CHEM _____ Lab Section Number: _____

Name (printed):_____

Signature:_____

This exam consists of 36 questions all of equal value for a total of 225 points. Make sure that your test has all of the pages. *Please read each problem carefully*. There are no intentionally misleading questions; each problem should be taken at its face value. Please mark your answers ***on the Scantron sheet*** provided to you ***and on the actual exam***.

You will be given a periodic table and an exam information sheet to use during the exam. You may remove it from the exam make it more accessible. You may also use the designated Casio fx-300ms-plus calculator or equivalent non-programmable non-graphing scientific calculator during the exam. Use the back pages of the test as scratch paper. You are not allowed to use any devices capable of accessing the internet, textbooks, notes, or homemade reference sheets during the exam.

You may leave if you finish the exam early. Give the exam and the information sheet to your TA and leave quietly without disturbing other students. Before leaving, check that all your answers have been properly entered on the Scantron sheet and the exam and that your name is written on every page of the exam and on the Scantron sheet.

All cell phones and electronic devices must be turned off and put away. Please remove all hats and caps. Place your books and all papers out of sight under your seat. If the TA believes that you might be looking at your neighbor's paper, you will be asked to move to a new location.

Exam scores will be posted on Blackboard as soon as the grading is complete. Your test will be returned to you in the first lab meeting of next week. If you have any questions regarding the grading of your exam, please notify your TA.

The time available for the exam is 120 minutes. **Good luck!**

Name: _____ Lab Section #: _____

Please mark your answers on the scantron sheet using a #2 pencil and also mark your answers on the exam itself.

Mark Test From "A" on your scantron.

1. Which of the following sets of quantum numbers describe an impossible situation?

   (a) n=2, l=1, m_l=-1, m_s= +1/2
   (b) n=5, l=2, m_l=2, m_s= -1/2
   (c) n=6, l=3, m_l=0, m_s=0
   (d) n=3, l=3, m_l=1, m_s= +1/2
   (e) n=4, l=2, m_l=1, m_s=+1/2

2. The thermite reaction gives off an enormous amount of heat. Which of the following is true of this reaction?

   (a) $\Delta H < 0$, process is exothermic
   (b) $\Delta H > 0$, process is endothermic
   (c) $\Delta H > 0$, process is exothermic
   (d) $\Delta H < 0$, process is endothermic
   (e) $\Delta H = 0$

3. Of the symbols below, which is used to express specific heat capacity?

   (a) $\boldsymbol{\nu}$
   (b) $\boldsymbol{\lambda}$
   (c) P
   (d) c
   (e) C

4. A radio wave has frequency of 8.6×10^9 Hz. What is the energy of one photon of this radiation?

   (a) 7.7×10^{-42} J
   (b) 2.3×10^{-33} J
   (c) 5.7×10^{-24} J
   (d) 1.7×10^{-15} J
   (e) 1.2×10^{-14} J

5. Which statement below best describes the Pauli Exclusion Principle?

   (a) no two electrons in the same atom can have the same set of four quantum numbers
   (b) two atoms of the same element must have the same number of protons.
   (c) it is impossible to determine accurately both the position and momentum of an electron simultaneously.
   (d) electrons of atoms in their ground states enter energetically equivalent sets of orbitals singly before they pair up in any orbital of the set.
   (e) charged atoms (ions) must generate a magnetic field when they are in motion.

6. What is the energy of the sole electron on the hydrogenic ion (Be^{3+}) when the electron is in the n = 3 level?

   (a) -2.42×10^{-19} J
   (b) -2.18×10^{-18} J
   (c) -3.88×10^{-18} J
   (d) -9.69×10^{-19} J
   (e) -6.06×10^{-18} J

7. A system that does no work but which transfers heat to the surroundings has

   (a) $q < 0$, $\Delta E > 0$
   (b) $q > 0$, $\Delta E > 0$
   (c) $q < 0$, $\Delta E < 0$
   (d) $q > 0$, $\Delta E < 0$
   (e) $q < 0$, $\Delta E = 0$

8. A system receives 575 J of heat and delivers 425 J of work. Calculate the change in the internal energy, ΔE, of the system

   (a) -150 J
   (b) -1000 J
   (c) 150 J
   (d) 1000 J
   (e) 575 J

9. Cold packs, whose temperatures are lowered when ammonium nitrate dissolves in water, are carried by athletic trainers when transporting ice is not possible. Which of the following is true of this reaction?

   (a) $\Delta H < 0$, process is exothermic
   (b) $\Delta H > 0$, process is endothermic
   (c) $\Delta H > 0$, process is exothermic
   (d) $\Delta H < 0$, process is endothermic
   (e) $\Delta H = 0$, since cold packs are sealed

10. Which one of the following is not a correct formation reaction?

(a) $1/2H_2(g) + 1/2Cl_2(g) \rightarrow HCl(g)$
(b) $6C(\text{graphite}) + 3H_2(g) \rightarrow C_6H_6(l)$
(c) $6C(\text{graphite}) + 6H_2(g) + 3O_2(g) \rightarrow C_6H_{12}O_6(s)$
(d) $Ca(s) + 1/8S_8(s) + 3O_2(g) + 2H_2(g) \rightarrow CaSO_4 \cdot 2H_2O(s)$
(e) $H_2(g) + O(g) \rightarrow H_2O(l)$

11. What is the threshold frequency for sodium metal if a photon with frequency $6.66 \times 10^{14}\ s^{-1}$ ejects an electron with 7.74×10^{-20} J kinetic energy?

(a) $6.32 \times 10^{14}\ s^{-1}$
(b) $5.49 \times 10^{14}\ s^{-1}$
(c) $5.24 \times 10^{14}\ s^{-1}$
(d) $4.48 \times 10^{14}\ s^{-1}$
(e) $4.52 \times 10^{14}\ s^{-1}$

12. According to the Heisenberg uncertainty principle, if the uncertainty in the speed of an electron is 3.5×10^3 m/s, what is the uncertainty in it position (in m)? (mass of an electron is 9.11×10^{-28} g)?

(a) 6.6×10^{-8} m
(b) 17 m
(c) 1.6×10^{-8} m
(d) 66 m
(e) 75 m

$$(\Delta x)(m\Delta u) \geq \frac{h}{4\pi}$$

13. What wavelength of light is capable of promoting the electron of an C^{5+} cation from the n = 3 energy level to n = 6?

(a) 121 nm
(b) 258 nm
(c) 320. nm
(d) 30.4 nm
(e) 1880 nm

14. How fast must a baseball(142 g) travel in order to have a wavelength that is equal to that of an X-ray photon with wavelength(λ=100. pm)?

(a) 4.67×10^{-32} m/s
(b) 4.67×10^{-29} m/s
(c) 4.67×10^{-23} m/s
(d) 4.67×10^{-20} m/s
(e) 4.67×10^{-19} m/s

15. List these atoms in order of increasing the first ionization energy (IE1): Li, Na, B, C, O

(a) Li < Na < C < B < O
(b) Na < Li < B < C < O
(c) Li < Na < B < C < O
(d) Na < Li < O < C < B
(e) