

CHE 105 Spring 2016 Exam 3

Your Name: _____

Your ID: _____

Question #: 1

The graph shows the velocity distribution for five gases at the same temperature.

Match each plot in the graph with one of these gases:

H₂O, O₂, N₂, He, H₂.

Assume ideal gas behavior.

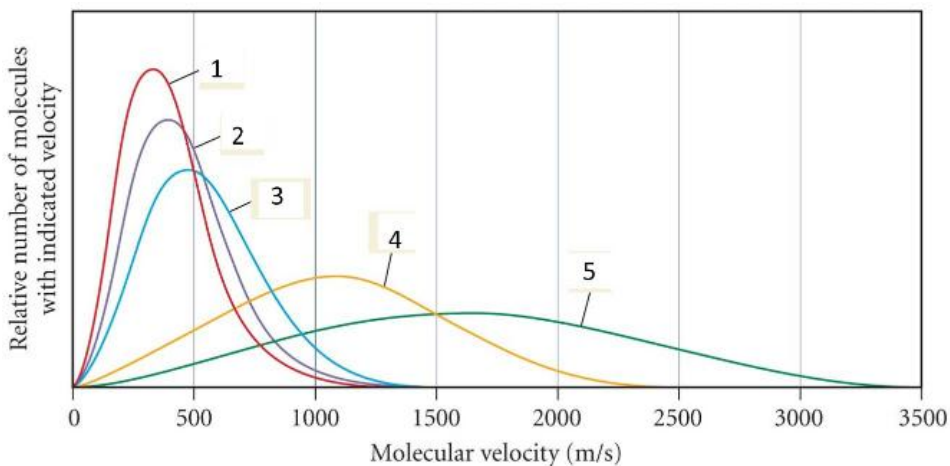
gas 1 is 1

gas 2 is 2

gas 3 is 3

gas 4 is 4

gas 5 is 5



1. _____

4. _____

2. _____

5. _____

3. _____

Question #: 2

Select **all** of the following conditions that cause a real gas to act **more** like an ideal gas.

- A. high pressure
- B. high temperature
- C. low temperature
- D. low pressure

Question #: 3

Which of the following statements is **correct** for a system that undergoes a change with negative q (heat) and positive w (work)?

- A. Work is done by the system while heat is lost to the surroundings.
- B. Work is done on the system while heat is lost to the surroundings.
- C. Work is done on the system while heat is absorbed by the system.
- D. Work is done by the system while heat is absorbed by the system.

Question #: 4

Calculate the internal energy change for a system that does 422 J of work while losing 227 J of energy as heat.

- A. +649 J
- B. -649 J
- C. -195 J
- D. +195 J

Question #: 5

A 10.0 g metal block at 65.0 °C is placed in 50.0 mL of water at 22.0 °C. The final temperature of both is 26.5 °C. The specific heat capacity of the metal is 1 J/g·°C.

The density of water is 1.00 g/mL.

The specific heat capacity of water is 4.18 J/g·°C.

Report your answer with **two** significant figures and **without** units.

1. _____

Question #: 6

The work done (w) when the volume of a system changes from 3.50 L to 2.40 L at a constant pressure of 2.00 atm is 1 J.

101.3 J = 1.000 L·atm

Report your answer with **two** significant digits, in the form 2.2E2 or 2.2E-2 if you use scientific notation.

1. _____

Question #: 7

Dissolving 6.00 g of CaCl₂ in 300. mL of water causes the temperature of the solution to increase by 3.43 °C. Determine ΔH for the reaction

$\text{CaCl}_2(s) \rightarrow \text{Ca}^{2+}(aq) + 2 \text{Cl}^{-}(aq)$.

The specific heat of the solution is 4.18 J/g·°C

The density of water is 1.00 g/mL.

The calorimeter absorbs no significant amount of heat.

- A. -79.6 kJ
 - B. 79.6 kJ
 - C. 44.0 kJ
 - D. -44.0 kJ
-

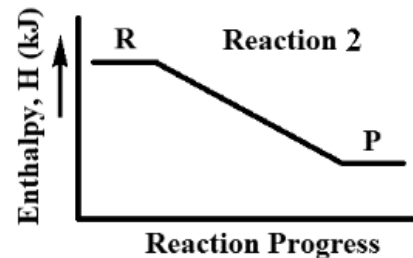
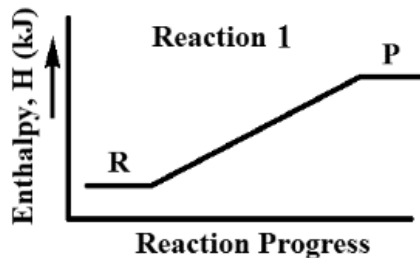
Question #: 8

Select **all** of the **true** statements about enthalpy (H) and internal energy (E).

- A. Enthalpy change is the heat evolved by a chemical reaction at constant pressure.
- B. Enthalpy change is the sum of the heat released and the work performed by a chemical reaction.
- C. The internal energy change is the heat evolved by a chemical reaction at constant pressure.
- D. The internal energy change is the sum of the heat released and the work performed by a chemical reaction.

Question #: 9

In chemical reactions **1** and **2**, reactant (**R**) is converted to product (**P**). The figures show the enthalpy of each system as the reaction proceeds towards completion.



Identify each reaction as

exothermic, **endothermic**

or **isothermic** (i.e., no enthalpy change).

Reaction **1** is 1 .

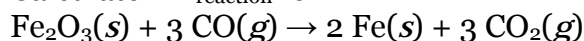
Reaction **2** is 2 .

1. _____

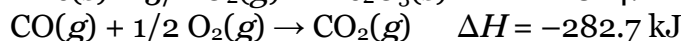
2. _____

Question #: 10

Calculate $\Delta H_{\text{reaction}}$ for



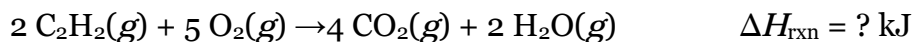
given



- A. -23.9 kJ
- B. 23.9 kJ
- C. -1106 kJ
- D. 1106 kJ
- E. -553 kJ
- F. 553 kJ

Question #: 11

Acetylene gas, C_2H_2 , is used in welding torches. What is the enthalpy of combustion of acetylene?



Substance	ΔH_f° (kJ/mol)
$\text{C}_2\text{H}_2(g)$	227
$\text{CO}(g)$	-110
$\text{CO}_2(g)$	-394
$\text{H}_2\text{O}(g)$	-242
$\text{H}_2\text{O}(l)$	-286
$\text{O}(g)$	249

- A. -2514 kJ
- B. -1269 kJ
- C. -1156 kJ
- D. 2601 kJ

Question #: 12

Based on their relative frequencies, identify which type of electromagnetic radiation is represented by waves **1**, **2** and **3** in the figure at right.

Choose one of these options for each wave:

ultraviolet, X-ray, radio

wave 1 = 1

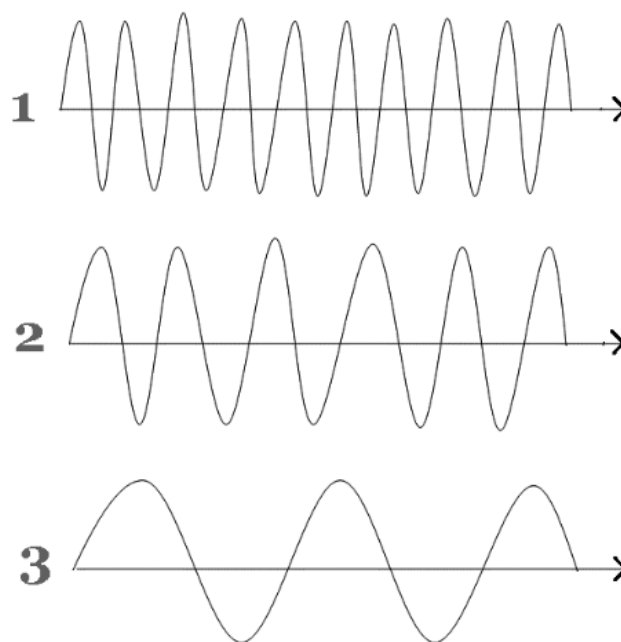
wave 2 = 2

wave 3 = 3

1. _____

2. _____

3. _____



Question #: 13

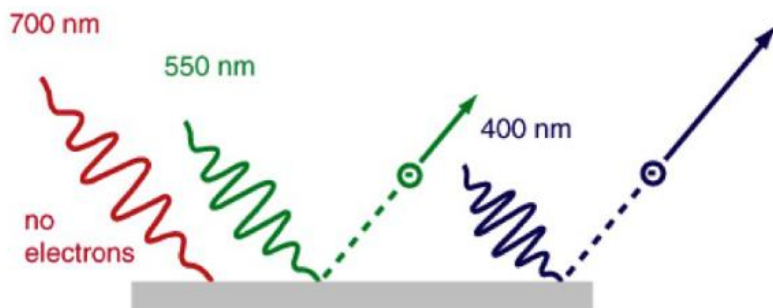
A pulse of ultraviolet light emits 2.5×10^{-17} J of energy at a wavelength of 9.8×10^{-7} m. The pulse consists of 1 photons of ultraviolet light.

Report your answer with **two** significant figures, using scientific notation in the format 2.2E2 or 2.2E-2.

1. _____

Question #: 14

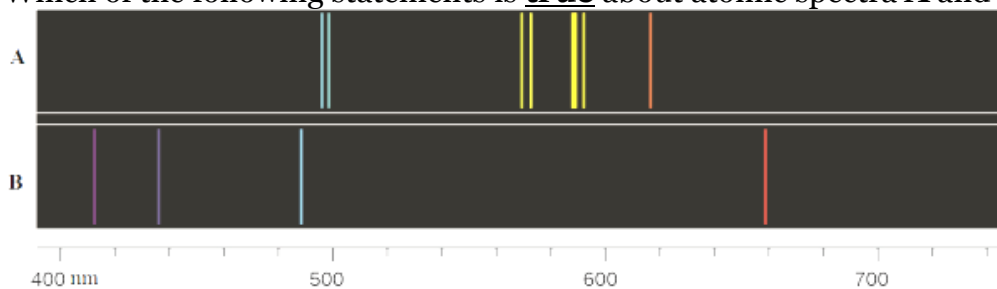
Light with three different wavelengths irradiates the surface of cesium metal. Which wavelength causes the **emission of an electron** with the **least** amount of kinetic energy?



- A. 700 nm
- B. 550 nm
- C. 400 nm
- D. Ejected electrons all have zero kinetic energy.
- E. Ejected electrons all have the same amount of kinetic energy.

