Periodic Table of the Elements
This print-out should have 30 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. V1:1, V2:1, V3:1, V4:1, V5:2.

**ACAMP 02 0001**
08:02, general, multiple choice, > 1 min, fixed.

001 (part 1 of 1) 6 points
A 200 nm photon has how many times the energy of a 700 nm photon?

1. 3.5 correct
2. 4.2
3. 0.29
4. 0.24
5. $9.93 \times 10^{-19}$
6. $2.84 \times 10^{-19}$

**Explanation:**
Energy of Light: $E = \frac{hc}{\lambda}$

For the 200 nm photon:

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ J} \cdot \text{s})(3 \times 10^8 \text{ m} \cdot \text{s}^{-1})}{200 \times 10^{-9} \text{ m}} = 9.94 \times 10^{-19} \text{ J}$$

For the 700 nm photon:

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ J} \cdot \text{s})(3 \times 10^8 \text{ m} \cdot \text{s}^{-1})}{700 \times 10^{-9} \text{ m}} = 2.84 \times 10^{-19} \text{ J}$$

Thus

$$\frac{9.94 \times 10^{-19} \text{ J}}{2.84 \times 10^{-19} \text{ J}} = 3.5$$

**ChemPrin3e T01 26**
08:05, general, multiple choice, < 1 min, fixed.

002 (part 1 of 1) 6 points
Which of the following emission lines corresponds to part of the Balmer series of lines in the spectrum of a hydrogen atom?

A) $n = 2 \rightarrow n = 1$
B) $n = 4 \rightarrow n = 2$
C) $n = 4 \rightarrow n = 1$
D) $n = 3 \rightarrow n = 2$
E) $n = 4 \rightarrow n = 3$

1. B and D only **correct**
2. A, D, and E only
3. A and C only
4. E only
5. B and C only
6. D and E only
7. B, C, and E only

**Explanation:**
The Balmer series is produced by electronic transitions which either begin (absorption spectra) or end (emission spectra) at the energy level $n = 2$. These correspond mostly to the visible region.

**ChemPrin3e 01 30**
08:05, general, numeric, > 1 min, normal.

003 (part 1 of 1) 6 points
In the spectrum of atomic hydrogen, a violet line is observed at 434 nm. What are the beginning and ending energy levels of the electron during the emission of energy that leads to this spectral line?

1. $n = 5, n = 2$ **correct**
2. $n = 6, n = 2$
3. $n = 6, n = 3$
4. $n = 5, n = 3$
5. $n = 4, n = 2$
6. $n = 4, n = 3$

Explanation:

\[ \lambda = 434 \text{ nm} = 4.34 \times 10^{-7} \text{ m} \]

Because the line is in the visible part of the spectrum, it belongs to the Balmer series for which the ending $n$ is 2.

For the starting value of $n$,

\[ \nu = \frac{c}{\lambda} = \frac{3 \times 10^8 \text{ m/s}}{4.34 \times 10^{-7} \text{ m}} = 6.909 \times 10^{14} \text{ s}^{-1} \]

Using the Rydberg formula,

\[ \nu = (3.29 \times 10^{15} \text{ s}^{-1}) \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right) \]

\[ \frac{3.29 \times 10^{15} \text{ s}^{-1}}{\nu} = \frac{1}{n_f^2} - \frac{1}{n_i^2} = \frac{1}{n_f^2} - \frac{1}{3.29 \times 10^{15} \text{ s}^{-1}}\]

\[ \frac{1}{n_f^2} - \frac{1}{3.29 \times 10^{15} \text{ s}^{-1}} = 0.04 \]

\[ n_f = \frac{1}{0.04} = 25 \]

\[ n_i = 5 \]

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OneD Ground State

08:06, general, multiple choice, < 1 min, fixed.

004 (part 1 of 1) 6 points

If a particle is in a one-dimensional box and is in its ground state, where would you MOST probably find the particle?

1. in the center of the box correct

2. at the two ends of the box

3. either side of the center of the box

4. anywhere in the box

Explanation:

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

005 (part 1 of 1) 6 points

Estimate the minimum uncertainty in the position of an electron of mass $9.109 \times 10^{-31} \text{ kg}$ if the error in its speed is 300000 m/s.

1. 386 pm

2. $3.86 \times 10^{-12} \text{ m}$

3. 193 pm correct

4. $1.93 \times 10^{-12} \text{ m}$

Explanation:

\[ m = 9.109 \times 10^{-31} \text{ kg} \quad \Delta v = \pm 300000 \text{ m/s} \]

\[ \Delta x = \frac{\hbar}{2m\Delta v} = \frac{1.055 \times 10^{-34} \text{ J} \cdot \text{s}}{2 (9.109 \times 10^{-31} \text{ kg}) (300000 \text{ m/s})} = (1.93033 \times 10^{-10} \text{ m}) \left( \frac{10^{12} \text{ pm}}{1 \text{ m}} \right) = 193.033 \text{ pm} . \]

DeBroglie Wavelength 03

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

006 (part 1 of 1) 6 points

What is the de Broglie wavelength of Schrödinger’s cat, Albert, running to his food bowl. Albert has a mass of 5200 g and is running at 1.6 m/s.

1. $7.964 \times 10^{-35} \text{ m}$ correct

2. $7.964 \times 10^{-38} \text{ m}$

3. $4.978 \times 10^{-35} \text{ m}$

4. $5.513 \times 10^{-33} \text{ m}$

Explanation:

\[ \lambda = \frac{\hbar}{p} = \frac{\hbar}{m \cdot v} \]

\[ = \frac{6.626 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s}}{(5.2 \text{ kg})(1.6 \text{ m/s})} \]

\[ = 7.96394 \times 10^{-35} \text{ m} \]
Schrodinger Eq 01
08:06, general, multiple choice, < 1 min, fixed.
007 (part 1 of 1) 6 points
Which of the following applications of the Schrodinger equation includes a potential energy term with both attractive and repulsive terms?

1. $V(r)$ for electrons in the helium atom correct

2. $V(x)$ for a particle in a box

3. $V(r)$ for the electron in the hydrogen atom

4. $V(x)$ for the standing wave of a plucked guitar string

5. None of these

Explanation:

Quantum Number 01
08:08, general, multiple choice, < 1 min, fixed.
009 (part 1 of 1) 6 points
What is the total number of orbitals found in the $n = 1$ through $n = 4$ shells?

1. 30 correct

2. 16

3. 60

4. 10

5. None of these

Explanation:

ChemPrin3e T01 38
08:07, general, multiple choice, < 1 min, fixed.
008 (part 1 of 1) 6 points
The three quantum numbers for an electron in a hydrogen atom in a certain state are $n = 4$, $\ell = 1$, $m_\ell = 1$. The electron is located in what type of orbital?

1. $4s$

2. $3p$

3. $3d$

4. $4d$

5. $4p$ correct

Explanation:

Electron Config 01
08:13, general, multiple choice, < 1 min, fixed.
011 (part 1 of 1) 6 points
Which of the following ions or neutral atoms does NOT possess the electronic configuration $[\text{Ar}] 4s^23d^2$?

1. $V^-$ correct

2. $\text{Fe}^{4+}$
3. Ti
4. H$^{21-}$
5. Ca$^{2-}$

**Explanation:**

ChemPrin3e T01 41
08:12, general, multiple choice, < 1 min, fixed.
012 (part 1 of 1) 6 points
Write the ground-state electron configuration of a chromium atom.

1. [Ar] 4s$^2$ 3d$^4$
2. [Ar] 4s$^1$ 3d$^5$
3. [Ar] 3d$^5$ 4s$^1$ **correct**
4. [Ar] 3d$^6$
5. [Ar] 3d$^4$ 4s$^2$

**Explanation:**
The Aufbau order of electron filling is 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, etc.

$s$ orbitals can hold 2 electrons, $p$ orbitals 6 electrons, and $d$ orbitals 10 electrons. Note some exceptions do occur in the electron configuration of atoms because of the stability of either a full or half-full outermost $d$-orbital, so you may need to account for this by ‘shuffling’ an electron from the $(n - 1)$ $s$ orbital. Finally use noble gas shorthand to get the answer: [Ar] 3d$^5$ 4s$^1$.

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**Valence Config 01**
08:13, general, multiple choice, < 1 min, fixed.
013 (part 1 of 1) 6 points
Which of the following valence configurations is INCORRECT?

1. Tl$^{2+}$ : $s^2d^{10}$ **correct**
2. Cu : $s^1d^{10}$
3. Bi$^{2+}$ : $s^2d^{10}p^1$
4. Sb$^{5+}$ : $d^{10}$
5. Pt : $d^{10}$

**Explanation:**

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**Periodic Table 01**
08:11, general, multiple choice, < 1 min, fixed.
014 (part 1 of 1) 6 points
Which of the following statements that describe the periodic table is true?

1. The first family of elements on the periodic table is the alkali metals. **correct**
2. Rows of the periodic table are referred to as families.
3. An element with an $s^2p^5$ valence shell is a noble gas.
4. There are three blocks represented on the periodic table of the elements.
5. The main group elements are found in the $s$, $p$ and $d$ blocks.

