Name_____Pd_____

A Modern Review

1. Calculate the deBroglie wavelength of the Earth. Its orbital speed is about $3 \cdot 10^4$ m/s.

$\lambda_{deB} = h/mv = 6.626 \cdot 10^{-34} / (6 \cdot 10^{24})(3 \cdot 10^4) = 3.68 \cdot 10^{-63}$

(Extremely particle-like!)

2. The work function of copper is 4.5 eV. Find the maximum kinetic energy of the photoelectrons emitted when ultraviolet light with frequency $1.5 \cdot 10^{15}$ Hz falls on the copper surface.

$E_{ph} = hf = 4.14 \cdot 10^{-15} (1.5 \cdot 10^{15}) = 6.21$ eV

$E_K = E_{ph} - \phi = 6.21 - 4.5 = 1.71$ eV

3. The threshold frequency for calcium is $7.7 \cdot 10^{14}$ Hz. Find the maximum kinetic energy (in eV) of the electrons emitted when light with a frequency of $1.2 \cdot 10^{15}$ Hz is directed at the calcium's surface.

$\phi = hf_0 = 4.14 \cdot 10^{-15} (7.7 \cdot 10^{14}) = 3.19$ eV

$E_{ph} = hf = 4.14 \cdot 10^{-15} (1.2 \cdot 10^{15}) = 4.97$ eV

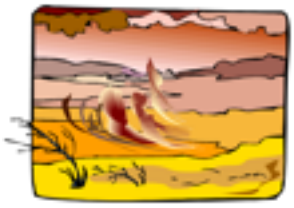
$E_K = E_{ph} - \phi = 4.97 - 3.19 = 1.78$ eV

4. What is the maximum wavelength of light that leads to photoelectric emission in platinum ($\phi = 1.02 \cdot 10^{-18}$ J)?

$\phi = hc/\lambda_0 = 1.242 \cdot 10^3 / (7.7 \cdot 10^{14}) = 3.19$ eV (6.35 eV)

$\lambda_0 = hc/\phi = 1.242 \cdot 10^3 / (6.35) = 195.6$ nm

5. What is the deBroglie wavelength of a 1mg grain of sand blown by a wind with a velocity of 20 m/s?



$\lambda_{deB} = h/mv = 6.626 \cdot 10^{-34} / (1 \cdot 10^{-6})(20) = 3.31 \cdot 10^{-29}$

(Still very particle-like!)

6. An electron in a hydrogen atom jumps from the ground state up to the 4th excited state. Calculate the amount of energy absorbed by the electron during this process. Where did this energy come from?

n=5

$\Delta E = 13.6 - 0.544$

$\Delta E = 13.056$ eV [It comes from light hitting the atom]

HYDROGEN

Orbital Number	Ionization Energy
n=6	0.378 eV
n=5	0.544 eV
n=4	0.850 eV
n=3	1.51 eV
n=2	3.40 eV
n=1	13.60 eV

7. The electron in problem #6 now jumps down to the 3rd excited state and then to the ground state. What are the frequencies of the photons emitted during this process? What colors of light are these photons?

n=4 n=1

5-4: $\Delta E = 0.85 - 0.544 = 0.306$ eV $\lambda_1 = hc/\phi = 1.242 \cdot 10^3 / (0.306) = 4058$ nm

4-1: $\Delta E = 13.6 - 0.85 = 12.75$ eV $\lambda_2 = hc/\phi = 1.242 \cdot 10^3 / (12.75) = 97.4$ nm

λ_1 is infrared and λ_2 is ultraviolet (not really "colors" at all)