CHE 105 Exam 3 Fall 2015

Your Name: _____ **Your ID:** _____

Question #: 1

A 10.0 g sample of nitroglycerine, $C_3H_5N_3O_9$ (molar mass 227.10 g/mol) completely explodes, producing gases according to the reaction equation below.

$$4\ C_3H_5N_3O_9(s) \rightarrow 12\ CO_2(g) + 10\ H_2O(g) + 6\ N_2(g) + O_2(g)$$

If the total pressure of the gases produced is 2.1 atm, what is the partial pressure of $O_2(g)$?

__1__ atm

Report your answer with **2 significant figures** and **do not include units**.

1. _____

Question #: 2

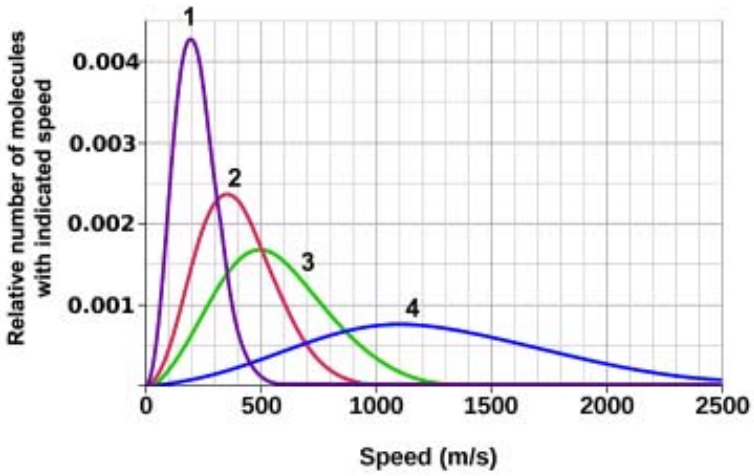
The figure shows the speed distributions of He, Ne, Ar and Kr at 25 °C. Which element is represented by curve #3 (green)?

A. He

B. Ne

C. Ar

D. Kr



Question #: 3

The van der Waals equation provides correction factors used to calculate the properties of a gas under nonideal conditions. Which of the following statements describe(s) why real gases behave least ideally at low temperature or high pressure?

Select **all** of the applicable statements.

A. At high pressure, the volume of the gas particles occupies a greater fraction of the total gas volume.

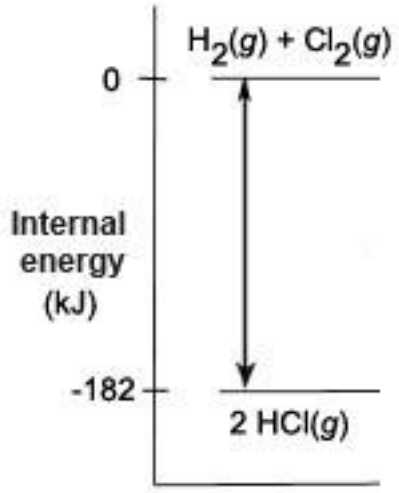
B. At high pressure, gas molecules move with slower kinetic energies.

C. At higher temperatures, the average kinetic energy of the gas molecules is lower.

D. At low temperature, intermolecular attractive forces become so effective that gas pressure is lower than predicted by the ideal gas law.

Question #: 4

$\Delta E_{surroundings}$ for the reaction $H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g)$ depicted below is __1__ kJ. Report your answer with three significant digits and without units.