**Explanation:**

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**ACAMP304 E2 01**
09:03, general, multiple choice, < 1 min, fixed.
015 (part 1 of 1) 6 points
Why is it harder to remove an electron from fluorine than from carbon, or, to put it another way, why are the valence electrons of fluorine more strongly bound than those of carbon?

1. Fluorine has more valence electrons than does carbon.
2. Carbon has a lower atomic mass than does fluorine.
3. The valence electrons of both fluorine and carbon are found at about the same distance from their respective nuclei but the greater positive charge of the fluorine nucleus attracts its valence electrons more strongly. **correct**
4. The statement is false; it takes very nearly the same energy to remove an electron from (ionize) both elements.

5. Fluorine has a nearly filled octet, which is always more stable than a partially filled octet.

**Explanation:**
For each element, the valence electrons are in the 2s and the 2p orbitals:
- C : 1s²2s²2p²; 6 protons in the nucleus; 6 electrons (total); 4 valence electrons.
- F : 1s²2s²2p⁵; 9 protons in the nucleus; 9 electrons (total); 7 valence electrons.

The effective nuclear charge felt by the valence electrons of fluorine is greater than the effective nuclear charge felt by the valence electrons of carbon. Therefore, the valence electrons of fluorine experience a greater Coulombic attractive force and are harder to remove.

**Ionization Energy**

09:03, general, multiple choice, < 1 min, fixed.  
017 (part 1 of 1) 6 points

Rank Na, Mg, Al and Si in terms of increasing ionization energy.

1. Na < Al < Mg < Si **correct**
2. Na < Mg < Al < Si
3. Si < Mg < Al < Na
4. Si < Al < Mg < Na
5. Na < Si < Mg < Al

**Explanation:**

6. None is appropriate because potassium sulfide is a covalent compound.

**Explanation:**
The best drawing will show the valence elec-
trons, the charges, and the appropriate ratio of ions for K₂S.

ChemPrin3e T02 07
10:05, general, multiple choice, < 1 min, fixed.
019 (part 1 of 1) 6 points
Which of the following has the highest lattice energy?

1. NaCl
2. KI
3. MgO correct
4. BaO
5. CaO

Explanation:
Mg²⁺ and O²⁻ have the highest charge densities.

DAL 07 013
11:07, general, multiple choice, > 1 min, fixed.
020 (part 1 of 1) 6 points
In the following group of compounds, O₃, SO₂, SO₃, I⁻, CO₃²⁻ identify those that exhibit resonance.

1. All exhibit resonance
2. O₃, SO₂, SO₃, CO₃²⁻ only correct
3. SO₃, I⁻, CO₃²⁻ only
4. CO₃²⁻ only
5. SO₂, SO₃ only

Explanation:
All except I⁻ exhibit resonance. Resonance occurs when more than one structure can be drawn for a compound involving changing the position of double bonds. O₃ has 2 resonance structures, SO₂ has 2 resonance structures, SO₃ has 3 resonance structures, and CO₃²⁻ has 3 resonance structures. I⁻ has 2 single bonds and no double bonds; there is no resonance for this structure.

ChemPrin3e T02 22
11:04, basic, multiple choice, < 1 min, fixed.
021 (part 1 of 1) 6 points
How many lone pairs of electrons are found in the Lewis structure of hydrazine (H₂NNH₂)?

1. 8
2. 4
3. 1
4. 0
5. 2 correct

Explanation:
The Lewis structure is H—N—N—H

ChemPrin3e 02 52
11:09, general, multiple choice, < 1 min, fixed.
022 (part 1 of 1) 6 points
Which of the species NO, BrO, CH₃⁺, BF₄⁻ are radicals?

1. NO and BrO only correct
2. NO and CH₃⁺ only
3. BrO and CH₃⁺ only
4. BrO and BF₄⁺ only
5. NO, CH₃⁺ and BF₄⁻ only
6. BrO, CH₃⁺ and BF₄⁻ only
7. NO and BF₄⁻ only

Explanation:
The Lewis structures are
\[ \cdot N\equiv\cdot O \quad \cdot \text{Br} - \cdot O \]
Radicals are species with an unpaired electron, so only NO and BrO are radicals.

**Lewis BCl₃ dash**
11:05, general, multiple choice, < 1 min, fixed.

023 (part 1 of 1) 6 points
Which of the following is the correct Lewis formula for boron trichloride (BCl₃)?

