

# Electronic Structure Quiz

Name KEY

1) Write out the equation that describes each of the following relationships:

a) energy of a photon and its frequency  $E = h\nu$

b) energy levels and wavelength of a standing wave  $E = \frac{2L}{\lambda}$

c) wavelength and electron energy level transitions in hydrogen  $\frac{1}{\lambda} = R \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

d) wavelength and momentum  $\lambda = \frac{h}{mv}$

e) uncertainty in a particles position and its momentum  $\Delta x \cdot \Delta(mv) \geq \frac{h}{4\pi}$

f) energy and energy level of hydrogen  $E = -2.178 \times 10^{-18} \text{ J} \left( \frac{1}{n^2} \right)$

g) frequency and wavelength of EM radiation  $\nu = \frac{c}{\lambda}$

h) energy and wavelength of EM radiation  $E = \frac{hc}{\lambda}$

2) Electromagnetic radiation emitted by an excited atom has a frequency of  $4.410 \times 10^{14}$  Hz. If visible, what color would it appear? If not visible, what region of the electromagnetic spectrum would it be in?

$$\lambda = \frac{c}{\nu} = \frac{3.00 \times 10^8 \text{ m} \cdot \text{s}^{-1}}{4.410 \times 10^{14} \text{ Hz}} \times \frac{\text{Hz}}{\text{s}^{-1}} \times \frac{\text{nm}}{10^{-9} \text{ m}} = 680.2 \text{ nm} \leftarrow \text{RED VISIBLE}$$

3) An x-ray has a wavelength of 1.34 angstroms. How many photons will be required to generate 125 kJ of total energy?

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ J} \cdot \text{s})(3.00 \times 10^8 \text{ m/s})}{1.34 \text{ \AA}} \times \frac{\text{\AA}}{10^{-10} \text{ m}} = 1.48 \times 10^{-15} \text{ J} \quad \begin{matrix} \text{PER PHOTON} \\ \downarrow \end{matrix}$$

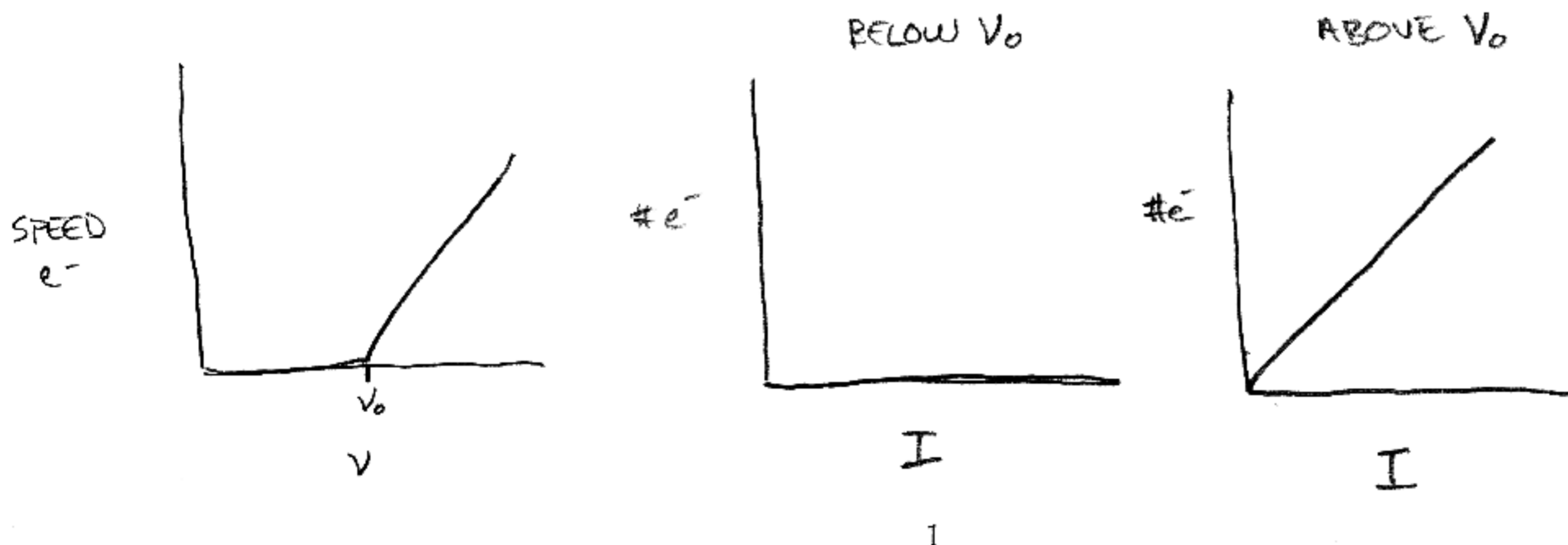
$$\frac{1.25 \times 10^5 \text{ J}}{1.48 \times 10^{-15} \text{ J}} = 8.45 \times 10^{19} \quad \uparrow \text{ \# OF PHOTONS}$$

4) The energy required to cause the ejection of electrons from the surface of indium metal via the photoelectric effect is 397 kJ/mol. What is the photoelectric threshold frequency for indium metal?

PER ELECTRON:  $\frac{397 \text{ kJ}}{\text{mol}} \times \frac{10^3 \text{ J}}{\text{kJ}} \times \frac{\text{mol}}{6.022 \times 10^{23}} = 6.59 \times 10^{-19} \text{ J}$

$E = h\nu$   
 $\nu = \frac{E}{h} = 9.95 \times 10^{14} \text{ s}^{-1}$

5) Sketch three graphs that illustrate the photoelectric effect: 1) frequency vs speed of electron, 2) number of electrons vs intensity (at low frequency), 3) number of electrons vs intensity (at high frequency)



6) What is the wavelength in angstroms of a 10.0 g bullet travelling at 1750 feet per second?

$$\lambda = \frac{h}{mv} = \frac{(6.626 \times 10^{-34} \text{ kg m}^2/\text{s}^2 \cdot \text{s})}{(10.0 \text{ g})(1750 \text{ ft/s})} \times \frac{10^3 \text{ g}}{\text{kg}} \times \frac{\text{ft}}{12 \text{ in.}} \times \frac{1 \text{ in.}}{2.54 \text{ cm}} \times \frac{\text{cm}}{10^{-2} \text{ m}} = 1.24 \times 10^{-34} \text{ m}$$

7) How many total electrons in an atom can have the quantum number(s):

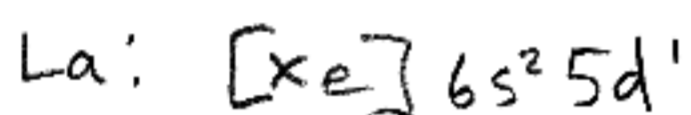
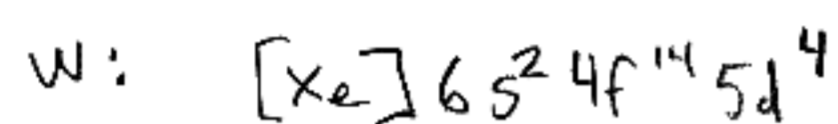
n = 2 and l = 1? 6

n = 4? 32

n = 5 and l = 0? 2

n = 5, l = 3 and m<sub>l</sub> = 3? 2

8) What are the abbreviated ground state electronic configurations for tungsten, cerium and lanthanum?



9) Sketch each of the following on the back of the previous page:

a)  $\Psi$  and  $\Psi^2$  plots for an electron in a one dimensional box, for n = 1, 2, 3 and 4

