

Please read and sign the Honor Code statement below:

I pledge that on my honor, as a University of Colorado at Boulder student, I have neither given nor received unauthorized assistance on this exam.

\_\_\_\_\_  
Signature

**General Instructions:** There are 20 questions. Be sure you have them all. Read each question carefully so that you know exactly what is being asked.

Each multiple choice question (1-20) is worth **5 points** and has **only one correct answer**. Bubble in your answers to these questions on the Scantron provided. **Only the Scantron will be graded, not anything that you write on the exam.**

At the end of the exam, turn in your Scantron and this signed cover sheet. You may keep the rest of the exam to check your answers against the key later.

Good luck!

1A 2A 3A 4A 5A 6A 7A 8A

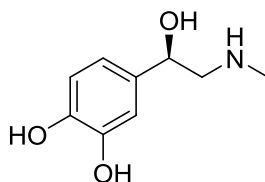
hydrogen 1 H 1.0079																				helium 2 He 4.0026						
lithium 3 Li 6.941	beryllium 4 Be 9.0122																				boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305																				aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80									
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	nickel 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29									
cesium 55 Cs 132.91	barium 56 Ba 137.33	* 57-70	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]								
francium 87 Fr [223]	radium 88 Ra [226]	* *	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]										

\* Lanthanide series

\*\* Actinide series

lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]

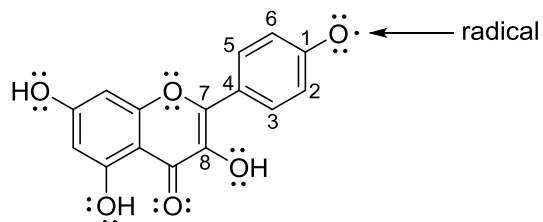
1. Certain individuals experience a severe allergic reaction when stung by bees. This potentially life-threatening allergic reaction is called anaphylaxis and is commonly treated by an injection of epinephrine:



**Epinephrine**

- All atoms in the structure are neutral, but the lone pairs have not been included explicitly. How many lone pairs of electrons should be shown in the structure of epinephrine?
- Four lone pairs
  - Six lone pairs
  - Eight lone pairs
  - Ten lone pairs
  - The number of lone pairs is not listed in the answer choices a-d
2. Which of these functional groups is present in epinephrine?
- Amide
  - Amine
  - Ketone
  - Ester
  - Ether
3. Certain functional groups can be classified as primary, secondary or tertiary. Two such groups are contained in epinephrine. Which statement best describes the classification of the two groups?
- Both are primary.
  - Both are secondary.
  - One is primary and one is secondary.
  - One is primary and one is tertiary.
  - One is secondary and one is tertiary.

4. Kaempferol is an antioxidant compound found in various foods, including blackberries, Brussels sprouts, and spinach.

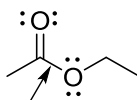


**Kaempferol radical**

The structure of kaempferol shown above has been converted to a radical. By drawing other resonance structures for this chemical species, we can show that the radical can be delocalized to various carbon atoms in the structure. Several of the carbon atoms have been labeled with numbers in the structure.

On which of the following carbon atoms will the radical NOT appear in the other resonance contributors?

- 1
  - 4
  - 6
  - 8
  - The radical will appear on all of these carbon atoms.
5. Consider the bond indicated by the arrow in this structure:



A typical C-O single bond length is 143 pm (pm = picometer) and a typical C=O bond is 123 pm. What do you expect the bond length of the indicated bond to be?

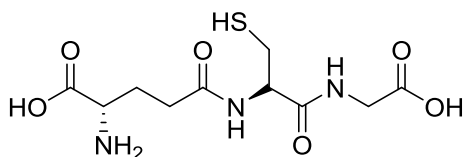
- 123 pm
- 143 pm
- More than 143 pm
- Less than 123 pm
- In between 123 and 143 pm

6. Eucalyptol is a major component of eucalyptus oil. It has an interesting cyclic structure, shown below. What type of compound is eucalyptol?



**Eucalyptol**

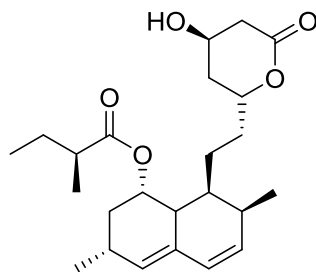
- a. Alcohol  
b. Amine  
c. Anhydride  
d. Ester  
e. Ether
7. Glutathione is an antioxidant found in plants, fungi, and bacteria. Although it is not a protein, it does contain peptide bonds. How many peptide bonds are there in glutathione?



