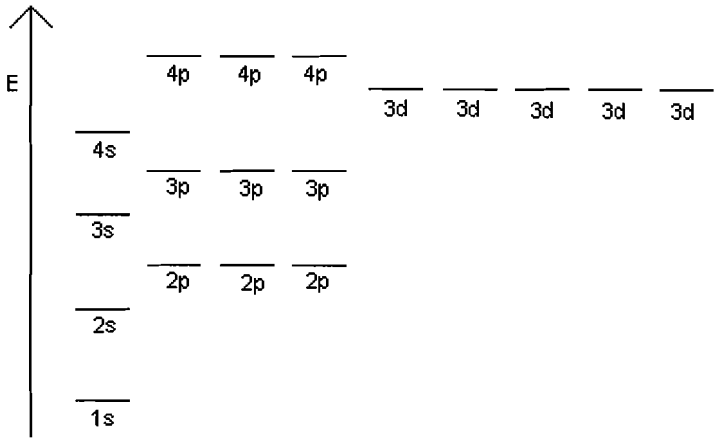
Chemistry 122	Winter 2008	Oregon State University
Final Exam	March 17, 2008	Dr. Richard Nafshun

Instructions: You should have with you several number two pencils, an eraser, your 3" x 5" note card, a calculator, and your University ID Card. If you have notes with you, place them in a sealed backpack and place the backpack OUT OF SIGHT or place the notes directly on the table at the front of the room.

Fill in the front page of the Scantron answer sheet with your last name, first name, middle initial, and student identification number. **Leave the class section number and the test form number blank.**

This exam consists of 37 multiple-choice questions. Each question has four points associated with it (Question 37 has six). Select the best multiple-choice answer by filling in the corresponding circle on the rear page of the answer sheet. If you have any questions before the exam, please ask. If you have any questions during the exam, please ask the proctor. Open and start this exam when instructed. When finished, place your Scantron form in the appropriate stack and present your University ID Card to the proctor. You may keep the exam packet, so please show your work and mark the answers you selected on it.

$R = 0.0821$ L•atm/mol•K	760 mm Hg = 760 torr = 1 atm	m = mol/kg
M = mol/L	$\Delta T_f = imk_f$	$\Delta T_b = imk_b$
$\Pi V = nRT$	$k_f (H_2O) = 1.86$ °C/m	$k_b(H_2O) = 0.512$ °C/m
$\ln[\frac{A}{A_o}] = -kt$	$k = Ae^{\frac{-Ea}{RT}}$	$K_a (CH_3COOH) = 1.8 \times 10^{-5}$
SC: $2r = s$	BCC: $4r = s\sqrt{3}$	FCC: $4r = s\sqrt{2}$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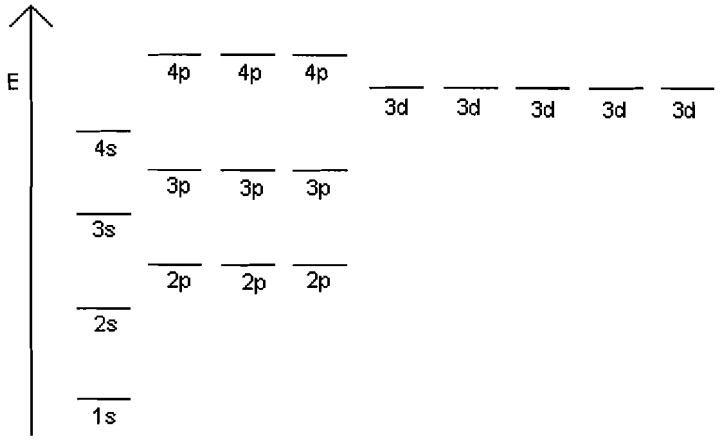
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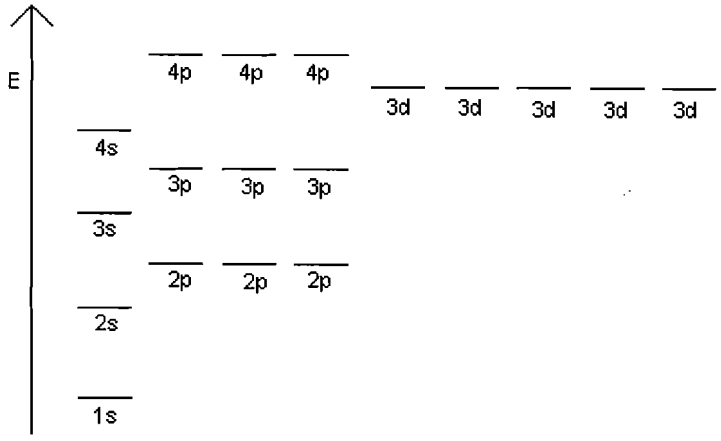
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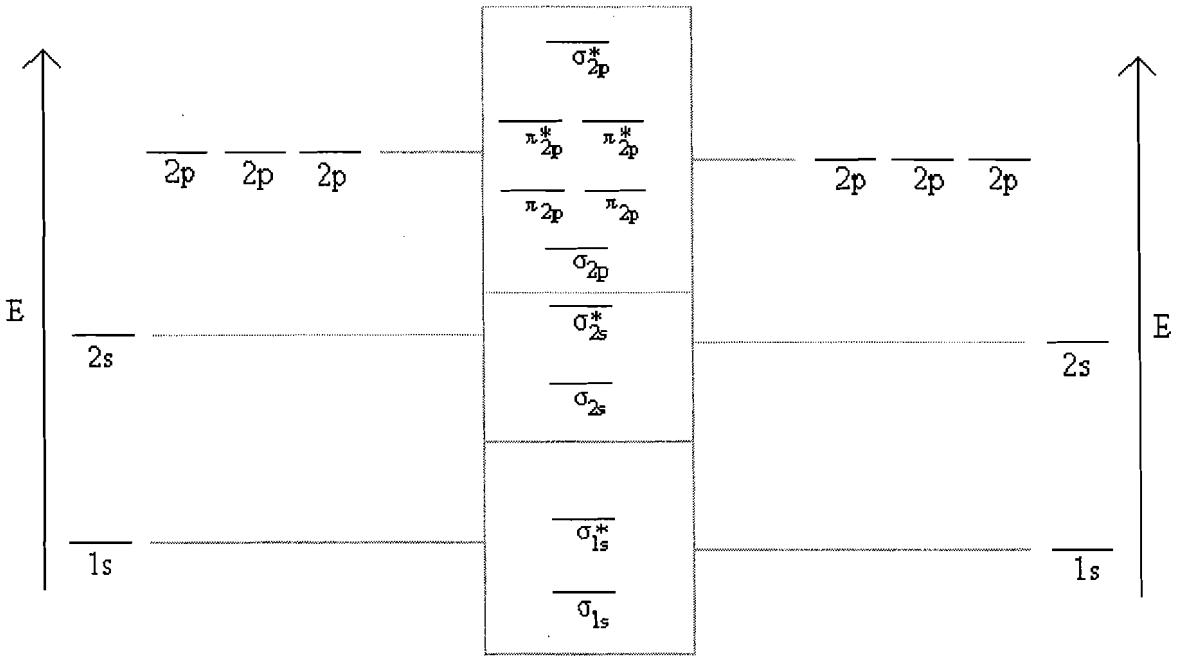
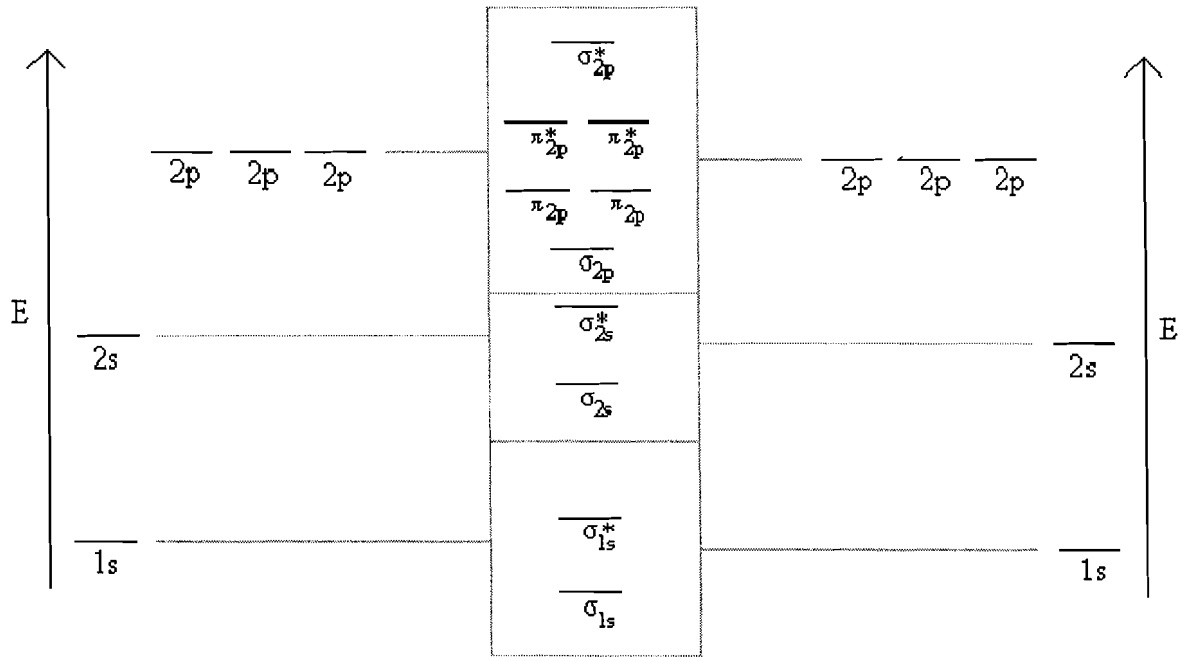


