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Physics 1314 Exam 3

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Please PRINT your name so that we can READ it.

Name: ______________________________

Useful Formulae and Physical Data

$E_\gamma = hf$	$\lambda = h/mv$
$E_\gamma = 13.6(1/n_f^2 - 1/n_i^2)\,\mathrm{eV}$	$E(\mathrm{eV}) = 1240/\lambda(\mathrm{nm})$
$h = 6.6 \times 10^{-34}$ J-s.	$r_{proton} = 1 \times 10^{-15}\,\mathrm{m}$
$E_n = -13.6/n^2\,\mathrm{eV}$	$r = r_0 n^2$
	$r_0 = 5 \times 10^{-11}\,\mathrm{m}$
$N = N_0 e^{-\lambda t}$	$\frac{\Delta N}{\Delta t} = \lambda N$
$(1/2)^n$ = fraction of R.N.R	$\tau_{1/2} = 0.693/\lambda$

OPEN BOOK. OPEN NOTES.

5 pts Does a blue photon or a red photon have more energy?

- The red photon is more energetic than a blue photon;
- The blue photon is more energetic than a red photon;
- Both kinds of photons have the same emnrgy.

5 pts I shine photons of energy $E_\gamma = 2\,\mathrm{eV}$ onto a zinc plate. What happens?

- The zinc plate becomes radioactive.
- No electrons are ejected from the zinc plate;
- The photons eject electrons from the zinc plate.

5 pts Suppose you double the size of the electron's orbit inside a hydrogen atom. What happens to the energy of this electron?

- The electron now has a smaller energy;
- The electron now has a larger energy;
- The energy of the electron remains unchanged.

5 pts In lab you saw the emission spectra from mercury and hydrogen. What do emission spectra look like?

- Emission spectra are narrow vertical lines with distinct colors;
- Emission spectra are broad colored, each with a mixture of color;
- Emission spectra are narrow vertical white lines;

5 pts Suppose I have 2 hydrogen atoms and the electron in each makes a transition to the *same* final energy level. In the process, a blue photon is emitted from one atom and a red photon is emitted from the other. Which atom was *larger* before these transitions took place?

- The hydrogen atom that emitted the red photon was larger;
- The hydrogen atom that emitted the blue photon was larger;
- Both atoms started with the same size.

5 pts What happens to the half-live $\tau_{1/2}$ of a radioactive substance as it decays?

- $\tau_{1/2}$ decreases;
- $\tau_{1/2}$ remains constant;
- $\tau_{1/2}$ increases.

5 pts Suppose you have a radioactive source with 512 radioactive nuclei. After 2 half-lives have passed, how many radioactive nuclei N remain?

- $N = 256$;
- $N = 128$;
- $N = 64$;

5 pts I have an electron and a proton moving at the same speed. Which, if any, has the larger de Broglie wavelength?

- The electron has the larger de Broglie wavelength;
- The proton has the larger de Broglie wavelength;
- The electron and the proton have the same de Broglie wavelength.

5 pts Suppose you have samples of 10^6 nuclei each of ${}^{238}_{53}I$ and ${}^{222}_{86}Rn$. The "radioisotope" ${}^{238}_{53}I$ has a half-life $\tau_{1/2} = 13.3\,\text{hours}$ and ${}^{222}_{86}Rn$ has a half-life $\tau_{1/2} = 3.82\,\text{days}$. Which sample has the greater activity?

- ${}^{222}_{86}Rn$ has the greater activity;
- ${}^{238}_{53}I$ has the greater activity;
- Both isotopes have the same activity.

5 pts We learned and observed that similar charges repel one another. We also claim that a nucleus contains protons, objects which are positively charged. What keeps a nucleus from flying apart then?

- Protons do not obey Coulomb's law anyway so there is no contradiction;
- A nucleus does not stay together forever. All nuclei eventually decay because the protons in them repel one another. Hence, there is no contradiction.
- There is another force at work, the *strong* force, which overcomes the Coulombic repulsive force between protons and which "glues" them together and to neutrons.

2. **20 pts.** Suppose you have $100\,\mu$g of a particular radioactive material, say, ${}^{25}_{13}Al$. You notice that after only 23 seconds have elapsed you have only $10\,\mu$g left of this substance. What is the half-live $\tau_{1/2}$, measured in seconds, of ${}^{25}_{13}Al$? Box your final answer.

2. **15 pts.** To improve the health of your bank account, you build a machine for discriminating between aluminum and gold coins all mixed up together in a large bucket. The idea is that you load the coins onto a conveyor belt and shine ultraviolet light onto the coins as they pass by. If you detect ejected electrons from the coins then you know you have detected an aluminum coin. If the work functions W for aluminum and gold are $W_{Al} = 4.3\,\mathrm{eV}$ and $W_{Au} = 5.1\,\mathrm{eV}$, respectively, what should be the wavelength λ of the ultraviolet light used in your machine? Box your final answer.

2. **15 pts.** To celebrate the impending conclusion of classes, you buy a glass tube containing hydrogen gas. You notice that it only requires $0.544\,\mathrm{eV}$ to ionize the atoms in this sample. What is the ratio $\mathcal{R}$ of the size of the un-ionized atoms to the radius of a proton? Box your final answer.