

# CHEMISTRY 112/115 TEST

Monday 17 August 2009

Name (Print Clearly): .....

Student ID number: .....

Signature: .....

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

---

## Instructions:

Attempt **all** questions. Enter answers in the spaces provided. There are 7 pages in total.

Total marks: 50

Time allowed: 70 minutes

---

## Periodic Table

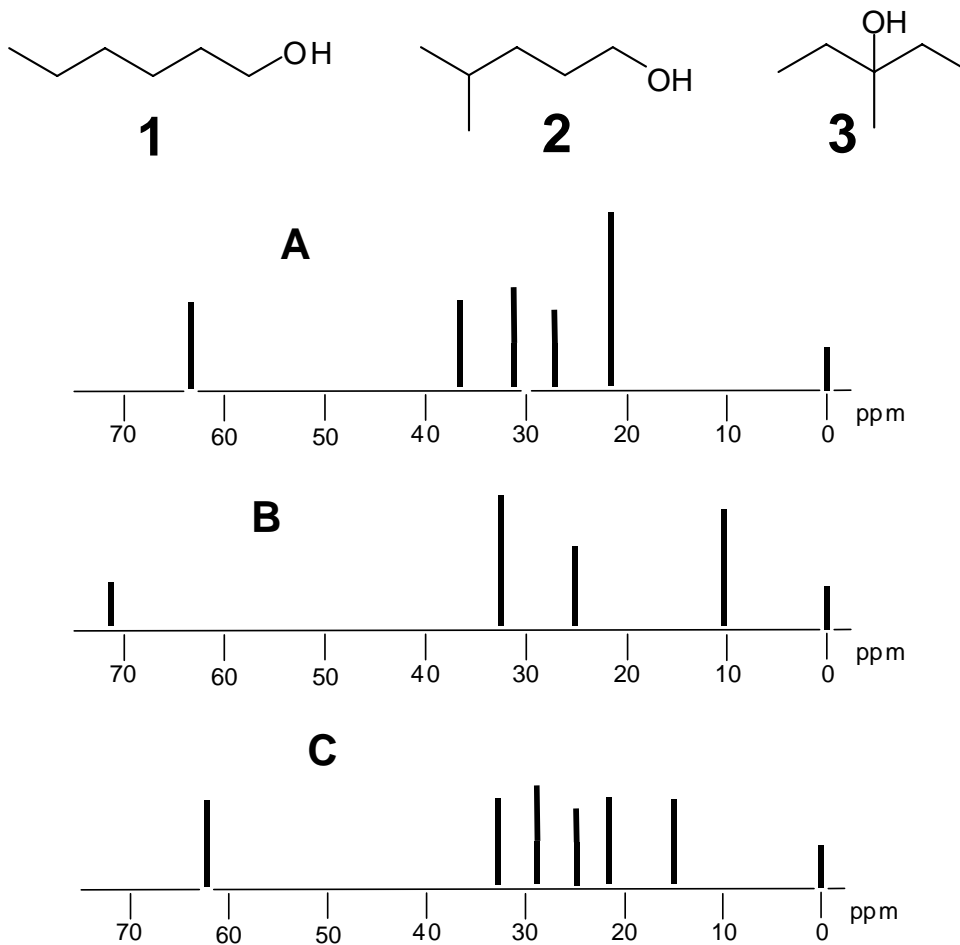
1 H 1.008																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.8	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.0	10 Ne 20.2
11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 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
-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------

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)
-------------------	-------------------	-------------------	------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	--------------------	--------------------	--------------------	--------------------

**Question 1** (4 marks)

Shown below are representations (A – C) of the  $^{13}\text{C}$  NMR spectra of three isomeric alcohols 1 – 3.

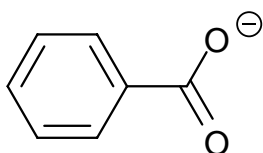


- (i) Which spectrum corresponds to isomer **1**?      Ans:
- (ii) Which spectrum corresponds to isomer **2**?      Ans:
- (iii) Which spectrum corresponds to isomer **3**?      Ans:
- (iv) What is the chemical structure of the compound that produces the signal at 0 ppm in each of the spectra?

Ans:

**Question 2** (2 marks)

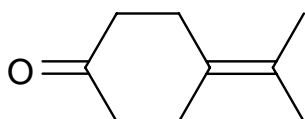
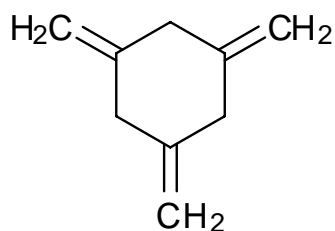
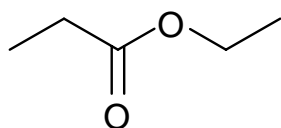
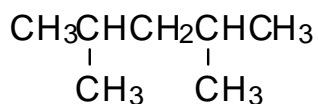
Draw the structures of **two** other resonance contributors of the following:



**Question 3** (8 marks)

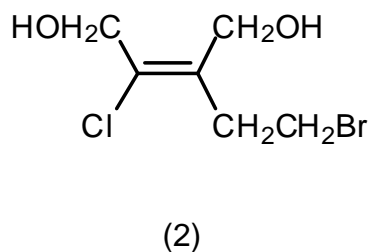
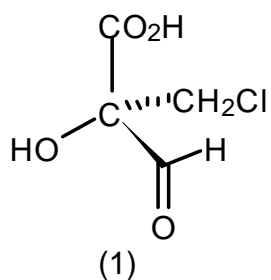
Show the number of signals expected in the  $^{13}\text{C}$  and  $^1\text{H}$  NMR spectra for each of the compounds shown below. Also give the relative integrals for the peaks in the  $^1\text{H}$  NMR spectrum for each compound.