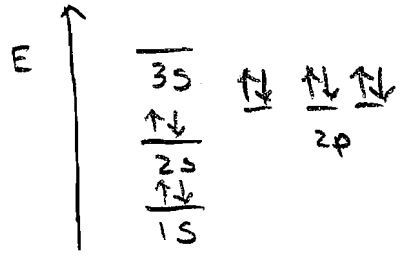


Please read each exam question carefully. Terms such as *correct, false, unpaired, pairs, H-C-F bond angle, H-C-H angle, greatest, and smallest are* used.

Unit 1 Material (First assessed on Exam 1)

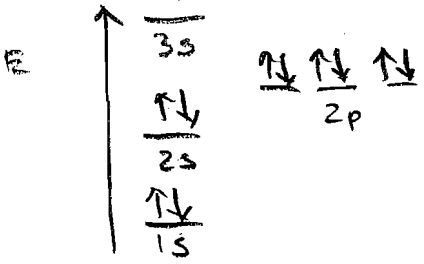
1. There are ___ **unpaired** electrons in a ground-state oxide (O^{2-}) ion.

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4



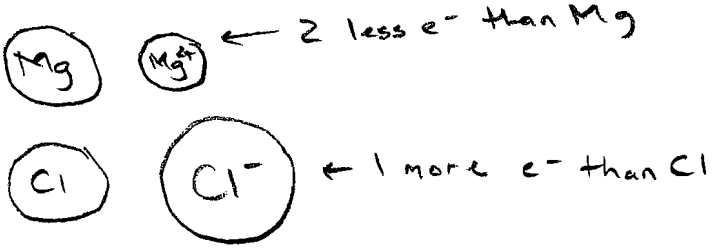
2. The ground-state electron configuration of a magnesium ion (Mg^{2+}) is:

(A) $1s^2 2s^2 3s^2 3p^2$
(B) $1s^2 2s^2 3s^1$
(C) $1s^2 2s^2 2p^4$
(D) ~~$1s^2 2s^2 2p^6 3s^2 3p^2$~~
(E) $1s^2 2s^2 2p^6$



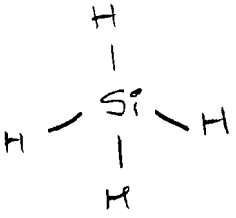
3. Consider Mg^{2+}, Mg, Cl^-, and Cl. Which of the following statements is correct?

(A) Cl^- is smaller than Cl
(B) Mg^{2+} is smaller than Mg



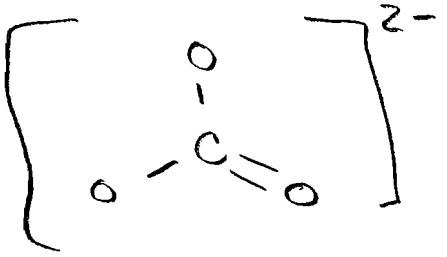
4. The Lewis Dot Structure of SiH_4 depicts:

(A) There are no lone **pairs** of electrons
(B) There is one lone **pair** of electrons
(C) There are two lone **pairs** of electrons
(D) There are four lone **pairs** of electrons
(E) There are six lone **pairs** of electrons



5. The carbon-oxygen bond order in the carbonate ion (CO_3^{2-}) is:

(A) 1.00
(B) 1.33
(C) 1.50
(D) 1.75
(E) 2.00



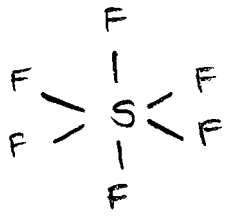
$$\text{Bond Order} = \frac{\#\text{ bonds}}{\#\text{ locations}} = \frac{4}{3} = 1.33$$

6. The H-O-H bond angle in H_2O is:

(A) 90°
(B) 120°
(C) 109.5°
(D) A little greater than 109.5°
(E) A little less than 109.5°

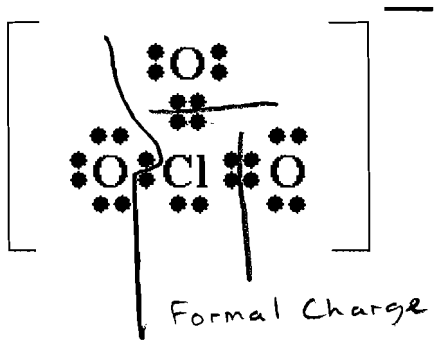
7. The fluorine-sulfur-fluorine bond angle in SF_6 is:

(A) 45°
(B) 60°
(C) 90°
(D) 120°
(E) 109.5°



Octahedral

8. A student ( ) proposes the Lewis Dot Structure below for the chlorate ion. Determine the formal charge on chlorine in this structure.



