

Kirkcaldy High School



Chemistry

Advanced Higher

Unit 3 - Organic Chemistry and

Instrumental Analysis

TUTORIAL ANSWERS

(a) Molecular orbitals

1. C
2. B
3. A
4. D
5. D
6. B
7. B
8. B
9. A

(b) Synthesis

1. D
2. A
3. D
4. D
5. A
6. C
7. C
8. B
9. B
10. C
11. C
12. B
13. B
14. A
15. D
16. D
17. C
18. C
19. C
20. B
21. A
22. D
23. D
24. D
25. D
26. B
27. D
28. A
29. C
30. B
31. A
32. D
33. A
34. D
35. B

36. D

37. C

38. A

39. D

40. C

41. B

42. C

43. D

44. A

45. A

46.

(a) It contains hydrogen bonding, as does water.

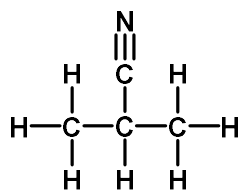
(b)

(i) Acid chloride

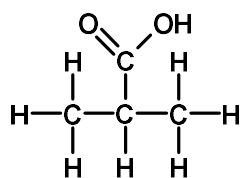
(ii) faster reaction than reaction with carboxylic acids, and no catalyst is needed.

47.

(a)



(b)



2-methyl propanoic acid

(c)

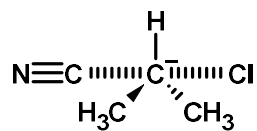
(i) Butan-1-ol

(ii) acidified permanganate, acidified dichromate or hot copper(II) oxide

(d)

(i) Nucleophilic substitution where two species are involved in the rate determining step

(ii)



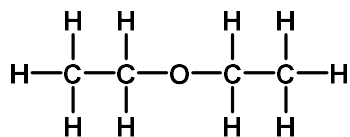
48.

(a)

(i) Sodium

(ii) acidified permanganate, acidified dichromate or hot copper(II) oxide

(b)

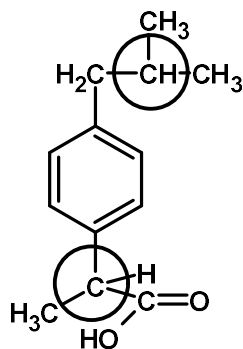


49.

(a) Electrophillic aromatic substitution

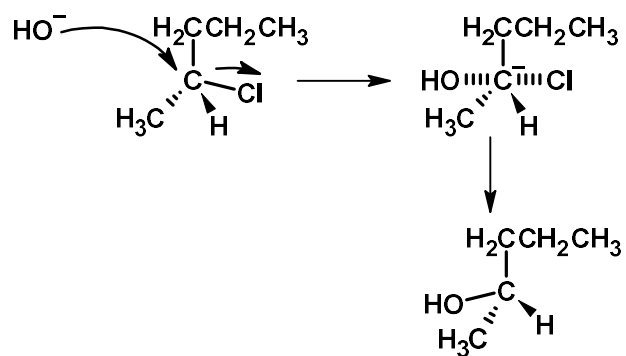
(b) Acid

(c)

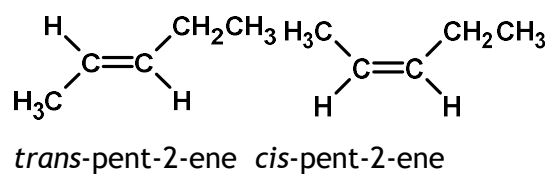


50.

(a)



(b)



51.

(a)

- (i) aluminium bromide or iron(III) bromide
- (ii) Nitrobenzene
- (iii) Sulfonation

(b) The electrons cannot move between molecules.

52.

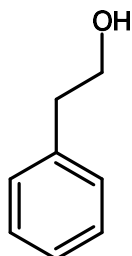
(a) alkylation

(b) The bond splits with a single electron on either atom

i.e.

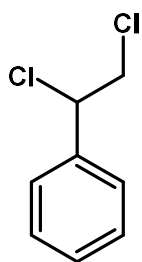


(c)



(d) Elimination

(e)



53.

(a) aluminium oxide, concentrated sulfuric acid or concentrated phosphoric acid

(b)

(i) 87.8 %

(ii) Possible side reactions producing unwanted products

(c) Open question. Could mention...

Properties of cyclohexanone (mpt., bpt., conductivity)

Reactions of cyclohexanone

Instrumental analysis of cyclohexanone (NMR, IR, Mass Spec, Elemental Analysis) and possible results of these.

54.

(a) chloromethane

(b) aluminium chloride

(c) Electrophilic aromatic substitution

55.

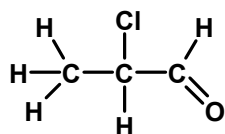
(a)

(i) Reduction

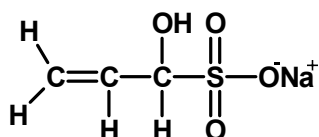
(b) IR, NMR, Mass Spec., Elemental analysis

(c)

(i)



(ii)



(iii) Lithium Aluminium Hydride

56. Open question. Could mention:

Reactions of domonic acid (oxidation/reduction, addition)

Geometric/optical isomers

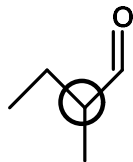
Instrumental analysis of domonic acid (NMR, IR, Mass Spec, Elemental Analysis) and possible results of these.

(c) Stereochemistry

1.

(a) $C_6H_8N_2$

(b)



2. D

3. A

4. A

5. B

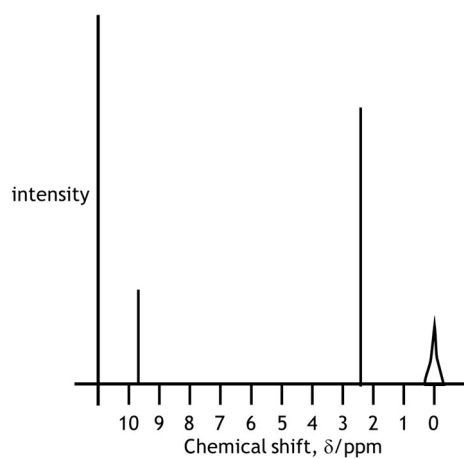
6. B

7. D

8. A

(d) Experimental Determination of structure

1. A
2. C
3. C
4. A
5. D
6. D
7. C
8. C
9. A
10. D
- 11.



(a)

(b) TMS (Tetramethylsilane)

12.

(a)

(i)

	C	H	O
% by mass of element in gas	$= \frac{12}{44} \times 100$	$= \frac{2 \times 1}{18} \times 100$	
	= 27.27	= 11.11	
mass of element in sample /g	$= \frac{27.27}{100} \times 3.52$	$= \frac{11.11}{100} \times 1.44$	
	= 0.96	= 0.16	= 1.76 - 0.96 - 0.16
	= <u>0.96 g</u>	= <u>0.16 g</u>	= <u>0.64 g</u>

(ii)

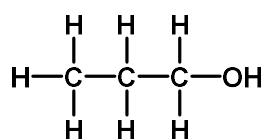
	C	H	O
mass of element in sample /g	= 0.96 g	= 0.16 g	= 0.64 g
n	$= \frac{0.96}{12}$	$= \frac{0.16}{1}$	$= \frac{0.64}{16}$
	= 0.08	= 0.16	= 0.04
÷ by smallest	$= \frac{0.08}{0.04}$	$= \frac{0.16}{0.04}$	$= \frac{0.04}{0.04}$
	= <u>2</u>	= <u>4</u>	= <u>1</u>

(b) $GFM(C_2H_4O) = (2 \times 12) + (4 \times 1) + (1 \times 16) = 24 + 4 + 16 = 44$ g.

Given GFM is 88 so 2×44 . This implies that the formula is $C_4H_8O_2$.

(c)

(i)



propan-1-ol

13.

(a) C=O stretch

(b)

(i)

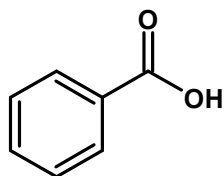
Element	C	H	O
% by mass	68.9	4.9	26.2
Divide by atomic mass	$\frac{68.9}{12}$	$\frac{4.9}{1}$	$\frac{26.2}{16}$
=	5.74	4.9	1.64
Divide to give whole numbers	$\frac{5.74}{1.64}$	$\frac{4.9}{1.64}$	$\frac{1.64}{1.64}$
=	3.5	2.99	1
X2=	7	6	2

$$\text{GFM}(\text{C}_7\text{H}_6\text{O}_2) = (7 \times 12) + (6 \times 1) + (2 \times 16) = 84 + 6 + 32 = 122 \text{ g.}$$

This implies that the formula is $\text{C}_7\text{H}_6\text{O}_2$.

(ii) $[\text{C}_6\text{H}_5]^+$

(c)

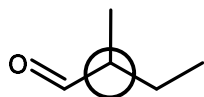


(d) 20.2 kJmol^{-1}

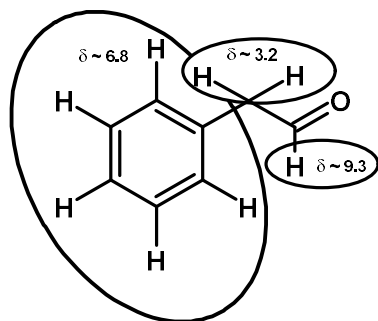
14. .

