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Interactive

Interactive Example Candidate Responses
Paper 42 (May/June 2016), Question 9

Cambridge International AS & A Level Chemistry 9701

Version 1.0

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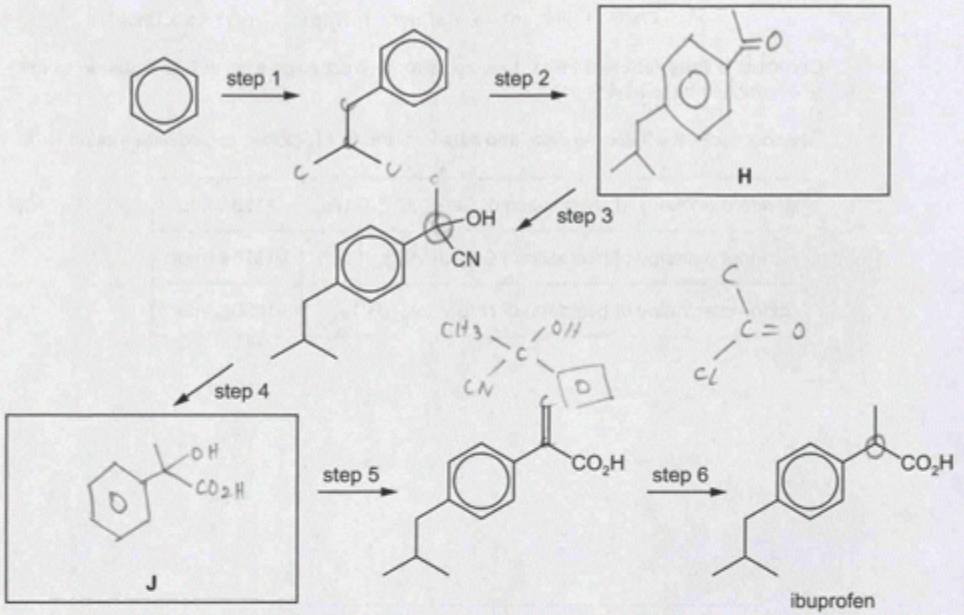
9 The anti-inflammatory drug ibuprofen can be synthesised from benzene via the following six steps.



(a) Draw circles around any chiral carbon atoms in the above five formulae. [1]

(b) Suggest the structures of compounds **H** and **J** and draw them in the boxes above. [2]

(c) Suggest reagents and conditions for steps 1-6.

step 1 $(CH_3)_2CHCH_2Cl$ + $AlCl_3$.

step 2 CH_3COCl + $AlCl_3$.

step 3 HCN in NaCN + heat under reflux.

step 4 dil HCl + heat under reflux.

step 5 Al_2O_3 ~~conc HCl~~ + heat to 300°C. dehydrate.

step 6 Ni + H_2 (g) at 100°C. hydrogenate.

[6]

(d) Name the mechanism of step 1 and state the *type of reaction* for step 6.

step 1 Electrophilic substitution.

step 6 Reduction.

[2]

[Total: 11]

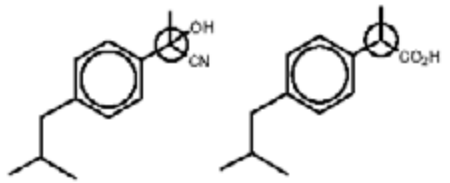
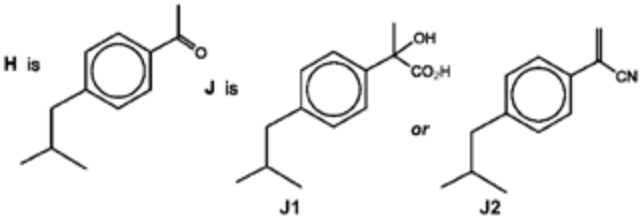
Your Mark