Question #: 15

Which of the following statements is **true** about atomic spectra **A** and **B**?

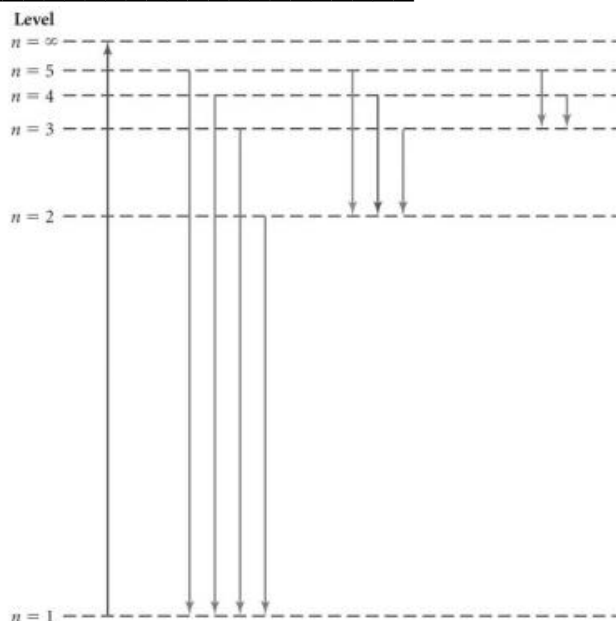


- A. Spectra **A** and **B** are emission spectra for the same element but at different wavelengths.
- B. Spectra **A** and **B** are emission spectra for two different elements.
- C. Spectra **A** and **B** are absorption spectra for two different elements.
- D. **A** is an absorption spectrum and **B** is an emission spectrum for two different elements.

Question #: 16

In a Bohr hydrogen atom, which electronic transition **releases** the **most** energetic photon?

- A. $n = 3 \rightarrow n = 1$
- B. $n = 4 \rightarrow n = 3$
- C. $n = 1 \rightarrow n = 4$
- D. $n = 2 \rightarrow n = 1$
- E. $n = 5 \rightarrow n = 2$



Question #: 17

The de Broglie wavelength of an electron (mass = 9.11×10^{-28} grams) traveling at a speed of 2.7×10^6 m/s is 1 nm.

Report your answer with **two** significant figures, in the form 2.2e2 or 2.2e-2 if you use scientific notation.

1. _____

Question #: 18

Select **all** of the **true** statements about quantum numbers.

- A. The principal quantum number, n , determines the shape of an orbital.
- B. Energy is absorbed when an electron moves from a shell with principal quantum number $n = 1$ to one with $n = 3$.
- C. The angular momentum quantum number, l , determines how many orbitals are in a subshell.
- D. The overall size of an orbital increases as the value of principal quantum number, n , increases.

Question #: 19

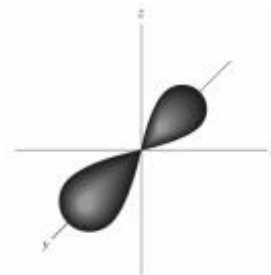
The $n = 4$ principal shell includes a total of 1 **orbital(s)**.

Your answer should be an integer.

1. _____

Question #: 20

The angular momentum quantum number, l , for the orbital shown equals 1 .



1. _____

Question #: 21

Select **all** of the values of m_l below that are **allowed** for an electron in a d orbital.

- A. -3
- B. -1
- C. 0
- D. 3

Question #: 22

An electron in an atom has quantum numbers $n = 4$ and $m_l = -1$.

Select **all** of the atomic orbitals that this electron may occupy.

- A. s orbital
- B. p orbital
- C. d orbital
- D. f orbital

Question #: 23

A Bohr hydrogen atom absorbs a photon with a frequency of 2.74×10^{14} Hz when an electron is promoted from the $n = 3$ to the $n = \underline{\quad 1 \quad}$ energy level.
Your answer should be an integer.

1. _____

Question #: 24

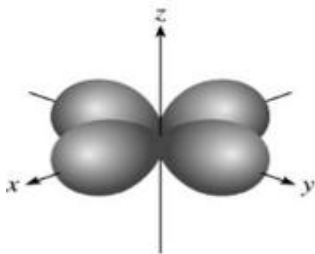
Select **all** of the **allowed** sets of quantum numbers for an electron in an atomic orbital.

- A. $n = 0$ $l = 3$ $m_l = 3$
 - B. $n = 2$ $l = 0$ $m_l = -1$
 - C. $n = 4$ $l = 3$ $m_l = 2$
 - D. $n = 3$ $l = 2$ $m_l = -1$
-

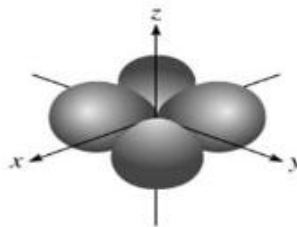
Question #: 25

Select **all** of the following figures that illustrate a d orbital.

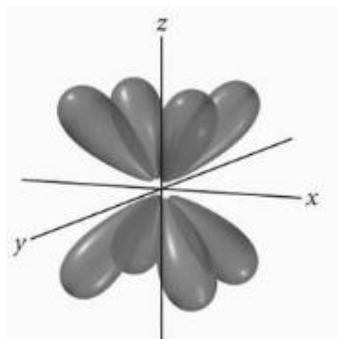
A.



