This print-out should have 8 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

ChemPrin3e 01 02
08:01, general, multiple choice, $<$ 1 min, wording-variable.

001

What is the correct order of increasing frequency?

1. radio waves, infrared radiation, visible light, ultraviolet radiation **correct**

2. radio waves, infrared radiation, ultraviolet radiation, visible light

3. infrared radiation, radio waves, visible light, ultraviolet radiation

4. radio waves, visible light, ultraviolet radiation, infrared radiation

5. ultraviolet radiation, visible light, infrared radiation, radio waves

Explanation:
radio waves < infrared radiation
< visible light < ultraviolet radiation

Mlib 69 0009
08:02, basic, multiple choice, $>$ 1 min, fixed.

002

It takes light with a wavelength of 261 nm, or less, to break the O — H bond in water. What energy does this correspond to (in kJ/photon) and what is the O — H bond strength in kJ/mol?

1. 7.6×10^{-22} kJ/photon, 458 kJ/mol **correct**

2. 7.6×10^{-22} kJ/photon, 458,000 kJ/mol

3. 6.6×10^{-25} kJ/photon, 0.40 kJ/mol

4. 6.6×10^{-25} kJ/photon, 4×10^{-4} kJ/mol

Explanation:

Photoelectric Effect
08:02, general, multiple choice, $<$ 1 min, fixed.

003

The photoelectric effect experiment was significant because

1. it required us to accept the fact that light can behave like particles, in contrast to the teachings of classical physics. **correct**

2. it demonstrated the existence of quantized states in atoms.

3. it proved that atoms cannot exist if the rules of classical physics were obeyed on the atomic scale.

4. it showed us how to make an instrument to detect light by converting photons into electrons, ultimately leading to the invention of the television camera.

5. it lead to the development of the Heisenberg Uncertainty Principle, a revolutionary development that forced us to abandon the idea of determinancy at the atomic scale and accept that all we can know are the probabilities of future outcomes.

Explanation:

ChemPrin3e 01 18
08:03, general, multiple choice, $>$ 1 min, fixed.

004

The average speed of a helium atom at 25°C is 1.23×10^3 m/s. What is the average wavelength of a helium atom at this temperature?

1. 8.11×10^{-11} m **correct**

2. 4.15×10^{-12} m

3. 7.43×10^{-15} m

4. 4.06×10^{-11} m

5. 2.03×10^{-11} m

Explanation:
$v = 1.23 \times 10^3$ m/s

The mass of one He atom is

$$\text{mass}_{\text{He}} = \frac{4.00 \text{ g/mol}}{6.022 \times 10^{23} \text{ atoms/mol}} = 6.64 \times 10^{-24} \text{ g} = 6.64 \times 10^{-27} \text{ kg}$$

Using de Broglie's relationship,

$$\lambda = \frac{h}{p} = \frac{h}{m\,v} = \frac{6.626 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s}}{(6.64 \times 10^{-27} \text{ kg})\,(1230 \text{ m/s})} = 8.11294 \times 10^{-11} \text{ m}$$

ChemPrin3e T01 10

08:03, general, multiple choice, < 1 min, fixed.

005

You are caught in a radar trap and hope to show that the speed measured by the radar gun is in error due to the uncertainty principle. If you assume that the uncertainty in your position is large, say about 10 m, and that the car has a mass of 2150 kg, what is the uncertainty in the velocity?

1. 4×10^{38} m/s

2. 1×10^{-39} m/s

3. 1×10^{33} m

4. 5.0×10^{-38} m/s

5. 2.5×10^{-39} m/s **correct**

Explanation:
$\Delta x = 10$ m $\qquad m = 2150$ kg

$$\Delta v = \frac{\hbar}{2\,m\,\Delta x} = \frac{1.055 \times 10^{-34} \text{ J} \cdot \text{s}}{2\,(2150 \text{ kg})\,(10 \text{ m})} = 2.45349 \times 10^{-39} \text{ m/s}$$

Brodbelt 565

08:08, general, multiple choice, > 1 min, fixed.

006

An orbital has a principal quantum number of 3. The magnetic quantum number is -2. What is the shape of the orbital?

1. s

2. p

3. d **correct**

4. f

5. s or p

6. p or d

7. d or f

8. s, p, or d

9. p, d, or f

Explanation:
For a value of $n = 3$, the subsidiary quantum number ℓ could have a value of 0, 1, or 2. However, the magnetic quantum number has a value of -2, so ℓ could not be 0 nor 1; it must be 2, which corresponds to the d-orbitals.

DAL 05 004

08:10, general, multiple choice, > 1 min, fixed.

007

Which of the following is not a permitted combination of quantum numbers?

1. $n = 3$, $\ell = 0$, $m_\ell = 0$, $m_s = \frac{1}{2}$

2. $n = 3$, $\ell = 0$, $m_\ell = 0$, $m_s = -\frac{1}{2}$

3. $n = 2$, $\ell = 1$, $m_\ell = -2$, $m_s = \frac{1}{2}$ **correct**

4. $n = 4$, $\ell = 2$, $m_\ell = 1$, $m_s = \frac{1}{2}$

5. $n = 4$, $\ell = 3$, $m_\ell = 3$, $m_s = -\frac{1}{2}$

Explanation:
For $n = 2$, m_ℓ can only have values of -1,

0, and +1.

Degenerate Orbitals

08:12, general, multiple choice, < 1 min, fixed.

008

Which statement gives the name and correct principle which is used to determine the arrangement of electrons in degenerate orbitals when writing electron configurations?

1. Hund's rule: put one electron in each degenerate orbital first, then add one more electron with an opposite spin to each orbital. **correct**

2. Aufbau priniciple: fill all degenerate orbitals first, then fill in any higher or lower energy orbitals which are not degenerate.

3. Pauli Principle: only put one electron in any orbital.

4. Mendeleev: leave unoccupied spaces in the degenerate orbitals in case we discover any new orbitals.

Explanation: