CHE 105 Spring 2017 Exam 3

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

Question #: 1

When energy flows into a system, the ΔE of the surroundings:

A. is positive in value.
B. is negative in value.
C. is exactly zero.
D. cannot be determined.

Question #: 2

Which one is **not** a state function?

A. pressure
B. temperature
C. work
D. volume
E. energy

Question #: 3

Select the **two** which correctly complete the sentence. The First Law of Thermodynamics states that

A. the energy of the universe is decreasing over time.
B. energy can be converted from one form to another.
C. energy cannot be created or destroyed in a reaction.
D. chemical energy is a form of kinetic energy.
E. thermal energy is a form of potential energy.

Question #: 4

What is the change in internal energy, ΔE, for a system that absorbs 571.2 kJ of heat and performs 77.7 kJ of work on the surroundings?
__1__ kJ
Report your answer with **one** decimal place. Do **NOT** include units in your answer.

1. _____

Question #: 5

A cylinder with a moving piston expands from an initial volume of 0.250 L to a final volume of 0.750 L against an external pressure of 2.50 atm. How much work is done, in joules (J)? 1 L•atm = 101.3 J
__1__ Joules
Report your answer with **three** significant figures. Do **NOT** include units in your answer.

1. _____

Question #: 6

What amount of heat is necessary to raise the temperature of 57.8 grams of benzene by 57.0 ^{o}C ? The specific heat capacity of benzene is 1.05 J/g·^{o}C.

A. 1.61 kJ
B. 16.6 kJ
C. 2.59 kJ
D. 2.86 kJ
E. 3.46 kJ

Question #: 7

When 2.02 g of glucose (molar mass = 180.2 g/mol) undergoes combustion in a bomb calorimeter, the temperature rises from 25.5 °C to 29.5 °C. What is ΔE for the combustion of glucose in kJ/mol glucose? The heat capacity of the bomb calorimeter is 4.90 kJ/°C.
__1__ kJ/mol glucose
Report your answer with **three** significant figures. Do **NOT** include units in your answer. Use the format 2.22E2 or 2.22E-2 for answers in scientific notation.

1. _____

Question #: 8

For the reaction below, what is the enthalpy change for the decomposition of 765 g of PCl_3? The molar mass of PCl_3 is 137.32 g/mol.
$4\ PCl_3(g) \rightarrow P_4(s) + 6\ Cl_2(g) \quad \Delta H^o_{rxn} = +1207\ kJ$

A. 2.31×10^3 kJ
B. 4.33×10^3 kJ
C. 6.72×10^3 kJ
D. 1.68×10^3 kJ

Question #: 9

When 75.0 mL of a 1.25 M HCl solution is mixed with a 100. mL of a 1.00 M NaOH solution in a constant-pressure calorimeter, the temperature of the resultant 175 mL solution increases from 23.0 °C to 33.0 °C. The final solution has a density of 1.00 g/mL. What is the enthalpy change (ΔH) of the reaction in kJ/mol of HCl? In this reaction NaOH is in excess. The specific heat capacity of the solution is 4.184 J/g•°C.
__1__ kJ/mol HCl
Report your answer with **three** significant figures. Do **NOT** include units in your answer.

1. _____

Question #: 10

From the equations and standard enthalpies of reaction given below, what is ΔH^{o}_{rxn} for the decomposition of SO_3 by the reaction:
$4\ SO_3(g) \rightarrow 4\ S(s) + 6\ O_2(g) \quad \Delta H^{o}_{rxn} = ?$
Given:
$SO_2(g) \rightarrow S(s) + O_2(g) \qquad \Delta H^{o}_{rxn} = +296.8\ kJ$
$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g) \quad \Delta H^{o}_{rxn} = -197.8\ kJ$

A. –494.6 kJ
B. –692.4 kJ
C. 1583 kJ
D. 1142 kJ
E. 993.1 kJ

Question #: 11

What is the correct equation for the formation of sucrose ($C_{12}H_{22}O_{11}$)? See attachment at end of exam to view a table of Standard Enthalpies of Formation.

A. $12\ C(graphite) + 11\ H_2(g) + 5.5\ O_2(g) \rightarrow C_{12}H_{22}O_{11}(s)$
B. $12\ C(graphite) + 22\ H(g) + 11\ O(g) \rightarrow C_{12}H_{22}O_{11}(s)$
C. $24\ C(graphite) + 44\ H_2(g) + 11\ O_2(g) \rightarrow C_{12}H_{22}O_{11}(s)$
D. $1\ C(graphite) + 1\ H(g) + 1\ O(g) \rightarrow C_{12}H_{22}O_{11}(s)$

Question #: 12

From the information provided, what is the standard enthalpy of formation, ΔH^{o}_{f} , for $IF(g)$?
$IF_7(g) + I_2(g) \rightarrow IF_5(g) + 2\ IF(g) \quad \Delta H^{o}_{rxn} = -89\ kJ$
ΔH^{o}_{f} of $IF_7(g) = -941\ kJ/mol$
ΔH^{o}_{f} of $IF_5(g) = -840\ kJ/mol$

A. 24 kJ/mol
B. 101 kJ/mol
C. –95 kJ/mol
D. –146 kJ/mol
E. –191 kJ/mol

Question #: 13

Which **two** statements about the nature of light are true?

A. For visible light, the amplitude determines the color of the light.
B. The wavelength of a photon is sufficient to determine its energy.
C. The frequency of a wave in Hertz is the number of waves passing through a given point in one millisecond.
D. Of all the visible colors, the one with the longest wavelength emits photons with the highest energy.
E. Visible light comprises only a small fraction of the electromagnetic spectrum.

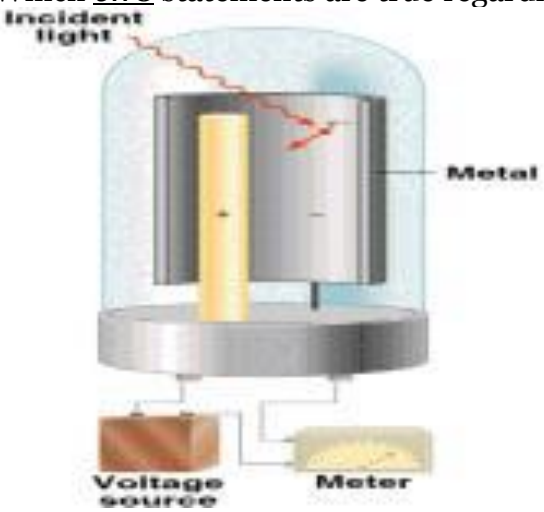
Question #: 14

What is the energy of a photon of red light emitted by a neon atom if its wavelength is 703.2 nm?
__1__ J
Report your answer with **three** significant figures. Do **NOT** include units in your answer. Use the format 2.22E2 or 2.22E-2 for answers in scientific notation.

1. _____

Question #: 15

Which **two** statements are true regarding the photoelectric effect?



A. Any frequency of incident light will eject electrons from the metal plate.
B. The total energy associated with an ejected electron is a function of the binding energy and the potential energy of the electron.
C. Once the threshold frequency is attained, increasing the intensity (amplitude) of the incident light increases the number of electrons ejected from the metal plate.
D. Once an electron is ejected, increasing the frequency of the incident light increases the kinetic energy of the electron.

Question #: 16

What is the velocity of a marble (mass = 8.66 grams) with a de Broglie wavelength of 3.46×10^{-33} m?

A. 11.3 m/s
B. 22.1 m/s
C. 38.8 m/s
D. 45.2 m/s
E. 52.9 m/s

Question #: 17

The Heisenberg Uncertainty Principle states that it is impossible to know simultaneously both the __1__ and the __2__ of a particle with certainty.