1. \( \text{Cl} - \overline{\text{B}} - \text{Cl} \) 
2. \( \text{Cl} - \overline{\text{B}} - \text{Cl} \) \text{ correct} 
3. \( \text{Cl} - \overline{\text{B}} - \text{Cl} \) 
4. \( \text{Cl} - \overline{\text{B}} - \text{Cl} \) 
5. \( \text{Cl} - \overline{\text{B}} - \text{Cl} \) 
6. \( \text{Cl} - \overline{\text{B}} - \text{Cl} \) 
7. \( \text{Cl} - \overline{\text{B}} - \text{Cl} \)

Explanation:
B contributes 3 valence \( e^- \) and each Cl contributes 7 valence \( e^- \) for a total of 24 \( e^- \);
B is a known exception to the octet rule and can form stable with 6 valence \( e^- \):

\[ \text{Cl} - \overline{\text{B}} - \text{Cl} \] 

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**JYL 70401b**
11:04, general, multiple choice, > 1 min, wording-variable.

024 (part 1 of 1) 6 points
Which of these substances has a Lewis formula incorporating a double bond?

1. \( \text{C}_2\text{H}_4 \) \text{ correct} 
2. \( \text{HBr} \) 
3. \( \text{CS} \) 
4. \( \text{H}_2\text{Te} \) 
5. \( \text{SbH}_3 \) 
6. \( \text{HCl} \) 
7. \( \text{PH}_3 \) 
8. \( \text{HF} \) 
9. \( \text{HI} \)
10. AsH₃

Explanation:
The structure for C₂H₄ is

```
     C
   / \  \
  H   C
   \ / \\
    H  H
```

Each C has 4 valence e⁻ and each H has 1 for a total of 12 e⁻.

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SF₆ correct

2. H₂O

3. CH₄

4. NH₃

Explanation:
S has 6 valence e⁻
F has 6 × 7 valence e⁻
Total = 48 valence e⁻

```
  \ F /  \\
 / \ F \ F
\ F H S F /
 \ F \ F / \\
```

SF₆ has 48 e⁻ but S has an expanded valence shell containing 12 e⁻, thus violating the octet rule.

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Lone Pairs 02

11:06, general, multiple choice, < 1 min, fixed.

026 (part 1 of 1) 6 points

How many lone electron pairs are found on the central atom of IF₂⁻?

1. 3 correct

2. 1

3. 2

4. 4

5. 5

Explanation:

For the electron dot representation

```
\ N \ O \ N \ O \ N \ O \\
\ \ \ \ \ \ \ \ \\
\ F \ S \ F \ F \ F \\
\ \ \ \ \ \ \\
```

of N₂O₅, what are the formal charges on each atom going from 1 to 4 in order?

1. 1, 0, −1, 1 correct

2. 0, 0, 1, −1

3. 0, 0, −1, 0

4. 1, 0, 0, −1

5. 0, 0, 0

6. −1, 2, 1, 0

Explanation:
The formal charge is calculated by

\[ FC = \text{group} \# - (\text{# bonds} + \text{# unshared} e^-) \]

Thus

\[ FC_1 = 5 - (4 + 0) = 1 \]
\[ FC_2 = 6 - (2 + 4) = 0 \]
\[ FC_3 = 6 - (1 + 6) = -1 \]
\[ FC_4 = 5 - (4 + 0) = 1 \]

ChemPrin3e T02 30

11:08, general, multiple choice, < 1 min, fixed.

028 (part 1 of 1) 6 points

Write three Lewis structures for the cyanate ion NCO⁻ where the arrangement of atoms
is N, C, and O, respectively. In the most plausible structure using formal charges,

1. there is a triple bond between N and C. **correct**

2. there are two double bonds.

3. there is a triple bond between C and O.

4. the formal charge on O is +1.

5. the formal charge on N is -1.

**Explanation:**

\[
\begin{array}{ccc}
0 & 0 & -1 \\
:N & \equiv & C \equiv O:
\end{array}
\]

\[
\begin{array}{ccc}
-1 & 0 & 0 \\
N & \equiv & C \equiv O
\end{array}
\]

\[
\begin{array}{ccc}
-2 & 0 & +1 \\
N & \equiv & C \equiv O
\end{array}
\]

**Bond Lengths**

10:09, general, multiple choice, < 1 min, fixed. **029** (part 1 of 1) 6 points

Using polarizability arguments, rank the bond lengths from longest to shortest for the H atom attached to a halogen atom.

1. HI > HBr > HCl > HF **correct**

2. HI > HCl > HF > HBr

3. HF > HCl > HBr > HI

4. HCl > HF > HI > HBr

**Explanation:**

**Electronegativity Diff 01**

09:05, general, multiple choice, < 1 min, fixed. **030** (part 1 of 1) 6 points

For which of the following bonds is the difference in electronegativity the largest?

1. H — F **correct**

2. H — H

3. H — C