1. The probability of finding an electron at the nucleus for an s-orbital is:

- (selected) Non-zero
- $h/2\pi$
- Infinity
- The same as to a p-orbital
- Zero

✓ **Correct**

Solution

2. The n and l quantum number values of the Schrödinger equation radial solution for a hydrogenic atom as given below are:

$$R_n^l(r) = \frac{1}{\sqrt{3}}\left(\frac{Z}{2a_0}\right)^{3/2}\frac{Zr}{a_0}e^{-Zr/2a_0}$$

- $n = 1,\ l = 0$
- $n = 3,\ l = 1$
- $n = 2,\ l = 0$
- $n = 3,\ l = 2$
- $n = 1,\ l = 1$
- (selected) $n = 2,\ l = 1$

3. The n and l quantum number values plus the number of nodes for the wavefunction given below are:

$$R_n^l(r) = 2\left(\frac{Z}{2a_0}\right)^{3/2}\left(1-\frac{Zr}{2a_0}\right)e^{-Zr/2a_0}$$

[Correct answer to be identified.]

- ○ $n=2,\ l=0,\ nodes\ 2$
- ○ $n=3,\ l=0,\ nodes\ 2$
- ○ $n=3,\ l=2,\ nodes\ 1$
- ○ $n=2,\ l=0,\ nodes\ 0$
- ◉ $n=2,\ l=0,\ nodes\ 1$

✓ **Correct**
Solution

4. The n and l quantum numbers plus number of nodes in the following radial solution of the Schroedinger equation for a hydrogenic atom are:

$$R_n^l(r) = \frac{2}{3}\left(\frac{Z}{3a_0}\right)^{3/2}\left[\left(3-6-\frac{Zr}{3a_0}+2\left(\frac{Zr}{3a_0}\right)^2\right)\right]e^{-Zr/3a_0}$$

[Correct answer to be indicated.]

- ○ $n=2,\ l=1,\ nodes=2$
- ◉ $n=3,\ l=0,\ nodes=2$
- ○ $n=2,\ l=0,\ nodes=1$
- ○ $n=3,\ l=0,\ nodes=3$
- ○ $n=2,\ l=0,\ nodes=2$

5. If the energy levels for a hydrogenic atom are given by $E_n = -13.6\ Z^2/n^2\ eV$, the ionization energy of the $U^{91+}\ ion$ in its ground state is:

- ○ $13.6\ eV$
- ○ $1,251.2\ eV$
- ○ $1,237.6\ eV$
- ◉ $115,110.4\ eV$
- ○ $112,621.6\ eV$

✓ **Correct**
Solution

6. The y-axis coordinate in a Cartesian axis system is given in spherical polar coordinates by:

- ○ $rsin\theta$
- ◉ $rsin\theta sin\varphi$
- ○ $rcos\theta sin\varphi$
- ○ $rsin\varphi$

✓ **Correct**
Solution

7. From the angular solution of the Schrödinger equation for a hydrogenic atom given below, the values for the l and m_l quantum numbers are :

$$Y_l^{m_l}(\theta, \phi) = -\sqrt{\frac{15}{8\pi}} sin\theta cos\theta e^{i\phi}$$

- ○ $l = 3,\ m_l = 1$
- ○ $l = 2,\ m_l = 0$
- ○ $l = 3,\ m_l = 2$
- ◉ $l = 2,\ m_l = 1$

✓ **Correct**

Solution

8. From the angular solution of the Schrödinger equation for a hydrogenic atom given below, the values for the l and m_l quantum numbers are :

$$Y_l^{m_l}(\theta, \phi) = -\left(\frac{105}{32\pi}\right)^{1/2} sin^2\theta cos\theta e^{2i\phi}$$

- ○ $l = 2,\ m_l = 1$
- ○ $l = 3,\ m_l = 1$
- ◉ $l = 3,\ m_l = 2$
- ○ $l = 2,\ m_l = 2$

✓ **Correct**

Solution

9. In the Balmer series, for the Hydrogen atom, a weak transition is observed at $397 nm$. What is the electronic emission transition this corresponds to.

- $n = 7$ to $n = 1$
- $n = 6$ to $n = 2$
- $n = 7$ to $n = 2$
- $n = 8$ to $n = 3$
- $n = 5$ to $n = 2$

✓ **Correct**

Solution

10. In the Balmer series of lines for the Hydrogen atom, a weak transition is observed at $397\ \mathrm{nm}$. The value of the same transition for the $Li^{2+}\ ion$ would correspond to an energy value of:

- $28.1\ \mathrm{eV}$
- $122.4\ \mathrm{eV}$
- $2.5\ \mathrm{eV}$
- $13.3\ \mathrm{eV}$
- $119.9\ \mathrm{eV}$

✓ Correct