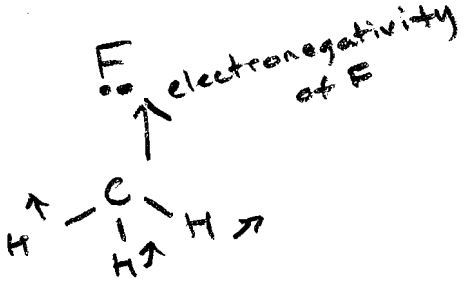
Formal Charge = group # - assigned e⁻

= 7 - 7 = 0

(A) The chlorine has a formal charge of -2
(B) The chlorine has a formal charge of -1
(C) The chlorine has a formal charge of 0
(D) The chlorine has a formal charge of +1
(E) The chlorine has a formal charge of +2

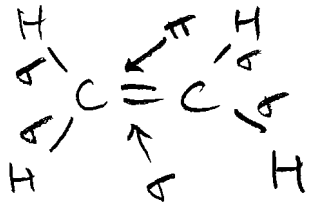
9. The H-C-H bond angle in monofluoromethane (CH_3F) is a little greater than 109.5°. This deviation from the ideal bond angle of 109.5° can be attributed to:

(A) Lone pairs of electrons on carbon
(B) The electronegativity of fluorine
(C) Hydrogen bonding
(D) Excessive amounts of Starbucks Coffee
(E) Sophie Monk



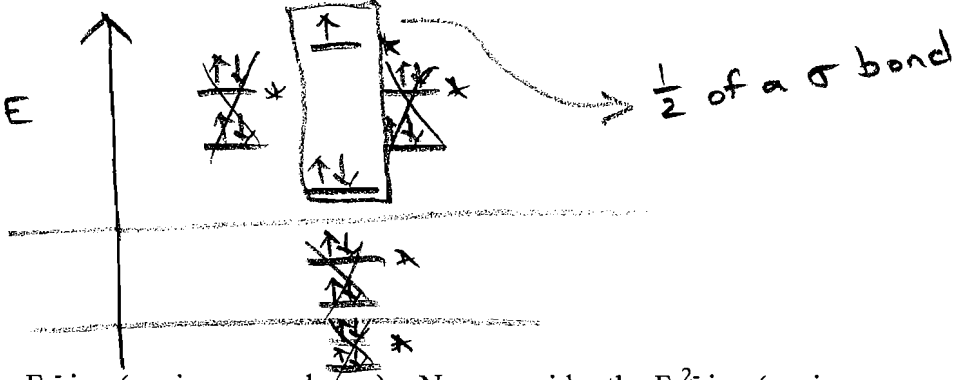
10. Consider ethene, C_2H_4. Draw the structure of ethene. Ethene contains:

(A) no π-bonds
(B) one π-bond
(C) two π-bonds
(D) three π-bonds



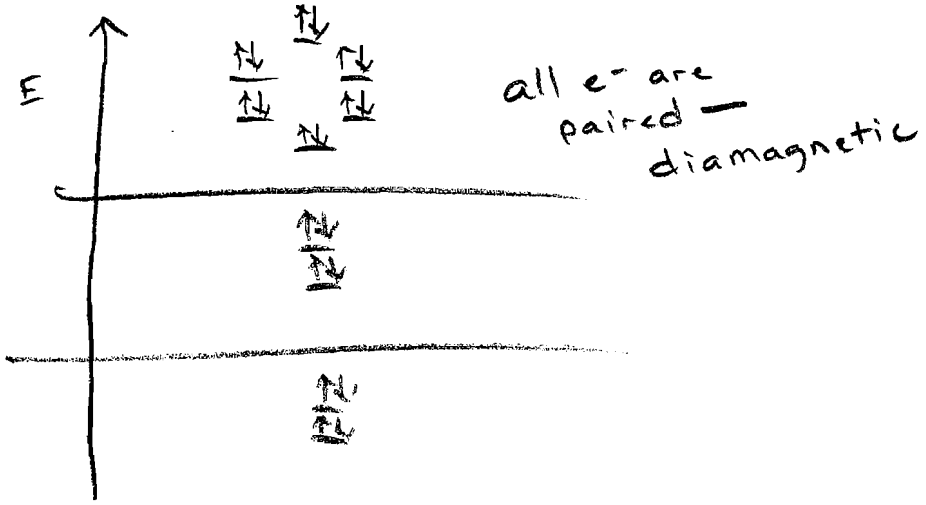
11. Molecular orbital theory predicts the F_2^- ion (a minus **one** charge) has a bond order of:

