KEY

PRINT NAME_____.

SIGN NAME_____.

You are required to answer all questions. Please write legibly and draw clearly.   Points will be deducted for illegible and unclear answers.   Please answer in the space provided after each question.   Use the reverse side if you need more space. There are a total of 100 points possible for this exam and the value of each section is shown in parenthesis beside that question. Note that some of the questions may give you a choice. Do only the number of choices asked for. Extra answers will not be graded. **READ ALL QUESTIONS CAREFULLY AND APPORTION YOUR TIME APPROPRIATELY.**
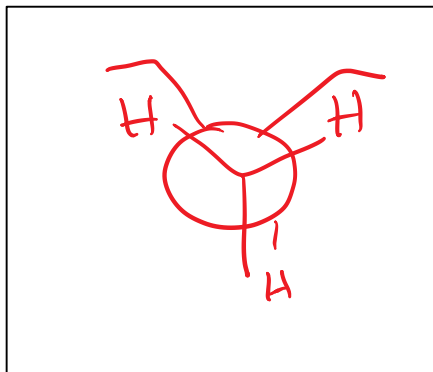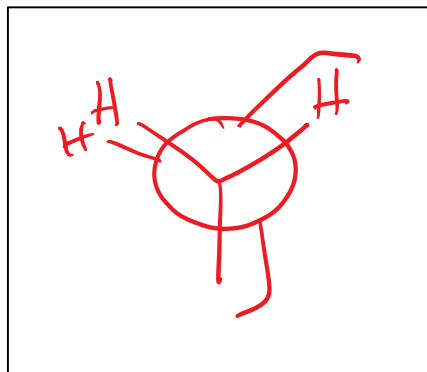
1. Consider the rotation about the C2-C3 bond of 3-ethylpentane (see below) and answer **A-D**. **(20)**

C2-C3 bond
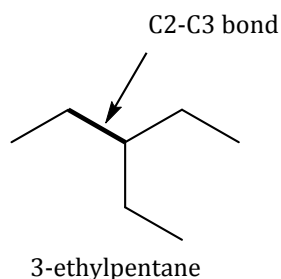
3-ethylpentane

Below are the Newman projections for 3 staggered conformations of 3-ethylpentane with respect to the C2-C3 bond.
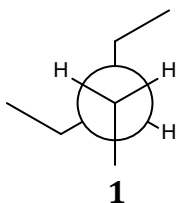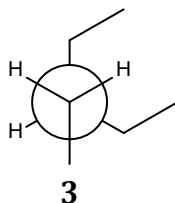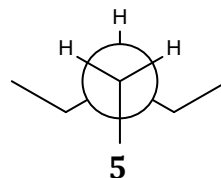
1   **2**   **3**   **4**   **5**   **6**

A. Draw the three missing eclipsed conformers (**2**, **4**, and **6**). *Please draw your answers in the boxes below.* **(6)**

Conformer 2	Conformer 4	Conformer 6
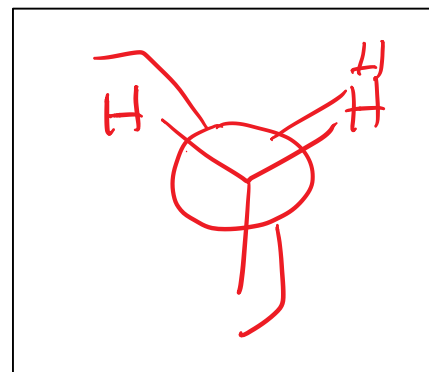
B. In the box below, list conformers **1-6** *from highest in energy to lowest in energy*. <u>If two conformers are energetically equivalent then list them **next** to one another.</u> **(6)**

Highest Energy Conformer(s)

Lowest Energy Conformer(s)

4 +6

2

5

1+3

C. At room temperature, in which conformation(s) **(1-6)** would you expect 3-ethylpentane to exist the majority of the time? *Circle all that apply.* **(4)**

(1)   2   (3)   4   5   6

D. Recall that H,H eclipsing interactions cost 4.0 kJ/mol of energy *per interaction*.

Suppose the energetic costs of a few other interactions are as shown in the table below. (*You can assume gauche interactions involving H have no energetic cost*).

