

Name: \_\_\_\_\_  
 Last First MI

**Chemistry 233-001/002  
 Exam 2 – Version Green**

Fall 2018

Dr. J. Osbourn

*Instructions:* The first 21 questions of this exam should be answered on the provided Scantron. You must use a pencil for filling in the Scantron sheet. Ensure all erasures are complete. Any questions left blank will be marked incorrect. Answer the remaining questions on the exam itself. Show all work and provide complete explanations.

**Please write your name on:**

- **The first page (Exam Cover Page)**
- **The second page (Grading Page)**
- **The Scantron Sheet – Circle your Last Name**

**Please bubble in your WVU Student ID Number on your Scantron sheet.**

**The Periodic Table**

1 IA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA																													
1 <b>H</b> 1.01	2 <b>He</b> 4.00											5 <b>B</b> 10.81	6 <b>C</b> 12.01	7 <b>N</b> 14.01	8 <b>O</b> 16.00	9 <b>F</b> 19.00	10 <b>Ne</b> 20.18																												
3 <b>Li</b> 6.94	4 <b>Be</b> 9.01											11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31	13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.07	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95																										
19 <b>K</b> 39.1	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.88	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.39	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.61	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80																												
37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.07	45 <b>Rh</b> 102.91	46 <b>Pd</b> 106.42	47 <b>Ag</b> 107.87	48 <b>Cd</b> 112.41	49 <b>In</b> 114.82	50 <b>Sn</b> 118.71	51 <b>Sb</b> 121.76	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.29																												
55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3	57 <b>La*</b> 138.9	72 <b>Hf</b> 178.5	73 <b>Ta</b> 180.9	74 <b>W</b> 183.9	75 <b>Re</b> 186.2	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1	79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6	81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2	83 <b>Bi</b> 209	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)																												
87 <b>Fr</b> (223)	88 <b>Ra</b> (226)	89 <b>Ac^</b> (227)	104 <b>Rf</b> (261)	105 <b>Db</b> (262)	106 <b>Sg</b> (263)	107 <b>Bh</b> (264)	108 <b>Hs</b> (265)	109 <b>Mt</b> (268)	110 <b>Ds</b> (271)	111 <b>Rg</b> (272)																																			
<table border="1"> <tr> <td>* 58 <b>Ce</b> 140.1</td> <td>59 <b>Pr</b> 140.9</td> <td>60 <b>Nd</b> 144.2</td> <td>61 <b>Pm</b> (145)</td> <td>62 <b>Sm</b> 150.4</td> <td>63 <b>Eu</b> 152.0</td> <td>64 <b>Gd</b> 157.3</td> <td>65 <b>Tb</b> 158.9</td> <td>66 <b>Dy</b> 162.5</td> <td>67 <b>Ho</b> 164.9</td> <td>68 <b>Er</b> 167.3</td> <td>69 <b>Tm</b> 168.9</td> <td>70 <b>Yb</b> 173.0</td> <td>71 <b>Lu</b> 175.0</td> </tr> <tr> <td>^ 90 <b>Th</b> 232.0</td> <td>91 <b>Pa</b> (231)</td> <td>92 <b>U</b> 238.0</td> <td>93 <b>Np</b> (237)</td> <td>94 <b>Pu</b> (244)</td> <td>95 <b>Am</b> (243)</td> <td>96 <b>Cm</b> (247)</td> <td>97 <b>Bk</b> (247)</td> <td>98 <b>Cf</b> (251)</td> <td>99 <b>Es</b> (252)</td> <td>100 <b>Fm</b> (257)</td> <td>101 <b>Md</b> (258)</td> <td>102 <b>No</b> (259)</td> <td>103 <b>Lr</b> (260)</td> </tr> </table>																		* 58 <b>Ce</b> 140.1	59 <b>Pr</b> 140.9	60 <b>Nd</b> 144.2	61 <b>Pm</b> (145)	62 <b>Sm</b> 150.4	63 <b>Eu</b> 152.0	64 <b>Gd</b> 157.3	65 <b>Tb</b> 158.9	66 <b>Dy</b> 162.5	67 <b>Ho</b> 164.9	68 <b>Er</b> 167.3	69 <b>Tm</b> 168.9	70 <b>Yb</b> 173.0	71 <b>Lu</b> 175.0	^ 90 <b>Th</b> 232.0	91 <b>Pa</b> (231)	92 <b>U</b> 238.0	93 <b>Np</b> (237)	94 <b>Pu</b> (244)	95 <b>Am</b> (243)	96 <b>Cm</b> (247)	97 <b>Bk</b> (247)	98 <b>Cf</b> (251)	99 <b>Es</b> (252)	100 <b>Fm</b> (257)	101 <b>Md</b> (258)	102 <b>No</b> (259)	103 <b>Lr</b> (260)
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**\*\*Please do not rip off this exam cover page\*\***