(A) 0.0
(B) 0.5
(C) 1.0
(D) 1.5
(E) 2.0

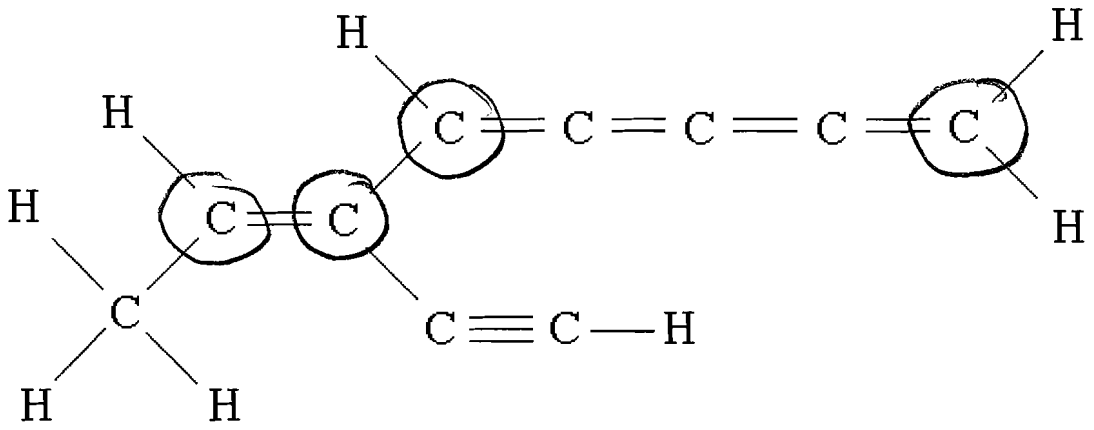


12. Question 11 considered the F_2^- ion (a minus **one** charge). Now consider the F_2^{2-} ion (a minus **two** charge). The F_2^{2-} ion is:

(A) paramagnetic
(B) diamagnetic
(C) megamagnetic
(D) duotronicmagnetic
(E) mos-def-magnetic



13. Consider the molecule below and identify the **correct** statement.



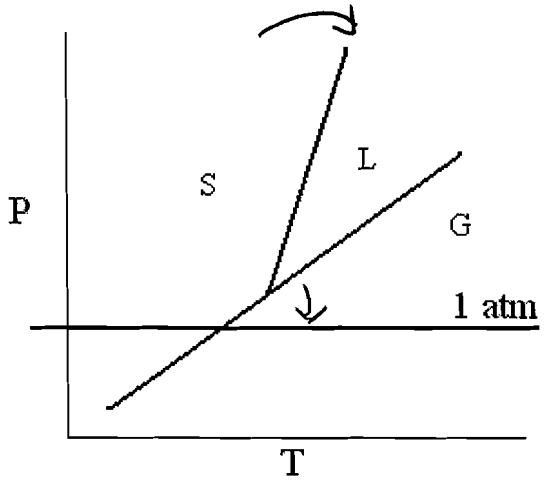
(A) There are 2 carbons that have sp^2 hybridization schemes
(B) There are 3 carbons that have sp^2 hybridization schemes
(C) There are 4 carbons that have sp^2 hybridization schemes
(D) There are 5 carbons that have sp^2 hybridization schemes
(E) There are 6 carbons that have sp^2 hybridization schemes

sp^2 $>C=$

Unit 2 Material (First assessed on Exam 2)

14. The phase diagram below is for:

(A) H_2O
(B) CO_2



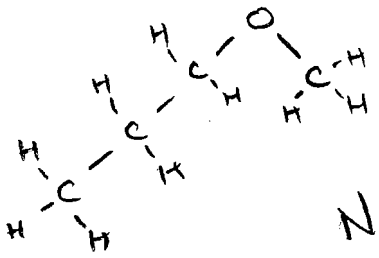
Na^+ Cl^- Na^+ I^-

15. Sodium chloride melts at 804 °C. Sodium iodide melts at 651 °C. The difference in melting points can be attributed to:

(A) Different intermolecular forces (dispersion, dipole-dipole, hydrogen bonding).
(B) Different ionic charges (+ and -).
(C) Different distances between nuclei (r).
(D) Network covalent compounds.

16. Consider H_2O, NH_3, $CH_3CH_2CH_2CH_2OH$, and $CH_3CH_2CH_2OCH_3$. Which of these **does not** exhibit hydrogen bonding?