(a) $C_6H_8N_2$

(b)



(c) Phenylethanal. 3 x 1H environments in a 1:5:2 ratio.



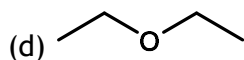
15.

(a) $C_4H_{10}O$

(b) Ether C-O stretch

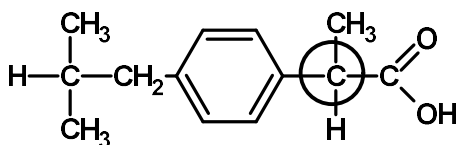
(c) $GFM(C_4H_{10}O) = (4 \times 12) + (10 \times 1) + (1 \times 16) = 48 + 10 + 16 = 74 \text{ g.}$

This implies that the formula is $C_4H_{10}O$.



(d) Ethoxyethane (diethyl ether)

16.



(a)

(b)

(i) Compound A. The 1690 cm^{-1} peak is a C=O ketone stretch which would not be present in the spectra of ibuprofen or compound B.

(c) Not all of the starting materials have been converted to ibuprofen (as shown in IR spectrum)
Side reactions producing unwanted products.

(d) Nucleophilic substitution of Br by CN^- .

Oxidation of CN by concentrated acid to give carboxyl group.

(e) Pharmaceutical Chemistry

1. A
2. C
3. C
4. D
5. A
- 6.

(a) Carbons 4 and 5

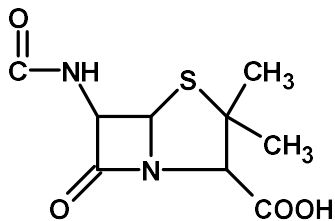
(b) The structural fragment of the molecule which confers pharmacological activity.

(c) Agonist

7.

(a) Antagonist - they are inhibiting the response from the body.

(b)



8. Agonist

Question Sources

Molecular Orbitals

1. 2006 MC29
2. 2007 MC 31
3. 2008 MC28
4. 200 MC
5. 2009 MC26
6. 2010 MC28
7. RH 2014 MC15
8. 2009 MC25
9. 2010 MC 29
10. RH2013 W7a,b
11. 2007 MC39
12. 2008 MC37
13. 2010 MC 38
14. 2008 MC 36
15. 2009 MC38
16. RH2014 MC16
17. RH2014 MC
18. 2006 W9

Synthesis

1. 2005 MC 26
2. 2005 MC 28
3. 2007 MC29
4. 2010 MC31
5. 2005 MC 29
6. 2008 MC 30
7. 2005 MC 33
8. 2005 MC 39
9. 2008 MC 27
10. 2005 MC 40
11. 2008 MC 25
12. 2007 MC33
13. 2007 MC 36

14. 2009 MC28
15. 2007 MC31
16. 2010 MC35
17. 2008 MC29
18. 2006 MC31
19. 2009 MC29
20. 2010 MC32
21. 2010 MC33
22. 2008MC33
23. 2009 MC27
24. 2010 MC25
25. 2007 MC 26
26. 2007 MC30
27. 2009 MC 34
28. 2007 MC27
29. 2010 MC 37
30. 2009 MC 35
31. 2010 MC 36
32. RH 2013 MC22
33. RH2013 MC23
34. RH 2013 MC24
35. RH2013 MC 25
36. RH2013 MC 26
37. RH2013 MC 27
38. RH2013 MC28
39. RH2013 MC30
40. RH2014 MC19
41. RH2014 MC 20
42. RH2014 MC21
43. RH2014 MC 22
44. RH2014 MC24
45. RH2014 MC 25
46. 2006 W10
47. 2006 W12
48. 2005 W 9
49. 2005 W10

50. 2005 W11
51. 2006 W11
52. RH2013 W10
53. RH2013 W11
54. RH2014 W6
55. RH2014 W8
56. RH2014 W10

Experimental Determination of Structure

1. 2006 MC37
2. 2008 MC38
3. 2006 MC39
4. 2010 MC 39
5. 2006 MC38
6. 2008 MC39
7. 2010 MC 40
8. RH 2013 MC7
9. RH 2014 MC29
10. RH2014 MC28
11. 2006 W13
12. 2007 W13
13. 2005 W13
14. RH2013 W7a,b,c
15. RH2013 W 12
16. RH2014 W9

Pharmaceutical Chemistry

1. 2006 MC40
2. 2008 MC40
3. 2009 MC40
4. RH2013 MC 29
5. RH2014 MC30
6. 2007 W11
7. 2005 W12
8. RH2013 W 7d