1. _____

Question #: 5

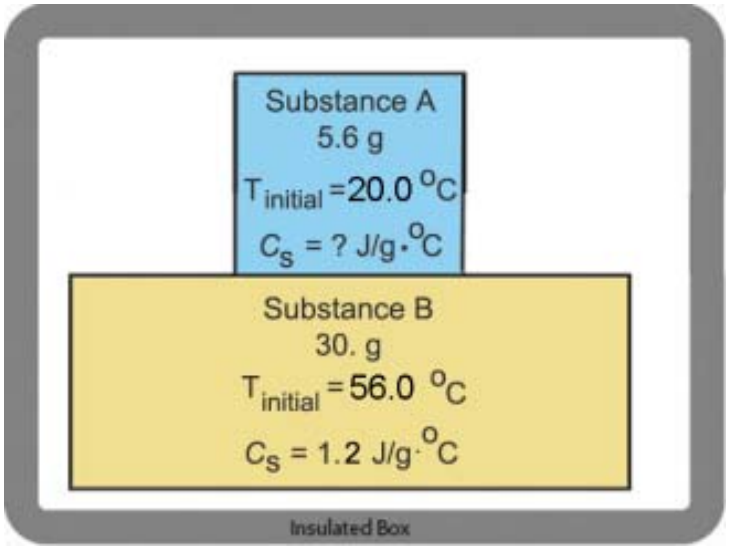
A baby's ventilator reduced the volume of 1.200 L of air in a balloon to 0.500 L at 1.00 atm of constant pressure, using an additional 0.25 kJ of thermal energy to heat the air. By how much did the internal energy of the air (the system) change?

101 J = 1.00 L•atm

A. +0.32 kJ
B. +72.95 kJ
C. +0.18 kJ
D. −0.18 kJ

Question #: 6

The initial conditions of blocks of two substances, A and B, are shown in the figure below. A and B come into contact with one another and reach thermal equilibrium at a final temperature 48.0 °C. What is the specific heat capacity (C_s) of substance A? No heat is lost during the transfer between the two blocks.



A. 0.30 J/g•°C
B. 1.8 J/g•°C
C. 2.4 J/g•°C
D. 1.3 J/g•°C

Question #: 7

A balloon is inflated from 0.010 L to 0.500 L against an external pressure of 1.00 atm. How much work is done?

101 J = 1.00 L•atm

A. −49.5 J
B. −4.85 J
C. +4.85 J
D. +1.01 J

Question #: 8

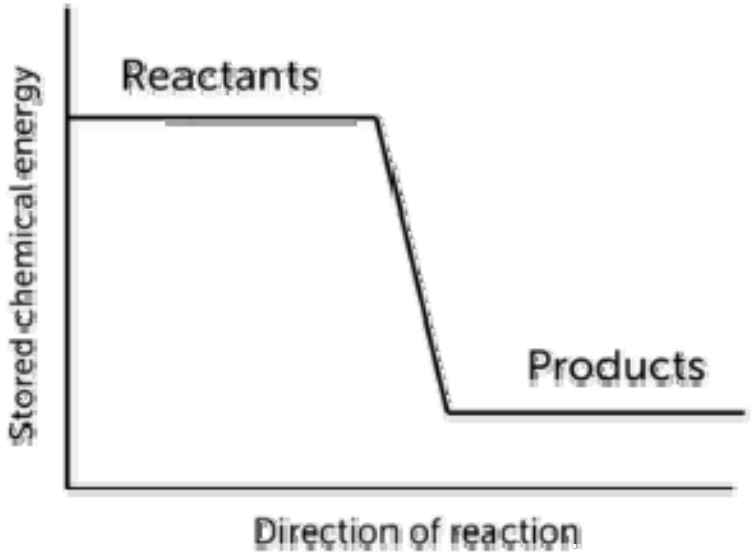
A 21.8 g sample of ethanol (C_2H_5OH, 46.07 g/mol) is burned in a bomb calorimeter, according to the following reaction equation. If the temperature rises from 25.0 °C to 62.3 °C, what is the heat capacity of the calorimeter?

$$C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 3\ H_2O(g) \quad \Delta H^\circ_{rxn} = -1235\ kJ$$

A. 5.65 kJ/°C
B. 63.7 kJ/°C
C. 33.1 kJ/°C
D. 15.7 kJ/°C

Question #: 9

Given the energy diagram below, is this reaction endothermic or exothermic, and is change in enthalpy positive or negative?



A. endothermic, positive ΔH
B. endothermic, negative ΔH
C. exothermic, positive ΔH
D. exothermic, negative ΔH

Question #: 10
Use the standard reaction enthalpies below to determine $\Delta H°_{rxn}$ for the reaction:

$8\ SO_3(g) \rightarrow S_8(s) + 12\ O_2(g)$ $\quad \Delta H°_{rxn} =$ __1__ kJ

Given:
$8\ SO_2(g) \rightarrow S_8(s) + 8\ O_2(g)$ $\quad \Delta H°_{rxn} = +2374$ kJ
$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$ $\quad \Delta H°_{rxn} = -198$ kJ

Report your answer without units and in scientific notation with three significant digits.

1. _____

Question #: 11
Given the following data, calculate the enthalpy of formation of $B_2H_6(g)$.

$$B_2H_6(g) + 6\ H_2O(l) \rightarrow 2\ H_3BO_3(s) + 6\ H_2(g) \quad \Delta H° = -510 \text{ kJ}$$

$\Delta H°_f$ of $H_3BO_3(s) = -1094$ kJ/mol
$\Delta H°_f$ of $H_2O(l) = -286$ kJ/mol
$\Delta H°_f$ of $B_2H_6(g)$ = __1__ kJ/mol.

Report your answer with **two significant figures** and **do not include units**.

1. _____

Question #: 12
Visible light falls immediately between the _____ and _____ regions of the electromagnetic spectrum.
Choose **two** regions.

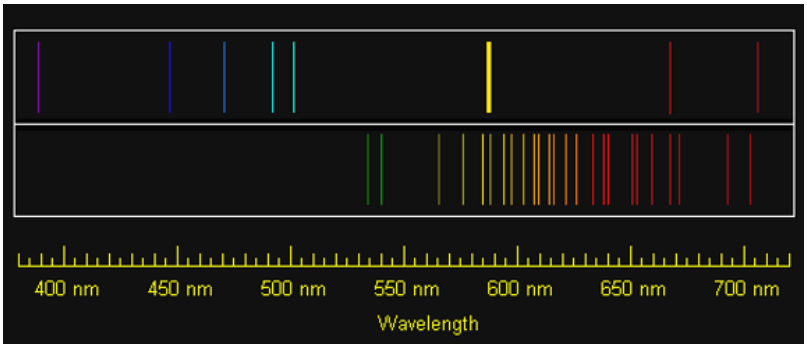
A. ultraviolet
B. infrared
C. radio
D. X-ray

Question #: 13
Consider light with a wavelength of 495 nm. The frequency is __1__ s^{-1} and there are __2__ kJ in 1.00 mole of photons.
Answer both to three significant figures and do not include units in your answer.

1. _____

2. _____

Question #: 14
Which of the following statements is **true** about the atomic spectra below?



A. They are emission spectra for the same element.
B. The emission spectrum of an element is on top and the absorption spectrum for the same element is on the bottom.
C. They are emission spectra for two different elements.
D. They are absorption spectra for two different elements.

Question #: 15
An atom absorbs the most energy when one of its electrons undergoes which transition?

A. $n = 1$ to $n = 2$
B. $n = 2$ to $n = 3$
C. $n = 3$ to $n = 4$
D. $n = 4$ to $n = 5$

Question #: 16
What is the minimum uncertainty in the position of an electron (mass= 9.11×10^{-31} kg) moving at a speed of 2.55×10^{7} m/s with an uncertainty in the speed of 4.35×10^{5} m/s?

A. 133 pm
B. 7.53 pm
C. 308 pm
D. 2270 pm

Question #: 17
If two electrons in the same atom have quantum number $l = 1$, they could be in _____.
Select **all** that apply.

A. orbitals at different principal (n) levels, but with the same shape.
B. the same orbital.
C. orbitals at the same principal (n) level, with the same shape but different orientations.
D. two different s orbitals.

Question #: 18

The quantum number n determines which properties of an atomic orbital?
Select **all** that apply.

A. relative size
B. relative energy
C. shape
D. orientation

Question #: 19

What is the electron configuration of a ground-state sulfur atom?
1
Use this format: $1s^2\ 2s^2\ 2p^3$...

1. _____

Question #: 20

Which of the following sets of quantum numbers (n, l, m_l) does **not** represent an allowed atomic orbital?

