

**Full Name:** .....

**Student ID #:** .....

**Signature:** .....

University of Canterbury

## Mid Year Examination and Test Period 2009

Prescription Number(s):      CHEM 114

Paper Title:                      Introductory Chemistry

Time Allowed:                      TWO HOURS

Number of pages:                  12 plus periodic table

Answer **ALL** questions

Please write your answers in the spaces provided.

Total marks = 100: you should allocate 1 minute per mark. Allow 20 minutes for reading time and checking time.

NOTE:                      There is a periodic table with atomic masses on the last page.

---

For examiners use only

1	2	3	4	5
6	7	8		<b>Total</b>
				/100

1. **(20 marks)**

(a) *(8 marks)*

Describe the interactions between water molecules in the three physical states of water.

(b) *(3 marks)*

Explain surface tension.

(c) (5 marks)

Discuss what happens to H<sub>2</sub>O molecules when the temperature of water is raised from 0°C to 100°C.

(d) (4 marks)

Explain why pure water solidifies at 0°C whereas water containing 40% ethyleneglycol (ethane-1,2-diol) solidifies at -10°C.

2. **(20 marks)**

(a) *(8 marks)*

Explain the differences between solutions, colloids and suspensions.

(b) *(4 marks)*

The water solubility of sodium chloride is 35.9 g per 100 mL at 25°C and the water solubility of silver bromide is  $1.5 \times 10^{-7}$  g per 100 mL at 25°C. Explain this difference.

(c) (4 marks)

In a saturated solution (at 25°C) of silver bromide,  $[\text{Ag}^+(\text{aq})] = 7.4 \times 10^{-7} \text{ M}$ . Calculate  $K_{\text{sp}}$  for silver bromide.

(d) (4 marks)

$K_{\text{sp}}(\text{BaSO}_4) = 1.1 \times 10^{-10}$ . Calculate  $[\text{BaSO}_4(\text{aq})]$  in a saturated solution.

3. (20 marks)

(a) (5 marks)

For the reaction

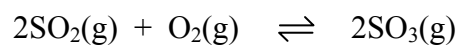


$$\Delta_r H^\circ = 90 \text{ kJ mol}^{-1}.$$

If the temperature of the reaction vessel is raised, what will the effect be on  $[\text{PCl}_5(\text{g})]$ ?  
Explain your answer.

(b) (2 marks)

Write the expression for  $K_c$  for the following reaction:



(c) (10 marks)

At  $T = 430^\circ\text{C}$ ,  $K_c = 54.3$  for the reaction  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$

- (i)  $\text{H}_2(\text{g})$  (0.243 mol),  $\text{I}_2(\text{g})$  (0.146 mol) and  $\text{HI}(\text{g})$  (1.98 mol) were put into a 1 L reaction vessel at  $430^\circ\text{C}$ . Calculate  $Q_c$  for the reaction under these conditions.
- (ii) Starting from the conditions in (i), will the concentration of HI increase or decrease as the reaction moves towards equilibrium? Explain your answer.
- (iii) At  $430^\circ\text{C}$ , what is the value of  $K_c$  for the reaction  $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$ ?
- (iv) At  $430^\circ\text{C}$ , what is the value of  $K_c$  for the reaction  $\frac{1}{2}\text{H}_2(\text{g}) + \frac{1}{2}\text{I}_2(\text{g}) \rightleftharpoons \text{HI}(\text{g})$ .

(d) (3 marks)

Of the following changes, circle those that will alter the value of an equilibrium constant of a gas-phase reaction conducted in a closed vessel.

- (i) adding more reactant;
- (ii) changing the volume of the reaction vessel;
- (iii) changing the temperature of the gas;
- (iv) adding an inert gas (e.g. helium).

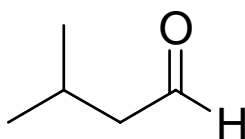
4. (8 marks)

(a) (2 marks)

Draw the structure of 2-hydroxypropanoic acid.

(b) (3 marks)

Give the systematic name of the following organic compound.

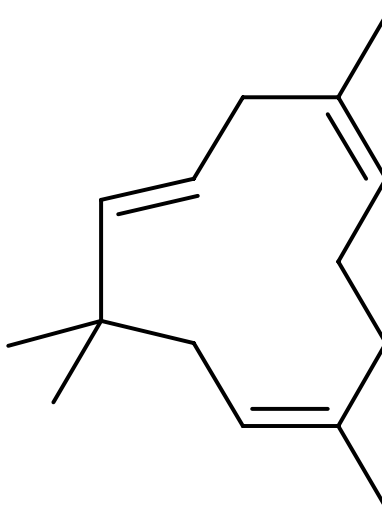


(c) (3 marks)

Draw a constitutional isomer of the compound shown in part (b) above. Briefly explain your reasoning.

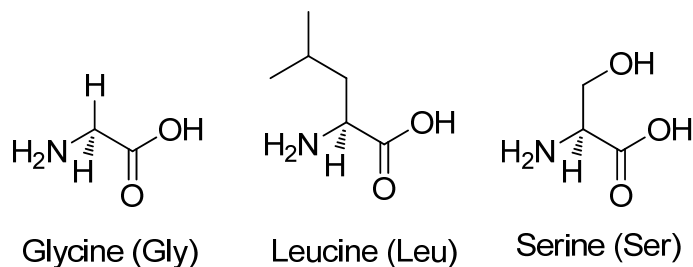
5. (6 marks)

The following sesquiterpene, humulene, is one of the flavouring agents found in hop flowers, used in beer brewing. Clearly identify the isoprene units in humulene. Using arrows, indicate the head-to-tail linkages. Circle the bonds that represent any extra C-C crosslinks.