Name: \_\_\_\_\_  
Last First MI

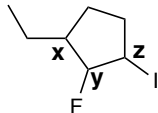
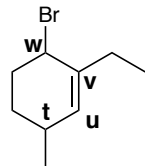
Grading Page (Exam 2)

<b>Page</b>	<b>Points Possible</b>	<b>Points Earned</b>
Multiple Choice (3-5)	42	
6	22	
7	19	
8	17	
<b>TOTAL</b>	<b>100</b>	

### Multiple-Choice

Choose the best answer for each of the following questions. Record each answer on the provided Scantron sheet. Also, circle each answer directly on the exam. (2 points each)

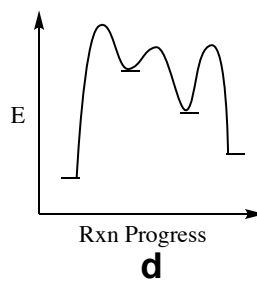
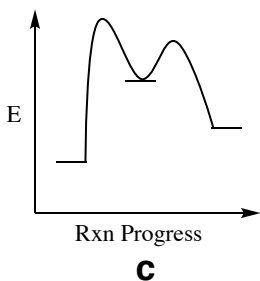
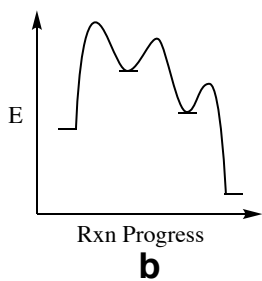
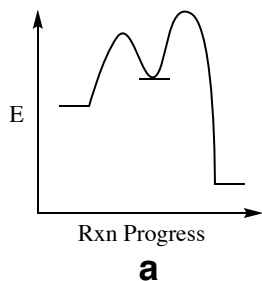
1. Which carbon in each cyclic molecule below would be designated as C#1 when determining the IUPAC names.



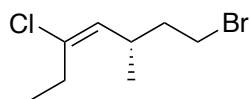
Structure I C#1

Structure II C#1

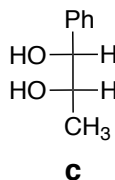
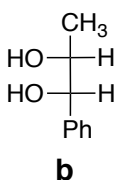
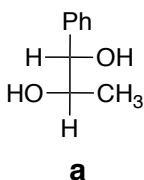
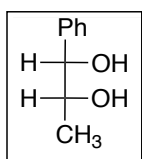
- |    |   |   |
|----|---|---|
| a. | w | z |
| b. | w | x |
| c. | v | z |
| d. | v | x |
| e. | u | x |
2. Which one of the following energy diagrams represents an endergonic reaction with two intermediates?



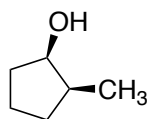
3. When writing the IUPAC name for the following compound, what is the appropriate stereochemical designation?



