This print-out should have 50 questions. Multiple-choice questions may continue on the next column or page - find all choices before answering.

## LDE Planck relation 001 <br> 00110.0 points

What is the energy, in Joules, of a photon of wavelength 200 nm ? What bond energy would this correspond to, in $\mathrm{kJ} \cdot \mathrm{mol}^{-1}$ ?

1. $1.32 \times 10^{-31} \mathrm{~J} ; 7.95 \times 10^{-11} \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
2. $9.94 \times 10^{-17} \mathrm{~J} ; 1.65 \times 10^{-43} \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
3. $1.32 \times 10^{-21} \mathrm{~J} ; 795 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
4. $9.94 \times 10^{-19} \mathrm{~J} ; 599 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
5. $1.32 \times 10^{-40} \mathrm{~J} ; 7.95 \times 10^{-20} \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
6. $9.94 \times 10^{-21} \mathrm{~J} ; 5.99 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$

## LDE Balmer Series 001 <br> 00210.0 points

Which of the following electronic transitions for a hydrogen atom would correspond to the highest energy emission found in the Balmer series?

1. $\mathrm{n}=2$ to $\mathrm{n}=1$
2. $\mathrm{n}=2$ to $\mathrm{n}=4$
3. $\mathrm{n}=3$ to $\mathrm{n}=1$
4. $\mathrm{n}=3$ to $\mathrm{n}=2$
5. $\mathrm{n}=1$ to $\mathrm{n}=2$
6. $\mathrm{n}=4$ to $\mathrm{n}=2$

## LDE Classical Failure 002 <br> 00310.0 points

Which of the following statement(s) is/are true?
I) The failure of classical mechanics to predict the absorptions/emission spectra of gases is called the ultraviolet catastro-
phe.
II) Quantum mechanics accurately predicted the behavior of blackbody radiators.
III) The emission spectra of gases are discrete rather than continuous.
IV) Any frequency of light will eject an electron from a metal surface as long as the intensity is sufficient.

1. II and III
2. I and III

## 3. I, II and IV

4. III and IV
5. II, III, and IV

## LDE Uncertainty Principle Theory 001 00410.0 points

Which of the following are true consequences of the uncertainty principle?
I) The uncertainty in an electron's momentum can never be less than $\frac{\hbar}{2}$;
II) An electron can be measured in two places at once;
III) Electrons and other particles do not have a well-defined position or momentum like particles in classical mechanics do.

1. II only
2. I only
3. I and II
4. II and III
5. I and III
6. III only

## De Broglie Wavelength 01 00510.0 points

Consider a flea of mass $4.5 \times 10^{-4} \mathrm{~g}$ moving
at $1.0 \mathrm{~m} / \mathrm{s}$ midway through its jump. What is its de Broglie wavelength?

1. $2.9818 \times 10^{-40} \mathrm{~m}$
2. $1.4725 \times 10^{-30} \mathrm{~m}$
3. $1.47244 \times 10^{-27} \mathrm{~m}$
4. $2.9818 \times 10^{-37} \mathrm{~m}$

## Msci 010303

00610.0 points

Which of the following is an intensive property?

1. density
2. mass
3. weight
4. volume
5. number of moles of molecules

## LDE quantum rules 002 $007 \quad 10.0$ points

Which of the following sets of quantum numbers are invalid, i.e. violate one or more boundary conditions?
I) $n=3, \ell=2, m_{\ell}=-2, m_{s}=+\frac{1}{2}$
II) $n=9, \ell=5, m_{\ell}=6, m_{s}=+\frac{1}{2}$
III) $n=2, \ell=1, m_{\ell}=0, m_{s}=+1$
IV) $n=2, \ell=0, m_{\ell}=0, m_{s}=+\frac{1}{2}$
V) $n=1, \ell=0, m_{\ell}=0, m_{s}=-\frac{1}{2}$

1. II, III

## 2. I, III, IV

3. I, II, IV
4. II only
5. I only
6. III only
7. IV only

## 8. I, IV

## Msci 051648 $008 \quad 10.0$ points

Hund's rule states that

1. electrons occupy all the orbitals of a given sublevel singly before pairing begins.
2. no two electrons in an atom may have identical sets of four quantum numbers.
3. it is impossible to determine accurately both the momentum and position of an electron simultaneously.