## 6. (13 marks)

The structures of the amino acids alanine, leucine and serine are given below.

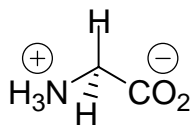


## (a) (9 marks)

Draw the structure of the tripeptide Gly-Ser-Leu. Clearly indicate any peptide bonds.

## (b) (4 marks)

The picture below shows the structure of the amino acid glycine in its zwitterionic form. Explain why this structure is the most likely at neutral pH, and the affect this has on the solubility of the molecule in biological systems.

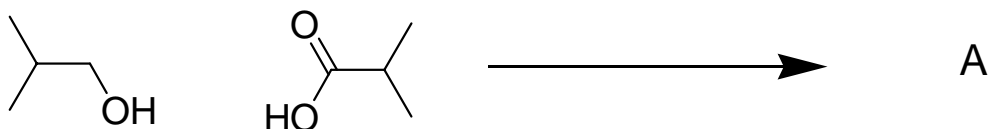


Glycine (Gly)

## 7. (8 marks)

(a) (3 marks)

Draw the structure of the molecule, A, formed by the reaction of the acid and alcohol shown below. What type of molecule is A?



(b) (5 marks)

Give the basic structure of a fatty acid, and explain how it acts as a soap.

## 8. (5 marks)

Shown below is a selection of natural products (A - O). Which of these is:

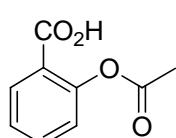
(i) A hexose sugar; (1 mark)

(ii) A saturated fatty acid; (1 mark)

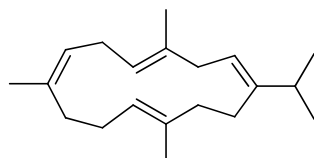
(iii) A disaccharide; (1 mark)

(iv) A monoterpene; (1 mark)

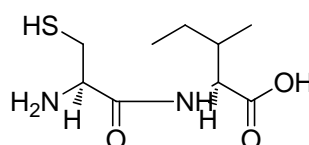
(v) A triglyceride. (1 mark)



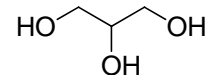
Aspirin (A)



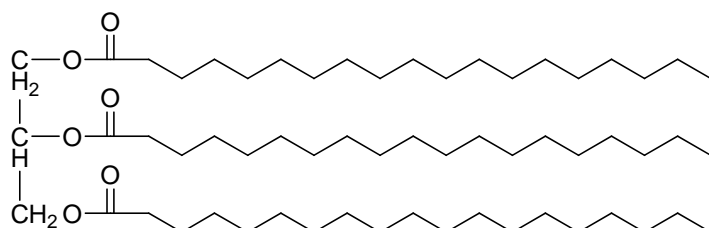
Cembrene (B)



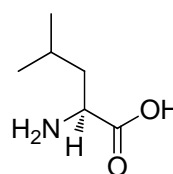
Cys-Ile (C)



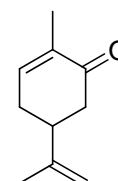
Triglycerol (D)



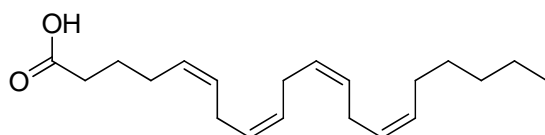
A fat (E)



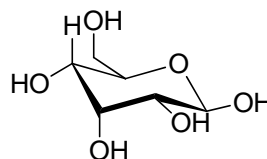
Leucine (F)



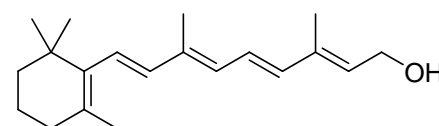
Carvone (G)



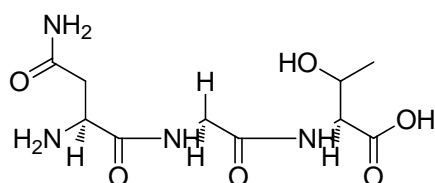
Arachidonic Acid (H)



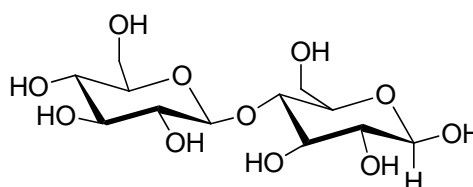
β-D-Allose (I)



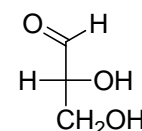
Vitamin A (J)



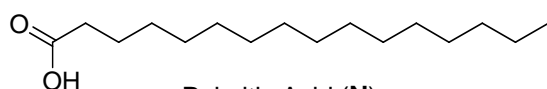
Asn-gly-thr (K)



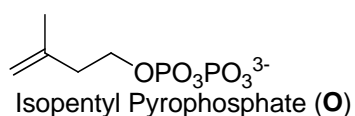
Maltose (L)



D-Glyceraldehyde (M)



Palmitic Acid (N)



Isopentyl Pyrophosphate (O)

END OF PAPER

## 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)
-------------------	-------------------	-------------------	------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	-------------------	--------------------	--------------------	--------------------	--------------------