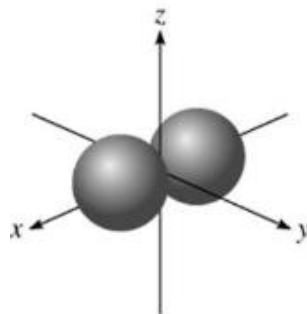
C.



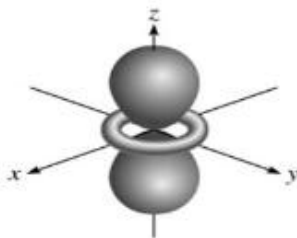
B.



D.



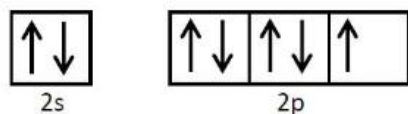
E.



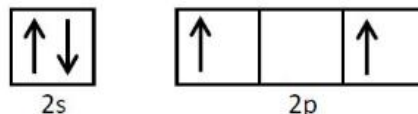
Question #: 26

Which orbital diagram violates the Pauli exclusion principle?

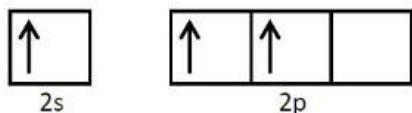
A.



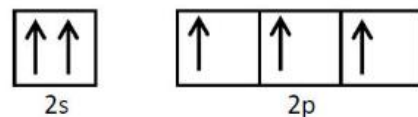
C.



B.



D.



Question #: 27

The electron configuration for a ground-state aluminum atom is 1 .

Use this format with spaces but no superscripts: 1s2 2s2 2p3...

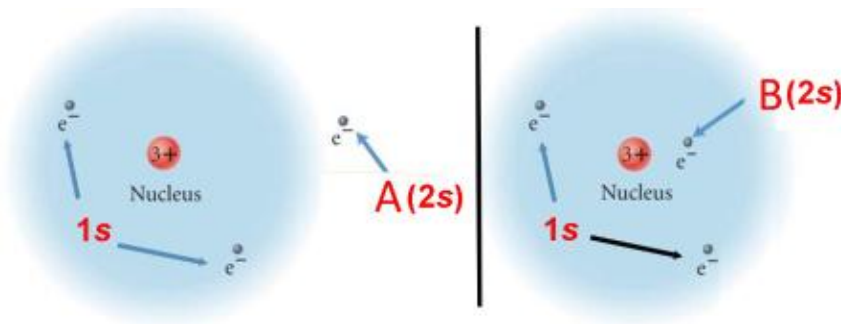
1. _____

Question #: 28

The figure at right represents a lithium atom. The shaded region represents the electron cloud of the 1s orbital.

Electron **A** is 1 (**shielded from, exposed to**) the full charge of the nucleus.

Electron **B** 2 (**shields, penetrates**) the 1s electron cloud.



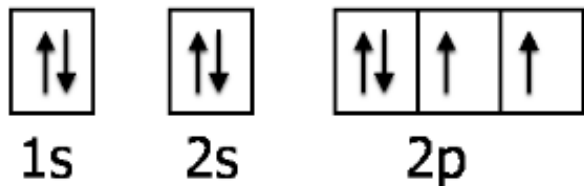
1. _____

2. _____

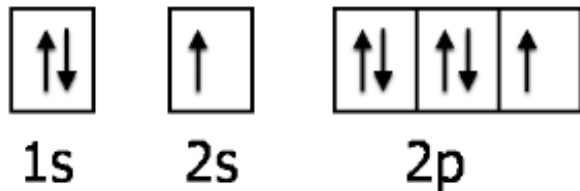
Question #: 29

Which figure shows the ground-state electron configuration of an oxygen atom?

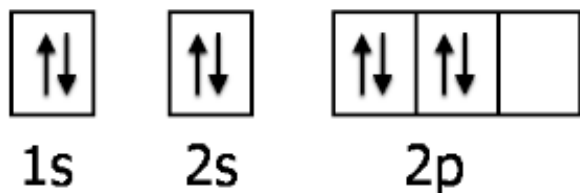
A.



B.



C.



Question #: 30

Visible light is emitted from a hydrogen atom when an electron moves from the $n = 3$ level to the $n = 2$ level. Light emitted when an electron moves from $n = 4$ to $n = 3$ is not in the visible region. Is it in the infrared or ultraviolet region of the electromagnetic spectrum? Why?

- A. Infrared, because a $n = 4$ to $n = 3$ transition emits more energy than a $n = 3$ to $n = 2$ transition.
- B. Infrared, because a $n = 4$ to $n = 3$ transition emits less energy than a $n = 3$ to $n = 2$ transition.
- C. Ultraviolet, because a $n = 4$ to $n = 3$ transition emits more energy than a $n = 3$ to $n = 2$ transition.
- D. Ultraviolet, because a $n = 4$ to $n = 3$ transition emits less energy than a $n = 3$ to $n = 2$ transition.

CHE 105 Spring 2016 Exam 3 Key

Question #: 1

The graph shows the velocity distribution for five gases at the same temperature.

Match each plot in the graph with one of these gases:

H₂O, O₂, N₂, He, H₂.

Assume ideal gas behavior.

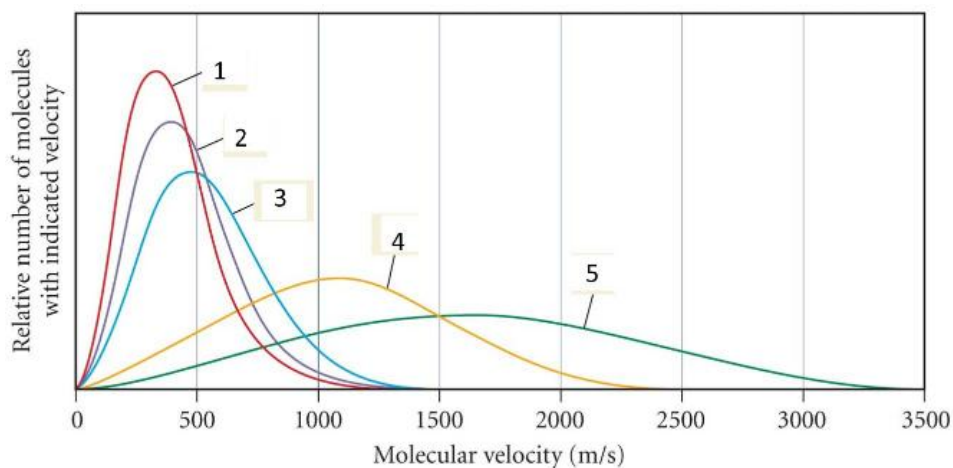
gas **1** is 1

gas **2** is 2

gas **3** is 3

gas **4** is 4

gas **5** is 5



1. O₂|o₂|oxygen|

2. N₂|n₂|nitrogen|

3. H₂O|h₂o|water|

4. He|HE|he|helium|

5. H₂|h₂|hydrogen|

Question #: 2

Select **all** of the following conditions that cause a real gas to act **more** like an ideal gas.

A. high pressure

✓ B. high temperature

C. low temperature

✓ D. low pressure

Question #: 3

Which of the following statements is **correct** for a system that undergoes a change with negative q (heat) and positive w (work)?

A. Work is done by the system while heat is lost to the surroundings.

✓ B. Work is done on the system while heat is lost to the surroundings.

C. Work is done on the system while heat is absorbed by the system.

D. Work is done by the system while heat is absorbed by the system.

Question #: 4

Calculate the internal energy change for a system that does 422 J of work while losing 227 J of energy as heat.

A. +649 J

✓ B. -649 J

C. -195 J

D. +195 J

Question #: 5

A 10.0 g metal block at 65.0 °C is placed in 50.0 mL of water at 22.0 °C. The final temperature of both is 26.5 °C. The specific heat capacity of the metal is 1 J/g·°C.

The density of water is 1.00 g/mL.

The specific heat capacity of water is 4.18 J/g·°C.

Report your answer with **two** significant figures and **without** units.

1. 2.4

Question #: 6

The work done (w) when the volume of a system changes from 3.50 L to 2.40 L at a constant pressure of 2.00 atm is 1 J.

$101.3 \text{ J} = 1.000 \text{ L}\cdot\text{atm}$

Report your answer with **two** significant digits, in the form 2.2E2 or 2.2E-2 if you use scientific notation.

1. 2.2E2|223|223 J|2.2E2 J|

Question #: 7

Dissolving 6.00 g of CaCl₂ in 300. mL of water causes the temperature of the solution to increase by 3.43 °C. Determine ΔH for the reaction

$\text{CaCl}_2(s) \rightarrow \text{Ca}^{2+}(aq) + 2 \text{Cl}^{-}(aq)$.

The specific heat of the solution is 4.18 J/g·°C

The density of water is 1.00 g/mL.

The calorimeter absorbs no significant amount of heat.

- ✓ A. -79.6 kJ
 - B. 79.6 kJ
 - C. 44.0 kJ
 - D. -44.0 kJ
-

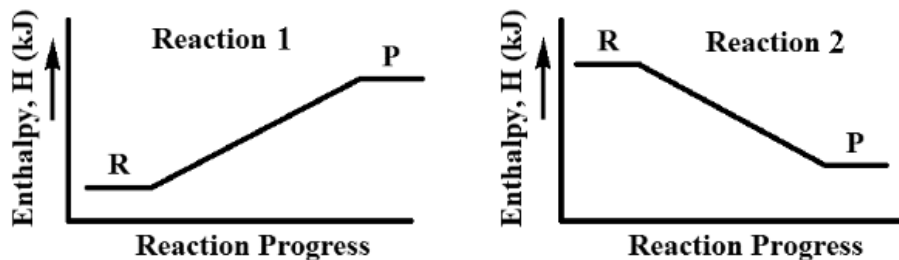
Question #: 8

Select **all** of the **true** statements about enthalpy (H) and internal energy (E).

- ✓ A. Enthalpy change is the heat evolved by a chemical reaction at constant pressure.
- B. Enthalpy change is the sum of the heat released and the work performed by a chemical reaction.
- C. The internal energy change is the heat evolved by a chemical reaction at constant pressure.
- ✓ D. The internal energy change is the sum of the heat released and the work performed by a chemical reaction.

Question #: 9

In chemical reactions **1** and **2**, reactant (**R**) is converted to product (**P**). The figures show the enthalpy of each system as the reaction proceeds towards completion.



Identify each reaction as

exothermic, endothermic

or **isothermic** (i.e., no enthalpy change).

Reaction **1** is 1 .

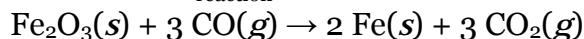
Reaction **2** is 2 .

1. endothermic|Endothermic|ENDOTHERMIC|endo|endothemic|endothemric|

2. exothermic|Exothermic|EXOTHERMIC|exo|exothemic|exothemric|

Question #: 10

Calculate $\Delta H_{\text{reaction}}$ for



given



✓ A. -23.9 kJ

B. 23.9 kJ

C. -1106 kJ

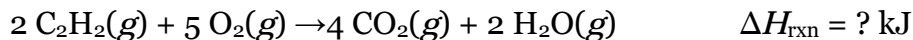
D. 1106 kJ

E. -553 kJ

F. 553 kJ

Question #: 11

Acetylene gas, C_2H_2 , is used in welding torches. What is the enthalpy of combustion of acetylene?



Substance	ΔH_f° (kJ/mol)
$\text{C}_2\text{H}_2(g)$	227
$\text{CO}(g)$	-110
$\text{CO}_2(g)$	-394
$\text{H}_2\text{O}(g)$	-242
$\text{H}_2\text{O}(l)$	-286
$\text{O}(g)$	249

✓ A. -2514 kJ

B. -1269 kJ

C. -1156 kJ

D. 2601 kJ

Question #: 12

Based on their relative frequencies, identify which type of electromagnetic radiation is represented by waves **1**, **2** and **3** in the figure at right.

Choose one of these options for each wave:

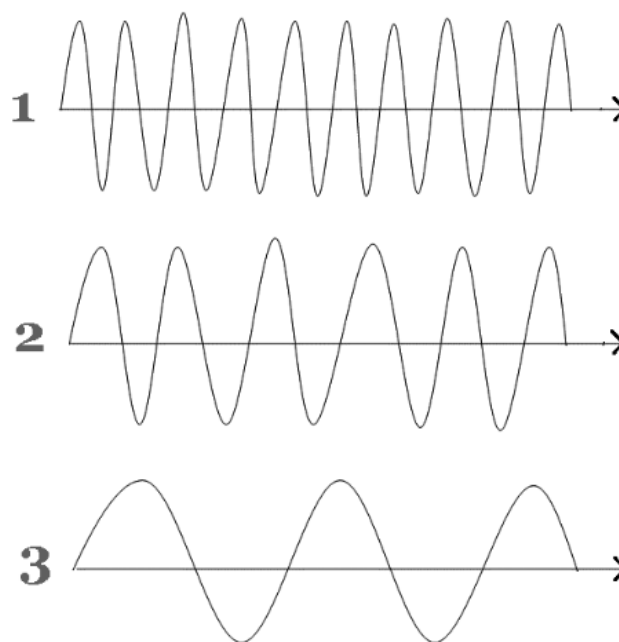
ultraviolet, X-ray, radio

wave 1 = 1

wave 2 = 2

wave 3 = 3

1. X-ray|x-ray|xray|Xray|x|X|
2. Ultraviolet|UV|
3. radio|radoi|radio wave|radio waves|radiowave|radiowaves|



Question #: 13

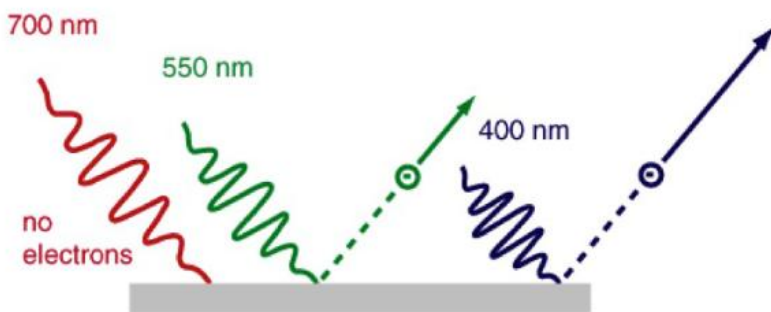
A pulse of ultraviolet light emits 2.5×10^{-17} J of energy at a wavelength of 9.8×10^{-7} m. The pulse consists of 1 photons of ultraviolet light.

Report your answer with **two** significant figures, using scientific notation in the format 2.2E2 or 2.2E-2.

1. 123|124|122|121|120|125|126|1.2E2|1.2 E 2|

Question #: 14

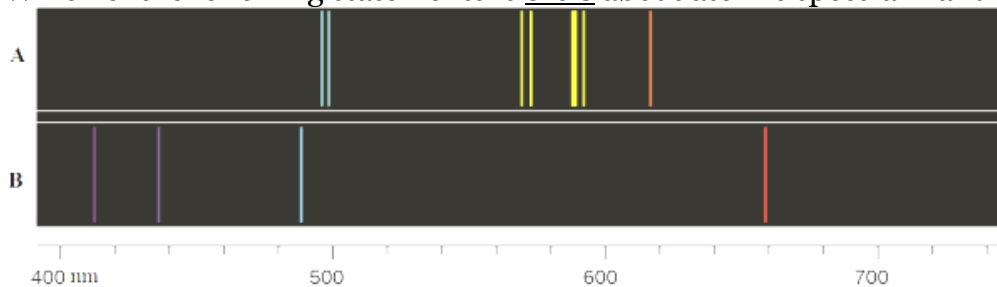
Light with three different wavelengths irradiates the surface of cesium metal. Which wavelength causes the **emission of an electron** with the **least** amount of kinetic energy?



- A. 700 nm
- ✓ B. 550 nm
- C. 400 nm
- D. Ejected electrons all have zero kinetic energy.
- E. Ejected electrons all have the same amount of kinetic energy.

Question #: 15

Which of the following statements is **true** about atomic spectra **A** and **B**?

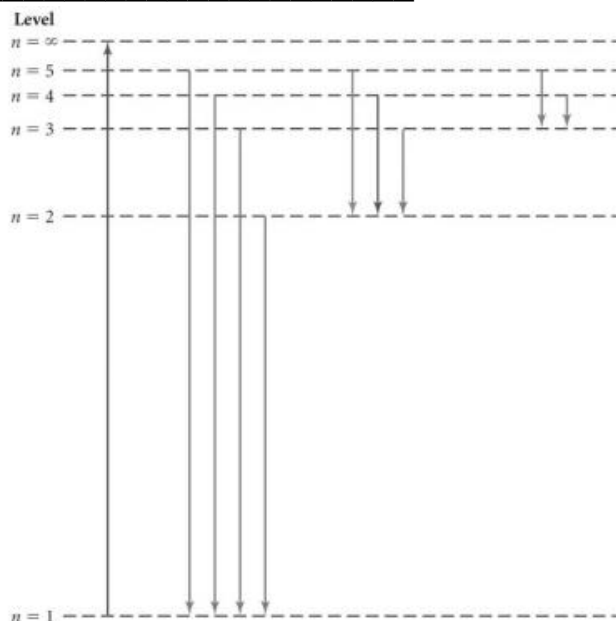


- A. Spectra **A** and **B** are emission spectra for the same element but at different wavelengths.
- ✓ B. Spectra **A** and **B** are emission spectra for two different elements.
- C. Spectra **A** and **B** are absorption spectra for two different elements.
- D. **A** is an absorption spectrum and **B** is an emission spectrum for two different elements.

Question #: 16

In a Bohr hydrogen atom, which electronic transition **releases** the **most** energetic photon?

- ✓ A. $n = 3 \rightarrow n = 1$
- B. $n = 4 \rightarrow n = 3$
- C. $n = 1 \rightarrow n = 4$
- D. $n = 2 \rightarrow n = 1$
- E. $n = 5 \rightarrow n = 2$



Question #: 17

The de Broglie wavelength of an electron (mass = 9.11×10^{-28} grams) traveling at a speed of 2.7×10^6 m/s is 1 nm.

Report your answer with **two** significant figures, in the form 2.2e2 or 2.2e-2 if you use scientific notation.

1. .27|0.27|2.7e-1|.26|.25|.26e-1|2.5e-1|2.7E-1|.26E-1|2.5E-1|0.26|0.25|

Question #: 18

Select **all** of the **true** statements about quantum numbers.

- A. The principal quantum number, n , determines the shape of an orbital.
- ✓ B. Energy is absorbed when an electron moves from a shell with principal quantum number $n = 1$ to one with $n = 3$.
- C. The angular momentum quantum number, l , determines how many orbitals are in a subshell.
- ✓ D. The overall size of an orbital increases as the value of principal quantum number, n , increases.

Question #: 19

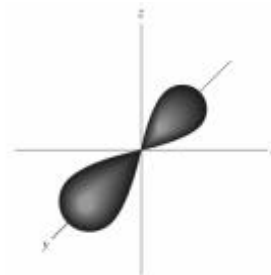
The $n = 4$ principal shell includes a total of 1 **orbital(s)**.

Your answer should be an integer.

1. 16|sixteen|

Question #: 20

The angular momentum quantum number, l , for the orbital shown equals 1 .



1. 1|one|

Question #: 21

Select **all** of the values of m_l below that are **allowed** for an electron in a d orbital.

- A. -3
- ✓ B. -1
- ✓ C. 0
- D. 3

Question #: 22

An electron in an atom has quantum numbers $n = 4$ and $m_l = -1$.

Select **all** of the atomic orbitals that this electron may occupy.

- A. s orbital
- ✓ B. p orbital
- ✓ C. d orbital
- ✓ D. f orbital

Question #: 23

A Bohr hydrogen atom absorbs a photon with a frequency of 2.74×10^{14} Hz when an electron is promoted from the $n = 3$ to the $n = \underline{\quad 1 \quad}$ energy level.

Your answer should be an integer.

1. 6|six|

Question #: 24

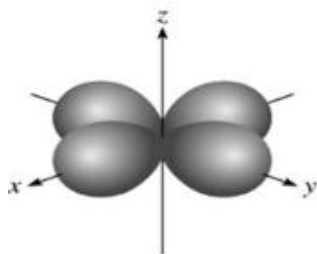
Select **all** of the **allowed** sets of quantum numbers for an electron in an atomic orbital.

- A. $n = 0$ $l = 3$ $m_l = 3$
 - B. $n = 2$ $l = 0$ $m_l = -1$
 - ✓ C. $n = 4$ $l = 3$ $m_l = 2$
 - ✓ D. $n = 3$ $l = 2$ $m_l = -1$
-

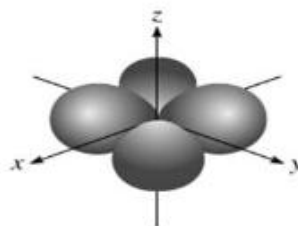
Question #: 25

Select **all** of the following figures that illustrate a d orbital.