1. _____
2. _____

Question #: 18

The ionization energy of a hydrogen atom can be described as a transition from the n = 1 ground state to n = ∞. How much energy is required to ionize (energize) a hydrogen atom?
__1__ J
Report your answer with **two** significant figures. Do **NOT** include units in your answer. Use the format 2.2E2 or 2.2E-2 for answers in scientific notation.

1. _____

Question #: 19

Which **two** sets of quantum numbers are **not** allowed?

A. $n = 4 \quad l = 2 \quad m_l = 3$
B. $n = 3 \quad l = 4 \quad m_l = 2$
C. $n = 3 \quad l = 2 \quad m_l = 2$
D. $n = 4 \quad l = 2 \quad m_l = 0$
E. $n = 4 \quad l = 3 \quad m_l = -2$

Question #: 20

Which one is **not** spherical?

A. The n = 1 orbital of a hydrogen atom.
B. The outermost (highest energy) orbital of a strontium atom.
C. The overall shape of a uranium atom
D. The outermost (highest energy) orbital of a krypton atom.

Question #: 21

Each of the following sets of quantum numbers represents a single electron. Which **two** electron representations can coexist in the same orbital **without** violating the Pauli Exclusion Principle?

A. $n = 3 \quad l = 1 \quad m_l = -1 \quad m_s = ½$
B. $n = 3 \quad l = 1 \quad m_l = -1 \quad m_s = -½$
C. $n = 3 \quad l = 1 \quad m_l = 1 \quad m_s = ½$
D. $n = 3 \quad l = 1 \quad m_l = 0 \quad m_s = -½$

Question #: 22

The fact that the sublevels (*i.e.*, *s*, *p*, *d*, *etc.*) of each principal quantum number exhibit different energies in multielectron atoms can be explained by:

A. the Bohr model of the atom.
B. Coulomb's law and penetration.
C. the Pauli exclusion principle.
D. electron spin and orbital phases.
E. Hund's rule.

Question #: 23

Hund's rule states that the most stable arrangement of electrons in a subshell is the one with the __1__ [greatest, least] number of __2__ [parallel, antiparallel] spins.

1. _____
2. _____

Question #: 24

What is the electron configuration of a cadmium (Cd) atom in its ground state?

A. $[Kr]5s^2 5d^{10}$
B. $[Kr]5s^2 4d^{10}$
C. $[Kr]5s^2 4d^{10} 5p^2$
D. $[Kr]4d^{10}$

Question #: 25

Neutral manganese atoms contain __1__ valence electrons and __2__ core electrons. Report each answer as a whole number (i.e. 1, 2, 3).

1. _____
2. _____

Question #: 26

Which ground-state electron configuration is **<u>incorrect</u>**?

A. chromium $[Ar]4s^1 3d^5$
B. silver $[Kr]5s^1 4d^{10}$
C. zirconium $[Kr]4d^4$
D. cobalt $[Ar]4s^2 3d^7$

Question #: 27

Based on its electron configuration, a neutral sulfur atom is _____ and a typical sulfur ion is _____.

A. paramagnetic, paramagnetic
B. diamagnetic, diamagnetic
C. paramagnetic, diamagnetic
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Question #: 28

Which one has the **<u>smallest</u>** atomic radius?

A. K
B. As
C. Rb
D. Sb

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Which electron configuration is correct for the Ni^{2+} cation?