| Mlib 024077 |
| :---: |
| $009 \quad 10.0$ points |
| rite the electron configuration for P. |

1. $1 s^{2} 2 s^{2} 2 p^{6} 3 d^{5}$
2. $1 s^{2} 2 s^{2} 2 p^{6} 3 s^{2} 3 p^{6}$
3. $1 s^{2} 2 s^{2} 2 p^{6} 3 s^{2} 3 p^{3}$
4. $1 s^{2} 2 s^{2} 2 p^{6} 3 p^{5}$

## LDE periodic trend theory 001 $010 \quad 10.0$ points

Which of the following BEST describes the purpose of effective nuclear charge?

1. It exists only to torture foolish CH 301 students who did not study.
2. It is a method to evaluate how much attraction a given electron "feels" from the nucleus so that periodic trends can be predicted and rationalized.
3. It is used to rationalize chemical bonding in covalently bonded molecules.
4. It is a measure of the effect of filled and half-filled subshells on the stability of atoms and ions.
5. It is a measure of how many protons a given atom has which is useful because of variations from isotope to isotope.
6. It is used to determine the number of valence electrons of a given species.

## LDE Ranking trends 002

 $011 \quad 10.0$ pointsRank the following species in terms of increasing electron affinity: Sulfur (S), Rubidium (Rb), Germanium (Ge), Krypton (Kr), Floruine (F)

1. Not enough information
2. $\mathrm{Kr}<\mathrm{Ge}<\mathrm{Rb}<\mathrm{S}<\mathrm{F}$
3. $\mathrm{Ge}<\mathrm{Rb}<\mathrm{S}<\mathrm{F}<\mathrm{Kr}$
4. $\mathrm{F}<\mathrm{Ge}<\mathrm{S}<\mathrm{Rb}<\mathrm{Kr}$
5. $\mathrm{Rb}<\mathrm{Ge}<\mathrm{S}<\mathrm{F}<\mathrm{Kr}$
6. $\mathrm{Kr}<\mathrm{Rb}<\mathrm{Ge}<\mathrm{S}<\mathrm{F}$

## ChemPrin3e T02 07 <br> 01210.0 points

Which of the following has the highest lattice energy?

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

## Line Drawing to Formula

$013 \quad 10.0$ points
Determine the molecular formula for the
molecule:


1. $\mathrm{C}_{6} \mathrm{H}_{6} \mathrm{Cl}_{2}$
2. $\mathrm{C}_{6} \mathrm{H}_{6}$
3. $\mathrm{C}_{4} \mathrm{H}_{12} \mathrm{Cl}_{2}$
4. $\mathrm{C}_{4} \mathrm{H}_{4} \mathrm{Cl}_{2}$
5. $\mathrm{C}_{6} \mathrm{H}_{4} \mathrm{Cl}_{2}$
6. $\mathrm{C}_{6} \mathrm{H}_{4} \mathrm{Cl}$

## LDE Lewis Structures 005 <br> $014 \quad 10.0$ points

Which of the following is the correct Lewis structure of hydroxylamine $\left(\mathrm{NH}_{2} \mathrm{OH}\right)$ ?

2. ${ }_{\mid}^{\mid}{ }_{\mathrm{H}}^{\mathrm{H}}=\stackrel{\mathrm{O}}{\mid} \mathrm{H}$
3.



Lewis HCN dash
$015 \quad 10.0$ points
Which of the following is the correct Lewis
formula for hydrogen cyanide (HCN)?
1.

$\because . . . \quad .:$
2. : $\ddot{\mathrm{H}} \ddot{-\mathrm{C}}-\ddot{\mathrm{N}}$ :
3. : $\ddot{\mathrm{H}}-\mathrm{C} \equiv \mathrm{N}$ :
4. : $\ddot{\mathrm{H}}-\mathrm{C}-\ddot{\mathrm{N}}$ :
5. : $\quad \ddot{\mathrm{H}}-\ddot{\mathrm{C}}-\stackrel{.}{\mathrm{N}}$ :
6. $\mathrm{H}-\stackrel{\ddot{\mathrm{C}}}{. .}-\stackrel{.}{\mathrm{N}}$ :
7. $\mathrm{H}-\ddot{\mathrm{C}}-\mathrm{N}$
8. : $\quad . . \ddot{\mathrm{H}}-\ddot{\mathrm{C}}=\stackrel{\text { N }}{ }$.
9. $\quad . \quad \mathrm{H}=\mathrm{C}=\stackrel{\circ}{\mathrm{N}}$.
10.