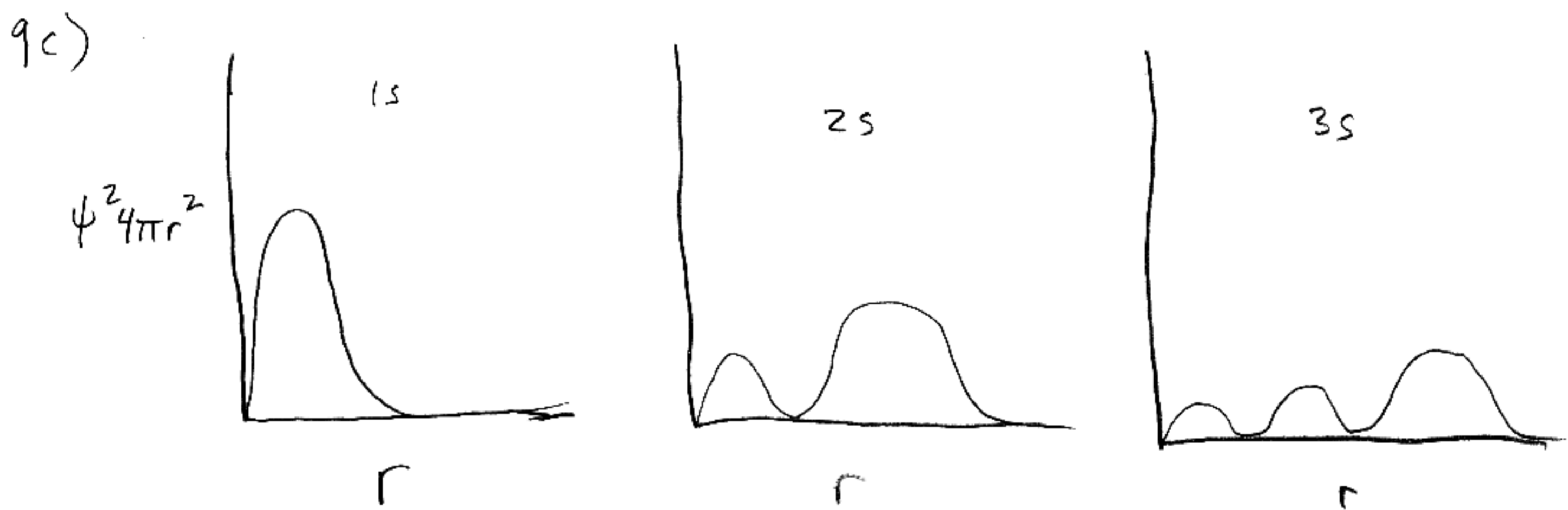
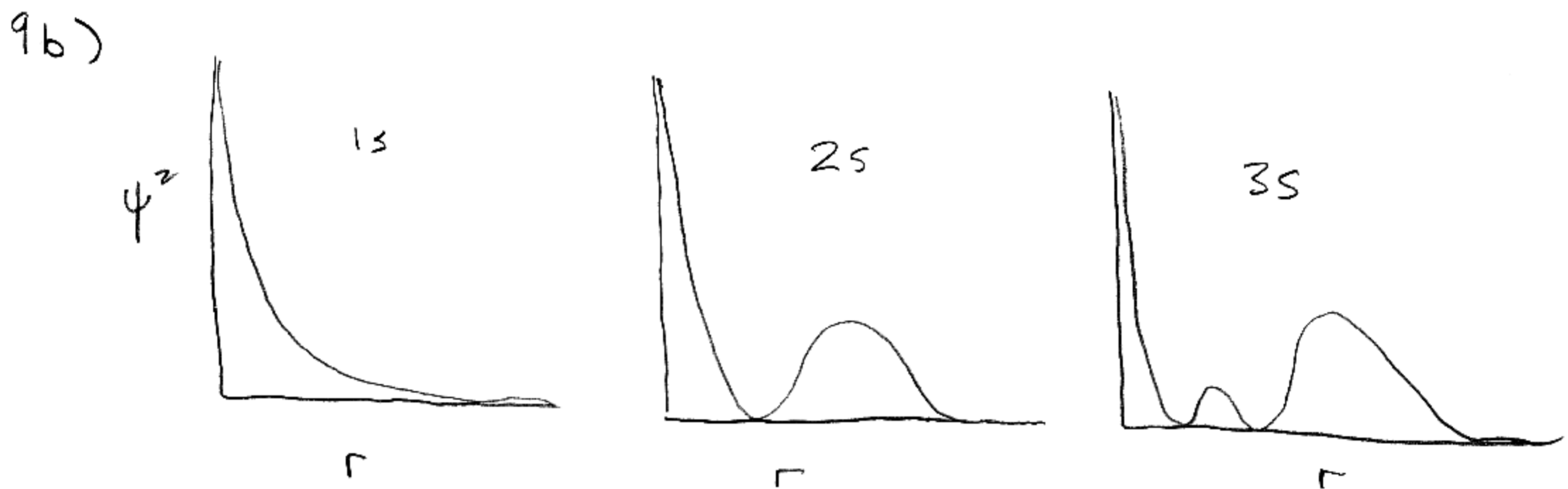
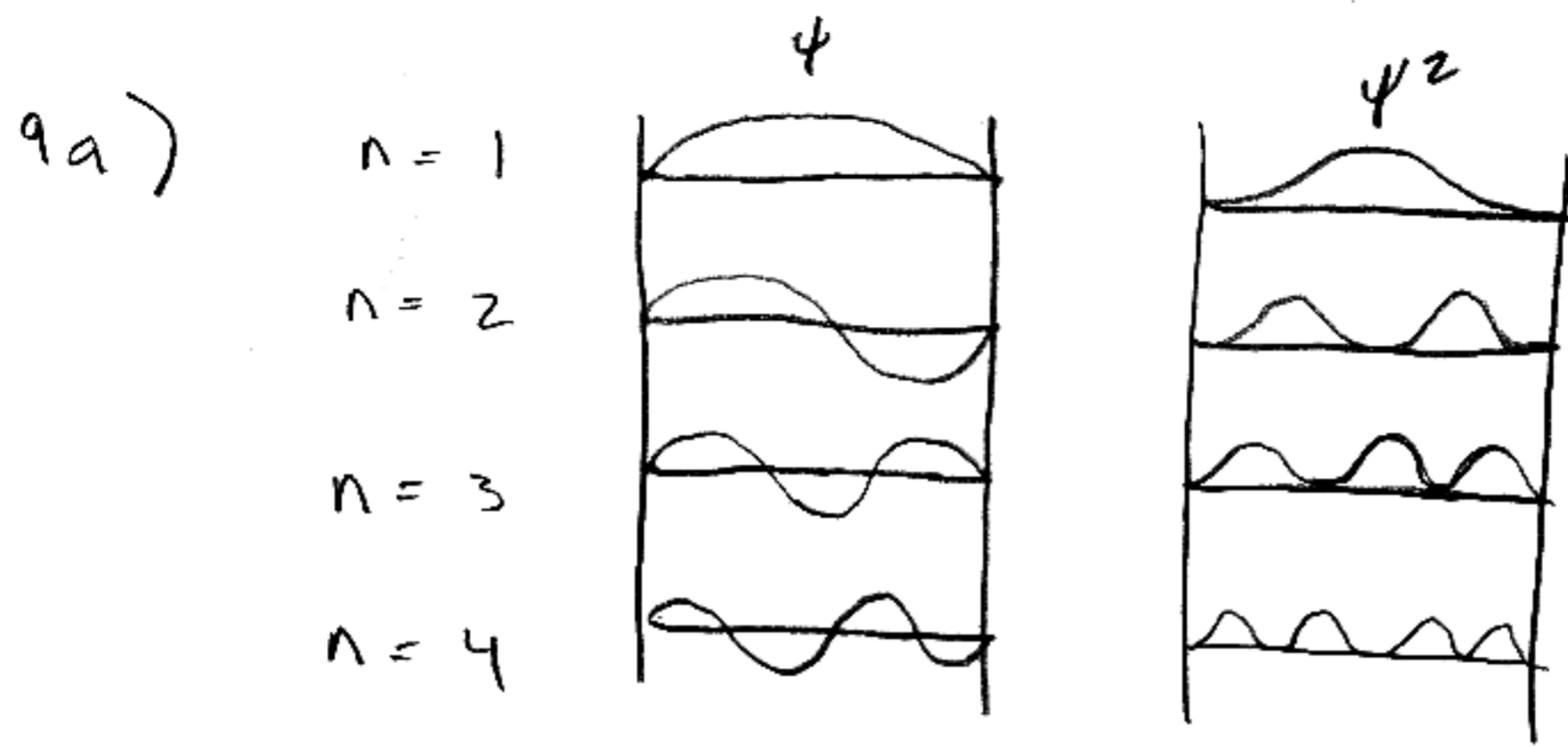
b) probability density plots for the 1s, 2s and 3s orbitals

c) radial probability distributions for the 1s, 2s and 3s orbitals

d) what is the difference between b and c?

10) What orbital is on the front bench?

HMMMM...



9d) ACCOUNTS FOR VOLUME OF SPHERE AND ILLUSTRATES THE MOST LIKELY DISTANCE(ES) AN ELECTRON WILL BE FROM THE NUCLEUS,