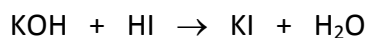


Chem1040 Practice Exam

- 1) Calculate the number of moles of carbon atoms present in a 12.3 g sample of $\text{CH}_4\text{CH}_3\text{OH}$ (molar mass = 48.1 g/mol).
- 2) When 2 moles of KOH are added to 3 moles of HI and the following reaction proceeds, what will be in the final mixture when the reaction comes to completion? (The reaction is practically not reversible.)



- (a) HI and KI
(b) KI and H_2O
(c) HI and H_2O
(d) HI , KI and H_2O
(e) KOH , HI , KI and H_2O
- 3) Freon-12 (CCl_2F_2), which is now a banned refrigerant, is prepared by the reaction,
- $$3\text{CCl}_4 + 2\text{SbF}_3 \rightarrow 3\text{CCl}_2\text{F}_2 + 2\text{SbCl}_3$$
- If 0.486 moles of CCl_4 is allowed to react with 0.376 moles of SbF_3 , which chemical substance will be the limiting reagent?
- (a) CCl_4
(b) CCl_2F_2
(c) SbCl_3
(d) SbF_3
(e) Cannot be determined from the given information.
- 4) Calculate the volume in mL of 0.8 M $\text{HCl}_{(\text{aq})}$ needed to completely react with 10.0 mL of 0.4 M $\text{Ba}(\text{OH})_{2(\text{aq})}$.
- 5) Place the following in the order basicity (strong to weak) of their conjugate base.
- A. HF ($\text{pK}_a = 3.45$)
B. HCOOH ($\text{pK}_a = 3.75$)
C. HClO ($\text{pK}_a = 7.53$)
D. HIO ($\text{pK}_a = 10.64$)
E. CH_3COOH ($\text{pK}_a = 4.75$)
- 6) What is the pH of a 0.12 M aqueous solution of the weak base morphine ($K_b = 1.6 \times 10^{-6}$)?
- (a) 8.20
(b) 3.56
(c) 10.64
(d) 11.10
(e) 11.56

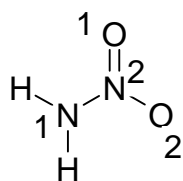
- 7) Calculate the H^+ and OH^- concentration for an aqueous solution with a pH of 10.9.
- 8) Methanoic acid (formic acid) is a weak acid with $K_a = 1.8 \times 10^{-4}$ in water at $25^\circ C$.
- (a) Calculate pK_b for the conjugate base of methanoic acid at $25^\circ C$.
- (b) A buffer solution is to be prepared from methanoic acid and sodium methanoate. What would be the pH of a solution prepared by dissolving 9.0×10^{-3} moles of sodium methanoate in 100 mL of 0.050 M methanoic acid? (Neglect any change in volume.)
- (c) What would be the change in the pH of the above solution following the addition of 0.2 mL (4 drops) of 5.0 M HCl? (Neglect any change in volume)
- 9) Not all inorganic salts dissolve completely in water, the degree of dissolution is given by the equilibrium constant, K_{sp} .
- i) Write an expression for K_{sp} for $Fe(OH)_2(s)$ in terms of chemical activities given the following expression:
- ii) 10g of $Fe(OH)_2(s)$ (M.W. 89.85 g mol^{-1}) is added to 100mL of water. Calculate the concentration of Fe^{2+} and the pH of the solution at equilibria.
- 10) On the diagram given in part (e) you are asked to draw a titration curve for the addition of 0.1M NaOH to 25 mL of freshly prepared 0.1M nitrous acid (HNO_2), whose $pK_a=3.30$ at $25^\circ C$, by evaluating the pH at the following points.
- (a) Point A, evaluate the pH of the original HNO_2 solution, before any NaOH is added.
- (b) Point B, As NaOH is being added to the HNO_2 solution, before the equivalence point is reached, the solution contains some remaining undissociated HNO_2 plus some salt, $NaNO_2$. What is the pH when 12.5 mL NaOH have been added?
- (c) Point C, At the equivalence point the system is "simply" a solution of x M $NaNO_2$. Determine x and then the pH of the solution.

