Write your name and date on the cover page
Do not open exam until instructed to do so

Name:_____

Date:_____

Exam I

Chem. 210

Do not open exam until told to do so.

Get out your pencil, eraser, and scientific nongraphing calculator.
Put everything else under the desk or on the floor.
Turn off or silence then stow all electronic devices.

You may leave the exam room after turning in your exam.
You may not return to the exam room after leaving (until the exam is over).

Provide the best answers as requested.
You must show work for credit.
Label your work should you use the back side of the paper.
If you have any questions during the exam, write them on the exam.
When told to do so, check that exam has all of its pages.

1) Given a selectivity ratio for free-radical chlorination of 5:4:1:0.004 (tertiary:secondary:primary:methyl) Predict the product yields for the monochlorination of 2-methylbutane

2) What is the rate of the reaction for the first-order rate law, rate=k[A], when the [A] drops to half its initial value (50% consumed)?

3) Draw the Kekulé (Lewis) structure for $C_2H_3O_2^-$ include resonance structures and formal charges. This is the polyatomic acetate ion that forms from acetic acid. It is resonance stabilized, which helps acetic acid to be more acidic. The structure contains 24 electrons. 12 used for bonds leaving 12. Give 12 to oxygens, then form = to C to satisfy octet rule.

4) Calculate $\Delta G°$ at 500°C for this reaction:

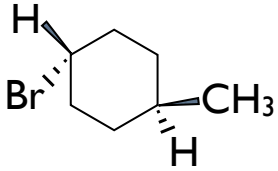
$CH_3CH_2Cl \rightarrow CH_2{=}CH_2 + HCl$

$\Delta H° = +64.9 kJ/mol$, $\Delta S° = +131.0 J/molK$

5) Draw a curved arrow diagram to form the conjugate base from this acid: H_2S

6) Which is the weakest acid
a) hydrogen cyanide, pKa=9.2
b) ammonium ion, pKa=9.3
c) methanethiol, pKa=10.0 (This one has the smallest Ka value)

7) Name this compound

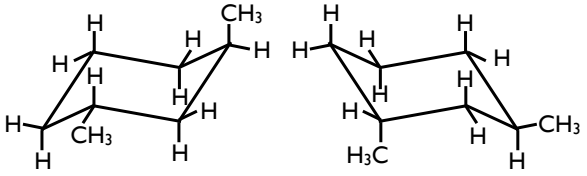


8) Draw this compound: cis-1,2-dimethylcyclopropane

9) Write a balanced equation for the combustion of propane

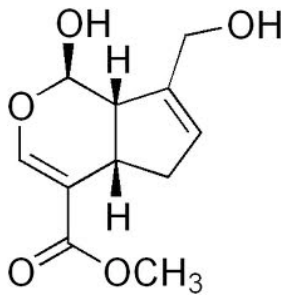
10) Provide the expected bond angles in CH_3Cl

11) Which conformer is more stable? Explain why.



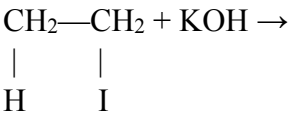
12) Show the bond polarity (partial positive and negative charges) for carbon and oxygen in: CH_2CO

13) Circle and identify the functional groups in the molecule below.



14) Write and name all the isomers (constitutional and stereoisomers) of C_5H_{10} that contain one ring.

15) Complete this reaction (elimination)



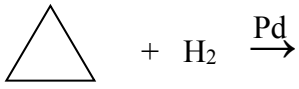
16) Provide the geometry about central atom for PCl_3

17) Write the initiation, propagation, and termination steps (radical chain mechanism) of free-radical chlorination of methane.

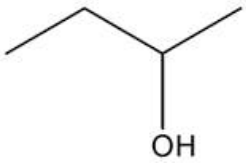
18) Which compound is 84% carbon and 16% hydrogen?

A. CH_4O
B. C_7H_{16}
C. C_6H_{10}
D. $C_{14}H_{22}$
E. $C_6H_{14}O_2$

19) Complete this reaction:



20) Provide the class of organic molecule based on the functional group



21) The calculated ΔH°_{comb} for cyclopropane is 1976kJ/mol (based on three CH_2 groups). The experimental ΔH°_{comb} for cyclopropane is 2091kJ/mol. What factors could explain this difference?

22) Predict the major product(s) (if any) for this reaction:
$CH_3CH_3 + I_2 \xrightarrow{\Delta}$

23) Draw two constitutional isomers for C_4H_{10} showing all atoms and bonds.

24) Which radical is the most stable

a) $CH_3CH_2CH_2\cdot$

b) $CH_3C(CH_3)CH_2\cdot$

c) $CH_3CH(CH_2CH_2\cdot)CH_3$

d) $CH_3C(CH_3)_2\cdot$

e) $CH_3C(CH_2CH_2CH_3)\cdot$

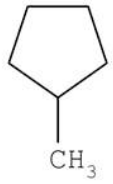
25) Calculate the DH° value for cyclobutane using these data:

Table of bond-dissociation energies.

