Chemistry 20L Exam Study Questions
Winter 2004
Answer Key

Open lab notebook, lecture guides and hand-written notes. **No lab manuals or texts.** Bring a calculator.

1. (a) percent error = $\left(\frac{0.02}{20.54} + \frac{0.003}{0.254} + \frac{0.05}{3.21}\right)$ X 100 = 2.8% ~ 3%

   (b) Absolute error = (30.078 - 20.174 + 9.813) ± (0.003 + 0.001 + 0.005) = 19.717 ±0.009

   % error = $\left(\frac{0.008}{19.717}\right)$ x 100 = 0.045% ~ 0.05%

   (c) absolute error = $\left[\left(\frac{0.002}{0.642} + \frac{0.004}{2.413}\right) \text{ X } 1.549\right] + 0.002$

   $= 0.007 + 0.002 = 0.009$

   % error = $\left(\frac{0.009}{(0.642)(2.413) - 0.501}\right)$ X 100 = $\frac{0.009}{1.048}$ X 100 = 0.86% ~ 0.9%

   (d) $\frac{12.635 \pm 0.005}{(5.967 \pm 0.003) + (0.478 \pm 0.004)} = \frac{12.635 \pm 0.005}{6.445 \pm 0.007}$

   % error = $\left(\frac{0.005}{12.635} + \frac{0.007}{6.445}\right)$ X 100 = 0.148% ~ 0.1%

2. (a) 1.625 X 2.8% = ±0.045 ~ ±0.05
   (b) ± 0.009
   (c) ± 0.009
   (d) $\frac{12.635}{6.445}$ x0.148% = ±0.003 or $\frac{12.635}{6.445}$ x0.1% = ±0.002

3. average = 20.905; average deviation = 0.035; relative average deviation = 0.17%

4. Molarity = moles solute/liter solution
   Normality = equivalents solute/liter solution
   Weight percent (w/v) = grams solute/100mL solvent
   Weight percent (w/w) = grams solute/100g solvent
   PPM = parts per million
   pH = -log [H^+]

5. (a) molarity is the appropriate unit when discussing chemical reactions since stoichiometry is based on mole relations. Molarity is dependent on temperature because of volume changes with temperature.
   PPM is useful when small concentrations are under investigations and the frame of reference is always at this level
   (b) weight percent is useful when the substances are solids and the preparation is a "recipe" only and does not convey any sense of a reaction that stoichiometry.

(c) like weight percent, volume percent is a "recipe" instruction and is useful for concentrations when the solute and solvent are liquids.

6. (a) Molecular weight of ethanol = 45 g/mol
Volume of 1.00×10^{-3} mol = 0.051 mL
PPM = 0.045g/1000g = $45g/10^6 g$ = 45 PPM
(b) wt % = 0.0045g/100g = 0.0045%
(c) vol % = 0.051 mL/1000 mL = 0.0051 mL/100 mL = 0.0051%

7. 2.00×10^{-4} M
4.00×10^{-4} N
0.00196% (w/v)
19.6 PPM

8. The molecular weight of sodium hydroxide NaOH, is 40.08g. The final concentration is

$$\frac{0.4063\text{g}}{40.00\,\text{g/mol}} \text{X} \frac{1000\,\text{mL/L}}{100.00\,\text{mL}} \text{X} \frac{10.00\text{ml}}{50.00\,\text{mL}} = 0.2032\text{M}$$

9. The question asks for copper not the salt. It is the concentration of the heavy metal that is usually the important issue.)
Weight of copper in the sample =weight of sample x AW of Cu /MW of $CuSO_4 \cdot 5H_2O$)

$$= \frac{0.1037\text{g} \times 63.55\ \text{g/mol}}{249.7\ \text{g/mol}} = 2.639\ 10^{-2}\ \text{g}$$

$$\text{concentration of Cu in diluted solution} = \left(\frac{2.639 \times 10^{-2}\ \text{g}}{0.100\text{L}}\right)\left(\frac{0.005\text{L}}{0.100\text{L}}\right) = 1.320 \times 10^{-3}\ \text{g/L}$$

Since this is a dilute aqueous solution 1.00 mL ~1.00g

$$\text{PPM Cu} \approx \left(\frac{1.320 \times 10^{-2}\text{g}}{1000\text{g}}\right)\left(\frac{1000\text{g}}{1000\text{g}}\right) = \left(\frac{13.20g}{10^6}\right) = 13.20 \approx 13.2\text{PPM}$$

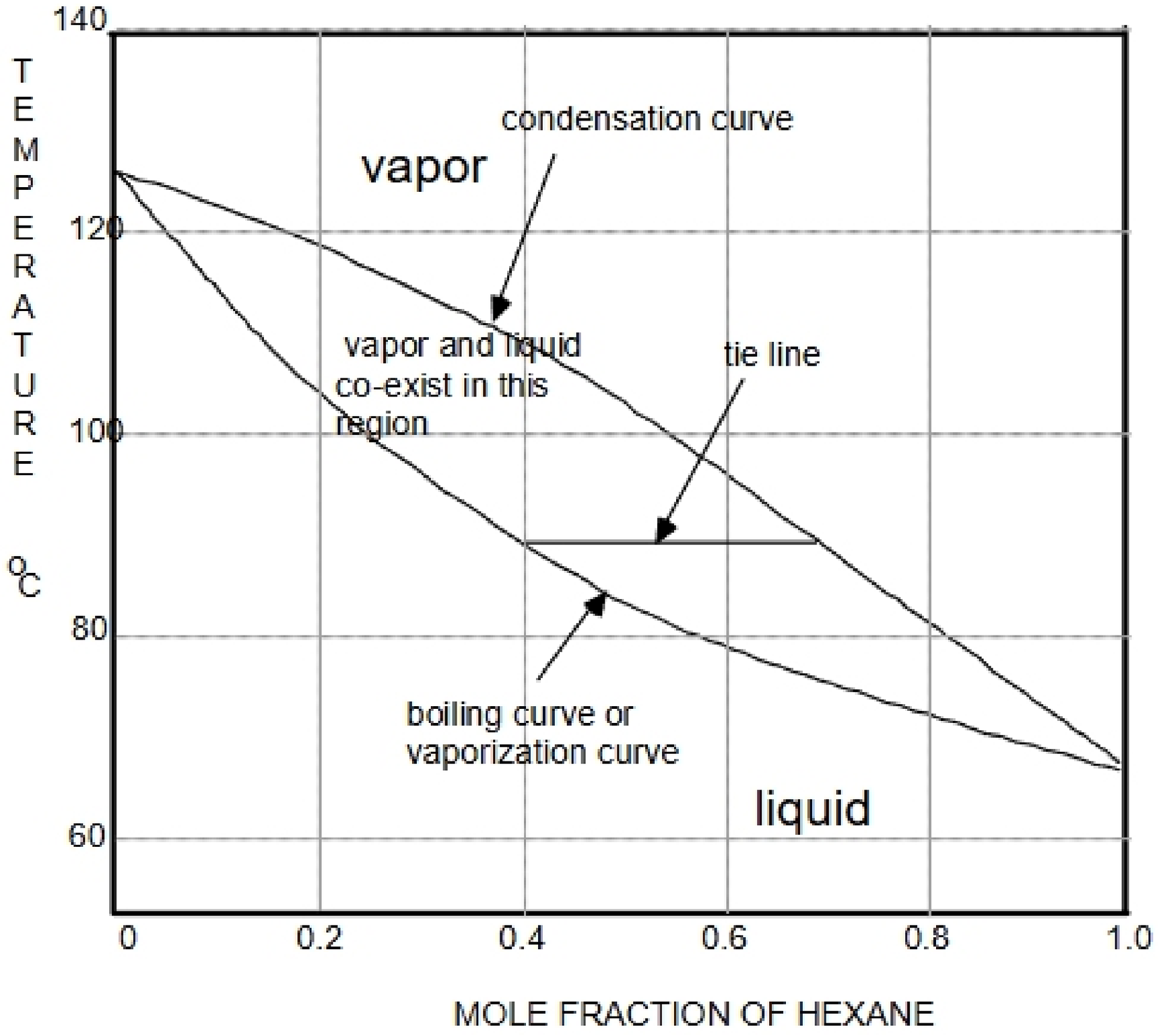
10. 0.56%
Note that the names of the pieces of equipment (e.g. 100-mL volumetric flask, 5-mL pipet) do not indicate the precision of the equipment. In part (b) of this question you calculate the uncertainty in the concentration. The absolute error in (a) is ±0.06 ppm. Rounding down to 13.2 is very conservative, and loses some of the significance of the measurements; reporting 13.20 implies a higher precision than is actually known if you assume ±1 in the last digit. The unambiguous way to report the answer is 13.20 ±0.56%.

