Chemistry 122
Exam 2

Winter 2007
March 1, 2007

Oregon State University
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 25 multiple-choice questions. Each question has four points associated with it. 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
M = mol/L
$\Pi V = nRT$
1000 mL = 1 L

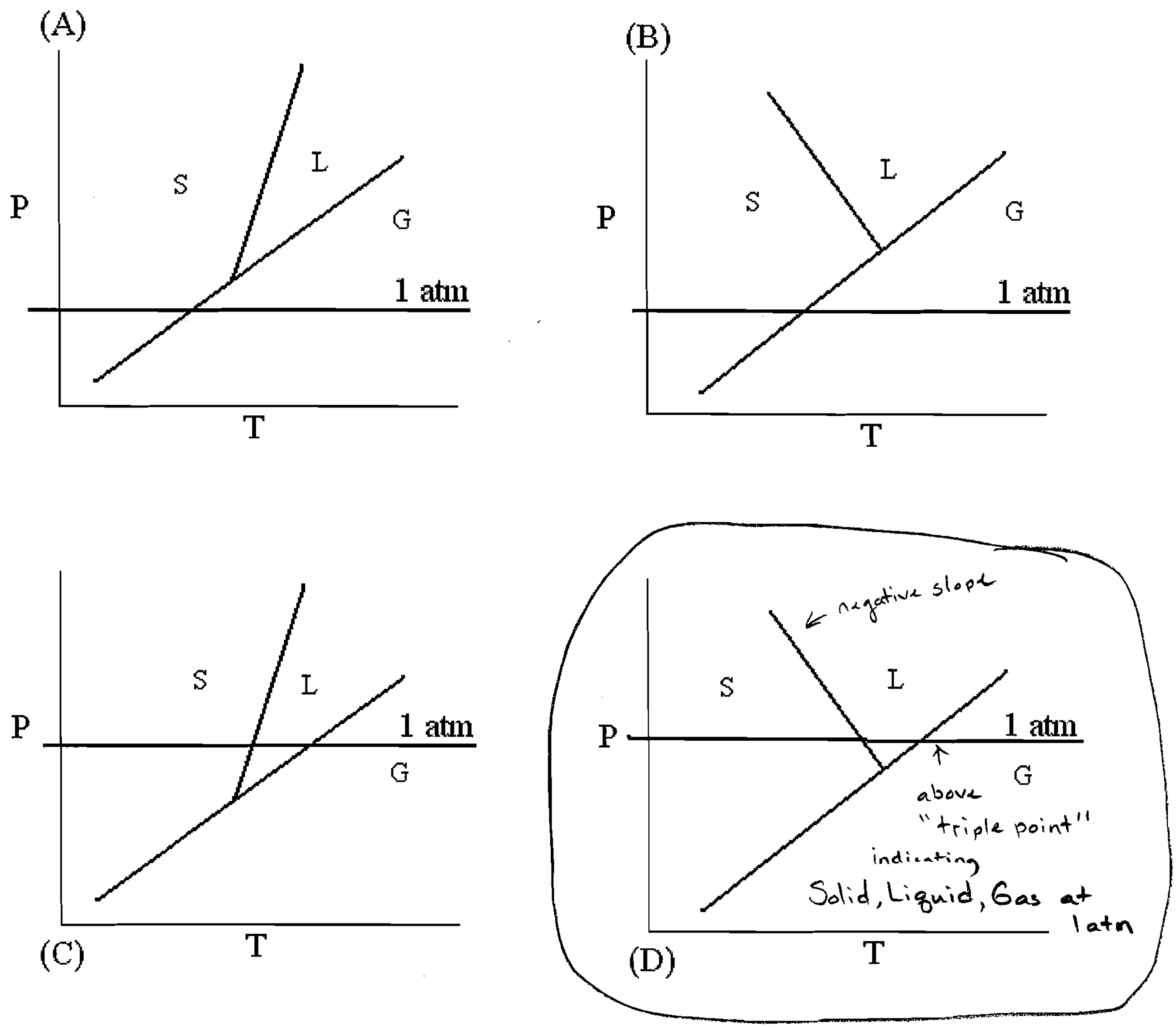
1 atm = 760 mm Hg
$\Delta T_f = i\, k_f m$
$k_f(H_2O) = 1.86$ °C/m
$\ln[\frac{A}{A_o}] = -kt$