A. (1, 0, 0)
B. (2, 2, 1)
C. (2, 1, –1)
D. (3, 2, 0)

Question #: 21

A photon with a frequency of 6.17×10^{14} Hz is emitted when an electron in a hydrogen atom moves from a higher energy level to the $n = 2$ level. What is the initial energy level?
$n =$ 1

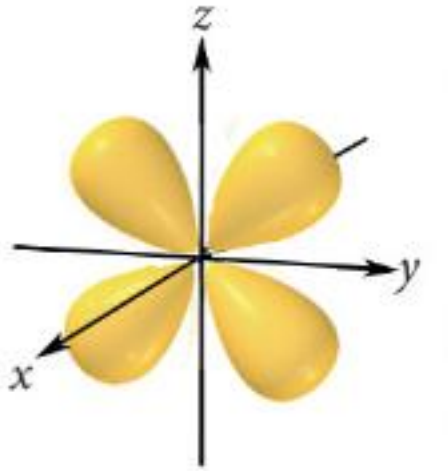
1. _____

Question #: 22

What is the maximum number of electrons that can have both of the quantum numbers, $n = 5$ and $l = 3$, in an atom?

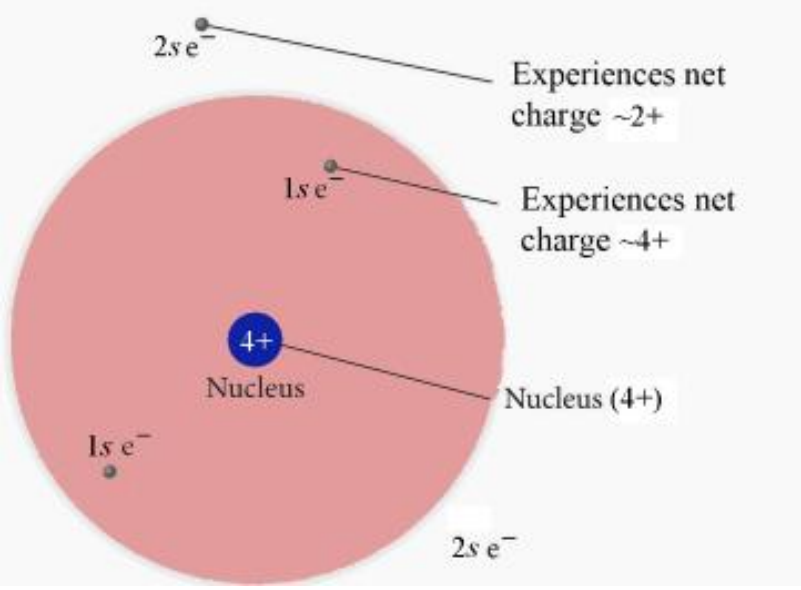
A. 7
B. 10
C. 14
D. 18

Question #: 23
What are possible quantum numbers (n, l, m_l) for the orbital shown below?



A. (5, 3, 0)
B. (3, 2, −2)
C. (4, 1, 0)
D. (5, 0, 0)

Question #: 24
This figure illustrates which effect experienced by 1*s* and 2*s* electrons in a beryllium atom?

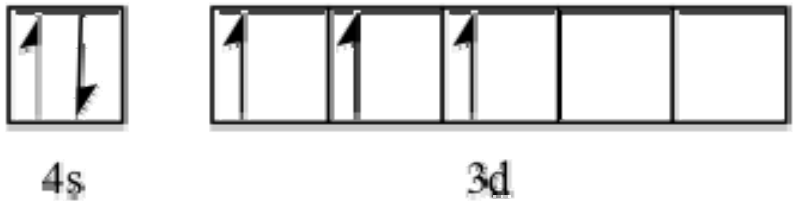


A. Pauli exclusion principle
B. shielding
C. electron affinity
D. Heisenberg uncertainty

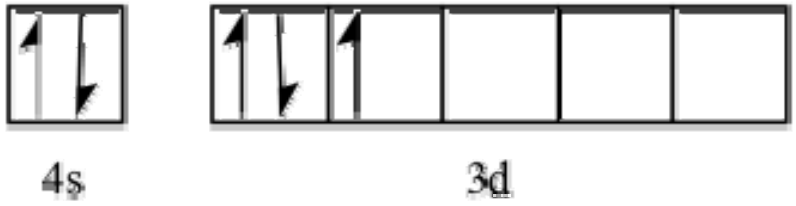
Question #: 25

Which orbital diagram shows the ground-state valence electron configuration for Mn^{2+}?

