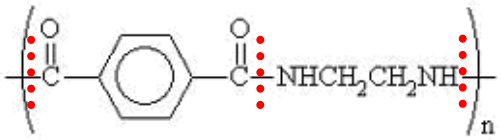
Part A: Multiple Choice Section [2 points each]

For each question, circle the letter of the one correct answer on your examination paper and enter this answer on the Test Scoring Sheet **in pencil only**. The Test Scoring Answer Sheet will be considered final. There is no penalty for incorrect answers. Answers must be transferred to the Test Scoring Answer Sheet **within** the time given for the examination.

1. What are the formulas of the monomers used to produce the nylon polymer below?



- condensation polymer; polyamide
- rxn: (dioate or dioyl acid) + diamine

A) $H_2NCH_2CH_2NH_2$ and (OHC)-C_6H_4-(CHO) (substituents are *para*) – diamine + dial ✗

B) CH_3CH_3 and (H_2NOOC)-C_6H_4-($COONH_2$) (substituents are *para*) – ethane + diamide ✗

C) $HOCH_2CH_2OH$ and (H_2NOOC)-C_6H_4-($COONH_2$) (substituents are *para*) – diol + diamide ✗

D) $H_2NCH_2CH_2NH_2$ and (CH_3OOC)-C_6H_4-($COOCH_3$) (substituents are *para*) – diamine + dioate ✓

2. Polyacrylonitrile, whose trade name is Orlon, resembles wool fibres.

Two repeating units of this polymer are: –CH_2–CH(CN)–CH_2–CH(CN)– – 2C repeating unit

Which of the following is the monomer used to produce this polymer? – addition polymer

– requires alkene: CH_2=CH(CN)

A) $CH_2CH(CN)$

B) $CH_2BrCH_2(CN)$

C) CH(Br)CH(CN)

D) $CH_3CH_2(CN)$

3. The ester $CH_3(CH_2)_2COO(CH_2)_4CH_3$ is responsible for the odour of apricots.

This ester can be prepared from Rxn: (carboxylic acid or acid halide) + alcohol

A) $CH_3(CH_2)_2COOH$ and $CH_3(CH_2)_3CHO$ – carboxylic acid + aldehyde ✗

B) $CH_3(CH_2)_2COOH$ and $CH_3(CH_2)_3CH_2OH$ – carboxylic acid + alcohol (correct # C's) ✓

C) $CH_3(CH_2)_2CHO$ and $CH_3(CH_2)_3COOH$ – aldehyde + carboxylic acid ✗

D) $CH_3(CH_2)_2CH_2OH$ and $CH_3(CH_2)_3COOH$ – alcohol + carboxylic acid (wrong # C's on each) ✗

4. Treatment of ethanol with $Na_2Cr_2O_{7(aq)}/H^+_{(aq)}$ yields compound **A** which reacts further to give **B**.

Identify A and B, respectively. Rxn: $CH_3CH_2OH \xrightarrow{\text{oxidation}}$ aldehyde $\xrightarrow{\text{oxidation}}$ carboxylic acid

A) CH_3OCH_3 and CH_3CH_3 – ether & alkane

B) CH_3CHO and CH_3COOH – aldehyde & carboxylic acid

C) CH_3COCH_3 and CH_3COOH – ketone & carboxylic acid

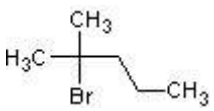
D) CH_3CHO and CH_3OCH_3 – aldehyde & ether