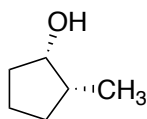
- |    |        |
|----|--------|
| a. | 3Z, 5S |
| b. | 3Z, 5R |
| c. | 3E, 5S |
| d. | 3E, 5R |
4. Which of the following Fischer projections are identical to the molecule shown in the box? *Bubble in the letter for all that apply!*



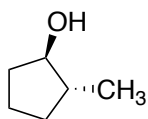
5. Consider the three stereoisomers shown below then choose the correct statement.



Compound I



Compound II

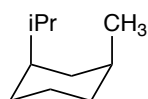


Compound III

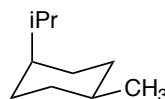
- Compound I and compound III will have different optical rotations.
  - Compound I and compound II will rotate light in opposite directions.
  - The magnitude of the optical rotation for compounds I and II will be the same.
  - The magnitude of the optical rotation for compounds II and III will be different.
  - All of the above statements are correct
6. Which one of the following is the **least stable** chair conformation of *cis*-1-isopropyl-4-methylcyclohexane?



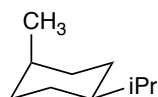
a



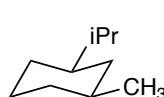
b



c

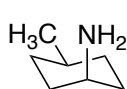
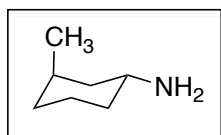


d

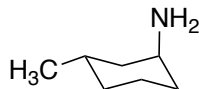


e

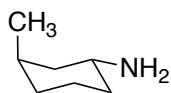
7. Which one of the following is the correct ring flip conformation of the compound shown in the box?



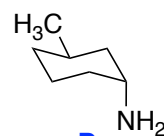
A



B

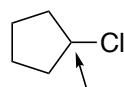
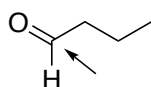
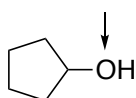


C



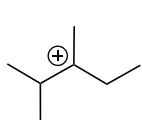
D

8. How would you best classify each of the indicated atoms?

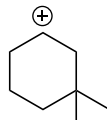


- |    |              |              |              |
|----|--------------|--------------|--------------|
| a. | Nucleophile  | Electrophile | Electrophile |
| b. | Nucleophile  | Nucleophile  | Electrophile |
| c. | Electrophile | Electrophile | Electrophile |
| d. | Electrophile | Nucleophile  | Electrophile |
| e. | Nucleophile  | Electrophile | Nucleophile  |

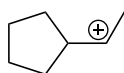
9. Which of the following carbocations will undergo rearrangement to become more stable. *Bubble in the letter for all that apply!*



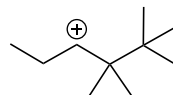
a



b

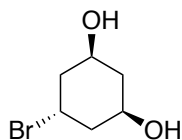


c



d

10. The compound shown below contains \_\_\_\_ chiral centers and \_\_\_\_ stereocenters.

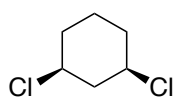


- a. 3, 3
- b. 2, 3
- c. 3, 2
- d. 2, 2
- e. 2, 1

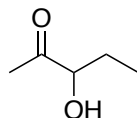
**For questions 11-15, determine whether each molecule is:**

**(a) Chiral, (b) Achiral, or (c) Meso-Achiral**

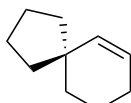
*Bubble these answers in on your Scantron sheet for credit!*



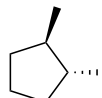
11.



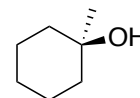
12.



13.



14.