A. [Ar] $4s^2\ 3d^6$
B. [Ar] $3d^8$
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F. [Ar] $4d^8$

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Which element has the following ionization energies?
IE_1 = 578 kJ/mol IE_2 = 1820 kJ/mol IE_3 = 2750 kJ/mol IE_4 = 11600 kJ/mol IE_5 = 14800 kJ/mol

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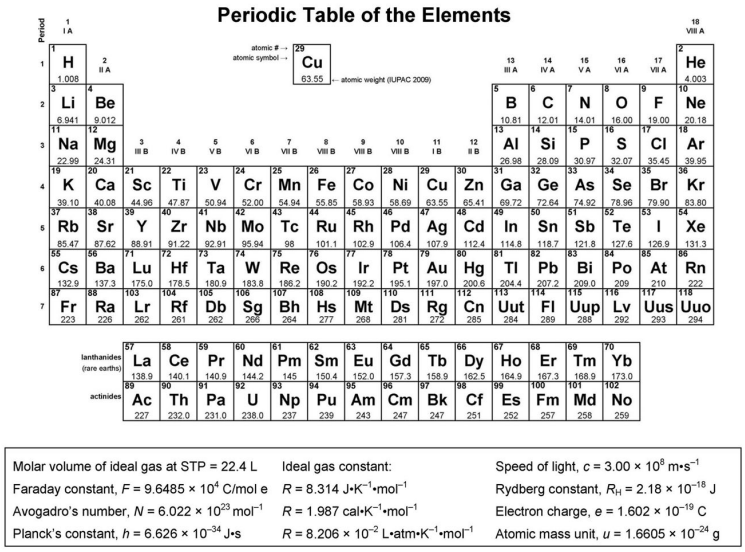

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1. 493.5|+493.5|

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1. -127|-127|- 127|

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1. -1.75E3|- 1.75E3|-1.75 E3|

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Attachment:

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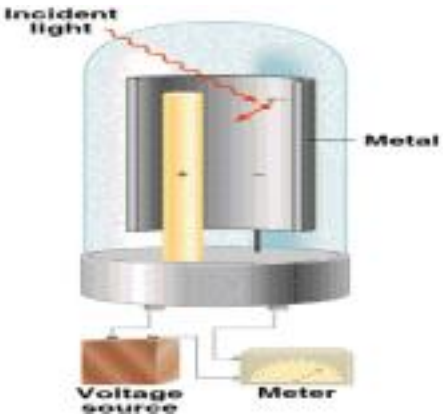

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The Heisenberg Uncertainty Principle states that it is impossible to know simultaneously both the __1__ and the __2__ of a particle with certainty.

1. momentum|position|
2. position|momentum|

Question #: 18

The ionization energy of a hydrogen atom can be described as a transition from the n = 1 ground state to n = ∞. How much energy is required to ionize (energize) a hydrogen atom?

1 J

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Hund's rule states that the most stable arrangement of electrons in a subshell is the one with the __1__ [greatest, least] number of __2__ [parallel, antiparallel] spins.

1. greatest
2. parallel

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A. $[Kr]5s^2 5d^{10}$
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C. $[Kr]5s^2 4d^{10} 5p^2$
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Report each answer as a whole number (i.e. 1, 2, 3).

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2. 18

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B. silver $[Kr]5s^1 4d^{10}$
✓C. zirconium $[Kr]4d^4$
D. cobalt $[Ar]4s^2 3d^7$

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Based on its electron configuration, a neutral sulfur atom is _____ and a typical sulfur ion is _____.

A. paramagnetic, paramagnetic
B. diamagnetic, diamagnetic
✓C. paramagnetic, diamagnetic
D. diamagnetic, paramagnetic

Question #: 28

Which one has the **smallest** atomic radius?

A. K
✓B. As
C. Rb

D. Sb

Question #: 29

Which electron configuration is correct for the Ni^{2+} cation?