5. What is the **major** product of the following reaction $(CH_3)_2CHCH_2CH_2CH_3 + Br_2/h\nu \rightarrow$?

A) 5-bromo-2-methylpentane 2×1° 3° 2° 2° 1°

B) 1,5-dibromo-2-methylpentane *major product – substitution of 3° H w/ Br*

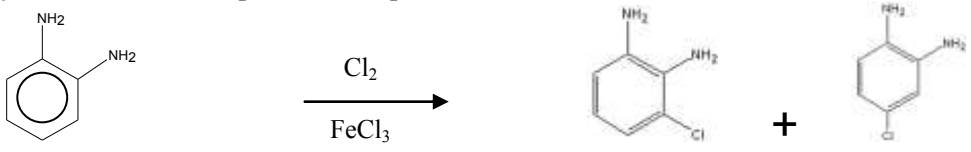
C) 2,3-dibromo-4-methylpentane i.e.,



D) 1-bromo-2-methylpentane

E) 2-bromo-2-methylpentane

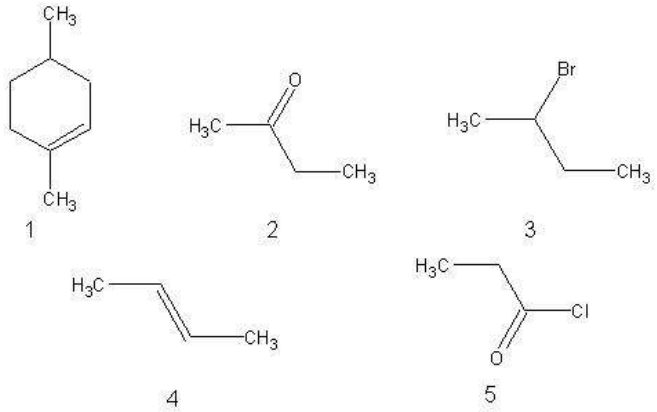
6. How many monochlorination products are predicted for the reaction below?



"3-chloro-" "4-chloro-"

A) 1
B) 3
C) 4
D) 2

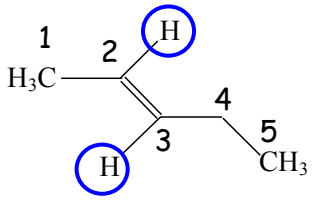
7. Which of the following compounds would be attacked **ONLY by a electrophilic reagent**?



- *electrophilic reagents look for electrons*
- *if ONLY attached by electrophilic reagent, can't have dipole moment*
- *looking for C=C sites*

A) 1, 2, 4 and 5 B) 2, 4 and 5 C) 2 and 5 D) 1 and 4 E) 3

8. Name the following compound.



A) *trans*-2-pentene
B) *trans*-1-methyl-1-butene
C) *trans*-2-hexene
D) *trans*-ethylmethylethene
E) *trans*-1-ethyl-1-propene

Consider the following molecules for questions 9 and 10:

London forces only

A. $CH_3CH_2CH_2CH_2CH_3$

B. $CH_3CH_2\overset{O}{\overset{\|}{C}}OCH_2CH_3$ *London forces & dipole-dipole*

London forces & dipole-dipole

C. $CH_3CH_2\overset{O}{\overset{\|}{C}}CH_2CH_3$

D. $CH_3CH_2CH_2CH_2CH_2OH$ *London forces, dipole-dipole & hydrogen bonding*

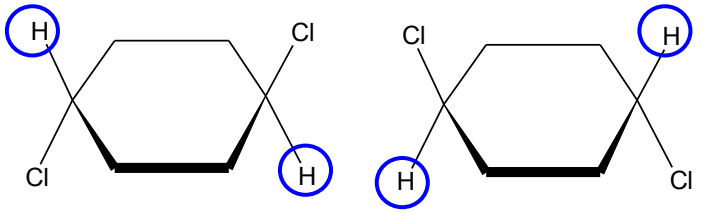
9. Which of the above molecules, **A, B, C or D,** has the highest water solubility?

10. Which of the above molecules **A, B, C or D,** has the lowest melting point?

11. Indicate the relationship between the following pairs of compounds:

Choose from:

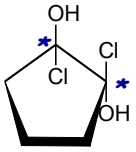
A) not isomers
B) structural isomers
C) geometric isomers
D) enantiomers
E) identical



not geometric b/c both trans; symmetrical & achiral; ∴ identical

12. Indicate what type of stereoisomers (if any) the following molecule has:

A) enantiometers only
B) geometric isomers only
C) both geometric isomers and enantiomers
D) neither geometric isomers nor enantiomers