Mlib 031025
$016 \quad 10.0$ points
How many resonance structures are there for the $\mathrm{NO}_{3}^{-}$polyatomic ion?

1. 5
2. 1
3. 2
4. This molecule does not exhibit resonance.
5. 3
6. 4

ChemPrin3e 0276
$017 \quad 10.0$ points
Which of the three Lewis structures is the most important for the fulminate ion $\left(\mathrm{CNO}^{-}\right)$?
I) $\begin{array}{cc}-1 & +1 \\ \ddot{\mathrm{C}} \equiv \mathrm{N} & -\ddot{\mathrm{O}} \text { : }\end{array}$
II) $\begin{aligned} & -2 \quad+1 \quad 0 \\ & \ddot{\mathrm{C}}=\mathrm{N}=\ddot{\mathrm{O}}\end{aligned}$
III) $\begin{array}{ll}-3 \quad+1 \quad+1 \\ : & \ddot{\mathrm{C}}-\mathrm{N} \equiv \mathrm{O}\end{array}$

1. I and II only
2. II only
3. All of these are important.
4. I only
5. None of these is important.
6. I and III only
7. II and III only
8. III only

## Brodbelt 0804

$018 \quad 10.0$ points
$\mathrm{ICl}_{3}$ is $s p^{3} d$ hybridized. What is the electronic and molecular geometry?

1. trigonal bipyramidal; T-shaped
2. tetrahedral; pyramidal
3. octahedral; T-shaped
4. trigonal bipyramidal, seesaw
5. trigonal planar; trigonal planar

LDE VSEPR Molecular Geometry 002
$019 \quad 10.0$ points
Which of the following molecules is/are polar?
I)

II)


1. I, II
2. I only
3. II, III
4. II only
5. I, III
6. III only
7. I, II, III

## LDE VB Sigma Pi Bonds 004 <br> $020 \quad 10.0$ points

How many sigma $(\sigma)$ and pi $(\pi)$ bonds are in the Lewis structure for $\mathrm{C}(\mathrm{COOH})_{4}$ ?

1. $12 \sigma, 0 \pi$
2. $12 \sigma, 4 \pi$
3. $8 \sigma, 4 \pi$
4. $16 \sigma, 0 \pi$
5. $16 \sigma, 4 \pi$

Give the hybridization of each central atom: nitrogen, middle carbon, right carbon.


1. $s p^{2}, s p^{2}, s p^{3}$
2. $s p, s p, s p$
3. $s p^{2}, s p^{3}, s p^{3}$
4. $s p^{2}, s p^{2}, s p^{2}$
5. $s p^{2}, s p, s p^{2}$
6. $s p, s p^{3}, s p^{3}$
7. $s p^{3}, s p^{2}, s p^{3}$
8. $s p^{3}, s p^{3}, s p^{3}$

## LDE VB Hybridization 002 <br> $022 \quad 10.0$ points

Consider the thionoester molecule


What orbitals were used to form the $\pi$ (pi) bond?

1. $s p^{3}, 3 s$
2. $2 s, 3 p$
3. $s p^{3}, 3 p$
4. $2 p, 3 p$
5. $s p^{2}, 3 s$

## $023 \quad 10.0$ points

All of the species below have the same bond order except for one of them. Which is it?

1. $\mathrm{Ne}_{2}^{+}$
2. $\mathrm{H}_{2}^{+}$
3. $\mathrm{F}_{2}^{-}$
4. $\mathrm{H}_{2}^{-}$
5. $\mathrm{B}_{2}^{-}$

## LDE Paramagnetism 004 $024 \quad 10.0$ points

Which of the following species is/are paramagnetic?
I) $\mathrm{Li}_{2}^{-}$
II) $\mathrm{O}_{2}$
III) $\mathrm{H}_{2}^{+}$

1. II and III
2. I and II
3. I only
4. II only
5. I, II and III
6. III only
7. I and III

## Msci 120911

$025 \quad 10.0$ points
2.0 g of $\mathrm{H}_{2}$ and 8.0 g of He are put in a 22.4 liter container at $0^{\circ} \mathrm{C}$. The total pressure is

1. 5.0 atm .
2. 3.0 atm .
3. 10.0 atm .
4. 1.0 atm .

