

CHEMISTRY 112/115 TEST

Monday 18 August 2008

Name (Print Clearly):

Student ID number:

Signature:

Course (circle one): **CHEM112** **CHEM115**

Instructions:

Attempt **all** questions. Enter answers in the spaces provided. There are 8 pages in total.

Total marks: 60

Time allowed: 75 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						

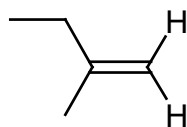
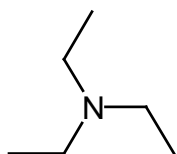
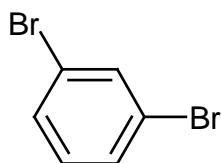
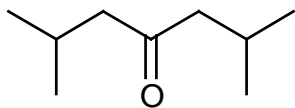
57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
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89 Ac (227)	90 Th 232.0	91 Pa (231)	92 U 238.1	93 Np (237)	94 Pu (242)	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 (3 marks)

Draw the structures of the resonance contributors of:

(i) benzene (C_6H_6)

(ii) the conjugate base of ethanoic acid ($\text{CH}_3\text{CO}_2\text{H}$).

Question 3 (12 marks)

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

Ans:

(ii) What does the abbreviation TLC stand for, in chemistry?

Ans:

(iii) Which common spectroscopic technique uses radiofrequency radiation?

Ans:

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

Ans:

(v) What technique is used to determine the empirical formula of an unknown compound?

Ans:

(vi) What is the name used to describe stereoisomers that are non-superimposable mirror images?

Ans:

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

Ans:

(viii) Do *R*-enantiomers always rotate light in a clockwise direction?

Ans:

(ix) Does a diastereoisomer of a chiral molecule have to be chiral?

Ans:

(x) What is the name used to describe isomers that have different atom connectivities?

Ans:

(xi) Do enantiomers have different melting points?

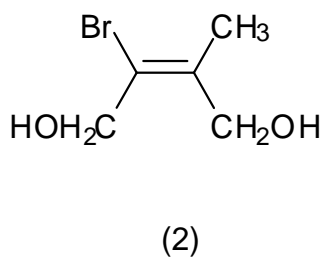
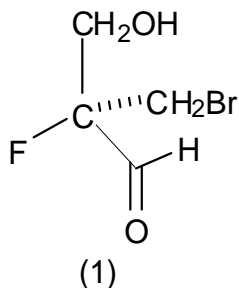
Ans:

(xii) If the *S*-enantiomer of a compound has a specific rotation of $+41.6^\circ$, what will be the rotation of the *R*-enantiomer?

Ans:

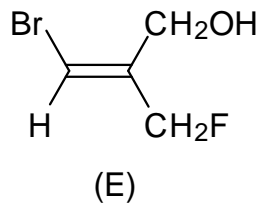
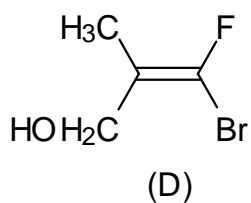
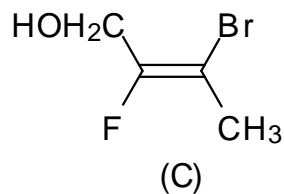
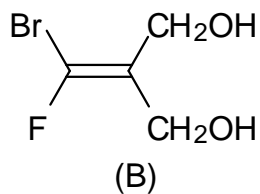
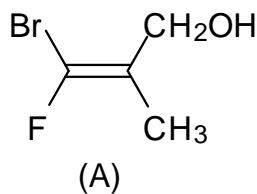
Question 4 (4 marks)

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 5 (4 marks)

Shown below are the structures (A – E) of five alkenes.



List two which are:

(a) not isomers

Ans:

(b) constitutional isomers

Ans:

(c) diastereoisomers

Ans:

(d) identical

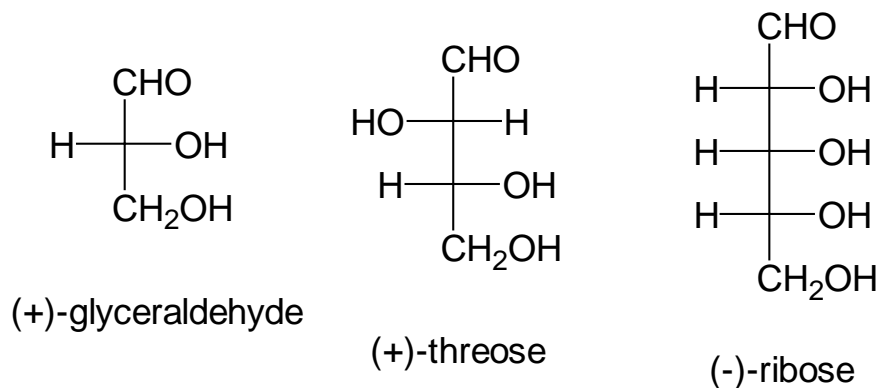
Ans:

Question 6 (1 mark)

Draw the structure of the simplest non-cyclic **alkane** that can exist as two enantiomers.