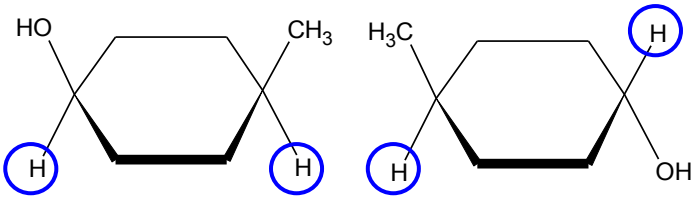


2 chiral centres; different groups to form cis/trans isomers

13. Indicate the relationship between the following pairs of compounds:

Choose from:

A) identical
B) enantiomers
C) geometric isomers
D) not isomers
E) structural isomers

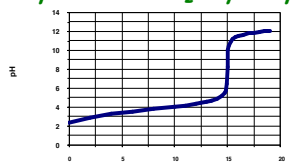


cis and trans geometric isomers

The following graphs are for the titration of 15.0 mL of different acids with 0.100 M $NaOH_{(aq)}$.

A

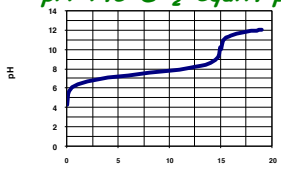
pH=3.75 @ ½ equiv. pt



pH>7 @ equiv. pt

B

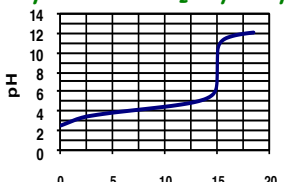
pH=7.5 @ ½ equiv. pt



pH>7 @ equiv. pt

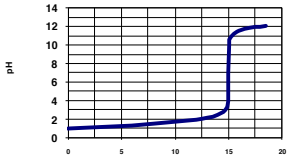
C

pH=4.25 @ ½ equiv. pt



pH>7 @ equiv. pt

D



pH=7 @ equiv. pt, ∴SA + SB

14. Which of the above graphs, **A, B, C or D** is most likely a titration of a strong acid?

15. Which of the above graphs, **A, B, C or D,** is the titration of a weak acid with the largest K_a value?

pH = pK_a @ ½ equiv. pt

16. Based on graph B, identify the acid: *$pK_a = 7.5$; $K_a = 10^{-7.5} = 3.2 \times 10^{-8}$*

A) HCl B) HClO C) CH_3COOH D) HF E) Need more information.

17. Which of the following indicators would be most suitable for the titration of 1.00 M $NH_{3(aq)}$ with 1.00 M $HCl_{(aq)}$?

Rxn: $NH_{3(aq)} + HCl_{(aq)} \rightarrow NH_4Cl_{(aq)}$

acidic salt ∴pH < 7 @ equiv. pt.

$NH_4^+(aq)$ is a weak acid; $K_a = 5.6 \times 10^{-10}$

∴pKin = 5.0 most suitable

A) alizarin (pK_{IN} = 11.7)
B) phenolphthalein (pK_{IN} = 9.4)
C) bromothymol blue (pK_{IN} = 7.1)
D) methyl red (pK_{IN} = 5.0)
E) thymol blue (pK_{IN} = 1.7)

18. For the titration of 25.0 mL of 0.100 M $HClO_{(aq)}$ ($pK_a = 7.5$) with 0.100 M $NaOH_{(aq)}$, the main species in solution after addition of 6.0 mL of base are

A) $ClO^-_{(aq)}$ and $Na^+_{(aq)}$.
B) $HClO_{(aq)}$.
C) $HClO_{(aq)}$, $OH^-_{(aq)}$ and $Na^+_{(aq)}$.
D) $ClO^-_{(aq)}$, $Na^+_{(aq)}$ and $OH^-_{(aq)}$.
E) $HClO_{(aq)}$, $ClO^-_{(aq)}$ and $Na^+_{(aq)}$.

Rxn: $HClO_{(aq)}$ + $NaOH_{(aq)}$ → $NaClO_{(aq)}$ + $H_2O_{(aq)}$
I 0.60 mmol(LR) 0
E 1.9 mmol 0 0.60 mmol
~3: 1 buffer solution!