m = mol/kg
$\Delta T_b = i\, k_b\, m$
$k_b(H_2O) = 0.512$ °C/m

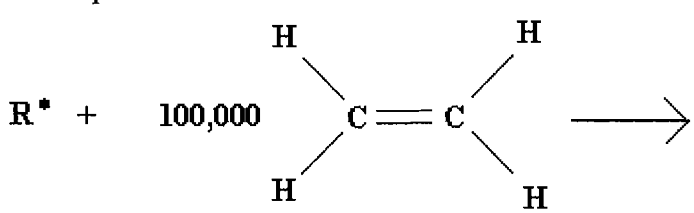
1 H Hydrogen 1.0079																	2 He Helium 4.0026
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.179
11 Na Sodium 22.98977	12 Mg Magnesium 24.305											13 Al Aluminum 26.9815	14 Si Silicon 28.0855	15 P Phosphorus 30.97376	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.08	21 Sc Scandium 44.9559	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.996	25 Mn Manganese 54.9380	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.70	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Srontium 87.62	39 Y Yttrium 88.9059	40 Zr Zirconium 91.22	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.94	43 Tc Technetium 98.906	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.4	47 Ag Silver 107.868	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.69	51 Sb Antimony 121.75	52 Te Tellurium 127.60	53 I Iodine 126.9045	54 Xe Xenon 131.30
55 Cs Cesium 132.9054	56 Ba Barium 137.33	57–71 *Rare earths	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.09	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.37	82 Pb Lead 207.2	83 Bi Bismuth 208.9804	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium 226.0254	89–103 †Actinides	104 Rf Rutherfordium (261)	105 Ha Hahnium (262)	106 Sg Seaborgium (263)	107 Ns Neilsbohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 ‡ (269)	111 ‡			114				

57 La Lanthanium 138.9055	58 Ce Cerium 140.12	59 Pr Praseodymium 140.9077	60 Nd Neodymium 144.24	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.9254	66 Dy Dysprosium 162.50	67 Ho Holmium 164.9304	68 Er Erbium 167.26	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
89 Ac Actinium 227.0278	90 Th Thorium 232.0381	91 Pa Protactinium 231.0359	92 U Uranium 238.029	93 Np Neptunium 237.0482	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium 259	103 Lr Lawrencium 262

1. Consider the phase diagrams below. Which diagram could correctly describe water?



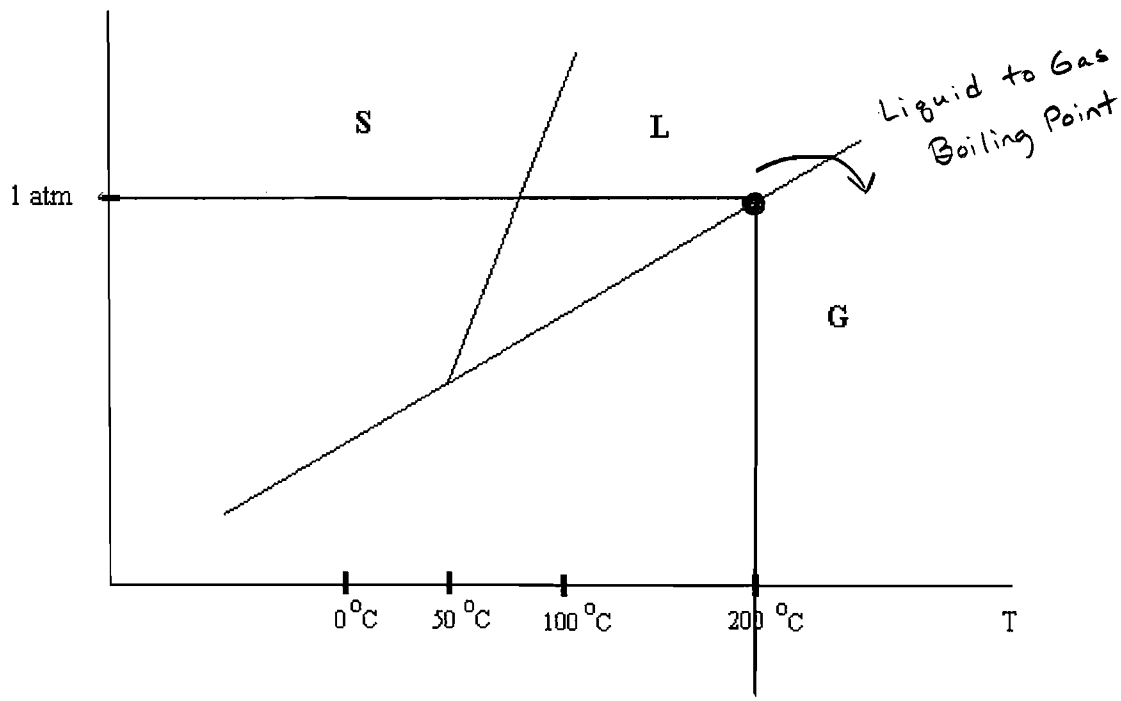
2. The reaction below will produce:



(A) Quartz
(B) A network covalent compound
(C) An ionic compound
(D) Soap
(E) A polymer

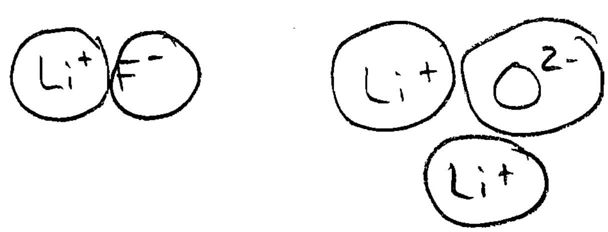
3. Consider the phase diagram below for compound Smashingpumpkinsarebackium. The normal boiling point is:

(A) 0 °C.
(B) 50 °C
(C) 75 °C
(D) 100 °C
(E) 200 °C



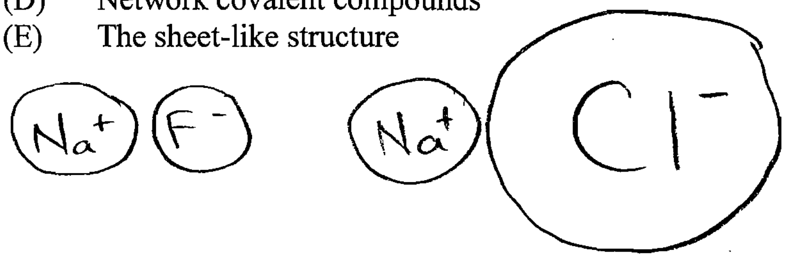
4. Lithium fluoride melts at 848 °C. Lithium oxide melts at 1570 °C. The difference in melting points can be attributed to:

(A) Different intermolecular forces (dispersion, dipole-dipole, hydrogen bonding)
(B) Different ionic charges (+1, +2, +3, -1, -2, -3…)
(C) Different distances between nuclei (ionic size)
(D) Network covalent compounds
(E) One is a molecule (attractions by intermolecular forces), one is an ionic compound (attractions by charges)



5. Sodium fluoride melts near 993 °C. Sodium chloride melts near 804 °C. The difference in melting points can be attributed to:

(A) Different intermolecular forces (dispersion, dipole-dipole, hydrogen bonding)
(B) Different ionic charges (+1, +2, +3, -1, -2, -3…)
(C) Different distances between nuclei (ionic size)
(D) Network covalent compounds
(E) The sheet-like structure



Molecule Ionic Compound

6. Ethane, CH_3CH_3, melts at -172 °C. Lithium oxide melts at 1570 °C. The difference in melting points can be attributed to:

(A) Different intermolecular forces (dispersion, dipole-dipole, hydrogen bonding)
(B) Different ionic charges (+1, +2, +3, -1, -2, -3…)
(C) Different distances between nuclei (ionic size)
(D) Network covalent compounds
(E) One is a molecule (attractions by intermolecular forces), one is an ionic compound (attractions by charges)

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

CH_3F

(A) [redacted] is a non-polar molecule which exhibits dipole-dipole forces.
(B) Cesium oxide is a non-polar molecule which exhibits dipole-dipole forces.
(C) Water is a polar molecule which exhibits hydrogen bonding.
(D) Quartz is a network covalent compound.
(E) Network covalent compounds typically melt at higher temperatures than molecules.

8. Consider CH_3CH_2OH and CH_3OCH_3. Which of the following statements is **false**?

(A) Both compounds exhibit dispersion forces.
(B) Both compounds exhibit dipole-dipole forces.
(C) Both compounds exhibit hydrogen bonding.

9. Consider LiF, Ne, H_2O, diamond, $CH_3CH_2CH_3$, Li_2O, LiCl, and Al_2O_3. Arranged in **increasing** melting point, these are:

	Lowest mp	**Highest mp**
(A)	Ne < $CH_3CH_2CH_3$ < Al_2O_3 < H_2O <LiF < LiCl < Li_2O < diamond	
(B)	Ne < $CH_3CH_2CH_3$ < H_2O <LiCl < LiF < Li_2O < Al_2O_3 < diamond	
(C)	Ne < $CH_3CH_2CH_3$ < H_2O <LiF < LiCl < Li_2O < Al_2O_3 < diamond	
(D)	Ne < $CH_3CH_2CH_3$ < H_2O <LiF < LiCl < Li_2O < Al_2O_3 < diamond	
(E)	LiF < Ne < H_2O < diamond < $CH_3CH_2CH_3$ < Li_2O < LiCl < Al_2O_3	

Inert Gases	Molecules		Ionic Compounds				Network Covalent Compounds
Ne	$CH_3CH_2CH_3$ (I)	H_2O (I)(II)(III)	LiCl +1 −1	LiF +1 −1	Li_2O +1 −2	Al_2O_3 +3 −2	diamond

Cl^- is bigger than F^-

stronger charges →

10. Which of the following has a hydrophilic end (polar, water-loving end) and a hydrophobic end (non-polar, water-fearing end) and has the ability to bridge water molecules to non-polar molecules?

(A) methane (CH_4)
(B) soap
(C) lithium chloride
(D) helium
(E) diamond

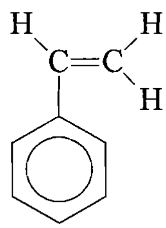
11. Which of the following compounds **cannot** undergo free radical polymerization?

(A) CF_2CF_2

(B) CCl_2CCl_2

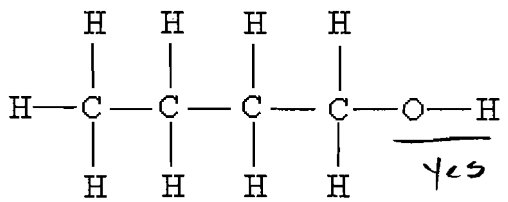
(C) CH_2CH_2

(D)

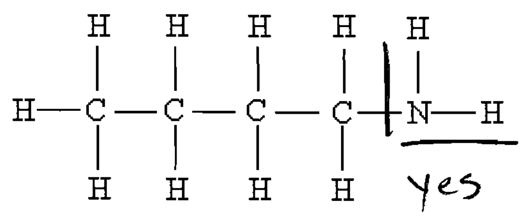


(E) CH_3CH_3 No pi-bond – only single bonds

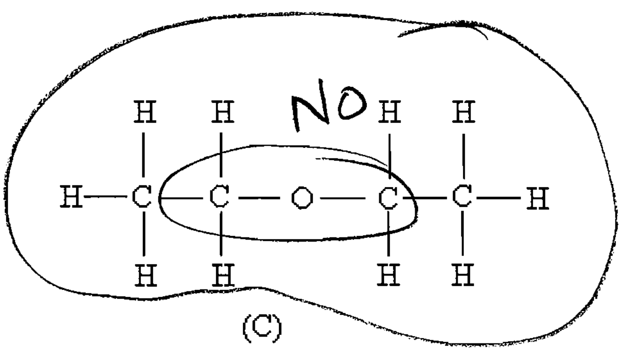
12. Which of the following molecules will **not** form hydrogen bonds?



(A)



(B)



(C)

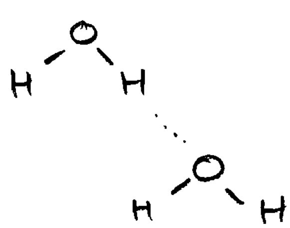
H—F

yes

(D)

13. The intermolecular forces that are **most** significant in accounting for the high boiling point of liquid water relative to other substances of similar molecular weight is/are the:

(A) Dispersion forces
(B) Dipole-dipole interactions
(C) Hydrogen bonding
(D) Network covalent forces
(E) Ionic charges



14. Compounds with relatively high vapor pressure have:

(A) high boiling points and weak intermolecular forces
(B) low boiling points and weak intermolecular forces
(C) high boiling points and strong intermolecular forces
(D) high boiling points and strong intermolecular forces