**Glutathione**

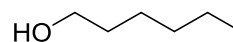
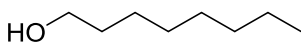
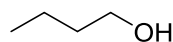
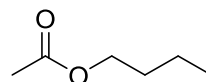
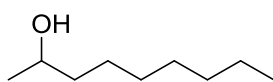
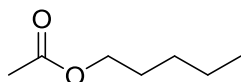
- a. 1  
b. 2  
c. 3  
d. 4  
e. 5
8. Which of these compounds is *not* a constitutional isomer of 2,3-dimethylbutane?
- a. 2,2,3-trimethylbutane  
b. 2-methylpentane  
c. 3-methylpentane  
d. hexane

9. Lovastatin is a compound used for the treatment of high cholesterol:



Lovastatin

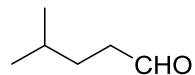
- According to valence bond theory, what orbitals are overlapping to form the OH  $\sigma$  bond? (Lone pairs are not explicitly shown in the structure.)
- a.  $sp$  on O and  $s$  on H  
b.  $sp^2$  on O and  $s$  on H  
c.  $sp^3$  on O and  $s$  on H  
d.  $p$  on O and  $s$  on H
10. How many  $\pi$  bonds are there in lovastatin?
- a. 1  
b. 2  
c. 3  
d. 4  
e. 5
11. In class, you saw *isoamyl acetate*. This compound is a component of banana oil and part of the mixture of substances injected by bees when they sting. The mixture also includes these compounds:



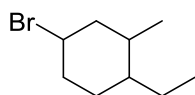
Which of these compounds is *not* included in the set shown above?

- a. 1-octanol  
b. 2-octanol  
c. 1-hexanol  
d. 1-butanol  
e. 2-nonanol

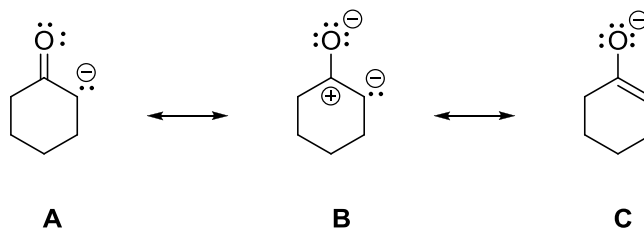
12. Which of these functional groups is contained in this structure?



- a. Alcohol
  - b. Aldehyde
  - c. Amine
  - d. Carboxylic acid
  - e. None of these
13. What is the correct IUPAC name for this compound?

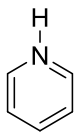


- a. 4-bromo-1-ethyl-2-methylcyclohexane
  - b. 1-bromo-3-methyl-4-ethylcyclohexane
  - c. 1-bromo-4-ethyl-3-methylcyclohexane
  - d. 1-ethyl-2-methyl-4-bromocyclohexane
  - e. None of these
14. Select the major resonance contributor. All lone pairs are shown in all structures.

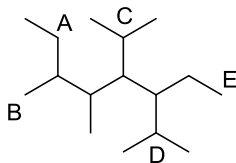


- a. A
- b. B
- c. C
- d. A and C
- e. All structures are equivalent

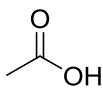
15. What is the formal charge on nitrogen in this structure? All lone pairs of electrons are shown.



- a. 0  
b. +1  
c. -1  
d. +2  
e. -2
16. What is the hybridization of the carbonyl carbon in a ketone?
- a.  $sp$   
b.  $sp^2$   
c.  $sp^3$   
d. The carbonyl carbon is not hybridized
17. Some of the carbons in this structure are labeled. Which of them is a secondary carbon?



18. Which of these compounds is a carboxylic acid derivative?



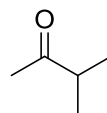
A



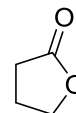
B



C

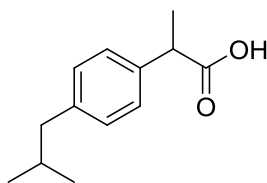


D



E

19. The structure of ibuprofen contains a benzene ring. What is the percentage of  $p$  character for the hybrid orbitals on a carbon in the benzene ring?



Ibuprofen

- a. 25%  
b. 33.3%  
c. 50%  
d. 66.7%  
e. 75%
20. The common name for 5-(1-methylethyl)nonane is
- a. 5-*tert*-butylnonane  
b. 5-*sec*-butylnonane  
c. 5-isopropylnonane  
d. 5-isobutylnonane