19. At the equivalence point in the titration of 0.300 M $HCOOH_{(aq)}$ and 0.150 M $KOH_{(aq)}$,

A) $[HCO_2^-] = 0.100$ M.
B) $[HCO_2^-] = 0.150$ M.
C) the pH is less than 7.
D) [HCOOH] = 0.075 M.
E) [HCOOH] = 0.150 M.

Rxn: $HCOOH_{(aq)}$ + $KOH_{(aq)}$ → $HCOOK_{(aq)}$ + $H_2O_{(aq)}$
0.300 M 0.150 M @ equiv. pt. # moles must equal!
1 L
0.300 moles → 0.300 moles ∴need 2L of KOH & V_{total} = 3L
$[HCOO^-]$ = 0.300 moles/3 L = 0.100 M at equiv. pt.

20. If 100 mL of each of the following solutions is mixed, which one produces a buffer?

A) 1.0 M $NH_{3(aq)}$ + 1.0 M $HCl_{(aq)}$ WB + SA w/ equal moles = equiv. pt.
B) 1.0 M $NH_{3(aq)}$ + 0.40 M $HCl_{(aq)}$ WB + SA w/ SA LR = buffer!
C) 1.0 M $NH_{3(aq)}$ + 0.45 M $KOH_{(aq)}$ WB + SB = basic sol'n/ not a bufer
D) 1.0 M $NH_4Cl_{(aq)}$ + 1.0 M $KOH_{(aq)}$ WA + SB w/ equal moles = equiv. pt.
E) 1.0 M $NH_4Cl_{(aq)}$ + 0.35 M $HCl_{(aq)}$ WA + SA = acidic sol'n/ not a bufer

21. Calculate the equilibrium constant for any reaction that occurs when potassium hydroxide is added to a hydrofluoric acid/sodium fluoride, $HF_{(aq)}/NaF_{(aq)}$, buffer.

A) 2.9×10^{3}
B) 3.4×10^{-4}
C) 2.9×10^{14}
D) 2.9×10^{-11}
E) 3.4×10^{10}

Added SB will only react with weak acid in buffer solution.
∴Rxn: $HF_{(aq)}$ + $KOH_{(aq)}$ → $KF_{(aq)}$ + $H_2O_{(aq)}$
Water on product side of equ'n, $\therefore K_{eq} = 1/K$ (reverse expression to definitions)
Water w/ weak base, $\therefore K_{eq} = 1/K_b(F^-) = K_a(HF)/K_w$

22. Which one of the following salts gives a basic aqueous solution?

A) $FeCl_3$ acidic salt b/c of Fe^{3+}
B) CH_3NH_3Cl acidic salt b/c of $CH_3NH_3^+$
C) $NaHCO_3$ basic salt b/c of HCO_3^-
D) NH_4ClO_4 acidic salt b/c of NH_4^+
E) $NaHSO_4$ acidic salt b/c of HSO_4^-

23. The following 0.10M aqueous solutions are arranged in order of increasing pH.

$C_6H_5NH_3I$ < HClO < **unknown** < CH_3NH_2 $K_b = 3.6\times10^{-4}$

Which one of the following 0.10 M aqueous solutions is the unknown?

A) HF $K_a = 3.4\times10^{-4}$ – too strong
B) $(CH_3)_3N$ $K_b = 6.5\times10^{-5}$
C) $(C_2H_5)_3N$ $K_b = 1.0\times10^{-3}$ – too strong
D) CH_3COOH $K_a = 1.8\times10^{-5}$ – too strong
E) C_5H_5NHBr $K_a = K_w/K_b(C_5H_5N) = 5.6\times10^{-6}$ – too strong

HClO – $K_a = 3.2\times10^{-8}$
∴looking for an acid weaker than HClO or a base weaker than CH_3NH_2