15. Which of the following best describes the properties of a typical metal?

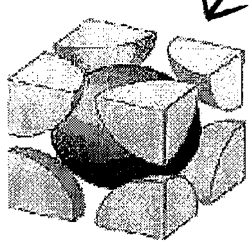
(A) Soft, very low melting point, poor electrical conductor
(B) Lustrous, good thermal conductor, good electrical conductor, ductile, and malleable
(C) Very hard, very high melting point, poor electrical conductor
(D) Lustrous, low melting point, low density, malleable

16. The equivalent number of atoms in the BCC unit cell is:

(A) 1
(B) 2
(C) 3
(D) 4
(E) 6

$8 \times \frac{1}{8} = 1$
$+ 1 \times 1 = 1$
2

17. The structure below [from a *Course Worksheet*] represents:



(A) An SC unit cell
(B) A BCC unit cell
(C) A FCC unit cell
(D) A stem unit cell
(E) An anterior lens epithelial unit cell

18. The boiling point of 2.450 m aqueous $MgCl_2$ is: $i = 3$

Mg^{2+} Cl^- Cl^-

3 pieces

(A) +107.5 °C.
(B) + 7.53 °C.
(C) +103.8 °C.
(D) +102.5 °C.
(E) -9.114 °C.

$\Delta T_b = i\, K_b\, m$

$\Delta T_b = (3)(0.512\ °C/m)(2.450\ m)$

$\Delta T_b = 3.76\ °C$

Water boils at 100°C

2.450 m $MgCl_2(aq)$ boils at 100°C + 3.76°C = 103.8°C

19. A student dissolves 5.66 g of an unknown protein in 1750 mL of water at 300 K. She measures the osmotic pressure to be 0.711 mm Hg. What is the molar mass of the protein?

(A) 8.52×10^4 g/mol.
(B) 6.65×10^4 g/mol.
(C) 6.65×10^{-4} g/mol.
(D) 1.17×10^4 g/mol.
(E) 2.08×10^4 g/mol.

Molar Mass = $\frac{g}{mol}$ ← 5.66 g from problem

$\pi V = nRT$

$$n = \frac{\pi V}{RT} = \frac{\left[(0.711\ mmHg)\left(\frac{1\ atm}{760\ mmHg}\right)\right](1.750\ L)}{\left(0.0821\ \frac{L \cdot atm}{mol \cdot K}\right)(300\ K)}$$

$n = 6.65 \times 10^{-5}$ mol

$$\text{Molar Mass} = \frac{5.66\ g}{6.65 \times 10^{-5}\ mol} = 8.52 \times 10^4\ g/mol$$

20. Why is molality used as the unit of concentration rather than molarity for colligative property calculations?

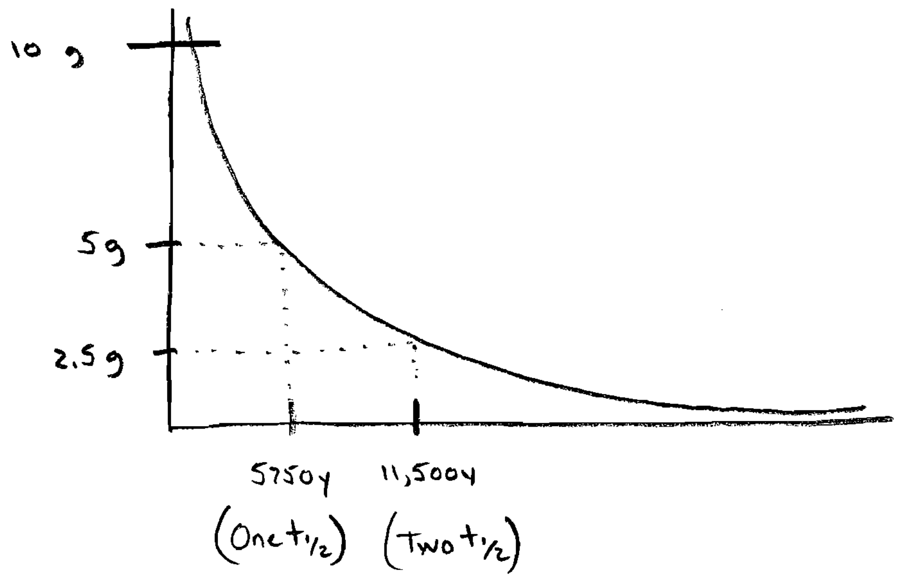
(A) Molarity is not temperature dependent; molality is
(B) Molality is not temperature dependent; molarity is.
(C) Molality calculations are easier to perform in lab.
(D) Molarity can only be used with network covalent compounds.
(E) Molarity can only be used with hydrophobic molecules.