9(a) ☐

9(b) ☐

9(c) ☐

9(d) ☐

Q9	Mark scheme
(a)	 [2]
(b)	 [2]
(c)	step 1: $(CH_3)_2CHCH_2Cl$ + $AlCl_3$ (+ heat) step 2: CH_3COCl + $AlCl_3$ (+ heat) step 3: HCN + NaCN **or** HCN + base or HCN + CN^- *(steps 4 and 5 could be reversed on J)* ***If J1** step 4 then step 5 **J2** step 5 then step 4* step 4: H_3O^+ + heat / aqueous HCl + heat step 5: conc H_2SO_4 + heat / conc H_3PO_4 + heat **or** Al_2O_3 + heat step 6: H_2 + Ni (+ heat) **[6]**
(d)	step 1: electrophilic substitution or alkylation step 6: reduction / hydrogenation / addition **[2]** **[Total: 11]**

EXAMINER COMMENTS

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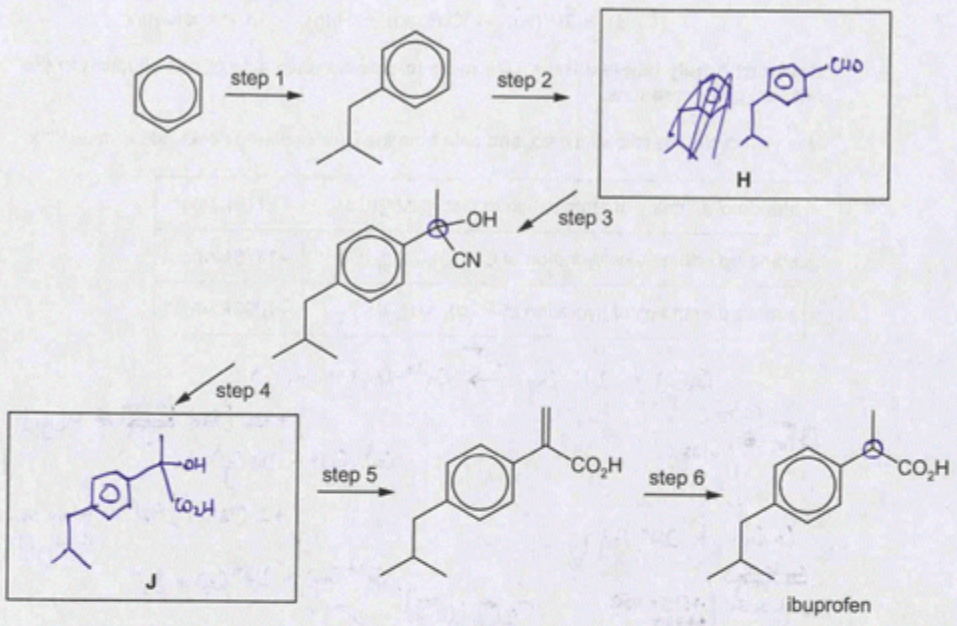

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(c) Suggest reagents and conditions for steps 1-6.

step 1 $(CH_3)_2CHCH_2CH_2Cl$ in $AlCl_3$ heat under reflux.

step 2 Cl–CHO with $AlCl_3$ heat under reflux

step 3 HCN with a little NaCN heat under reflux.

step 4 HCl (aq) heat under reflux.

step 5 concentrated H_2SO_4 ~~heat~~ heat at 180 °C.

step 6 H_2 (g) + Pt (s)

[6]

(d) Name the mechanism of step 1 and state the *type of reaction* for step 6.

step 1 Electrophilic substitution

step 6 Electrophilic addition.

[2]

[Total: 11]

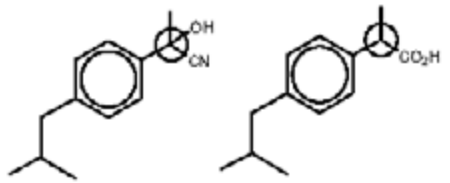
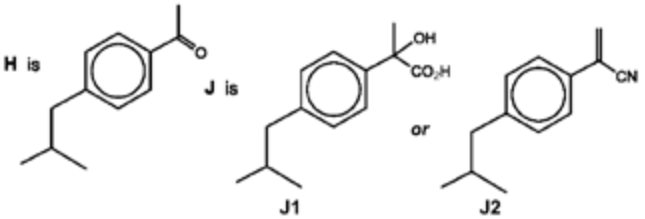
Your Mark