24. The pH of 0.10 M CH_3COOH is 2.87. What is the percent ionisation of $CH_3COOH_{(aq)}$?

A) 1.3%
B) 10%
C) 0.13%
D) 5.0%
E) 13%

$CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$

0.10 M $10^{-pH} = 1.3\times10^{-3}$

% ionisation = $([H_3O^+]/[CH_3COOH])*100\%$

$= (1.3\times10^{-3}/0.10)*100 = 1.3\%$

25. Which pairs of ions can exist in large concentrations simultaneously in aqueous solution?

A) Ag^+ and Cl^- → $AgCl_{(s)}$
B) Ca^{2+} and CO_3^{2-} → $CaCO_{3(s)}$
C) H_3O^+ and I^- → no rxn b/c I^- is unreactive.
D) Ba^{2+} and SO_4^{2-} → $BaSO_{4(s)}$
E) H_3O^+ and CN^- → $HCN_{(aq)} + H_2O_{(l)}$

26. Phosgene was used as a poisonous gas in World War I. At high temperatures it decomposes as follows:

$COCl_{2(g)} \rightleftharpoons CO_{(g)} + Cl_{2(g)}$; $K_c = 4.6\times10^{-3}$ at 800K.

If 1.5 millimoles of $COCl_2$, CO & Cl_2 are mixed in a 1 L container at 800K, which of the following statements is true?

A) $[COCl_2] = [CO] = [Cl_2]$ at equilibrium.
B) The system is at equilibrium and therefore no net change occurs.
C) $COCl_{2(g)}$ will be formed until equilibrium is reached.
D) $CO_{(g)}$ and $Cl_{2(g)}$ will be formed until equilibrium is reached.

$Q = ([CO][Cl_2])/[COCl_2]$

$Q = (1.5\times10^{-3})(1.5\times10^{-3})/(1.5\times10^{-3})$

$Q = 1.5\times10^{-3} < K$

∴ too few products & rxn moves L→R

27. A 50.0-mL sample of sulphuric acid from a lake near a mine was titrated to the stoichiometric point with 4.204×10^{-4} moles sodium hydroxide. What is the molarity of sulphuric acid in the sample?

A) 0.00420 M
B) 0.000210 M
C) 0.0105 M
D) 0.00841 M
E) 0.0168 M

$H_2SO_{4(aq)} + 2NaOH_{(aq)} \rightleftharpoons Na_2SO_{4(aq)} + 2H_2O_{(l)}$

4.204×10^{-4} mol × 1 mol H_2SO_4/2 mol NaOH = 2.102×10^{-4} mol

$[H_2SO_4] = 2.102\times10^{-4}$ mol/0.0500 L = 0.00420 M

28. The production of iron from its ores involves several chemical processes that take place in several stages and in different temperature zones within a blast furnace. Here are the key reactions:

$3Fe_2O_{3(s)} + CO_{(g)} \rightarrow 2Fe_3O_{4(s)} + CO_{2(g)}$

$Fe_3O_{4(s)} + CO_{(g)} \rightarrow 3FeO_{(s)} + CO_{2(g)}$

$FeO_{(s)} + CO_{(g)} \rightarrow Fe_{(l)} + CO_{2(g)}$

If 6.0 megamoles of $Fe_{(l)}$ are to be produced, how many megamoles of $Fe_2O_{3(s)}$ are required?

A) 6.0
B) 2.0
C) 12
D) 1.0
E) 3.0

6.0 Mmol × (1 mol FeO/1 mol Fe) = 6.0 Mmol FeO

6.0 Mmol × (1 mol Fe_3O_4/3 mol FeO) = 2.0 Mmol Fe_3O_4

2.0 Mmol × (3 mol Fe_2O_3/2 mol Fe_3O_4) = 3.0 Mmol Fe_2O_3

29. Penicillin G contains 9.59% sulphur. If there is one sulphur atom per penicillin molecule, what is the molar mass of penicillin G?

A) 2990 g mol^{-1}
B) 102 g mol^{-1}
C) 307 g mol^{-1}
D) 334 g mol^{-1}
E) 3070 g mol^{-1}

(9.59/100) = (S/penicillin G) = (32.06 g·mol^{-1} / x)
x = 334 g·mol^{-1}

30. The Recommended Daily Allowance (RDA) for vitamin C ($C_6H_8O_6$) is 90 mg or 5.1×10^{-4} moles. How many oxygen atoms are in the RDA for vitamin C?