Interaction	Energetic "Cost" (kJ/mol)
H, CH_2CH_3 eclipsing	8.0
CH_3, CH_2CH_3 eclipsing	13.0
CH_3, CH_2CH_3 gauche	7.0
CH_3, H eclipsing	6.0

Using this information, what is the difference in energy (kJ/mol) between

    i. conformer **3** and conformer **6**? **(2)**

$$4.0$$
$$+\ 8.0$$
$$\underline{13.0}$$
$$25.0$$

$$25.0 - 7.0 = 18.0 \text{ kJ/mol}$$

    ii. conformer **5** and conformer **2**? **(2)**

$$8.0$$
$$8.0$$
$$+\ 6.0$$
$$\underline{}$$
$$22.0$$

$$7.0$$
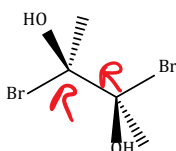$$\underline{+\ 7.0}$$
$$14.0$$

$$= 8.0 \text{ kJ/mol}^2$$

Answer questions 2 - 5 regarding the structures A-F below. (16)
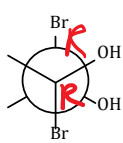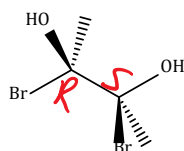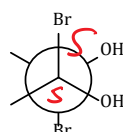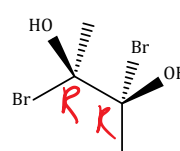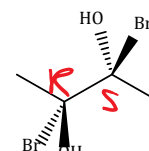

| A | B | C | D | E | F |

2. From the structures **A-F** above, identify any **one** (**1**) pair of enantiomers. **(4)**

 A + D, C + D, D + E

3. From the structures **A-F** above, identify any **one** (**1**) pair of diastereomers. **(4)**

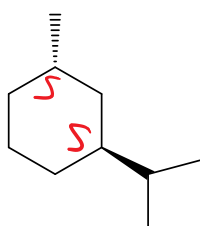 A + B, B + C, B + D, B + E, A + F, C + F, D + F, E + F

4. From the structures **A-F** above, identify any **one** (**1**) *meso* structure. **(4)**
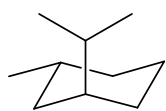
 B or F

5. From the structures **A-F** above, select two that, if mixed in equimolar proportions, would yield an optically active mixture. **(4)**
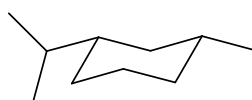
 Any Answer from 3 or A + C or A + E

For questions 6-10, consider the structures A-F below and circle "True" or "False." (15)
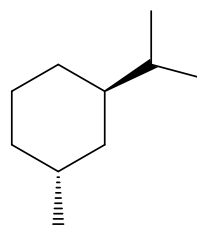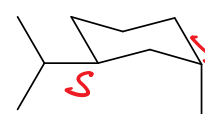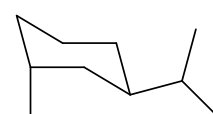
| A | B | C | D | E | F |

6. Structures **A** and **E** are identical. ~~True~~ False

7. Structure **C** has no enantiomer. True ~~False~~

8. Structures **C** and **D** are diastereomers. ~~True~~ False

9. Molecules **A** and **D** would have the same boiling point. ~~True~~ False

10. Molecule **B** is in its preferred chair conformation. True ~~False~~

11. What is the correct IUPAC name for the following molecule? *Circle your answer.* **(6)**
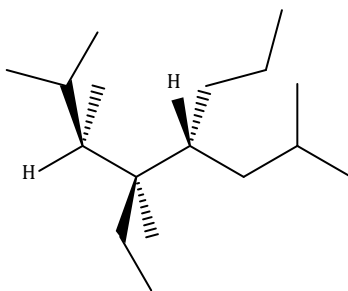
a. (3S, 4R, 5R)-4-ethyl-2,3,7-trimethyl-5-propyloctane
b. (3R, 4R, 5R)-4-ethyl-2,3,7-trimethyl-5-propyloctane
c. (1R, 2R, 3R)-2-ethyl-1-isopropyl-1,2,5-trimethyl-3-propylhexane
d. (3S, 4R, 5R)-5-ethyl-2,6,7-trimethyl-4-propyloctane
e. (3R, 4R, 5R)-4-ethyl-5-isobutyl-2,3-dimethyloctane

Question 12 relates to the molecule below. **(15)**
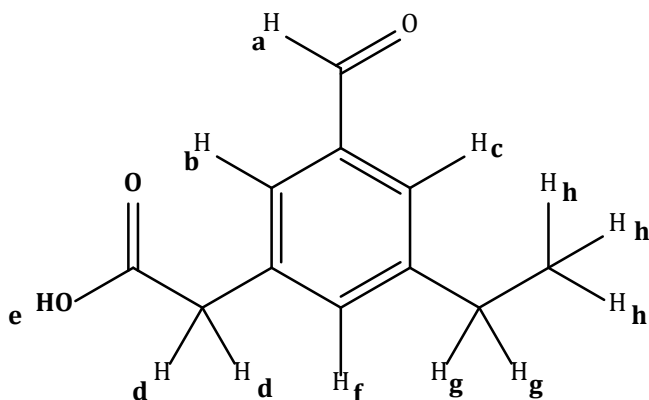
On the drawing above, like groups of protons are labeled the alphabetically.

12. Predict and fill in the proton NMR data for the above molecule. List the data in approximate order of increasing chemical shift. Use the following abbreviations: s = singlet, d = doublet, t = triplet, q = quartet, quint = quintet, sext = sextet, sept = septet, m = multiplet.