11. **Absorbance** is a measure of the light absorbed by a solution. Specifically it is the negative log of the fraction of light transmitted through the solution. Because it is a logarithm, it is a dimensionless quantity.
b is the symbol for the thickness of the solution through which the light being absorbed passes. **b** is often called the 'cell length" or "path length" and is reported in centimeters.
ε is the molar extinction coefficient. It is the amount of light absorbed by 1 cm of a 1M solution of the compound.

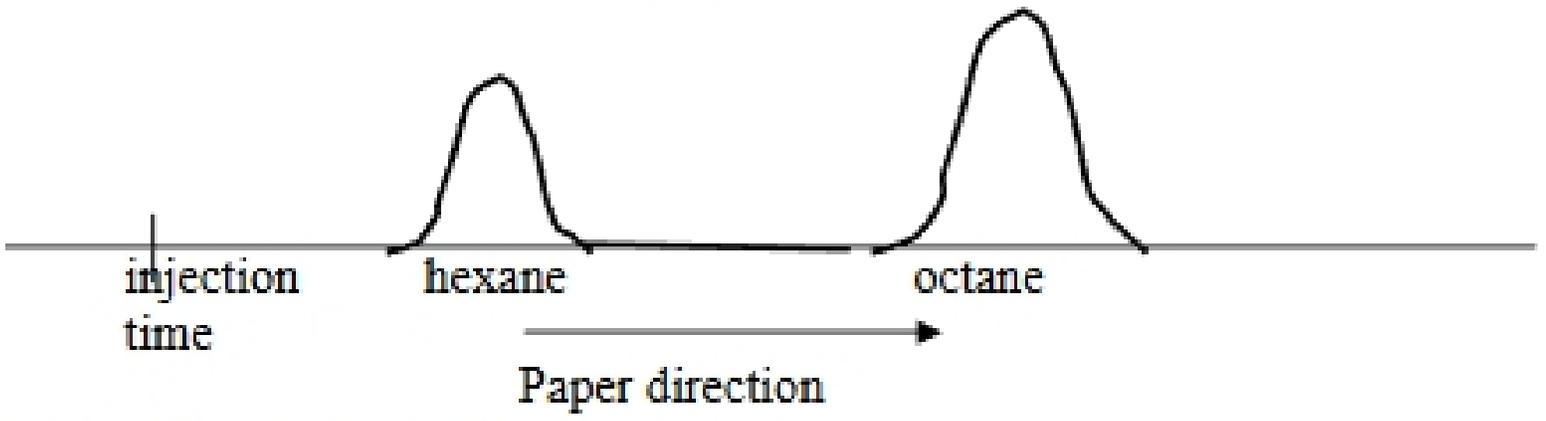
12. 44.5%

13. (a) 2390/M (c) 2.09×10^{-4}

14. (a) A 60% octane solution will begin to boil at 90°C. The composition of the vapor in equilibrium with the solution is 70% hexane.



(b) Gas chromatogram of original mixture.



(c) Gas chromatogram of first distillate.