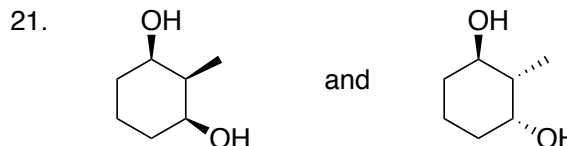
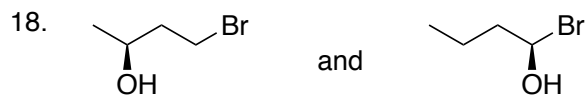
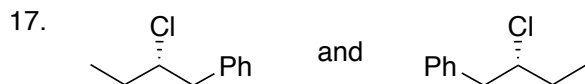
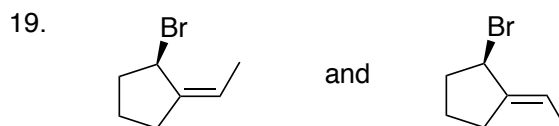
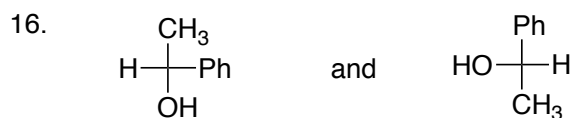


15.

**For questions 16-21, determine whether each pair of molecules represent:**

**(a) Identical Compounds, (b) Constitutional Isomers, (c) Enantiomers, or (d) Diastereomers**

*Bubble these answers in on your Scantron sheet for credit!*

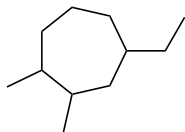


## Completion Section

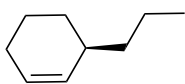
Answer the remaining questions in the spaces provided.

22. Provide the IUPAC name for each. Include *R*, *S*, *E*, and *Z* where appropriate. (3 points each)

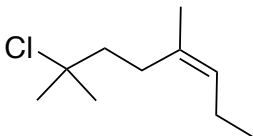
a.



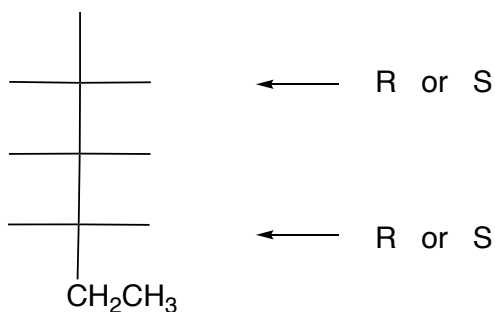
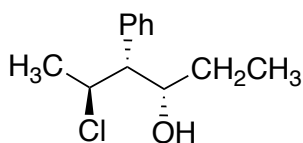
b.



c.



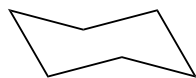
23. a. Draw the molecule shown below as a Fischer projection using the template provided. b. Determine the *R/S* configuration at the indicated chiral centers. (4 points)



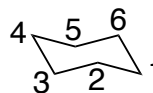
**Note:** You can also use the original molecule to determine the *R/S* assignments.

24. Using the template below, draw a structure that meets the following criteria. (3 points)

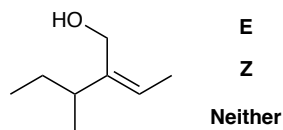
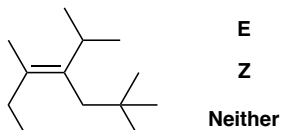
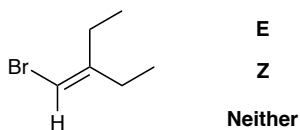
- Axial  $\text{CH}_3$  at C3
- Equatorial Br at C2
- OH at C1 that is *trans* to the  $\text{CH}_3$



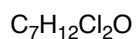
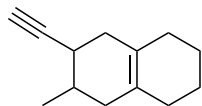
Numbering Scheme:



25. Determine if each alkene is *E/Z* or neither *E* nor *Z*. (2 points each)



26. Determine the degree of unsaturation for each. (1 point each)



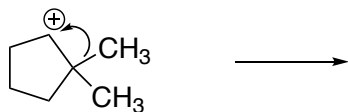
\_\_\_\_\_

\_\_\_\_\_

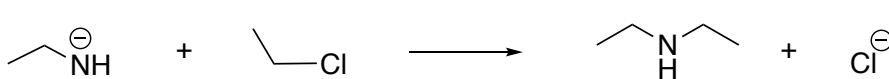
\_\_\_\_\_

27. Complete each reaction below by drawing in the missing curved arrows in the reactants or the missing product(s). (2 points each)

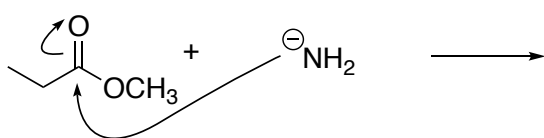
a.



