

Question	1-4	5-7	8-10	11-12	Total
Mark	/28	/17	/23	/22	/90

CHEMISTRY 112/115 TEST

Tuesday 11 September 2007

Name (Print Clearly):

Student ID number:

Signature:

Instructions:

Attempt **all** questions. Enter answers in the spaces provided. There are 10 pages in total.

Total marks: 90

Time allowed: 90 minutes

Periodic Table

1 H 1.008																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.8	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.0	10 Ne 20.2
11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.9	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (99)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57-71 see below	72 Hf 178.5	73 Ta 181.0	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 see below	104 Rf (257)	105 Db (260)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110	111	112						

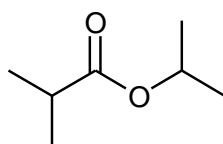
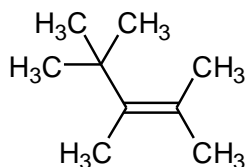
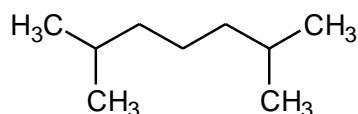
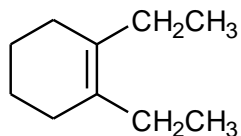
57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
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89 Ac (227)	90 Th 232.0	91 Pa (231)	92 U 238.1	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (245)	98 Cf (251)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (254)	103 Lr (257)
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Question 1 (8 marks)

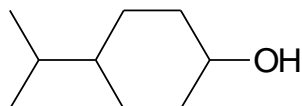
Show the number of signals expected in the ^{13}C and ^1H NMR spectra for each of the compounds shown below. Also give the relative integrals for the peaks in the ^1H NMR spectrum for each compound.

^{13}C NMR ^1H NMR Integral ratio



Question 2 (4 marks)

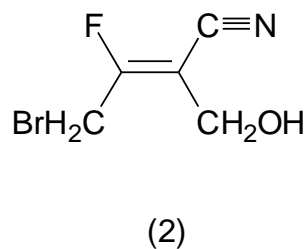
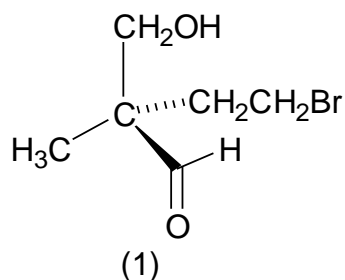
The alcohol shown below occurs in nature.



- (i) What is its molecular formula and molecular mass? Ans:
- (ii) Can it exist as two enantiomers? Ans:
- (iii) Can it exist as two diastereoisomers? Ans:
- (iv) How many peaks are there in its ^{13}C NMR spectrum? Ans:

Question 3 (4 marks)

For each of the structures (1) and (2), shown below, label the substituents with the **appropriate priority order** and give the **appropriate stereochemical descriptor** (*R*-, *S*-, *E*- or *Z*-).



Question 4 (12 marks)

(i) What is the name of the instrument used to measure optical rotation?

Ans:

(ii) What technique gives the most detailed information about molecular structure, including the accurate measurement of bond lengths and angles?

Ans:

(iii) What types of energy levels are involved in the absorption of infrared light?

Ans:

(iv) What types of energy levels are involved in the absorption of visible light?

Ans:

(v) What technique is used to determine the ratio of carbon to hydrogen in an unknown compound?

Ans:

(vi) What is the name used to describe a molecule containing stereogenic centres but which is superimposable on its mirror image?

Ans:

(vii) What is the name used to describe stereoisomers that are not enantiomers?

Ans:

(viii) What is the term used to describe a 50:50 mixture of two enantiomers?

Ans:

Question 4 continued on the next page

- (ix) For an alkene to exist as two *E*- and *Z*- isomers, must all four substituents on the double bond be different?

Ans:

- (x) What is the name given to isomers that have different atom connectivities?