(A) H_2O
(B) NH_3
(C) $CH_3CH_2CH_2CH_2OH$
(D) $CH_3CH_2CH_2OCH_3$
(E) HF



No H-O
H-S
H-N
H-F bond

17. Consider CH_3CH_2OH, CaO, CH_3CH_3, CaS, CH_3OCH_3, Ar. Arranged in increasing melting point, these are:

	Lowest melting point					Highest melting point
(A)	CH_3CH_2OH	< Ar <	CH_3CH_3	< CH_3OCH_3 <	CaO	< CaS
(B)	Ar	< CH_3CH_3 <	CH_3OCH_3	< CH_3CH_2OH <	CaS	< CaO
(C)	Ar	< CH_3OCH_3 <	CH_3CH_3	< CH_3CH_2OH <	CaO	< CaS
(D)	Ar	< CH_3CH_3 <	CH_3OCH_3	< CH_3CH_2OH <	CaO	< CaS
(E)	Ar	< CH_3CH_3 <	CH_3CH_2OH	< CH_3OCH_3 <	CaO	< CaS

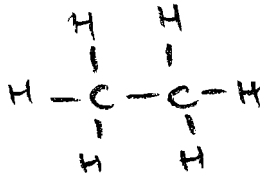
Inert Gases	Non-Polar Molecules	Polar Molecules	Molecules w/ H-Bonding	Ionic Solids	Network Covalent Compounds
Ar	CH_3CH_3	CH_3OCH_3	CH_3CH_2OH	Ca^{2+} S^{2-} Ca^{2+} O^{2-}	—

18. Which of the following is **false**?

(A) Carbon dioxide is a non-polar molecule which exhibits dispersion forces. ✓
(B) Cesium oxide is a non-polar molecule which exhibits dipole-dipole forces. Ionic Cs_2O
(C) Water is a polar molecule which exhibits hydrogen bonding.
(D) Diamond is a network covalent compound.
(E) Network covalent compounds typically melt at higher temperatures than molecules.

19. Which of the following compounds **cannot** undergo free radical polymerization?

(A) C_2H_4
(B) C_2H_6 No π bond
(C) C_2F_4
(D) C_2Cl_4
(E) C_2F_2



20. The cubic form for the fictitious element SpringBreakium (Sp) is BCC. The atomic radius is 177.0 pm and the molar mass is 291.5 g/mol. The density of Sp is:
[1 m = 1 x 10^{12} pm 1 m = 100 cm]

(A) 7.06 g/cm^3
(B) 3.55 g/cm^3
(C) 5.68 g/cm^3
(D) 14.2 g/cm^3
(E) 16.8 g/cm^3

$$d = \frac{m}{V} = \frac{9.68\times10^{-22}\ g}{6.83\times10^{-23}\ cm^3} = 14.2\ g/cm^3$$

① Mass

$$291.5\ \frac{g}{mol}\left(\frac{1\ mol}{6.022\times10^{23}\ atoms}\right)\left(\frac{2\ atoms}{1\ BCC\ unit\ cell}\right) = 9.68\times10^{-22}\ \frac{g}{BCC}$$

② Volume

$$r = 177.0\ pm\left(\frac{1\ m}{1\times10^{12}\ pm}\right)\left(\frac{100\ cm}{1\ m}\right) = 1.77\times10^{-8}\ cm$$

$$4r = s\sqrt{3} \qquad s = \frac{4r}{\sqrt{3}} = \frac{(4)(1.77\times10^{-8}\ cm)}{\sqrt{3}} = 4.09\times10^{-8}\ cm$$

$$V = s^3 = (4.09\times10^{-8}\ cm)^3 = 6.83\times10^{-23}\ cm^3$$

21. A student dissolves 12.000 g of an unknown polymer in 800 mL of water at 320 K. She measures the osmotic pressure to be 0.0677 mm Hg. What is the molar mass of the polymer?

(A) 2.71×10^6 g/mol
(B) 4.43×10^6 g/mol
(C) 1.73×10^5 g/mol
(D) 1.73×10^6 g/mol
(E) 2.26×10^6 g/mol

$\Pi V = nRT$

$$n = \frac{\Pi V}{RT} = \frac{\left[\frac{0.0677 \text{ mm Hg}}{760 \text{ mm Hg}}{1 \text{ atm}}\right](0.800 \text{ L})}{\left(0.08216 \frac{\text{L·atm}}{\text{mol·K}}\right)(320 \text{ K})}$$

$$n = 2.71 \times 10^{-6} \text{ mol}$$

$$\text{Molar Mass} = \frac{g}{\text{mol}} = \frac{12.000 \text{ g}}{2.71 \times 10^{-6} \text{ mol}} = 4.43 \times 10^6 \frac{g}{\text{mol}}$$

22. A student () obtains a 120 gram sample of ^{198}Au ($t_{1/2}$ = 2.70 days). How long will it take so that only 50.0 grams of ^{198}Au remain?