Msci 12 0918a
$026 \quad 10.0$ points
What volume will 40.0 L of He at $50.00^{\circ} \mathrm{C}$ and 1201 torr occupy at STP?

1. 31.1 L
2. 53.4 L
3. 12.8 L
4. 18.6 L
5. 26.7 L

## Mass Density and Pressure $027 \quad 10.0$ points

A sample of nitrous oxide gas (NO) has a density of $12 \mathrm{~g} \mathrm{~L}^{-1}$. What pressure does the sample exert at $27^{\circ} \mathrm{C}$ ?

1. 61.6 atm
2. not enough information
3. 9.9 atm
4. 1.0 atm
5. 997.9 atm

## Brodbelt 12 04a <br> $028 \quad 10.0$ points

For the reaction
$2 \mathrm{HCl}+\mathrm{Na}_{2} \mathrm{CO}_{3} \rightarrow 2 \mathrm{NaCl}+\mathrm{H}_{2} \mathrm{O}+\mathrm{CO}_{2}$
179.2 liters of $\mathrm{CO}_{2}$ is collected at STP. How many moles of NaCl are also formed?

1. 4.0 moles
2. 16.0 moles
3. 8.0 moles
4. 32.0 moles
5. 6.0 moles
6. 12.5 moles

## rms velocity of He 01 <br> $029 \quad 10.0$ points

Helium has a rms velocity ( $v_{\mathrm{rms}}$ ) that is 4.21 times faster than which of the following gases?

1. chlorine, $\mathrm{Cl}_{2}$
2. oxygen, $\mathrm{O}_{2}$
3. neon, Ne
4. argon, Ar
5. xenon, Xe

## LDE Gas Non-ideality 002

$030 \quad 10.0$ points
Which of the following does not affect the ideality of gases?
I) the temperature of the gas
II) the density of the gas
III) the size of the gas molecules

1. none of the above
2. I only
3. II and III
4. III only
5. I and II
6. I, II, and III
7. II only
8. I and III

LDE Intermolecular Forces 001 $031 \quad 10.0$ points
Which of the following statements regarding intermolecular forces (IMF) is/are true?
I) Intermolecular forces result from attractive forces between regions of positive and negative charge density in neighboring molecules.
II) The stronger the bonds within a molecule
are, the stronger the intermolecular forces will be.
III) Only non-polar molecules have instantaneous dipoles.

1. I and II
2. III only
3. II only
4. I only
5. I, II, and III
6. II and III
7. I and III

## LDE Intermolecular Forces 002 <br> $032 \quad 10.0$ points

Which of the following is not correctly paired with its dominant type of intermolecular forces?

1. $\mathrm{C}_{6} \mathrm{H}_{6}$ (benzene), instantaneous dipoles
2. $\mathrm{SiH}_{4}$, instantaneous dipoles
3. CaO , ionic forces
4. $\mathrm{NH}_{3}$, hydrogen bonding
5. HBr , hydrogen bonding

## Explaining Dispersion Forces $033 \quad 10.0$ points

Carbon tetrachloride $\left(\mathrm{CCl}_{4}\right)$ and $n$-octane $\left(\mathrm{C}_{8} \mathrm{H}_{18}\right)$ are both non-polar molecules. At standard pressure, they boil at 345 K and 399 K, respectively. Which answer choice below correctly explains their boiling points?



1. $\mathrm{C}_{8} \mathrm{H}_{18}$ has a higher boiling point because its electron cloud is larger and allows it to form more instantaneous dipoles.
2. $\mathrm{CCl}_{4}$ has a lower boiling point because its smaller surface area allows it to form stronger instantaneous dipoles.
3. $\mathrm{C}_{8} \mathrm{H}_{18}$ has a higher boiling point because its greater molecular weight enables it to form stronger instantaneous dipoles.
4. $\mathrm{C}_{8} \mathrm{H}_{18}$ has a higher boiling point because its smaller surface area allows it to form stronger instantaneous dipoles.
5. $\mathrm{CCl}_{4}$ has a lower boiling point because its greater molecular weight enables it to form stronger instantaneous dipoles.