Ans:

- (xi) Do enantiomers have different NMR spectra?

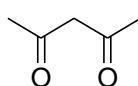
Ans:

- (xii) If the *R*-enantiomer of a compound has a specific rotation of $+37.5^\circ$, what will be the rotation of the *S*-enantiomer?

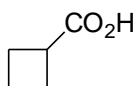
Ans:

Question 5 (8 marks)

Shown below are the structures (A – G) of seven isomers with the formula $C_5H_8O_2$.



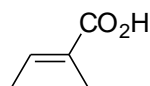
(A)



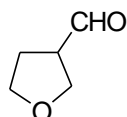
(B)



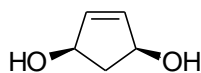
(C)



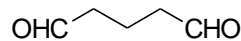
(D)



(E)



(F)

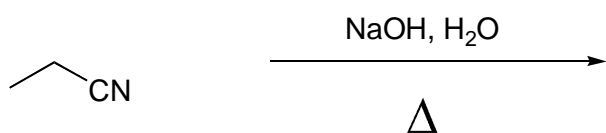
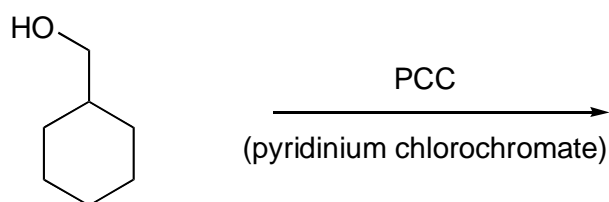
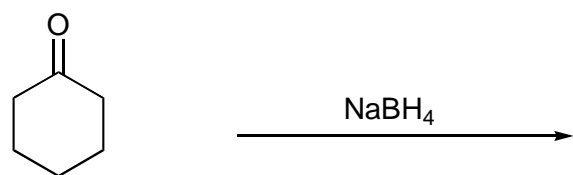
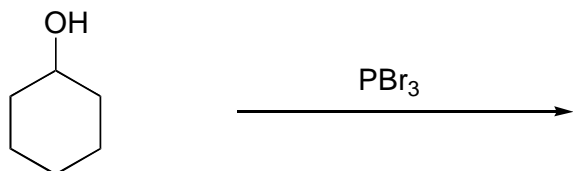
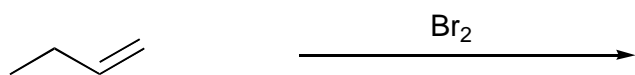


(G)

- (a) How many peaks would be in the 1H NMR spectrum of isomer G? Ans:
- (b) Which isomers would show three peaks in their ^{13}C NMR spectra? Ans:
- (c) Which isomers are aldehydes? Ans:
- (d) Which would not show a C=O or an O-H stretch in an infrared spectrum? Ans:
- (e) Which could exist as two enantiomers? Ans:
- (f) Which could exist as *E*- and *Z*- diastereoisomers? Ans:
- (g) Which would have only two peaks in their 1H NMR spectra? Ans:
- (h) Which isomer is a meso compound? Ans:

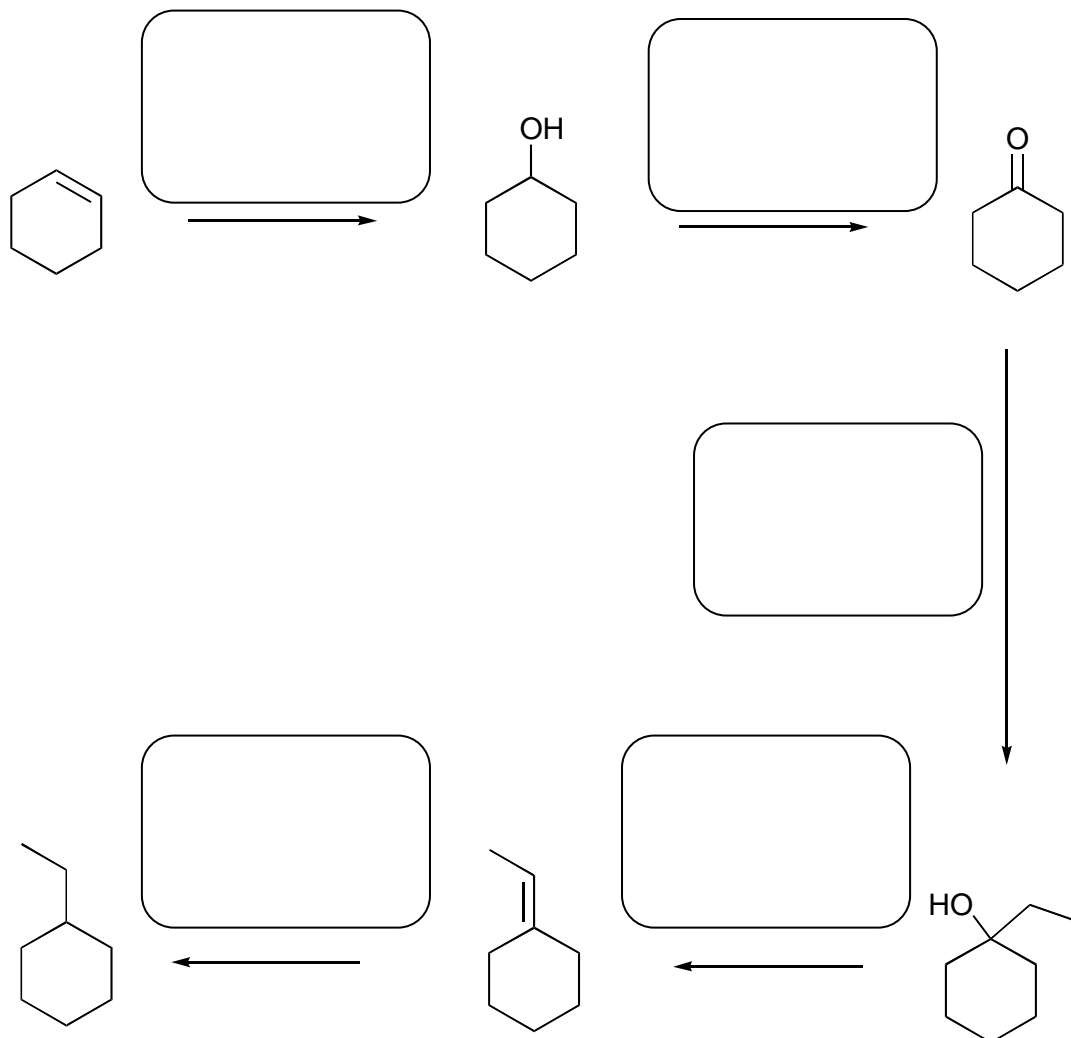
Question 8 (5 marks)

Draw the structures of the products of the following reactions.



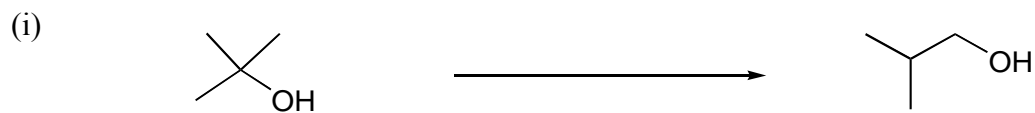
Question 9 (5 marks)

In the reaction shown below, write the missing reagents in the boxes provided.