Question 7 (8 marks)

Shown below are the structures of three carbohydrates, drawn as Fischer projections.



(i) Which of these is a pentose? Ans:

(ii) Which of these rotate(s) plane polarised light in an anti-clockwise direction? Ans:

(iii) Could these compounds be readily distinguished by:

Elemental analysis? Ans: Yes No

Mass spectrometry? Ans: Yes No

Infrared spectroscopy? Ans: Yes No

^{13}C NMR? Ans: Yes No

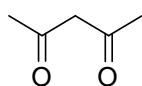
(iv) Draw the structure (as a Fischer projection) of:

(-)-threose

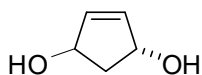
a diastereoisomer of (+)-threose

Question 8 (4 marks)

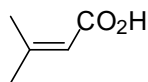
Shown below are the structures (A – G) of seven isomers with the formula $C_5H_8O_2$.



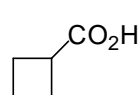
(A)



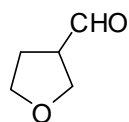
(B)



(C)



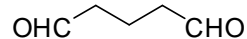
(D)



(E)



(F)

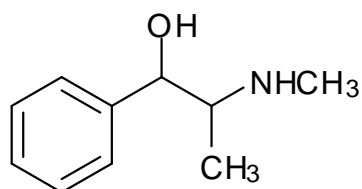


(G)

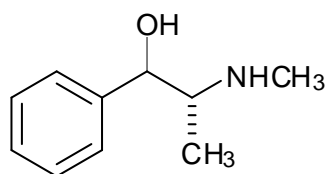
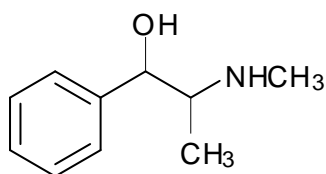
- (a) How many peaks would be in the ^{13}C NMR spectrum of isomer D? Ans:
- (b) Which isomers would show two peaks in their 1H NMR spectra? Ans:
- (c) Which would not show a C=O or an O-H stretch in an infrared spectrum? Ans:
- (e) Which isomers could exist as two enantiomers? Ans:

Question 9 (3 marks)

The decongestant ephedrine has a structure that can be represented as shown below.

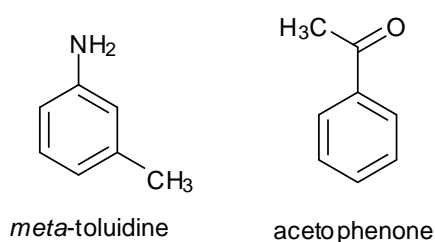


- (i) How many stereogenic centres are there in ephedrine? Ans:
- (ii) How many stereoisomers are there for this structure? Ans:
- (iii) Two such isomers are shown below. Are they enantiomers or diastereoisomers? Ans:



Question 10 (2 marks)

In the laboratory you separated *meta*-toluidine from acetophenone.



Draw the chemical reaction that you used to modify the solubility of one of these components in order to carry out this separation.

Question 11 (2 marks)

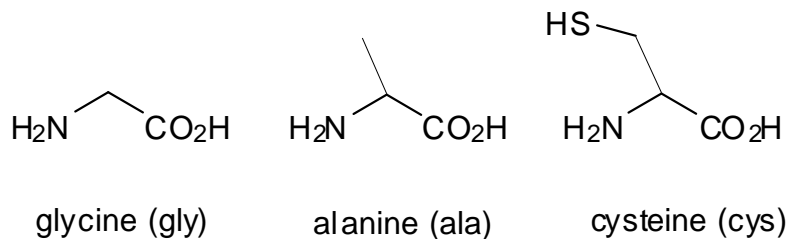
High resolution mass spectrometry can distinguish between compounds with the same nominal mass, but which differ in their exact mass. From the list below, select the molecular formula that would best match an experimental mass measurement of **136.0901** for a molecule that was known to be an **alcohol**.

	Nominal mass	Exact mass
C ₃ H ₄ O ₆	136	136.000784
C ₄ H ₈ O ₅	136	136.037168
C ₅ H ₁₂ O ₄	136	136.073552
C ₆ O ₄	136	135.979657
C ₇ H ₄ O ₃	136	136.016041
C ₈ H ₈ O ₂	136	136.052426
C ₉ H ₁₂ O	136	136.088810
C ₁₀ O	136	135.994914
C ₁₀ H ₁₆	136	136.125794
C ₁₁ H ₄	136	136.021299

Ans:

Question 12 (9 marks)

Shown below are the structures of three of the natural α -amino acids.



- (i) Which of these does not exhibit optical rotation? Ans:
- (ii) Is natural ala the R- or S- enantiomer? Ans:
- (iii) Is natural cys the R- or S- enantiomer? Ans:
- (iv) How many **dipeptides** are possible from a pool of these three amino acids? Ans:
- (v) Draw the structure of the tripeptide cys-gly-ala.
- (vi) In your answer to (v) circle the peptide bonds.
- (vii) Draw the structure that ala would have in solution at:

pH 7

pH 1

END OF PAPER