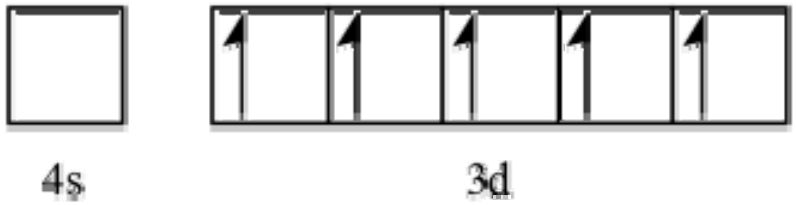
A.



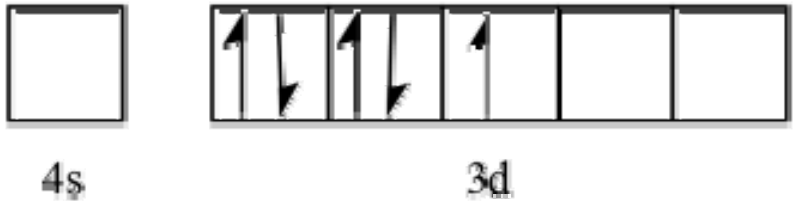
B.



C.



D.



Question #: 26

What is the ground-state electron configuration for silver?

A. $[Kr]5s^2 4d^9$

B. $[Kr]5s^1 4d^{10}$

C. $[Kr]5s^2 5d^9$

D. $[Kr]5s^1 5d^{10}$

Question #: 27

Which group of elements is sorted from **largest to smallest** atomic radius?

A. K >Si >S >O

B. Ca >Rb >Al >He

C. B >C >Mg >F

D. Ge >Si >Ga >Be

Question #: 28
Which equation below represents the **electron affinity** of Na?

A. $Na(g) + e^- \rightarrow Na^-(g)$
B. $Na(g) \rightarrow Na^+(g) + e^-$
C. $Na(g) + e^- \rightarrow Na^+(g)$
D. $Na^+(g) \rightarrow Na(g) + e^-$

Question #: 29
The first ten ionization energies (kJ/mol) of an element are:

1012; 1907; 2914; 4964; 6274; 21,267; 25,431; 29,872; 35,905; 40,130.

This element belongs to group __1__ (numerical label of a column or family) of the periodic table.

1. _____

Question #: 30
Because of the __1__ [low, high] ionization energies of alkali metals, they are readily __2__ [oxidized, reduced].

Reactivity __3__ [increases, decreases] down the column because ionization energy __4__ [increases, decreases] down the column.

1. _____

2. _____

3. _____

4. _____

CHE 105 Exam 3 Fall 2015 Key

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Report your answer with **2 significant figures** and **do not include units**.

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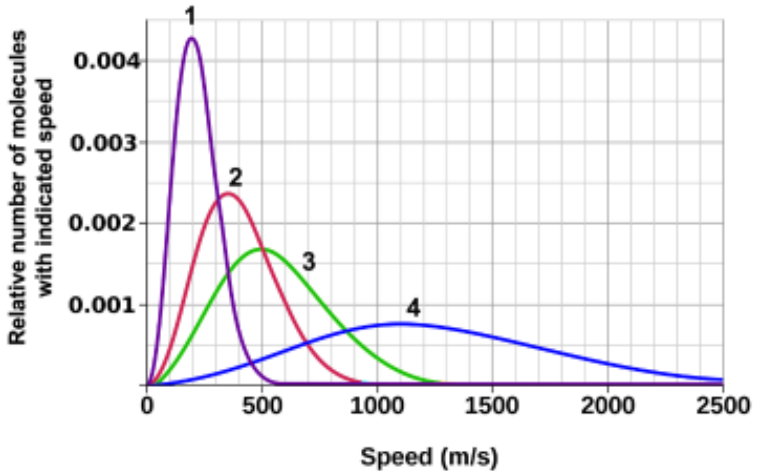
The figure shows the speed distributions of He, Ne, Ar and Kr at 25 °C. Which element is represented by curve #3 (green)?



