Past-paper walk-through

Characteristic organic reactions ▪ 13.2

eXercise

Questions in this set

- 9701/24 N25 Q3 ▪ 11 marks
- 9701/33 N25 Q3 ▪ 14 marks

Reading the mark scheme

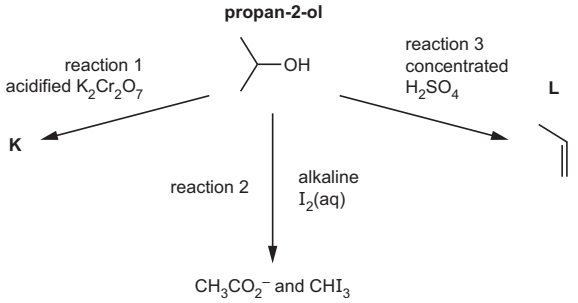
- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 3

9701/24 N25 ▪ Q3 ▪ 11 marks

3 Propan-2-ol, $(CH_3)_2CHOH$, is sometimes added to fuel to help it burn.

Fig. 3.1 shows some reactions of propan-2-ol.



Question 3

Fig. 3.1

(a) (i) Draw the structure of organic compound **K**.

Question 3

[1]

(ii) State an observation you would make in reaction 2.

Question 3

(iii) State the type of reaction that is shown in reaction 3.

Question 3

(iv) Complete Fig. 3.2 to show the pi (π) bond in **L** that is formed from orbital overlap.

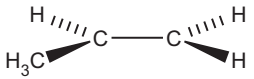
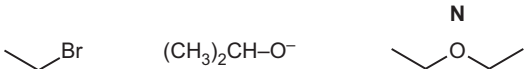


Fig. 3.2

[1]

(b) Propan-2-ol reacts with sodium to produce $(CH_3)_2CH–O^-$ anions.

These anions react with 2-bromopropane to form compound **N**, as shown in Fig. 3.3.



Question 3

Question 3

Fig. 3.3

(i) Write an equation for the reaction of propan-2-ol with sodium.

Question 3

(ii) The reaction of 2-bromopropane with $(CH_3)_2CH–O^-$ anions follows an S_N1 mechanism.

Complete Fig. 3.4 to show this mechanism. Include charges, dipoles, lone pairs of electrons and curly arrows, as appropriate.

Fig. 3.4

[3]

(iii) Suggest how the rate of the S_N1 reaction would change, if at all, if 2-chloropropane were used instead of 2-bromopropane.

Question 3

used instead of 2-bromopropane.

Question 3

. .

Explain your answer.

Question 3

(iv) **N** is also added to petrol to make it burn more smoothly.

Construct an equation for the complete combustion of **N**, $C_6H_{14}O$.

Question 3

[Total: 11]

Solution 3

(a)(i)

Mark scheme

- 1

(a)(ii)

Mark scheme

- yellow precipitate
- 1

Solution 3

(a)(iii)

Mark scheme

- elimination
- 1
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(a)(iv)

Mark scheme

- 1

Solution 3

(b)(i)

Mark scheme

- $(CH3)2CHOH + Na \rightarrow (CH3)2CHO(-)Na(+) + \ 1/2\ H2$
- 1

Solution 3

(b)(ii)

Mark scheme

- M1 correct dipole on +C—Br – AND curly arrow from C—Br bond to Br M2
- intermediate M3
- curly arrow from lone pair of (CH3)2CHO– to C+
- 3

Solution 3

(b)(iii)

Mark scheme

- M1 rate would decrease M2
- C—Br is weaker (than C—Cl, so breaks more easily)
- 2

Solution 3

(b)(iv)

Mark scheme

- $C6H14O + 9O2 \rightarrow 6CO2 + 7H2O$
- 1

Question 3

9701/33 N25 ▪ Q3 ▪ 14 marks

3 Half-fill the 250 cm^3 beaker with water and place it on a tripod and gauze. Heat the water until boiling then switch off your Bunsen burner. This will be your hot water bath for use in **(b)(i)**. Start **(a)(i)** while the water is heating.

(a) **FA 4** is an aqueous solution containing three ions. One ion is **not** listed in the Qualitative analysis notes. **FA 5** is an aqueous solution containing two ions. The cation in **FA 5** is listed in the Qualitative analysis notes. The anions in both **FA 4** and **FA 5** contain sulfur.

(i) Carry out the following tests using a 1 cm depth of either **FA 4** or **FA 5** in a test-tube. Record your observations in Table 3.1.

Table 3.1

test	*observations*	
	FA 4	**FA 5**
Test 1 Add aqueous		

Question 3

Add aqueous sodium hydroxide.		
Test 2 Add aqueous ammonia.		
Test 3 Add aqueous sodium carbonate.		
Test 4 Add aqueous barium chloride or aqueous barium nitrate.		

Question 3

Test 5 Add acidified aqueous potassium manganate(VII).		

[5]

(ii) From your observations in **(a)(i)**, deduce the identities of the ions present in **FA 4** and **FA 5**. Give the formula of each ion in Table 3.2. If you are unable to identify an ion write 'unknown'.

Table 3.2

ions present	**FA 4**	**FA 5**
cations		

Question 3

anions		

[3]

(b) (i) Both **FA 6** and **FA 7** are one of propan-1-ol, propan-2-ol, methanoic acid or ethanoic acid. You will carry out tests to investigate the identities of **FA 6** and **FA 7**. For each test use a 1 cm depth of **FA 6** or **FA 7** in a test-tube. Record your observations in Table 3.3.