21. The half-life is:

(A) The amount of time required for the entire sample to decay
(B) Exactly 0.500 years
(C) The amount of time required for half the sample to decay
(D) The amount of time required for the sample to decay so only a few atoms remain
(E) The 20 minute period between the second and third quarters of a football game

22. A student () obtains a 10.00 gram sample of ^{14}C ($t_{1/2}$ = 5750 years). How many grams of ^{14}C will remain after 11,500 years?

(A) 10.00 grams
(B) 5.00 grams
(C) 2.50 grams
(D) 2.00 grams
(E) 1.25 grams



23. A student () obtains a 10.00 gram sample of ^{14}C ($t_{1/2}$ = 5750 years). How long will it take so that only 2.00 grams of ^{131}I remain?

(A) 5750 years
(B) 11,500 years
(C) 2875 years
(D) 13,351 years
(E) 1851 years

① Calc k

$$\ln \frac{1}{2} = -k t_{1/2}$$

$$-0.693 = -k(5750y)$$

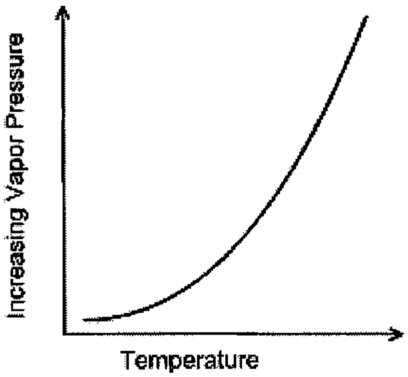
$$k = 1.21 \times 10^{-4} \frac{1}{y}$$

② Calc t

$$\ln\left(\frac{2.00g}{10.00g}\right) = -\left(1.21 \times 10^{-4} \frac{1}{y}\right)(t)$$

$$t = 13,351y$$

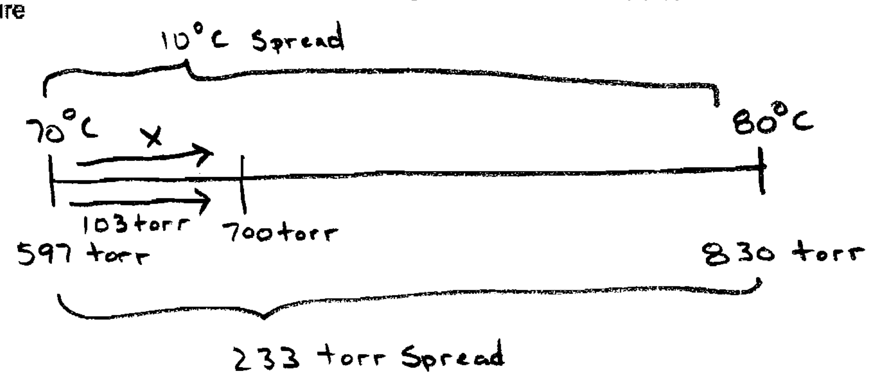
24. The data below were obtained for ethyl acetate. Estimate by interpolation the temperature when the vapor pressure is 700 torr.



ethyl acetate

Temp. (°C)	V.P. (torr)
10	45
20	74
30	118
40	185
50	282
60	417
70	597
80	830
90	1124

(A) 74.1 °C.
(B) 74.4 °C.
(C) 75.1 °C.
(D) 75.4 °C.
(E) 78.7 °C.



$$\frac{x}{103\text{ torr}} = \frac{10^\circ C}{233\text{ torr}} \qquad x = 4.42^\circ C$$

$$T = 70^\circ C + 4.42^\circ C = 74.4^\circ C$$

25. The Chemistry 122 final exam is Monday, March 19, 2007 at 7:30am; yes, this is only three hours after my ordinary bedtime. After the chemistry final I will be…

(A) Sleeping
(B) Hosting the best Spring Break Party ever
(C) Two words: You Tube
(D) Preparing for my other seven final exams
(E) On my way to Florida to engage in hot, wild sox (because it will be Spring Training and the Red Sox play their games in Ft. Myers, Florida)

[Any response will receive full credit; even no response.]