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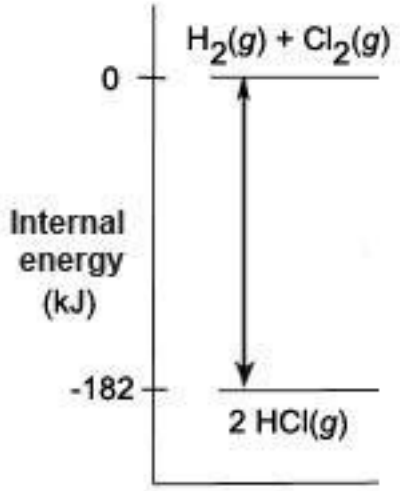

1. 182|+182|1.82E2|+1.82E2|

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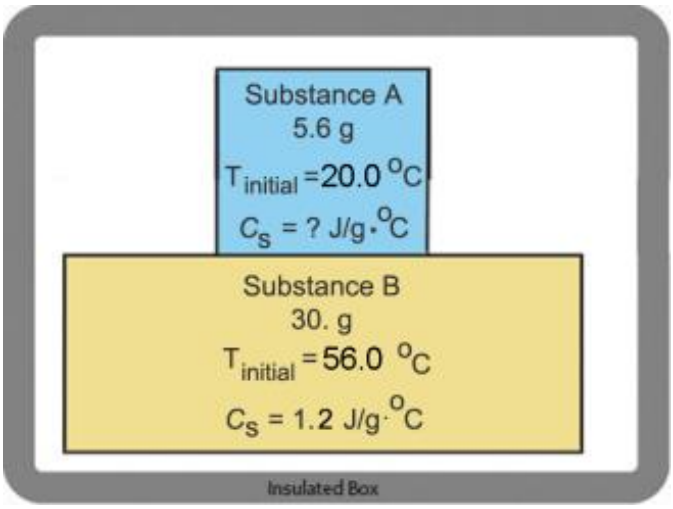

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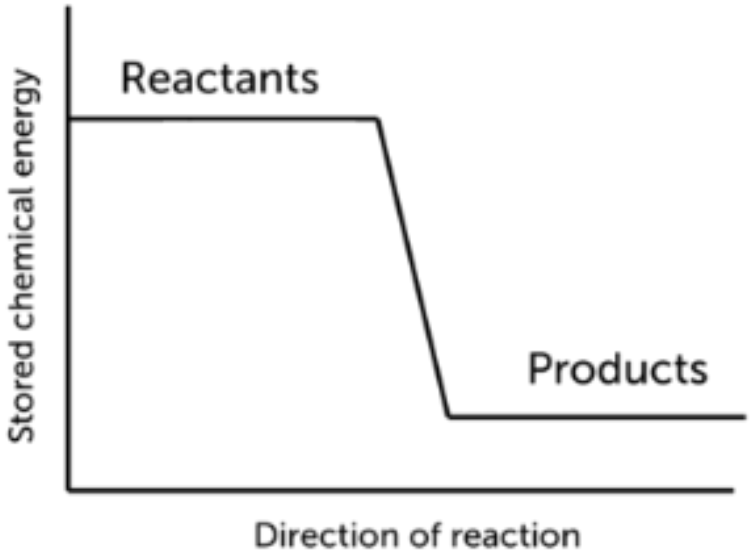

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$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$ $\Delta H^\circ_{rxn} = -198$ kJ
Report your answer with **3 significant figures** and **do not include units**, using the format 2.2E2 or 2.2E-2 if you use scientific notation.

1. 3.17E3|3.17 E3|+3.17E3|+3.17 E3|3.17E+3|3.17 E+3|

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Given the following data, calculate the enthalpy of formation of $B_2H_6(g)$.
$B_2H_6(g) + 6\ H_2O(l) \rightarrow 2\ H_3BO_3(s) + 6\ H_2(g)$ $\Delta H^\circ = -510$ kJ
ΔH°_f of $H_3BO_3(s) = -1094$ kJ/mol
ΔH°_f of $H_2O(l) = -286$ kJ/mol
ΔH°_f of $B_2H_6(g)$ = __1__ kJ/mol.
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1. 38|39|37|

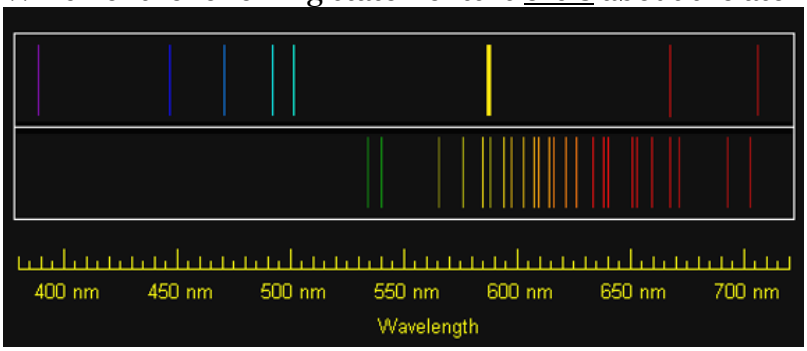
Question #: 12
Visible light falls immediately between the _____ and _____ regions of the electromagnetic spectrum.
Choose **two** regions.