9(a) ☐

9(b) ☐

9(c) ☐

9(d) ☐

Q9	Mark scheme
(a)	 **[2]**
(b)	 **[2]**
(c)	step 1: $(CH_3)_2CHCH_2C\mathit{l}$ + $Al\mathit{C}l_3$ (+ heat) step 2: $CH_3COC\mathit{l}$ + $Al\mathit{C}l_3$ (+ heat) step 3: HCN + NaCN **or** HCN + base or HCN + CN^- *(steps 4 and 5 could be reversed on J)* ***If J1** step 4 then step 5 **J2** step 5 then step 4* step 4: H_3O^+ + heat / aqueous $HC\mathit{l}$ + heat step 5: conc H_2SO_4 + heat / conc H_3PO_4 + heat **or** Al_2O_3 + heat step 6: H_2 + Ni (+ heat) **[6]**
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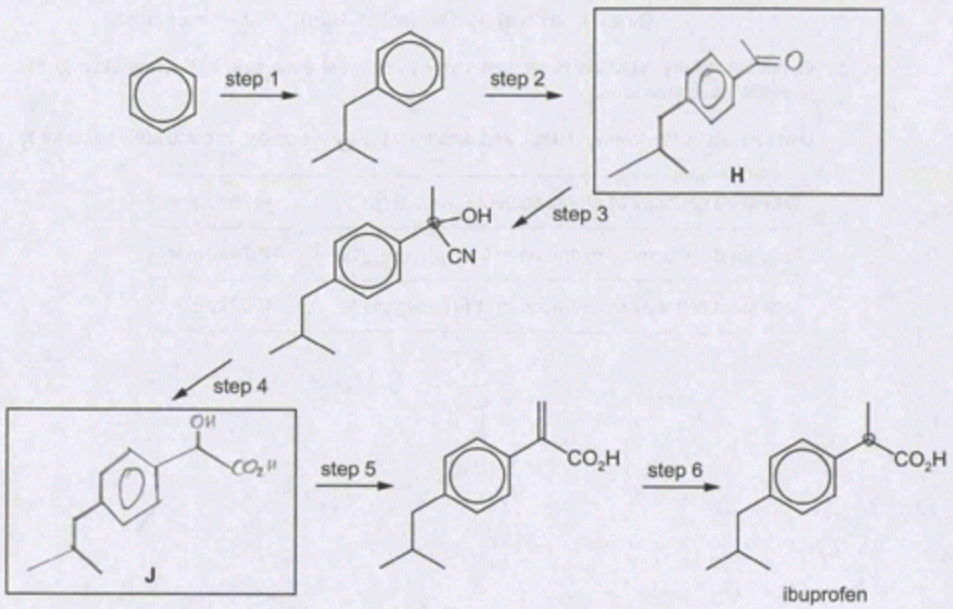

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(b) Suggest the structures of compounds **H** and **J** and draw them in the boxes above. [2]

(c) Suggest reagents and conditions for steps 1-6.

step 1 ~~3-methyl~~ $(CH_3)_2CHCH_2Cl + AlCl_3$ + heat

step 2 $CH_3COCl + AlCl_3$ + heat

step 3 HCN in sulfuric acid

step 4 $KMnO_4$ + heat

step 5 $LiAlH_4$ in dry ether

step 6 CH_3 HCHO + $LiAlH_4$ in dry ether

[6]

(d) Name the mechanism of step 1 and state the *type of reaction* for step 6.

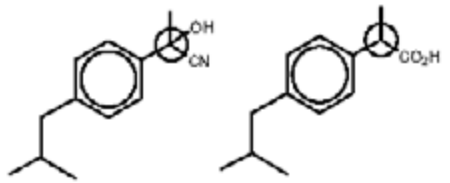
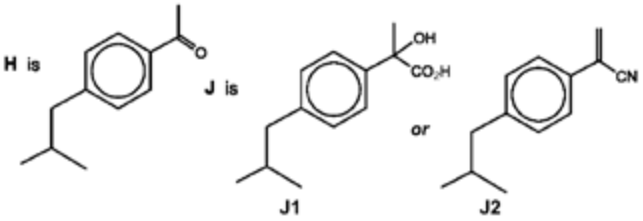
step 1 electrophilic substitution

step 6 nucleophilic substitution

[2]

[Total: 11]

	Your Mark
9(a)	
9(b)	
9(c)	
9(d)	

Q9	Mark scheme
(a)	 [2]
(b)	 [2]
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