## LDE Physical Properties 001

 03410.0 pointsWhich of the following statements about boiling is false?

1. Boiling occurs when vapor pressure exceeds atmospheric pressure.
2. For a given pressure, the boiling point is always at a higher temperature than melting point.
3. The boiling point of a liquid is independent of atmospheric pressure.
4. As intermolecular forces increase, boiling point increases as well.

## VP IMF Ranking <br> $035 \quad 10.0$ points

Rank the compounds
$\mathrm{CH}_{3} \mathrm{CH}_{2} \mathrm{OH} \quad \mathrm{CH}_{3} \mathrm{NH}_{2} \quad \mathrm{CH}_{3} \mathrm{OH} \quad \mathrm{NaOH}$ in terms of increasing vapor pressure.

$$
\text { 1. } \mathrm{NaOH}<\mathrm{CH}_{3} \mathrm{NH}_{2}<\mathrm{CH}_{3} \mathrm{OH}
$$

$$
\text { 2. } \mathrm{NaOH}<\mathrm{CH}_{3} \mathrm{OH}<\mathrm{CH}_{3} \mathrm{NH}_{2}
$$

3. $\mathrm{NaOH}<\mathrm{CH}_{3} \mathrm{CH}_{2} \mathrm{OH}<\mathrm{CH}_{3} \mathrm{OH}$
$<\mathrm{CH}_{3} \mathrm{NH}_{2}$
4. $\mathrm{CH}_{3} \mathrm{CH}_{2} \mathrm{OH}<\mathrm{CH}_{3} \mathrm{OH}<\mathrm{CH}_{3} \mathrm{NH}_{2}$ $<\mathrm{NaOH}$
5. $\mathrm{CH}_{3} \mathrm{NH}_{2}<\mathrm{CH}_{3} \mathrm{OH}<\mathrm{CH}_{3} \mathrm{CH}_{2} \mathrm{OH}$
$<\mathrm{NaOH}$

## LaBrake CIC CH5 02 <br> $036 \quad 10.0$ points

Which of the following substances would you predict might evaporate the fastest?

1. $\mathrm{C}_{8} \mathrm{H}_{18}$
2. $\mathrm{C}_{6} \mathrm{H}_{14}$
3. $\mathrm{C}_{10} \mathrm{H}_{22}$
4. $\mathrm{C}_{12} \mathrm{H}_{24}$

## LDE Thermodynamic Theory 012 U not E $037 \quad 10.0$ points

Which of the following statements concerning the laws of thermodynamics is not true?

1. Entropy always increases in an isolated system.
2. $S=0$ for a perfect crystal at absolute zero.
3. $\Delta S_{\text {univ }}>0$
4. Free energy is conserved in a closed system.
5. $\Delta \mathrm{U}_{\text {univ }}=0$

## LDE Thermodynamic Work 0034 03810.0 points

For which of the following reactions at room temperature $\left(25^{\circ} \mathrm{C}\right)$ would there be 5.0 kJ of work done on the system?

1. $2 \mathrm{H}_{2} \mathrm{O}_{2}(\ell) \rightarrow 2 \mathrm{H}_{2} \mathrm{O}(\ell)+\mathrm{O}_{2}(\mathrm{~g})$
2. $2 \mathrm{H}_{2} \mathrm{O}(\ell)+\mathrm{O}_{2}(\mathrm{~g}) \rightarrow 2 \mathrm{H}_{2} \mathrm{O}_{2}(\ell)$
3. $\mathrm{CH}_{4}(\mathrm{~g})+2 \mathrm{O}_{2}(\mathrm{~g}) \rightarrow \mathrm{CO}_{2}(\mathrm{~g})+2 \mathrm{H}_{2} \mathrm{O}(\mathrm{g})$

$$
\begin{aligned}
& \text { 4. } \mathrm{N}_{2} \mathrm{H}_{2}(\mathrm{~g})+\mathrm{CH}_{3} \mathrm{OH}(\mathrm{~g}) \rightarrow \\
& \qquad \mathrm{CH}_{2} \mathrm{O}(\mathrm{~g})+\mathrm{N}_{2}(\mathrm{~g})+2 \mathrm{H}_{2}(\mathrm{~g})
\end{aligned}
$$