✓A. ultraviolet
✓B. infrared
C. radio
D. X-ray

Question #: 13
Consider light with a wavelength of 495 nm. The frequency is __1__ s^{-1} and there are __2__ kJ in 1.00 mole of photons.
Answer both to three significant figures and do not include units in your answer. Use the form 2.22E2 or 2.22E-2 if you use scientific notation.

1. 6.06E14|6.06e14|6.06 E14|6.06 e14|6.05E14|6.05e14|6.05 E14|6.05 e14|6.07E14|6.07e14|6.07 E14|6.07 e14|
2. 242|241|243|2.42E2|2.41E2|2.43E2|2.42 E2|2.41 E2|2.43 E2|

Question #: 14
Which of the following statements is **true** about the atomic spectra below?



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Question #: 15
An atom absorbs the most energy when one of its electrons undergoes which transition?

✓A. $n = 1$ to $n = 2$
B. $n = 2$ to $n = 3$
C. $n = 3$ to $n = 4$
D. $n = 4$ to $n = 5$

Question #: 16
What is the minimum uncertainty in the position of an electron (mass= 9.11×10^{-31} kg) moving at a speed of 2.55×10^{7} m/s with an uncertainty in the speed of 4.35×10^{5} m/s?

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Question #: 17
If two electrons in the same atom have quantum number $l = 1$, they could be in _____.
Select **all** that apply.

✓A. orbitals at different principal (n) levels, but with the same shape.
✓B. the same orbital.
✓C. orbitals at the same principal (n) level, with the same shape but different orientations.
D. two different *s* orbitals.

Question #: 18
The quantum number n determines which properties of an atomic orbital?
Select **all** that apply.

✓A. relative size
✓B. relative energy
C. shape
D. orientation

Question #: 19
What is the electron configuration of a ground-state sulfur atom?
1
Use this format with spaces but no superscripts: 1s2 2s2 2p3...

1. 1s2 2s2 2p6 3s2 3p4|1s^2 2s^2 2p^6 3s^2 3p^4|1s2 2s2 2p6 3s2 3p4|1s^2 2s^2 2p^6 3s^2 3p^4|[Ne] 3s2 3p4|[Ne]3s2 3p4|[Ne] 3s^2 3p^4|[Ne] 3s2 3p4|

Question #: 20
Which of the following sets of quantum numbers (n, l, m_l) does **not** represent an allowed atomic orbital?

A. (1, 0, 0)
✓B. (2, 2, 1)
C. (2, 1, –1)
D. (3, 2, 0)

Question #: 21

A photon with a frequency of 6.17×10^{14} Hz is emitted when an electron in a hydrogen atom moves from a higher energy level to the $n = 2$ level. What is the initial energy level?

$n =$ 1

1. 4|four|

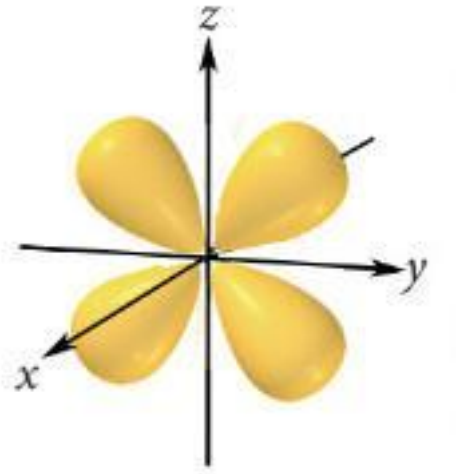
Question #: 22

What is the maximum number of electrons that can have both of the quantum numbers, $n = 5$ and $l = 3$, in an atom?