$^{13}\text{C}$  NMR       $^1\text{H}$  NMR      Integral ratio



**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** (12 marks)

(i) What technique is used to determine the **empirical** formula of an organic compound?

Ans:

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

Ans:

(iii) What feature appears in the infrared spectrum of a carboxylic acid but not an ester?

Ans:

(iv) What region of the electromagnetic spectrum induces excitation between **electronic** energy levels?

Ans:

(v) What technique involves the use of magnetic fields to analyse ionised molecules?

Ans:

(vi) What term is used to describe isomers that have the same atom connectivity but a different arrangement in space of the atoms?

Ans:

(vii) Do *S*-enantiomers always rotate light in an anti-clockwise direction?

Ans:

(viii) Do enantiomers have different NMR spectra?

Ans:

(ix) If the *R*-enantiomer of a compound has a specific rotation of  $-32.6^\circ$ , what will be the rotation of the *S*-enantiomer?

Ans:

(x) What does a polarimeter measure?

Ans:

(xi) What is a 1:1 mixture of two enantiomers called?

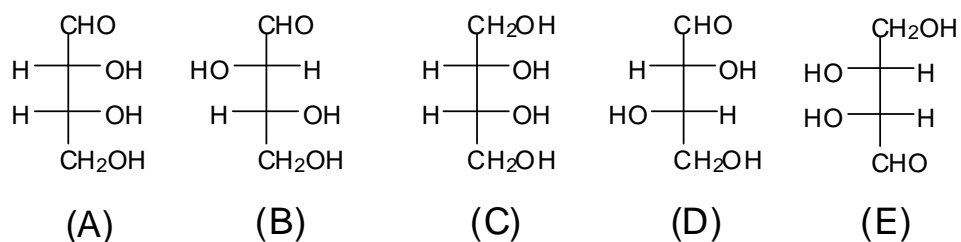
Ans:

(xii) What experimental technique is most commonly used to purify **solid** compounds?

Ans:

**Question 6** (5 marks)

Consider the structures (A – E) below which are drawn as Fischer projections.



List two which are:

(a) not isomers Ans:

(b) diastereoisomers Ans:

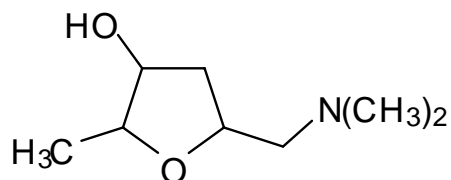
(c) enantiomers Ans:

(d) identical Ans:

Which of these is a meso compound? Ans:

**Question 7** (3 marks)

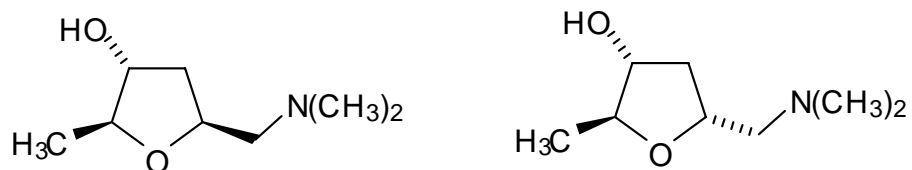
The molecule shown below is found in certain poisonous mushrooms.



(i) How many stereogenic centres does it have? Ans:

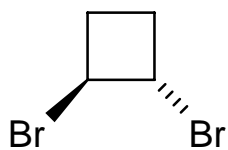
(ii) How many stereoisomers are there for this structure? Ans:

(iii) Two such isomers are shown below. Are they enantiomers or diastereoisomers? Ans:

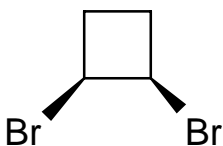


**Question 8** (4 marks)

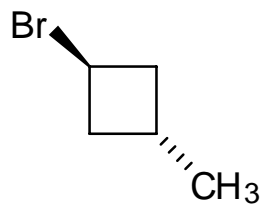
For each of the structures shown below state (Yes/No) whether it can exist as two enantiomers.



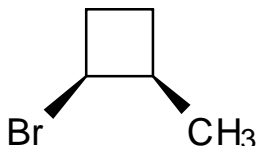
Ans:



Ans:



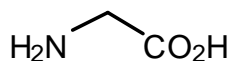
Ans:



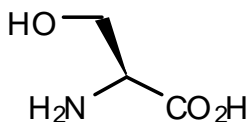
Ans:

**Question 9** (8 marks)

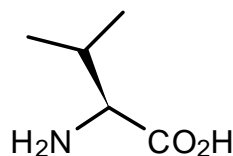
Shown below are the structures of three of the natural  $\alpha$ -amino acids.



glycine (gly)



serine (ser)



valine (val)

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

pH 7

pH 11

**END OF PAPER**