Name_____Pd_____

The Bohr Atom—Hydrogen and More

1. Determine the frequency and wavelength of light emitted when an electron in the HYDROGEN atom jumps from the 5th excited state to the 2nd orbital.

0.378 eV 3.40 eV

$\Delta E = 3.022 \text{ eV} = hf = 4.14 \cdot 10^{-15} f$

$f = 7.3 \cdot 10^{14}$ Hz

$v = f\lambda$

$3 \cdot 10^{8} = 7.3 \cdot 10^{14} \lambda$

$\lambda = 4.11 \cdot 10^{-7}$ m

2. When an electron is removed from an atom it is said to be "ionized." The energy of an electron is then considered zero. How much energy is required to ionize an electron from the 3rd excited state in HYDROGEN?

0.85 eV

HYDROGEN

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

Orbital Number ***Ionization Energy***

3. What frequency of light is required to ionize a ground state electron in HYDROGEN?

$\Delta E = hf$

$13.6 = 4.14 \cdot 10^{-15} f$ $f = 3.29 \cdot 10^{15}$ Hz

4. Looking at HYDROGEN one last time, if a photon of 103 nm is emitted from a hydrogen atom, what jump did the electron make in that atom? After giving off the first photon, the electron emits only one more photon as it drops back to the ground state. What color or type of light is this last emission?

$\Delta E = hc/\lambda$

$\Delta E = (4.14 \cdot 10^{-15})(3 \cdot 10^{8})/(103 \cdot 10^{-9}) = 12.06$ eV

This is the 3→1 jump

It can't emit another photon! It's in the ground state already!

5. Looking at the MADEUPIUM atom's atomic energy levels as shown at right (assume it is also a single electron atom), which consecutive orbital jumps will require photons of the same energy?

☒ 3 to 4 ☐ 1 to 2 ☐ 5 to 6 ☒ 4 to 5 ☐ 2 to 3

6. Looking again at MADEUPIUM, which two of the following jumps would emit the same frequency of light?

☐ 5 to 4 ☒ 6 to 3 ☐ 5 to 2 ☐ 3 to 1 ☒ 2 to 1

MADEUPIUM

n=6	1 eV
n=5	2 eV
n=4	5 eV
n=3	8 eV
n=2	13 eV
n=1	20 eV

Orbital Number ***Ionization Energy***

7. Look at MADEUPIUM one more time. Are there any jumps that would emit visible light? Which ones?

$\Delta E = hc/\lambda$

$\Delta E = (4.14 \cdot 10^{-15})(3 \cdot 10^{8})/(400 \cdot 10^{-9}) = 3.105$ eV for violet 5→4

$\Delta E = (4.14 \cdot 10^{-15})(3 \cdot 10^{8})/(700 \cdot 10^{-9}) = 1.774$ eV for red 4→3

both are 414 nm (violet)

8. MADEUPIUM's single electron is in the ground state. Light of 56.45 nm hits the atom. Explain what you think will happen to the electron with what you know about the structure of MADEUPIUM and the ideas from previous problems on this page.

$\Delta E = hc/\lambda$

$\Delta E = (4.14 \cdot 10^{-15})(3 \cdot 10^{8})/(56.45 \cdot 10^{-9}) = 22$ eV

It will be ejected from the atom (with 2 eV of extra energy!)