5. $\mathrm{CH}_{2} \mathrm{O}(\mathrm{g})+\mathrm{N}_{2}(\mathrm{~g})+2 \mathrm{H}_{2}(\mathrm{~g}) \rightarrow$

$$
\mathrm{N}_{2} \mathrm{H}_{2}(\mathrm{~g})+\mathrm{CH}_{3} \mathrm{OH}(\mathrm{~g})
$$

6. $\mathrm{CO}_{2}(\mathrm{~g})+2 \mathrm{H}_{2} \mathrm{O}(\mathrm{g}) \rightarrow \mathrm{CH}_{4}(\mathrm{~g})+2 \mathrm{O}_{2}(\mathrm{~g})$

## LDE Bomb Calorimeter 002 <br> $039 \quad 10.0$ points

If we set up a bomb calorimetry experiment to determine the molar internal energy of combustion of ethene $\left(\mathrm{C}_{2} \mathrm{H}_{4}\right)$ using 1 L of water as our heat sink, 2.805 g of ethene, and measure an initial and final temperature of $25.20^{\circ} \mathrm{C}$ and $58.92^{\circ} \mathrm{C}$, respectively, what will be the experimentally determined molar internal energy of combustion of ethene? Assume the density of water is $1.00 \mathrm{~g} \cdot \mathrm{~mL}^{-1}$ and the calorimeter itself absorbs no heat. The specific heat capacity of water is 4.184 $\mathrm{J} \cdot \mathrm{g}^{-1} \cdot \mathrm{~K}^{-1}$.

$$
\text { 1. }-14.11 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}
$$

$$
\text { 2. }-141,100 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}
$$

3. $-14,110 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
4. $-141.1 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
5. $-1,411 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$

## LDE Bond Enthalpy 002 <br> $040 \quad 10.0$ points

Using the provided bond enthalpy data, calculate the change in enthalpy for the following reaction:

$$
\mathrm{CH}_{4}(\mathrm{~g})+\mathrm{O}_{2}(\mathrm{~g}) \longleftrightarrow \mathrm{CH}_{2} \mathrm{O}(\mathrm{~g})+\mathrm{H}_{2} \mathrm{O}(\mathrm{~g})
$$

2. $710 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
3. $-577 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
4. $577 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
5. $-349 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
6. $349 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$

## ChemPrin3e T06 48

$041 \quad 10.0$ points
Calculate the standard enthalpy of combustion of butane $\left(\mathrm{C}_{4} \mathrm{H}_{10}(\mathrm{~g})\right)$ at 298 K from standard enthalpy of formation data.

$$
\begin{aligned}
& \text { 1. }-895.49 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1} \\
& \text { 2. }-2342.32 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1} \\
& \text { 3. }-2877.04 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1} \\
& \text { 4. }-2843.5 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1} \\
& \text { 5. }-2056.49 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}
\end{aligned}
$$

## LDE Thermodynamic Signs 001 04210.0 points

When wood is burning (i.e. a combustion process is occurring), which of the following quantities is positive?

1. Work.
2. Change in enthalpy.
3. Change in entropy.
4. Change in Gibbs' free energy.

## ChemPrin3e 072526 $043 \quad 10.0$ points

Which one shows the substances in the decreasing order of their molar entropy?

1. $\mathrm{CO}_{2}(\mathrm{~g}), \mathrm{H}_{2} \mathrm{O}(\ell), \mathrm{Ne}(\mathrm{g}), \mathrm{Ar}(\mathrm{g})$
2. $-710 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$