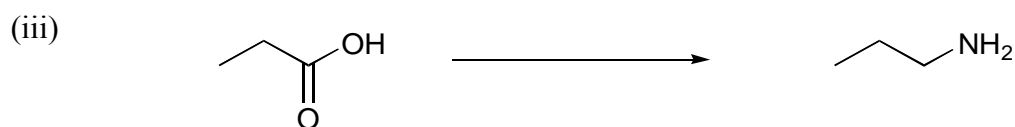
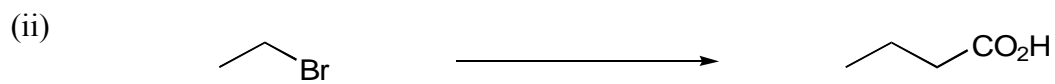


Question 10 (13 marks)

For each of the following transformations draw a reaction scheme that could be used to convert the starting material to the final product. For each step of the reaction sequence specify all necessary reagents and reactions conditions.



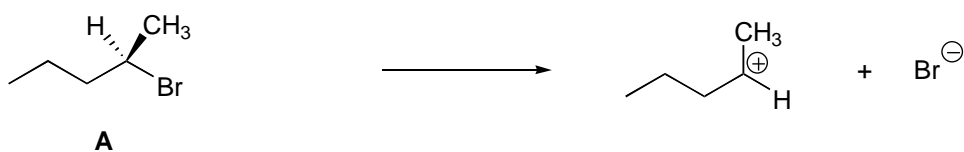
Question 10 continued on the next page



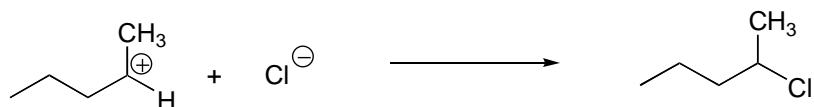
Question 11 (15 marks)

Shown below is the mechanism for the substitution of an optically active alkyl bromide.

Step 1



Step 2



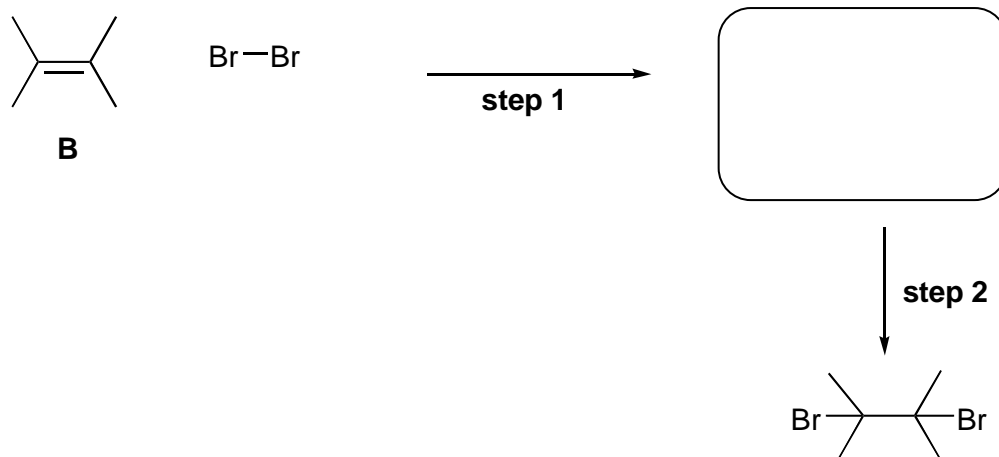
(a) Name alkyl bromide **A**. Ans:

(b) For each step above draw an arrow on the diagram to indicate the movement of electrons.

Question 11 continued on the next page

Question 12 (7 marks)

Shown below is the reaction of an alkene with bromine.



- (i) Name the alkene **B**. Ans:
- (ii) For step 1, draw curly arrows on the diagram to indicate the movement of electrons.
- (iii) Give the structure of the intermediate in the box provided.
- (iv) What is the name given to this type of intermediate Ans:
- (v) If NaCl is also included in the reaction, a second product is formed in addition to the dibromo product shown above. Give the structure of this product.
- Ans:
- (vi) If the concentration of NaCl is increased, what effect will this have on the reaction rate and product distribution?

Ans:

END OF PAPER