A. 7
B. 10
✓C. 14
D. 18

Question #: 23

What are possible quantum numbers (n, l, m_l) for the orbital shown below?



A. (5, 3, 0)
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C. (4, 1, 0)
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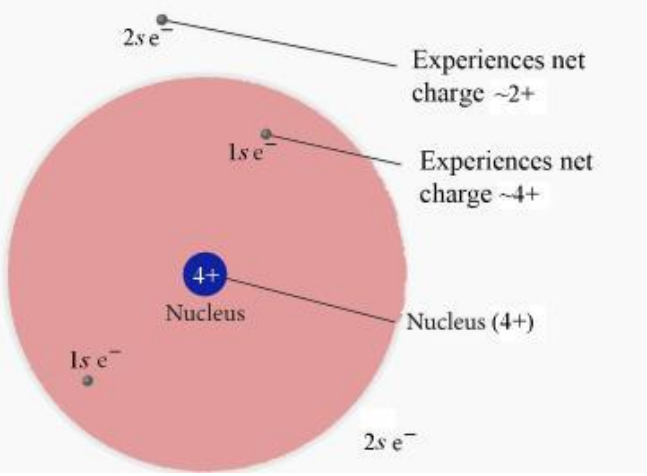
Question #: 24

This figure illustrates which effect experienced by 1*s* and 2*s* electrons in a beryllium atom?



A. Pauli exclusion principle
✓B. shielding
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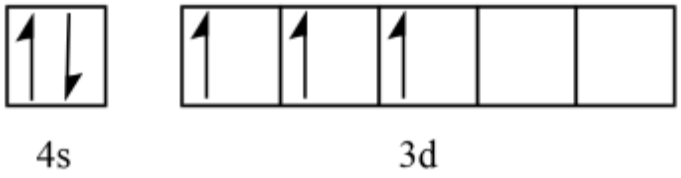
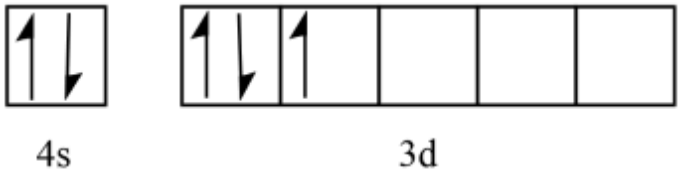
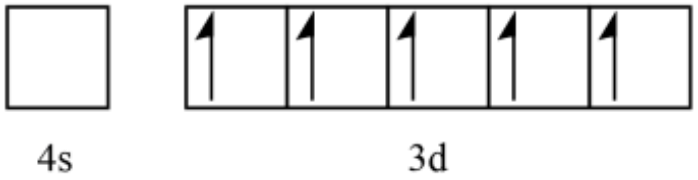
A.



B.



✓C.



D.

Question #: 26

What is the ground-state electron configuration for silver?

A. [Kr]$5s^2 4d^9$

✓B. [Kr]$5s^1 4d^{10}$

C. [Kr]$5s^2 5d^9$

D. [Kr]$5s^1 5d^{10}$

Question #: 27

Which group of elements is sorted from **largest to smallest** atomic radius?

✓A. K >Si >S >O

B. Ca >Rb >Al >He

C. B >C >Mg >F

D. Ge >Si >Ga >Be

Question #: 28

Which equation below represents the **electron affinity** of Na?

✓A. $Na(g) + e^- \rightarrow Na^-(g)$

B. $Na(g) \rightarrow Na^+(g) + e^-$

C. $Na(g) + e^- \rightarrow Na^+(g)$

D. $Na^+(g) \rightarrow Na(g) + e^-$

Question #: 29

The first ten ionization energies (kJ/mol) of an element are:
1012; 1907; 2914; 4964; 6274; 21,267; 25,431; 29,872; 35,905; 40,130.
This element belongs to group __1__ (numerical label of a column or family) of the periodic table.

1. 5A|VA|15|5 A|V A|

Question #: 30

Because of the ___1___ [low, high] ionization energies of alkali metals, they are readily ___2___ [oxidized, reduced].
Reactivity ___3___ [increases, decreases] down the column because ionization energy ___4___ [increases, decreases] down the column.

1. low
2. oxidized
3. increase
4. decreases