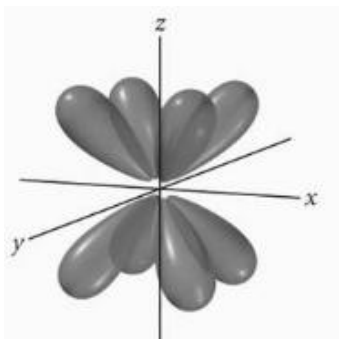
✓ A.



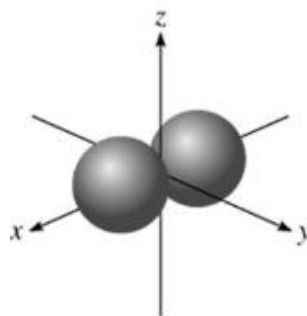
✓ C.



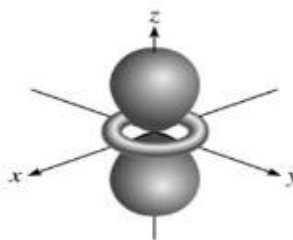
B.



D.



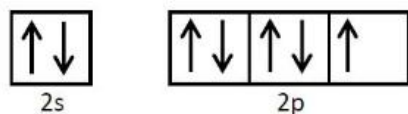
✓ E.



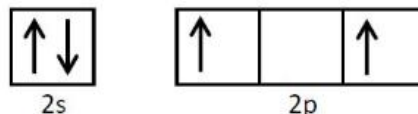
Question #: 26

Which orbital diagram violates the Pauli exclusion principle?

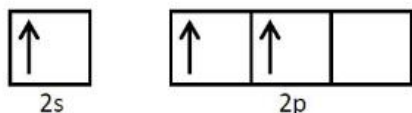
A.



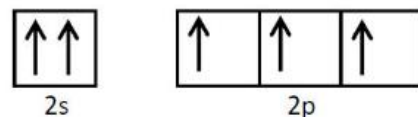
C.



B.



✓D.



Question #: 27

The electron configuration for a ground-state aluminum atom is 1.

Use this format with spaces but no superscripts: 1s2 2s2 2p3...

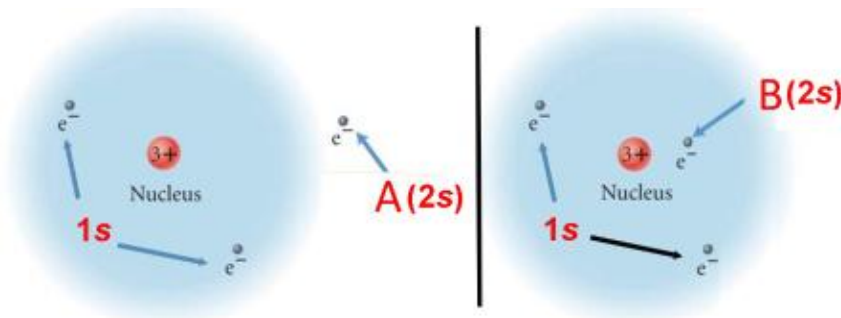
1. 1s2 2s2 2p6 3s2 3p1 | [Ne] 3s2 3p1

Question #: 28

The figure at right represents a lithium atom. The shaded region represents the electron cloud of the 1s orbital.

Electron **A** is 1 (**shielded from, exposed to**) the full charge of the nucleus.

Electron **B** 2 (**shields, penetrates**) the 1s electron cloud.



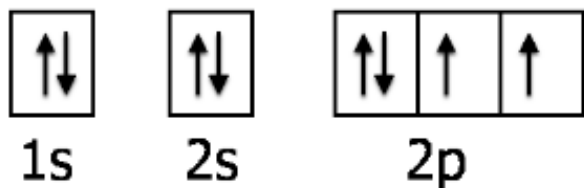
1. shielded from | shielded | shield |

2. penetrates | penetrate |

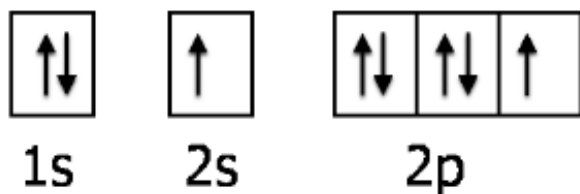
Question #: 29

Which figure shows the ground-state electron configuration of an oxygen atom?

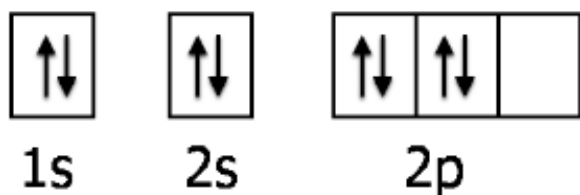
✓ A.



B.



C.



Question #: 30

Visible light is emitted from a hydrogen atom when an electron moves from the $n = 3$ level to the $n = 2$ level. Light emitted when an electron moves from $n = 4$ to $n = 3$ is not in the visible region. Is it in the infrared or ultraviolet region of the electromagnetic spectrum? Why?

- A. Infrared, because a $n = 4$ to $n = 3$ transition emits more energy than a $n = 3$ to $n = 2$ transition.
- ✓ B. Infrared, because a $n = 4$ to $n = 3$ transition emits less energy than a $n = 3$ to $n = 2$ transition.
- C. Ultraviolet, because a $n = 4$ to $n = 3$ transition emits more energy than a $n = 3$ to $n = 2$ transition.
- D. Ultraviolet, because a $n = 4$ to $n = 3$ transition emits less energy than a $n = 3$ to $n = 2$ transition.