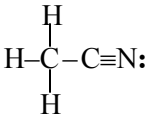
A) 1.4×10^{-28} atoms
B) 1.8×10^{21} atoms
C) 5.1×10^{19} atoms
D) 5.1×10^{-27} atoms
E) 3.1×10^{20} atoms

5.1×10^{-4} mol vit. C × (6 mol oxygen atoms/1 mol vit C) = 3.1×10^{-3} moles O atoms
3.1×10^{-3} moles O atoms × (6.022×10^{23} atoms/ 1 mol) = 1.8×10^{21} oxygen atoms

31. How many sigma and how many pi bonds are present in acetonitrile, CH_3CN?

A) 4 sigma and 3 pi
B) 5 sigma and 1 pi
C) 7 sigma and 0 pi
D) 5 sigma and 2 pi
E) 3 sigma and 3 pi

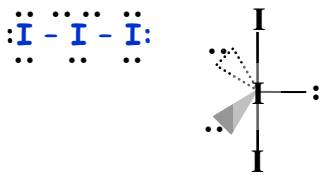
1 sigma bond – for every bond
1 pi bond in a double bond
2 pi bonds in a triple bond



32. What type of hybrid orbitals are used by the central iodine atom in I_3^-?

A) sp^3d^2
B) sp^2
C) sp^3d
D) sp^3
E) sp

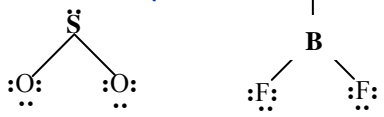
V = (7*3)+1 = 22 electrons
AB_2E_3; steric# = 5
hybrid: sp^3d



33. In the case of SO_2 and BF_3, are they polar molecules?

A) Both are polar molecules.
B) Only SO_2 is a polar molecule.
C) Only BF_3 is a polar molecule.
D) Neither are polar molecules.

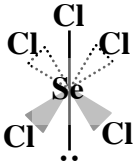
SO_2: V=(3×6) = 18 e^-s; AB_2E = bent & polar (has resonance)
BF_3: V=3+(3×7)=24 e^-s; AB_3 = trigonal planar & non-polar



34. What is the shape of $SeCl_5^-$?

A) seesaw
B) square planar
C) tetrahedral
D) trigonal bipyramidal
E) square pyramidal

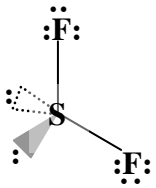
V = 6 + (5*7) + 1 = 42 e^-s
AB_5E; steric# = 6



35. The F–S–F bond angle in SF_2 is

A) < 109.5°
B) 109.5°
C) < 120° but >109°
D) 120°
E) 180°

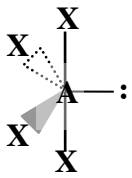
V = 6 + (2*7) = 20 e⁻'s
AB_2E_2; steric# = 4
framework = tetrahedral (109.5°)
shape = bent (∴ <109.5°)



36. What is the shape of a molecule that has the formula AX_4 **plus** one pair of non-bonding electrons on the central atom?

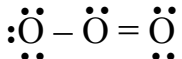
A) tetrahedral
B) square pyramidal
C) square planar
D) seesaw
E) trigonal bipyramidal

AX_4E; steric# = 5
framework = trigonal bipyramidal
shape = seesaw



37. For the Lewis structure below, the formal charges on the atoms moving **from left to right** are

A) +1, –1, 0
B) 0, +1, –1
C) –1, +1, 0
D) –1, 0, +1
E) +1, 0, –1



6 6 6 # valence electrons for each atom
-7 -5 -6 # electrons drawn around each atom
-1 +1 0 formal charges on each atom

38. How many unpaired electrons are there in an ion of iron(III), Fe^{3+}?

A) 1 B) 3 C) 5 D) 2 E) 4

Fe (Z=26): [Ar]$3d^6 4s^2$
Fe^{3+}: [Ar]$3d^5$

39. What is the ground-state electron configuration of chromium (Cr)?

A) [Ar]$3d^4 4s^2$
B) [Ar]$3d^5 4s^1$
C) [Ar]$4d^4 4s^2$
D) [Ar]$4d^5 4s^1$
E) [Ar]$3d^6$