## $046 \quad 10.0$ points

2. $\mathrm{H}_{2} \mathrm{O}(\ell), \mathrm{Ne}(\mathrm{g}), \operatorname{Ar}(\mathrm{g}), \mathrm{CO}_{2}(\mathrm{~g})$
3. None of these
4. $\mathrm{CO}_{2}(\mathrm{~g}), \mathrm{Ar}(\mathrm{g}), \mathrm{Ne}(\mathrm{g}), \mathrm{H}_{2} \mathrm{O}(\ell)$
5. $\mathrm{H}_{2} \mathrm{O}(\ell), \mathrm{Ar}(\mathrm{g}), \mathrm{Ne}(\mathrm{g}), \mathrm{CO}_{2}(\mathrm{~g})$
6. $\mathrm{H}_{2} \mathrm{O}(\ell), \mathrm{CO}_{2}(\mathrm{~g}), \mathrm{Ne}(\mathrm{g}), \mathrm{Ar}(\mathrm{g})$

## LDE Entropy 002 <br> 04410.0 points

Which of the reactions below will likely have the largest increase in entropy $\left(\Delta S_{\mathrm{rxn}}\right)$ ?

1. $\mathrm{N}_{2} \mathrm{H}_{4}(\mathrm{~g})+\mathrm{H}_{2}(\mathrm{~g}) \rightarrow 2 \mathrm{NH}_{3}(\mathrm{~g})$
2. $2 \mathrm{CH}_{4}(\mathrm{~g})+2 \mathrm{O}_{3}(\mathrm{~g}) \rightarrow$

$$
4 \mathrm{H}_{2} \mathrm{O}(\mathrm{~g})+2 \mathrm{CO}(\mathrm{~g})
$$

3. $\mathrm{C}_{5} \mathrm{H}_{12}(\ell)+8 \mathrm{O}_{2}(\mathrm{~g}) \rightarrow$

$$
6 \mathrm{H}_{2} \mathrm{O}(\mathrm{~g})+5 \mathrm{CO}_{2}(\mathrm{~g})
$$

4. $\mathrm{S}_{3}(\mathrm{~g})+9 \mathrm{~F}_{2}(\mathrm{~g}) \rightarrow 3 \mathrm{SF}_{6}(\mathrm{~g})$
5. $\mathrm{Na}^{+}(\mathrm{g})+\mathrm{Cl}^{-}(\mathrm{g}) \rightarrow \mathrm{NaCl}(\mathrm{s})$

## entropy change for metal heating 1 $045 \quad 10.0$ points

150 grams of iron is heated from $25^{\circ} \mathrm{C}$ to $150^{\circ} \mathrm{C}$. What is $\Delta S$ for this change? The specific heat capacity of iron is $0.450 \mathrm{~J} / \mathrm{g} \mathrm{K}$.

1. $-121 \mathrm{~J} / \mathrm{K}$
2. $-23.6 \mathrm{~J} / \mathrm{K}$
3. $+23.6 \mathrm{~J} / \mathrm{K}$
4. $-8438 \mathrm{~J} / \mathrm{K}$
5. $+121 \mathrm{~J} / \mathrm{K}$
6. $+8438 \mathrm{~J} / \mathrm{K}$
7. 0 J/K

Calculate $\Delta S_{\text {surr }}^{\circ}$ at 298 K for the reaction

$$
\begin{aligned}
& \quad 6 \mathrm{C}(\mathrm{~s})+3 \mathrm{H}_{2}(\mathrm{~g}) \rightarrow \mathrm{C}_{6} \mathrm{H}_{6}(\ell) \\
& \Delta H_{\mathrm{r}}^{\circ}=+49.0 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1} \text { and } \Delta S_{\mathrm{r}}^{\circ}=-253 \\
& \mathrm{~J} \cdot \mathrm{~K}^{-1} \cdot \mathrm{~mol}^{-1} \cdot \\
& \text { 1. }-417 \mathrm{~J} \cdot \mathrm{~K}^{-1} \cdot \mathrm{~mol}^{-1} \\
& \text { 2. }+253 \mathrm{~J} \cdot \mathrm{~K}^{-1} \cdot \mathrm{~mol}^{-1} \\
& \text { 3. }+164 \mathrm{~J} \cdot \mathrm{~K}^{-1} \cdot \mathrm{~mol}^{-1} \\
& \text { 4. }-253 \mathrm{~J} \cdot \mathrm{~K}^{-1} \cdot \mathrm{~mol}^{-1} \\
& \text { 5. }-164 \mathrm{~J} \cdot \mathrm{~K}^{-1} \cdot \mathrm{~mol}^{-1}
\end{aligned}
$$

## LDE Temperature and Phase Changes 003

## $047 \quad 10.0$ points

Based on the enthalpy of sublimation $\left(\Delta H_{\text {sub }}=393.5 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}\right)$ and entropy of sublimation $\left(\Delta S_{\text {sub }}=2.023 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1} \cdot \mathrm{~K}^{-1}\right)$ of carbon dioxide, at what temperature does this phase transition occur?