Table 3.3

test	*observations*	
	FA 6	**FA 7**
Test 1 Add a few drops of acidified aqueous potassium manganate(VII), then		

Question 3

place the test-tube in the hot

Question 3

place the test-tube in the hot water bath.		
Test 2 Add a 2 cm depth of aqueous iodine followed by drops of aqueous sodium hydroxide until the colour just disappears.		
If no reaction is visible, place the test-tube in the hot water bath.		
Test 3 Add aqueous sodium carbonate.		

[3]

(ii) From your observations in **(b)(i)** deduce the identities of **FA 6** and **FA 7**. Give reasons for

Question 3

your answers

Question 3

your answers.

Question 3

Question 3

Question 3

Question 3

Question 3

Question 3

[2]

(c) A student carrying out a similar set of tests identifies two unknown compounds to be ethanol and propanoic acid.

Write an equation for the reaction between these two compounds.

Question 3

[Total: 14]

Qualitative analysis notes

1 Reactions of cations

cation	reaction with	
	NaOH(aq)	**NH_3(aq)**
aluminium, Al^{3+}(aq)	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, NH_4^+(aq)	no ppt. ammonia produced on warming	–
barium, Ba^{2+}(aq)	faint white ppt. is observed unless [Ba^{2+}(aq)] is very low	no ppt.
calcium, Ca^{2+}(aq)	white ppt. unless [Ca^{2+}(aq)] is very low	no ppt.

Question 3

Question 3

chromium(III), Cr^{3+}(aq)	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), Cu^{2+}(aq)	pale blue ppt. insoluble in excess	pale blue ppt. soluble in excess giving dark blue solution
iron(II), Fe^{2+}(aq)	green ppt. turning brown on contact with air insoluble in excess	green ppt. turning brown on contact with air insoluble in excess
iron(III), Fe^{3+}(aq)	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
magnesium, Mg^{2+}(aq)	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), Mn^{2+}(aq)	off-white ppt. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air insoluble in excess
zinc, Zn^{2+}(aq)	white ppt. soluble in excess	white ppt. soluble in excess

Question 3

Question 3

2 Reactions of anions

anion	reaction
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chloride, Cl^-(aq)	gives white ppt. with Ag^+(aq) (soluble in NH_3(aq))
bromide, Br^-(aq)	gives cream / off-white ppt. with Ag^+(aq) (partially soluble in NH_3(aq))
iodide, I^-(aq)	gives pale yellow ppt. with Ag^+(aq) (insoluble in NH_3(aq))
nitrate, NO_3^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil
nitrite, NO_2^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil; decolourises acidified aqueous $KMnO_4$
sulfate, SO_4^{2-}(aq)	gives white ppt. with Ba^{2+}(aq) (insoluble in excess dilute strong acids); gives white ppt. with high [Ca^{2+}(aq)]
sulfite, SO_3^{2-}(aq)	gives white ppt. with Ba^{2+}(aq) (soluble in excess dilute strong acids); decolourises acidified aqueous $KMnO_4$

Question 3

thiosulfate, $S_2O_3^{2-}(aq)$	gives off-white/pale yellow ppt. slowly with H^+

3 Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater
hydrogen, H_2	‘pops’ with a lighted splint
oxygen, O_2	relights a glowing splint

Solution 3

(a)(i) Mark scheme

- 2 * = 1 mark (round down). Max 5 marks.
- test
- observations
- FA 4
- FA 5/1 + NaOH(aq)
- red-brown / brown ppt
- AND
- insoluble in excess *

Solution 3

- white ppt *
- soluble in excess *
- 2
- + NH3(aq)
- red-brown / brown ppt
- AND
- insoluble in excess *
- white ppt
- AND
- insoluble in excess *

Solution 3

- 3
- + Na2CO3(aq)
- fizzing *
- gas gives white ppt with
- limewater *
- red-brown ppt *
- white ppt *
- fizzing *
- gas gives white ppt with
- limewater (award if not awarded

Solution 3

- for FA 4)
- 4
- + BaCl 2(aq) /
- Ba(NO3)2(aq)
- white ppt
- AND
- white ppt *
- 5
- + H+ / KMnO4(aq)
- stays purple / no change AND stays purple / no change *

Solution 3

- 5
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Solution 3

(a)(ii) Mark scheme

- ions
- FA 4
- FA 5
- cations
- Fe3+; H+
- Al 3+
- anions
- SO42−

Solution 3

- $SO4^{2-}$
- 5 ions correct = 3 marks
- 3 or 4 ions correct = 2 marks
- 2 ions correct = 1 mark
- 3

Solution 3

(b)(i) Mark scheme

- 2 * = 1 mark (round down)
- test
- observations
- FA 6
- FA 7/1 + H+ / KMnO4(aq)
- (turns paler pink)
- (purple fades slightly)
- and warm

Solution 3

- decolourises / turns colourless /
- turns (pale) yellow *
- decolourises / turns colourless /
- turns (pale) yellow *
- 2
- + I2(aq) + NaOH
- (and warm)
- no change *
- ppt * that is (pale) yellow *
- 3

Solution 3

- + Na2CO3(aq)
- fizzing *
- no change *
- 3
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Solution 3

(b)(ii)

Mark scheme

- M1 (FA 6 is) methanoic acid because it produces CO2 / reacts with sodium carbonate
- AND it can be oxidised / it reacts with KMnO4 **M2**
- (FA 7 is) propan-2-ol as it gives a ppt in test 2
- OR gives a positive tri-iodomethane/iodoform test
- OR has the $-CH(OH)CH3$ group
- 2

Solution 3

(c)

Mark scheme

- Correct equation
- $CH3CH2COOH + CH3CH2OH \rightarrow CH3CH2COOCH2CH3 + H2O$
- OR
- $C2H5COOH + C2H5OH \rightarrow C2H5COOC2H5 + H2O$
- 1