Cr (Z=24): [Ar]$3d^4 4s^2$ → [Ar]$3d^5 4s^1$

40. Which one of the following has the **highest** first ionisation energy?

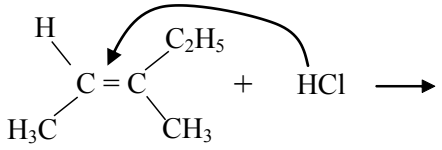
A) oxygen
B) nitrogen
C) carbon
D) boron
E) beryllium

General Trend: IE increases across a row, i.e., Be < B < C < N < O
Changes due to electron configurations: B < Be < C < O < N
i.e., $2p^1 < 2s^2 < 2p^2 < 2p^4 < 2p^3$
i.e., it takes more energy to remove an e^- from a filled or half-filled shell

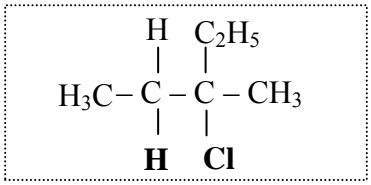
Part B [20 points]

- 1 for each mistake within structures, i.e., too many H's; 5 bonds on C, etc..

(a) For the reactions below by entering the missing species in each box. (**2 marks per box**)



addition reaction



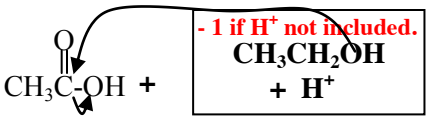
- 1 if Cl and H are on the wrong C's.

Reaction follows Markovnikov's rule – H's go with friends; Cl on higher ordered carbon (3° C).

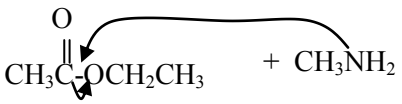
major product

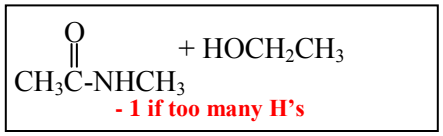
8 /8

substitution reaction (alkyl halide + nucleophile = amine)



- 1 if H^+ not included.





- 1 if too many H's

substitution rxn (carboxylic acid + alcohol/H^+ = ester) **substitution rxn (ester + amine = amide)**

(b) A side reaction in the manufacturing of rayon from wood pulp is

$$3CS_{2(l)} + 6NaOH_{(aq)} \rightarrow 2Na_2CS_{3(s)} + Na_2CO_{3(aq)} + 3H_2O_{(l)}.$$

If 117 g of CS_2 (MM = 76.0 g/mol) and 7.00 L of a 0.400M NaOH are reacted, determine how many moles of Na_2CS_3 are produced. **Show your work!**

CS_2: 117 g × 1 mol/76.0 g = 1.54 moles **(1 pt)**

1.54 moles CS_2 × 2 mol Na_2CS_3/3 mol CS_2
= 1.03 moles Na_2CS_3 **(1 pt)**

NaOH: 7.00 L × 0.400 M = 2.80 moles **(1 pt)**

2.80 moles NaOH × 2 mol Na_2CS_3/6 mol NaOH
= 0.933 moles Na_2CS_3 **(1 pt)**

Final Answer: 0.933 moles Na_2CS_3 are produced **(1 pt for correct LR)**

5 /5

(c) A buffer is prepared by adding 0.0550 moles of HBr to 200.0 mL of 0.675 M dimethylamine, $(CH_3)_2NH(aq)$. Write the **net ionic equation** for the reaction. Show your work as you **calculate the pH** of this buffer, assuming no volume change.