(A) 3.60 days
(B) 3.19 days
(C) 6.48 days
(D) 2.40 days
(E) 3.41 days

① Calc k

$$\ln\left[\frac{1}{2}\right] = -k t_{1/2} : -0.6931 = -(k)(2.70 \text{ d})$$

$$k = 0.2567 \frac{1}{\text{d}}$$

② Calc t

$$\ln\left[\frac{A}{A_0}\right] = -kt : \ln\left[\frac{50.0 \text{ g}}{120 \text{ g}}\right] = -\left(0.2567 \frac{1}{\text{d}}\right)(t)$$

$$t = 3.41 \text{ d}$$

23. The following are initial rate data for: **A + B → C + D**

Experiment	Initial [A]	Initial [B]	Initial Rate
1	0.10	0.10	0.00214
2	0.20	0.10	0.00856
3	0.10	0.20	0.00214

(A) The rate law is Rate = $k[A]^1[B]^2$
(B) The rate law is Rate = $k[A]^2[B]^1$
(C) The rate law is Rate = $k[A]^2[B]^0$
(D) The rate law is Rate = $k[A]^0[B]^1$
(E) The rate law is Rate = $k[A]^1[B]^0$

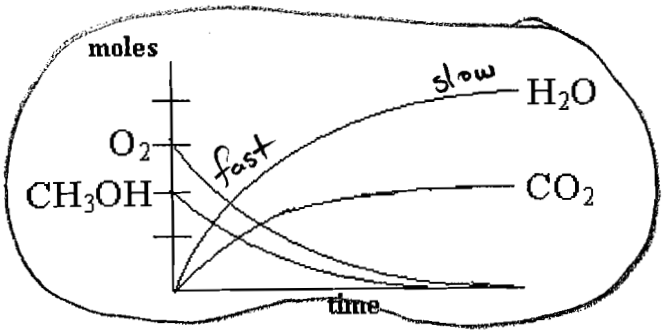
$[A]^2$ $[B]^0$

Unit 3 Material (Not previously assessed)

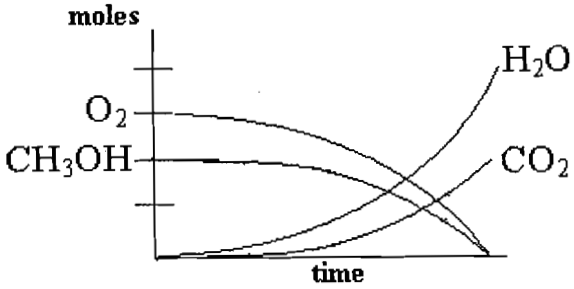
24. As the reaction proceeds, the rate:

(A) increases.
(B) decreases. less reactant present
(C) remains constant.

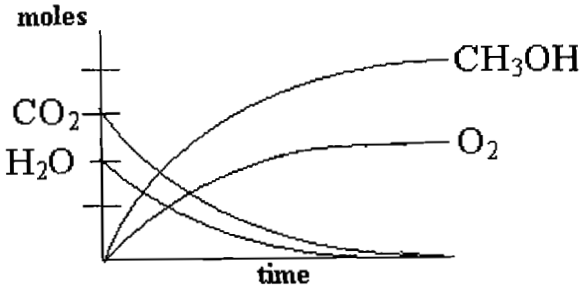
25. Which graph could correctly depict the changes in concentrations for the reaction $2\ CH_3OH\ (l) + 3\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 4\ H_2O\ (g)$?



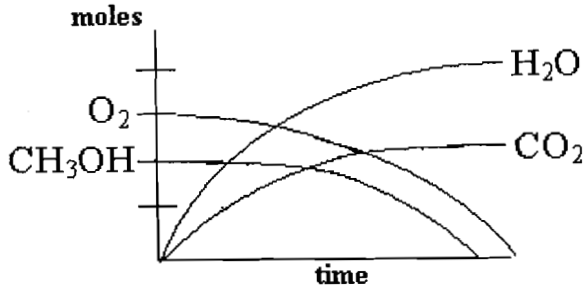
(A)



(C)



(B)



(D)

26. The equilibrium law expression for the reaction $Cu\ (s) + 2\ Ag^+\ (aq) \Leftrightarrow Cu^{2+}\ (aq) + 2\ Ag\ (s)$ is:

(A) $K_c = \dfrac{[Cu^{2+}][2\ Ag]}{[Cu][2\ Ag^+]}$

(B) $K_c = \dfrac{[Cu][2\ Ag^+]}{[Cu^{2+}][2\ Ag]}$

(C) $K_c = \dfrac{[Cu^{2+}][Ag]^2}{[Cu][Ag^+]^2}$

(D) $K_c = \dfrac{[Cu^{2+}]}{[Ag^+]^2}$

27. Consider the system $2\ FeCl_3\ (aq) + SnCl_2\ (aq) \Leftrightarrow 2\ FeCl_2\ (aq) + SnCl_4\ (aq)$ $K_c = 0.447$

A student prepares the system and measures:

$[FeCl_3] = 0.120$ M $[SnCl_2] = 0.220$ M $[FeCl_2] = 0.166$ M $[SnCl_4] = 0.0923$ M

(A) The system is at equilibrium.
(B) The system is not at equilibrium.

$$Q = \frac{\text{products}}{\text{reactants}} = \frac{[FeCl_2]^2[SnCl_4]}{[FeCl_3]^2[SnCl_2]} = \frac{(0.166)^2(0.0923)}{(0.120)^2(0.220)} = 0.8028$$

$Q \neq K$

the system is not at equilibrium

28. The following reaction is at equilibrium:

$2HBr\ (g) \Leftrightarrow H_2\ (g) + Br_2\ (g)$ $\Delta H^\circ = +72$ kJ (endothermic)

heat →

(A) The concentration of H_2 (g) increases when the system is heated.
(B) The concentration of H_2 (g) decreases when the system is heated.
(C) The concentration of H_2 (g) stays the same when the system is heated.

29. The reaction below is at equilibrium. Which of the following statements is true?

$2HBr\ (g) \Leftrightarrow H_2\ (g) + Br_2\ (g)$ $\Delta H^\circ = +72$ kJ (endothermic)

(A) The concentration of Br_2 (g) increases when H_2 (g) is added.
(B) The concentration of Br_2 (g) decreases when H_2 (g) is added.
(C) The concentration of Br_2 (g) stays the same when H_2 (g) is added.

H_2 will react with (use up) Br_2 to produce HBr

30. The pH of 0.0790 M HCl (aq) is:

(A) 1.10
(B) 1.00
(C) 0.0790
(D) 1.01
(E) -0.0790

$HCl \xrightarrow{100\%} H^+ + Cl^-$

0.0790 M 0.0790 M

$pH = -\log[H^+]$

$= -\log(0.0790) = 1.10$

31. A student obtains 0.105 M CH_3COOH (aq). The "ICE" table used to solve the equilibrium expression for this weak acid is:

(A)

	CH_3COOH (aq)	+ H_2O (l)	⇔	CH_3COO^- (aq)	+ H_3O^+ (aq)
I	0			0.105	0.105
C	+x			+x	+x
E	x			0.105+x	0.105+x

(B)

	CH_3COOH (aq)	+ H_2O (l)	⇔	CH_3COO^- (aq)	+ H_3O^+ (aq)
I	0			0	0
C	-x			+x/2	+x/2
E	-x			x	x

(C)

	CH_3COOH (aq)	+ H_2O (l)	⇔	CH_3COO^- (aq)	+ H_3O^+ (aq)
I	0.105			0	0
C	-x			+x/2	+x/2
E	0.105-x			x/2	x/2

(D)

	CH_3COOH (aq)	+ H_2O (l)	⇔	CH_3COO^- (aq)	+ H_3O^+ (aq)
I	0.105			0.105	0.105
C	-x			+x	+x
E	0.105-x			0.105+x	0.105+x

(E)

	CH_3COOH (aq)	+ H_2O (l)	⇔	CH_3COO^- (aq)	+ H_3O^+ (aq)
I	0.105			0	0
C	-x			+x	+x
E	0.105-x			x	x

32. CH_3COOH (aq) is a weak acid ($K_a = 1.80 \times 10^{-5}$). The pH of 0.0790 M CH_3COOH (aq) is:

(A) 0.00119
(B) 0.0790
(C) 1.42×10^{-6}
(D) 2.92
(E) 1.10

$K_a = 1.80 \times 10^{-5} = \frac{x^2}{0.0790 - (x) \rightarrow \text{out}}$

$x = [H^+] = 0.00119$

$pH = -\log[H^+] = -\log(0.00119) = 2.92$

33. Well, well, well... CH 122 is over. Now it's time to:

(A) Sleep for days.

(B) Try out for the Green Bay Packers starting quarterback position.

(C) Two words: iPod downloads.

(D) Watch *Iron Man*.

(E) Speak to Nafshun about becoming a Chemistry TA next year. It's the best job in the world. You get to do chemistry and work with cool students. But be warned... there are a few tests you need to pass. All Chemistry TAs had to carry massive amounts of glassware across vast deserts to get fit. They had to drink enormous amounts of concentrated acids to build up tolerance. They had to breathe huge volumes of poison gases to build up resistance. They had to survive six weeks of chemistry boot-camp to become desensitized to arrogant faculty members.

[Any response will receive full credit; even no response.]
Questions 1 through 32 have four points attached (128 total). Any response to Question 33 will receive full credit (2 Points total); even no response. The point total for this exam is 130 points. See the grade sheet for grade computation details. Final exam keys, scores, and course grades will be posted on the CH 122 website as they become available.