- (d) Point D, after the addition of 50 mL of the NaOH solution, what are the OH^- concentration, and hence the pH?
- (e) Draw the titration curve and identify points A, B, C and D on the curve
- (f) Indicate on the titration curve any region where buffer action is occurring.
- 11) The equilibrium constant for the reaction below is $K_c = 2.5 \times 10^{-4}$ at 25°C . If the initial concentrations were $[\text{N}_2] = [\text{C}_2\text{H}_2] = [\text{HCN}] = 1.00 \text{ mol L}^{-1}$, then what is $[\text{HCN}]$ at equilibrium?
- 12) Which of the following pairs of solution will give a precipitate when mixed?
 $\text{NH}_4\text{Cl}_{(\text{aq})}$ and $\text{Ca}(\text{CH}_3\text{COO})_{2(\text{aq})}$
 $\text{AgNO}_3_{(\text{aq})}$ and $\text{NaCH}_3\text{COO}_{(\text{aq})}$
 $\text{Ba}(\text{OH})_{2(\text{aq})}$ and $(\text{NH}_4)_2\text{SO}_4_{(\text{aq})}$
 $\text{Hg}(\text{NO}_3)_{2(\text{aq})}$ and $\text{KClO}_4_{(\text{aq})}$
 $\text{Na}_2\text{SO}_4_{(\text{aq})}$ and $\text{CuCl}_2_{(\text{aq})}$
- 13) What is the ground state electron configuration of a) the phosphorus atom? b) the Cr^{2+} ion?
- 14) Estimate the F-Xe-F bond angle in XeF_2 . Choose from 90, 109, 120, or 180 degrees.
- 15) What set of hybrid orbitals is used by P atom in PF_3 ?
A) sp B) sp^2 C) sp^3 D) dsp^3 E) d^2sp^3

16) Consider the molecule NH_2NO_2 shown below:

a) Determine the orbital hybridization for N(1), N(2), O(1), O(2) atoms.

b) Predict the magnitude of the angle of:



i) H-N(1)-H

ii) N(1)-N(2)=O(1)

iii) Determine the number of lone pairs of electrons

17) Which of the following characteristics should apply to PF_3 ?

(I) trigonal planar

(II) one lone pair of electrons on P

(III) sp^2 hybridized phosphorous atom

(IV) polar molecule

(V) polar bonds

A. (I), (IV), and (V)

B. (II), (III), and (IV)

C. (I), (II), and (IV)

D. (II), (IV), and (V)

E. (I), (III), and (V)

18) For the following molecules, draw the best Lewis structure, showing all valence electrons.

You only have to show 1 resonant form if there are multiple resonant forms of equal importance. Give the name of the molecular geometry and state the bond angles in the molecule.

a) SF_5^-

b) NCO^-

19) Write the possible Lewis structures for the thiocyanate anion (SCN^-). (Carbon is central).

Determine the formal charge on each atom. From this decide which is the preferred structure.

20) Draw the resonance forms for sulphur trioxide (SO_3), in which the central sulphur atom is bonded to the three oxygens, AND indicate the formal charge on all atoms. (Assume that the octet rule is satisfied for all atoms).

21) Using the terms below, indicate the relationship between the following pairs of molecules.
Use only one term for each pair.