A. [Ar] $4s^2\ 3d^6$
✓B. [Ar] $3d^8$
C. [Ar] $4s^2\ 3d^8$
D. [Ar] $4s^2\ 4d^8$
E. [Ar] $3s^2\ 3d^8$
F. [Ar] $4d^8$

Question #: 30

Which element has the following ionization energies?
IE_1 = 578 kJ/mol IE_2 = 1820 kJ/mol IE_3 = 2750 kJ/mol IE_4 = 11600 kJ/mol IE_5 = 14800 kJ/mol

A. Na
B. Mg
✓C. Al
D. Si
E. P

TABLE 6.2 | **Standard Enthalpies of Formation (at 25°C)***

Substance or Ion	ΔH_f° (kJ/mol)
$e^-(g)$	0
Bromine	
$Br(g)$	111.9
$Br^-(aq)$	−121.5
$Br^-(g)$	−219.0
$Br_2(g)$	30.91
$Br_2(l)$	0
$HBr(g)$	−36.44
Calcium	
$Ca(s)$	0
$Ca^{2+}(aq)$	−542.8
$CaCO_3(s,$ calcite)	−1206.9
$CaO(s)$	−635.1
Carbon	
$C(g)$	716.7
$C(s,$ diamond)	1.897
$C(s,$ graphite)	0
$CCl_4(g)$	−95.98
$CCl_4(l)$	−135.4
$CO(g)$	−110.5
$CO_2(g)$	−393.5
$CO_3^{2-}(aq)$	−677.1
$CS_2(g)$	116.9
$CS_2(l)$	89.70
$HCN(g)$	135.1
$HCN(l)$	108.9
$HCO_3^-(aq)$	−692.0
Hydrocarbons	
$CH_4(g)$	−74.87
$C_2H_4(g)$	52.47
$C_2H_6(g)$	−84.68
$C_6H_6(l)$	49.0
Alcohols	
$CH_3OH(l)$	−238.7
$C_2H_5OH(l)$	−277.7
Aldehydes	
$HCHO(g)$	−117
$CH_3CHO(g)$	−166.1
$CH_3CHO(l)$	−191.8
Chlorine	
$Cl(g)$	121.3
$Cl^-(aq)$	−167.2
$Cl^-(g)$	−234.0
$Cl_2(g)$	0
$HCl(g)$	−92.31
Fluorine	
$F(g)$	79.39
$F^-(g)$	−255.1
$F^-(aq)$	−332.6
$F_2(g)$	0
$HF(g)$	−272.5
Hydrogen	
$H(g)$	218.0
$H^+(aq)$	0
$H^+(g)$	1536.2
$H_2(g)$	0
Iodine	
$I(g)$	106.8
$I^-(aq)$	−55.19
$I^-(g)$	−194.6
$I_2(s)$	0
$HI(g)$	26.36
Lead	
$Pb(s)$	0
$Pb^{2+}(aq)$	−1.7
$PbO(s)$	−219.4
$PbS(s)$	−98.32
Nitrogen	
$N(g)$	472.7
$N_2(g)$	0
$NH_3(g)$	−45.90
$NH_4^+(aq)$	−132.5
$NO(g)$	90.29
$NO_2(g)$	33.10
$HNO_3(aq)$	−207.4
Oxygen	
$O(g)$	249.2
$O_2(g)$	0
$O_3(g)$	142.7
$OH^-(aq)$	−230.0
$H_2O(g)$	−241.8
$H_2O(l)$	−285.8
Silicon	
$Si(s)$	0
$SiCl_4(l)$	−687.0
$SiF_4(g)$	−1614.9
$SiO_2(s,$ quartz)	−910.9
Silver	
$Ag(s)$	0
$Ag^+(aq)$	105.6
$AgBr(s)$	−100.4
$AgCl(s)$	−127.1
$AgF(s)$	−204.6
$AgI(s)$	−61.84
Sodium	
$Na(g)$	107.3
$Na(s)$	0
$Na^+(aq)$	−240.1
$Na^+(g)$	609.3
$Na_2CO_3(s)$	−1130.8
$NaCl(s)$	−411.1
$NaHCO_3(s)$	−950.8
Sulfur	
$S(g)$	277.0
$S(s,$ monoclinic)	0.360
$S(s,$ rhombic)	0
$S_2(g)$	128.6
$SO_2(g)$	−296.8
$H_2S(g)$	−20.50