1. 0.2 K
2. $-78.5^{\circ} \mathrm{C}$
3. $78.5^{\circ} \mathrm{C}$
4. -78.5 K
5. $0.2^{\circ} \mathrm{C}$

## ChemPrin3e T07 59 <br> $048 \quad 10.0$ points

For the reaction

$$
2 \mathrm{C}(\mathrm{~s})+2 \mathrm{H}_{2}(\mathrm{~g}) \rightarrow \mathrm{C}_{2} \mathrm{H}_{4}(\mathrm{~g})
$$

$\Delta H_{\mathrm{r}}^{\circ}=+52.3 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$ and $\Delta S_{\mathrm{r}}^{\circ}=$ $-53.07 \mathrm{~J} \cdot \mathrm{~K}^{-1} \cdot \mathrm{~mol}^{-1}$ at 298 K . The reverse reaction will be spontaneous at

1. temperatures above 985 K .
2. temperatures below 1015 K .
3. no temperatures.
4. temperatures below 985 K .
5. all temperatures.

## ChemPrin3e T07 52 <br> $049 \quad 10.0$ points

Calculate $\Delta G_{\mathrm{r}}^{\circ}$ for the decomposition of mercury(II) oxide

| $2 \mathrm{HgO}(\mathrm{s}) \rightarrow 2 \mathrm{Hg}(\ell)+\mathrm{O}_{2}(\mathrm{~g})$ |  |  |  |
| :--- | ---: | ---: | ---: |
| $\Delta H_{\mathrm{f}}^{\circ}$ | -90.83 | - | - |
| $\left(\mathrm{kJ} \cdot \mathrm{mol}^{-1}\right)$ |  |  |  |
| $\Delta S_{\mathrm{m}}^{\circ}$ | 70.29 | 76.02 | 205.14 |
| $\left(\mathrm{~J} \cdot \mathrm{~K}^{-1} \cdot \mathrm{~mol}^{-1}\right)$ |  |  |  |

at 298 K .

1. $-246.2 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
2. $+117.1 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
3. $-117.1 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
4. $+246.2 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$
5. $-64.5 \mathrm{~kJ} \cdot \mathrm{~mol}^{-1}$

## LDE Gibbs Stability Ranking 002 <br> $050 \quad 10.0$ points

Use the table data

|  | $\Delta G_{\mathrm{rxn}}^{\circ}$ <br> $[\mathrm{kg} /(\mathrm{mol} \cdot \mathrm{K})]$ |
| :--- | :--- |
| $\mathrm{AgCl}(\mathrm{s}) \rightarrow \mathrm{Ag}(\mathrm{s})+\frac{1}{2} \mathrm{Cl}_{2}(\mathrm{~g})$ | 109.7 |
| $2 \mathrm{Ag}(\mathrm{s})+\frac{1}{2} \mathrm{O}_{2}(\mathrm{~g}) \rightarrow \mathrm{Ag}_{2} \mathrm{O}(\mathrm{s})$ | -10.8 |
| $\frac{1}{2} \mathrm{~N}_{2}(\mathrm{~g})+\mathrm{O}_{2}(\mathrm{~g}) \rightarrow \mathrm{NO}_{2}(\mathrm{~g})$ | 51.8 |
| $\mathrm{HI}(\mathrm{g}) \rightarrow \frac{1}{2} \mathrm{H}_{2}(\mathrm{~g})+\frac{1}{2} \mathrm{I}_{2}(\mathrm{~g})$ | -1.3 |

to pick the thermodynamically most stable species.

1. $\mathrm{Ag}_{2} \mathrm{O}(\mathrm{s})$
2. $\mathrm{AgCl}(\mathrm{s})$
3. $\mathrm{HI}(\mathrm{g})$
4. $\mathrm{NO}_{2}(\mathrm{~g})$