Bond	kJ/mol
$C_2H_5C-C_2H_5$	368

Ring size	Total Strain
3	115
4	110
5	27
6	0.4

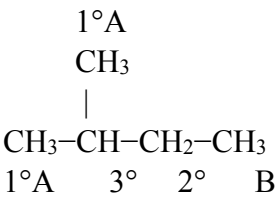
26) Predict the major product (if any) for this reaction:



$+ Br_2 \xrightarrow{\Delta}$

Answers

1)

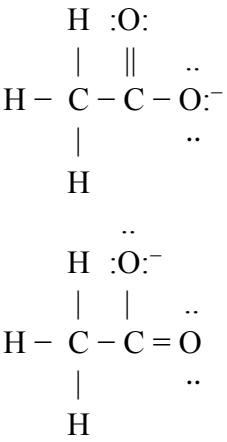


primary 1°A 6Hx1 = 6 giving 27% 1-chloro-2-methylbutane
primary 1°B 3Hx1 = 3 giving 14% 1-chloro-3-methylbutane
secondary 2° 2Hx4 = 8 giving 36% 2-chloro-3-methylbutane
tertiary 3° 1Hx5 = 5 giving 23% 2-chloro-3-methylbutane
Total 22

2)

Initially: rate(o)=k[Ao]
Halfway: rate(1/2)=k 1/2[Ao]
rate(1/2)/rate(o) = 1/2, so the rate when [A] drops to half of its initial value is 1/2 of the initial rate

3)



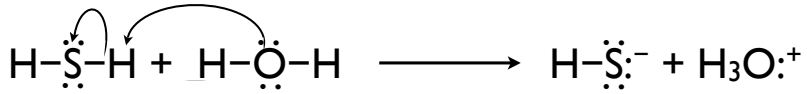
The formal charges are as marked. Most atoms are 0. The formal charge on (:O− is given by

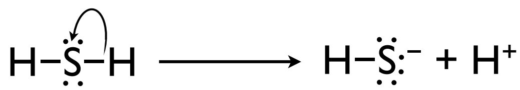
FC = Group number - nonbonding electrons - 1/2 bonding electrons=6-6-1/2(2)=-1

A structural formula may be provided such as $CH_3CO_2^-$

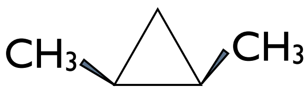
4) $\Delta G° = -36.4$kJ/mol at 500°C (773K).

5)





6) *c) methanethiol, pKa=10.0 (This one has the smallest Ka and biggest pKa value)
7) trans-1-bromo-4-methylcyclohexane

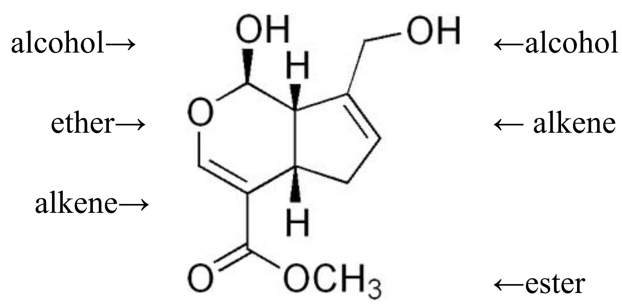
8) 

9) $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
10) 109.5°
11) Both conformers are equally stable with 1axial & 1 equatorial CH_3
12)

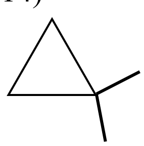
$$\overset{\delta+}{C}\!=\!\overset{\delta-}{O}\text{:}$$

$H_2C=C=O$: (δ+ on C, δ− on O; lone pair on O)

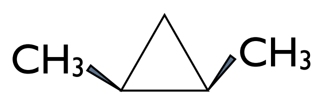
13)



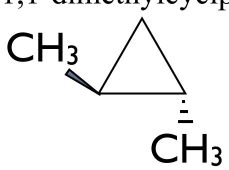
14)



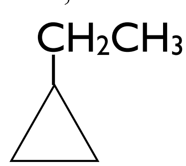
1,1-dimethylcyclpropane



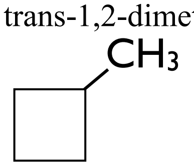
cis-1,2-dimethylcyclopropane



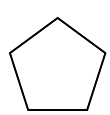
trans-1,2-dimethylcyclopropane



ethylcyclopropane



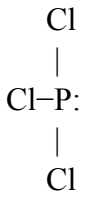
methylcyclobutane



cyclopentane

15) $H_2C=CH_2 + H_2O + KI$

16)



(either tetrahedral for the electron-pair geometry or pyrimidal for the molecular geometry)

17)
Initiation: $Cl{-}Cl \rightarrow 2Cl\cdot$ ($\Delta H° = 243kJ/mol$)
Propagation step 1: $Cl\cdot + H_3C{-}H \rightarrow H{-}Cl + H_3C\cdot$ ($\Delta H° = 8kJ/mol$)
Propagation step 2: $H_3C\cdot + Cl{-}Cl \rightarrow Cl\cdot + H_3C{-}Cl$ ($\Delta H° = -113kJ/mol$)
(The sum of $\Delta H°$ for the two propagation steps is always $\Delta H°$ for the reaction)
Termination: $Cl\cdot + Cl\cdot \rightarrow Cl{-}Cl$
$H_3C\cdot + H_3C\cdot \rightarrow CH_3{-}CH_3$
$H_3C\cdot + Cl\cdot \rightarrow H_3C{-}Cl$

18)
A and E are not possible because they contain oxygen.
B has 7x12=84gC in 7x12+1x16g = 100g compound = 84% C, so the answer is B

19) $CH_3CH_2CH_3$

20) alcohol

21) ring strain, torsional strain, and bond-angle strain.

22) No reaction, iodine does not undergo free-radical halogenation

23)
$CH_3CH_2CH_2CH_3$ and 

24) d - tertiary radicals are the most stable because it takes the least energy to break the tertiary C-H bond homolytically.

25) Cyclobutane= 368-110 = 258kJ/mol
26) The major product is 1-bromo-1-methylcyclopentane