	Splitting Pattern	Integration Value	Assignment
Lowest Chemical Shift	t	3	h
	q	2	g
	s	2	d
	s	1	f
	s	1	c
	s	1	b
	s	1	a
Highest Chemical Shift	s	1	e

4

Answer questions 13-15 regarding structures **A-F** below.
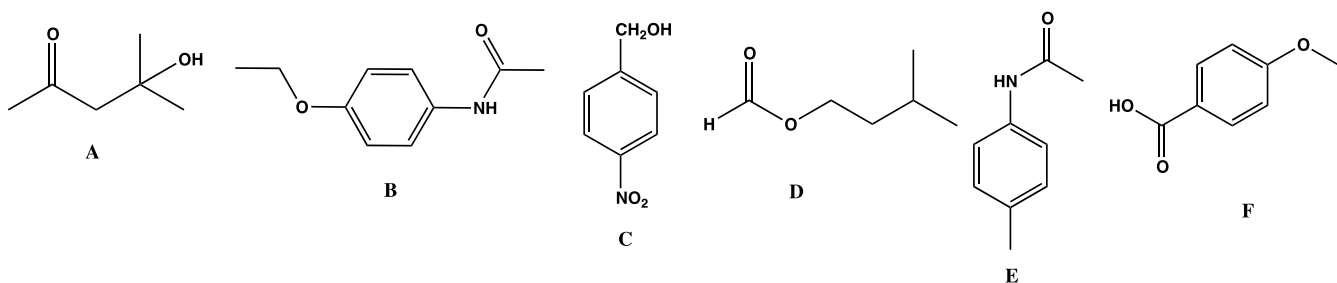
13. Which of the above structures (**A-F**) matches the ^{1}H NMR spectrum below? *Circle your answer.* **(4)**
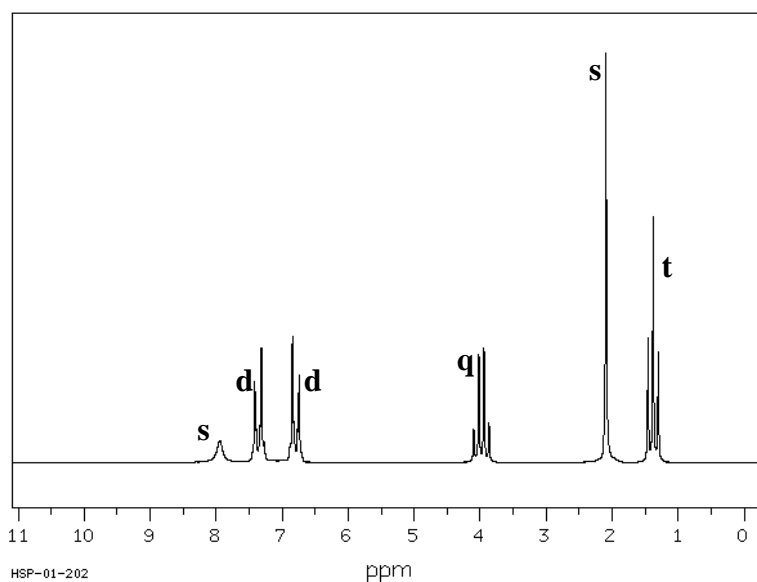
A   **B**   C   D   E   F

HSP-01-202   ppm

14. How many signals would you expect to see in the ^{1}H NMR spectrum of compound **D**? *Circle your answer.* **(4)**

3   4   **5**   6   7

15. The ^{1}H NMR spectrum of one of the compounds **A-F** is found to have the following integration values: 2.1:0.7:1.4:1.4:2.1. The spectrum must be that of which compound? *Circle your answer.* **(4)**

A   B   C   D   **E**   F

16. Four unique stereoisomers exist for the molecule 1-ethyl-2,3-dimethylcyclopropane.

    A. Draw a stereoisomer of 1-ethyl-2,3-dimethylcyclopropane that is **achiral**. **(4)**

    B. Draw a stereoisomer of 1-ethyl-2,3-dimethylcyclopropane that would give 7 signals in an ^{1}H NMR experiment. **(4)**

17. Indicate if each the following statements **A-D** regarding NMR spectroscopy is true or false. *Circle your answer.* **(8)**

    A. During an NMR spectroscopy experiment, electromagnetic radiation in the radiofrequency range is used to cause nuclear spin excitations.   *True*   *False*

    B. An NMR signal that appears at higher ppm value is said to be upfield from a signal that appears at a lower ppm value.   *True*   *False*

    C. In an NMR spectrum, nuclei that are shielded appear at lower ppm values than nuclei that are deshielded.   *True*   *False*

    D. The amount of energy required to cause "resonance" during an NMR experiment is directly proportional to the strength of the external magnetic field.   *True*   *False*