Chem 101 practice problems: Do these by yourself and then compare your answers with the key on the next page.

_____ 1) What is the speed that the 98.8 kHz radiowaves travel in <u>comparison</u> to a light photon of wavelength 500 nm? Assume they are traveling in a vacuum.
a) 3.0×10^8 m/s. b) less than 3.0×10^8 m/s. c) more than 3.0×10^8 m/s.
d) not enough information has been supplied to answer this question.

_____ 2) What is the wavelength of the radio wave (in question (1) above)? Choose *closest* answer:
a) 650 meters b) 30 m c) 1000 m d) 2900 m

_____ 3) Electromagnetic radiation whose photons have 3.0×10^{-19} Joules of energy is:
a) infrared b) mid-visible c) ultraviolet d) visible close to red e) visible close to ultraviolet.

_____ 4) Arrange these elements in the order of increasing atomic radius: Sn, P, O, Sr
a) Sn< P< O< Sr b) O<P<Sn<Sr c) Sr<Sn<P<O d) Sn<Sr<P<O

5) Explain what the **photoelectric effect** shows about the nature of light.

6) A student had 7 beakers, each containing 100. mL of 0.500 M NaOH (aq). To each, the student adds increasing amounts (in grams) of an acid whose molar weight is 120. g/mole.

a) Predict the temperature change in expt # 7.

b) For each experiment, indicate which is the limiting reagent, NaOH or the acid, or in which one are they *equimolar*.

c) When the acid reacts with NaOH, how many hydrogen ions are involved? (i.e. is the acid monoprotic, diprotic or triprotic?)

Expt #	Mass of acid	Temp. change°C
1	0.5g	1.2°C
2	1.0	2.4
3	2.0	4.8
4	2.5	6.0
5	3.0	7.2
6	3.5	7.15
7	4.0	?

7) Suppose that 18.5 g of chlorine trifluoride gas (ClF_3(g), 92.5 g/mole) is reacted with 11.50 g of sodium metal (Na(s), 23.0 g/mol) to form sodium chloride (NaCl(s), 58.5g/mol) and sodium fluoride (NaF(s), 42.0 g/mol). The reaction occurs at 1 bar and 25.0 °C. (ΔH_f°'s: ClF_3(g)=-163.2 kJ/mol, NaCl(s)=-411 kJ/mol; NaF(s)=-574 kJ/mol)
a) write the balanced equation :

b) which is the limiting reagent?

c) How much heat is released in this reaction as described using the grams of reactant shown above?

d) Does the system do any P-V **work**? Explain (wrong explanations=0 points). [1 pt]

Key:

1) A For all of them the speed is a constant = $3x10^8$m/s

2) D Use $\lambda\nu = c$ or $\lambda = c/\nu$ or $\lambda = (3x10^8 m/s)/(98.8x10^3/s) = 3036$ => d is the closest

3) D) $E=hc/\lambda$ => $\lambda = hc/E = (6.63x10^{-34}Js(3x10^8))/ (3x10^{-19}) = 6.63x10^{-7}=663x10^{-9}$m =663 nm; this is close to 700 which is the lower energy end, namely **red**.

4) B

5) it showed particle nature of light

6)

a) about 7.15-7.2°C

b) acid is limiting in Expt #'s 1-4, equimolar in Expt #5, NaOH is limiting in Expt #'s 6-7

c) acid is diprotic. 2 hydrogens per acid.

Note: in Expt #5, equimolar case, # moles H^+ = # moles OH^- = # moles NaOH = (.100L)(.500M)=0.0500moles.

But for that expt, Expt#5, #moles of acid = 3.0g(1mol/120g)=0.0250 moles acid

So there must be 0.0500moles H^+ / 0.0250moles acid = 2 moles H^+/mol acid

7) a) $ClF_3(g) + 4\ Na(s) \rightarrow NaCl(s) + 3\ NaF(s)$

b) assume Na limiting: #g ClF_3 needed

= 11.50gNa(1mol/23.0g)(1mol ClF_3/4 molNa)(92.5g ClF_3/molClF_3) = 11.56g ClF_3<18.5g

so indeed Na is limiting.

moles Na = 11.50/23.0 = 0.500 moles Na

c) -246.2 kJ

From the formation enthalpies: $\Delta H° = \sum\Delta H°_f(prod) - \sum\Delta H°_f(rxt)$

= (3)(-574kJ/mol) +(-411 kJ/mol) - (-163.2 kJ/mol) = - 1970 kJ/mol

But that's per mole of what? Of ClF_3! (see equation again).

We can write: $\Delta H° = -1970$ kJ/4 mol Na = -492.5 kJ/mol Na

OK, ΔH = (0.500 mol Na)(-492.5 kJ/mol) = **-246.2 kJ**

d) yes PV work is involved because we have a gas (namely ClF_3) converting into solid substances… Since there is ΔV, and $W = p\Delta V$, then there is work done ON the system, compressing it.