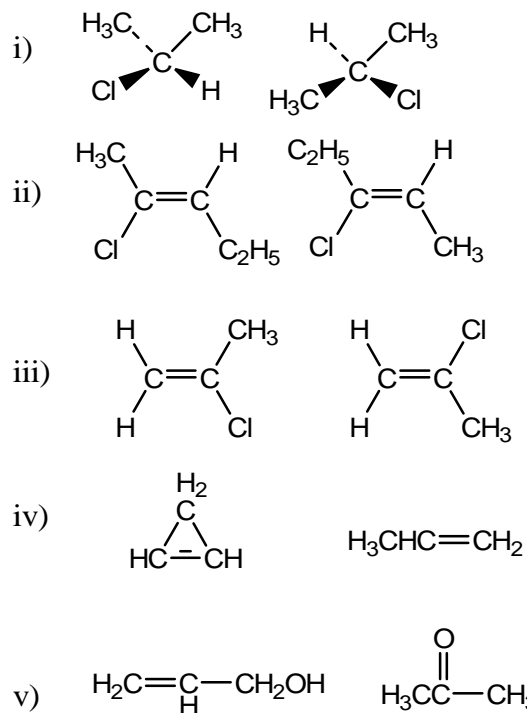
Structural isomers

Geometric (cis/trans) isomers

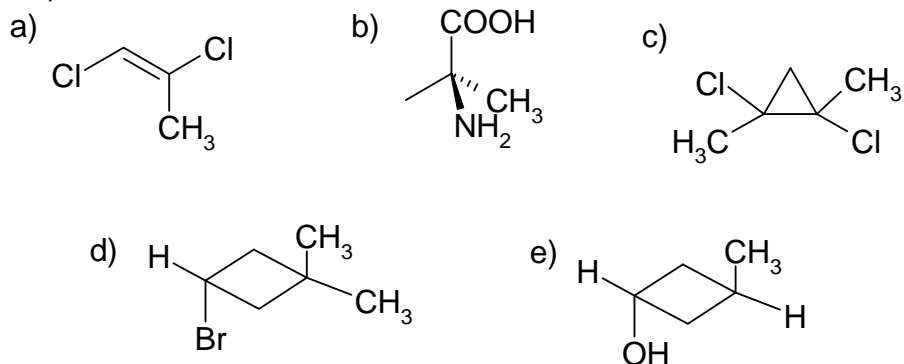
Enantiomers

identical molecules

none of the above



22) Which of the following molecules does not have any stereoisomers (geometric or enantiomers)?



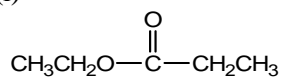
23) Rank the following four-carbon compounds based on the decreasing order of boiling point.

- A. $\text{CH}_3\text{C}(\text{O})\text{CH}_2\text{CH}_3$
- B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(\text{O})\text{NH}_2$
- D. $\text{CH}_3\text{OCH}_2\text{CH}_2\text{CH}_3$
- E. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

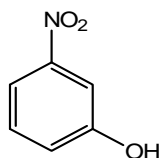
24) Arrange the following compounds according to boiling point (i.e. list them starting with the one with the lowest boiling point and finish with the one with the highest boiling point): propane, 1-pentanol, methane, dimethyl ether, 1-propanol.

25) Name the following compounds by the IUPAC system.

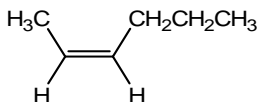
(i)



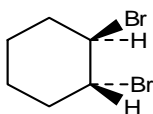
(ii)



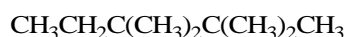
(iii)



(iv)



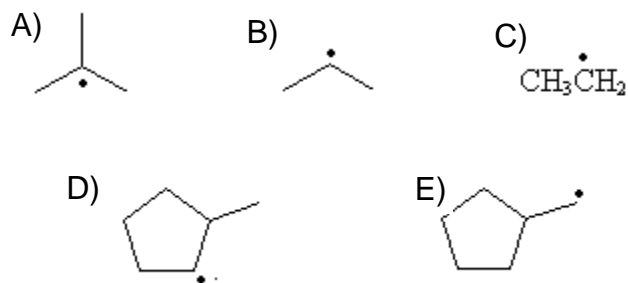
(v)



26) Draw the structural formula of the following compounds.

- (i) 2,2-dimethylcyclohexanone
- (ii) 3-methylcyclopentene
- (iii) potassium benzoate
- (iv) 1-chloro-2-butyne
- (v) 2,6-dimethyl-2,5-heptadiene

27) Which of the following free radical intermediate is the least stable?

