reaction)**