Net Ionic Equation: **$(CH_3)_2NH(aq) + H_3O^+(aq) \rightarrow (CH_3)_2NH_2^+(aq) + H_2O(l)$** **(2 pts;**

(OR $CH_3NH_2(aq) + H^+(aq) \rightarrow CH_3NH_3^+(aq)$) –1 for each mistake)

	CH_3NH_2	H^+	$CH_3NH_3^+$	
I	0.135	0.0550	0	moles of CH_3NH_2 = 0.200 L × 0.675 M
C	–0.0550	– 0.0550	+ 0.0550	= 0.135 moles
E	0.080 **(1 pt)**	0	0.0550 **(1 pt)**	

OR

0.400 M 0.275 M

$K_b((CH_3)_2NH) = 5.4\times10^{-4}$; $pK_b((CH_3)_2NH) = 3.27$

$K_a(CH_3NH_3^+) = 1.0\times10^{-14}/5.4\times10^{-4} = 1.85\times10^{-11}$ **pK_a** = –log (K_a) = **10.73 (1 pt)**

$pH = pK_a + \log (CH_3NH_2)/(CH_3NH_3^+) = 10.73 + \log (0.080\ mol)/(0.0550\ mol)$

OR $= 10.73 + \log (0.400M)/(0.275M)$ **(1 pt for correct sub)**

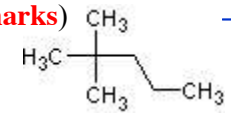
$pH = 10.73 + 0.163 = 10.89$

Final Answer: pH = 10.89 (± 0.02 = 10.87 – 10.91) (1 pt)

7 /7

Bonus 2/2

BONUS QUESTION: How many monochlorination products are possible if 2,2-dimethylpentane reacts with Cl_2/hv? Write the number in the box. (**2 marks**)



→ 1-chloro-2,2-dimethylpentane
3-chloro-2,2-dimethylpentane
4-chloro-2,2-dimethylpentane
5-chloro-2,2-dimethylpentane

4

PAGE TOTAL 22/20

Intials:

DATA PAGE AND ROUGH WORK

Avogadro's Number = 6.022×10^{23} mol^{-1}

Gas constant, R = 8.314 J mol^{-1} K^{-1}

= 8.314 L kPa mol^{-1} K^{-1}

= 0.0821 L atm mol^{-1} K^{-1}

1 atm = 101.3 kPa = 760 Torr

$h = 6.626 \times 10^{-34}$ J s

$c = 2.998 \times 10^{8}$ m/s

$K_w = 1.0 \times 10^{-14}$ at 25ºC

273.15 K = 0°C

1 megamole = 1×10^{6} moles

Acidity and Basicity Constants at 25ºC

Acid	K_a	Base	K_b
HSO_4^-	1.2×10^{-2}	$(C_2H_5)_3N$	1.0×10^{-3}
HCOOH	1.8×10^{-4}	CH_3NH_2	3.6×10^{-4}
HF	3.4×10^{-4}	$(CH_3)_2NH$	5.4×10^{-4}
CH_3COOH	1.8×10^{-5}	$(CH_3)_3N$	6.5×10^{-5}
HClO	3.2×10^{-8}	NH_3	1.8×10^{-5}
HBrO	2.0×10^{-9}	C_5H_5N (pyridine)	1.8×10^{-9}
HCN	4.9×10^{-10}	$C_6H_5NH_2$ (aniline)	4.3×10^{-10}

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds								

Molar Masses

H	1.01	O	16.00	Al	26.98	Cl	35.45
C	12.01	F	19.00	Ar	39.95	Cu	63.54
N	14.01	Na	22.99	S	32.06	Ba	137.33

Solubility Rules for some ionic compounds in water

1.	All alkali metal and ammonium salts are SOLUBLE.
2.	All nitrate, acetate, chlorate & perchlorate salts are SOLUBLE.
3.	Most chloride, bromide & iodide salts are SOLUBLE -- EXCEPT for silver, lead or mercury (I) halides.
4.	Most sulphate salts are SOLUBLE -- EXCEPT for silver, lead, mercury (I), calcium, strontium or barium sulphates.
5.	Carbonate, phosphate & oxalate salts are NOT SOLUBLE -- EXCEPT for alkali metal or ammonium salts.
6.	Hydroxides, oxides & sulfides are NOT SOLUBLE -- EXCEPT for alkali metal, ammonium, calcium, strontium or barium salts.
7.	Chromate salts are NOT SOLUBLE -- EXCEPT for alkali metal, ammonium, calcium or magnesium chromates.

Circle how well you feel you did overall (out of 100) on this exam.	80 – 100	70 – 79	60 – 69	50 – 59	0 – 49
	A	B	C	D	F