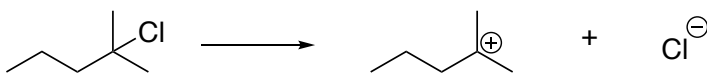
b.



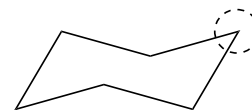
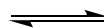
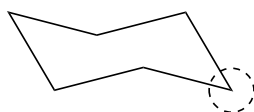
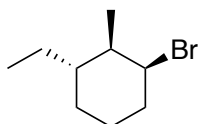
c.



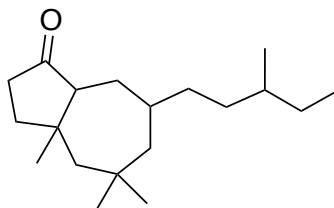
d.



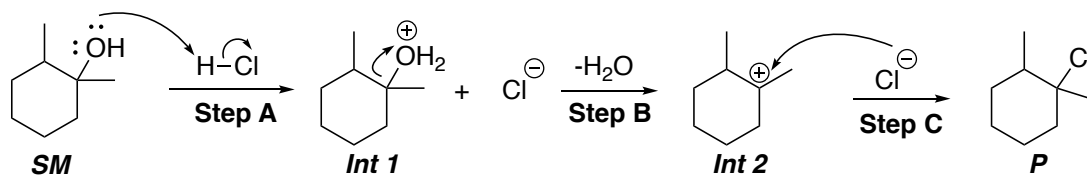
28. Draw both chair conformations for the compound shown below using the templates provided. Put the Br on the carbon indicated by the circle and orient your other group based on that reference point. Circle the chair conformation that is lowest in energy. (5 points)



29. Identify every chiral center in the following molecule with an asterisk \*. (3 points)



30. For the reaction shown below, label each step as a nucleophilic attack, loss of a leaving group, proton transfer or carbocation rearrangement. (3 points)

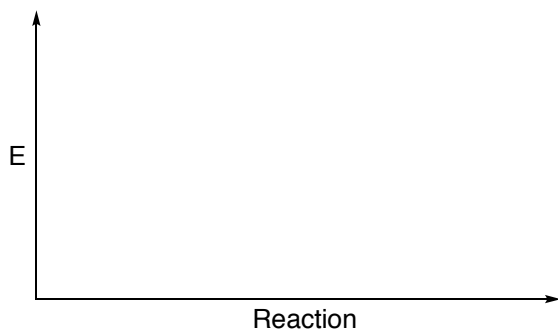


Step A: \_\_\_\_\_

Step B: \_\_\_\_\_

Step C: \_\_\_\_\_

31. Draw a reaction coordinate (energy diagram) for the reaction in question 30. Label the starting material (SM), product (P), and Intermediates (Int 1 & Int 2) on the coordinate. (4 points)



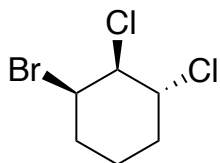
**Notes:**

- Step B is the rate determining step
- The reaction is exothermic/exergonic
- Int 2 is less stable than Int 1

32. Consider **1-bromo-2,3-dichlorocyclohexane**. (6 points)

a. What is the maximum possible number of stereoisomers for this compound?

b. One stereoisomer is shown below. Draw the enantiomer and a diastereomer of this compound.



\_\_\_\_\_

Enantiomer

\_\_\_\_\_

Diastereomer

33. Draw an achiral stereoisomer of 1,2,3-tribromocyclohexane. (2 points)

34. Explain why cyclopropane has significant torsional strain. (2 points)