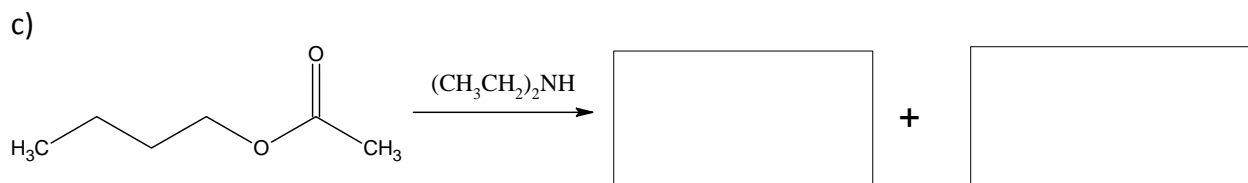
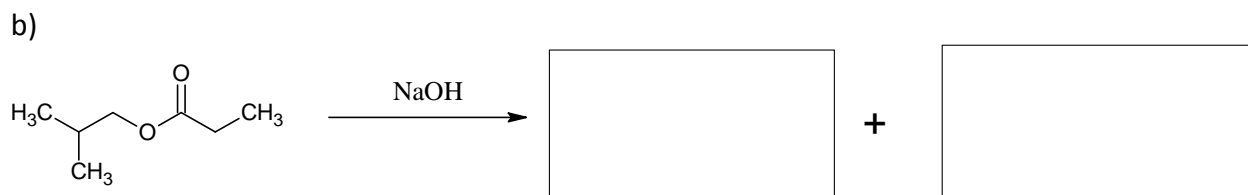
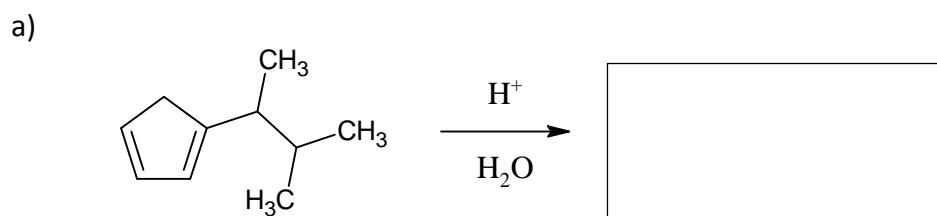


Ans: C

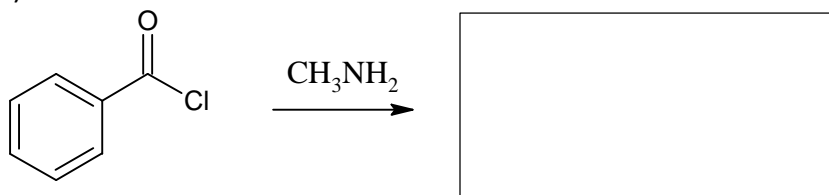
28) Which of the following compounds has the most reactive kind of C-H bond for reaction with Br_2 under ultraviolet light?

- a) butane
- b) pentane
- c) 2,2-dimethylbutane
- d) cyclopentane
- e) 2-methylbutane

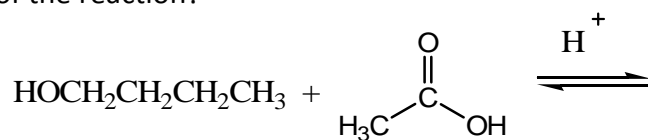
29) Complete the following reactions by providing the appropriate products in the boxes provided:



d)



30) Butanol and ethanic acid react in acidic solution to give a compound that smells fruity. Draw the structures of the products formed from this reaction. Also, what can be done to improve the yield of the reaction?



31) Draw all structures possible for $\text{C}_3\text{H}_5\text{Cl}_3$. Indicate with an asterisk (*) any chiral carbon atoms which are present. Be sure to include all hydrogen atoms.

32) How many products are possible in the reaction of 1,3-dichlorobenzene with $\text{HNO}_3/\text{H}_2\text{SO}_4$? Draw and name each of the products.

33) Fill in the missing reagents and products.

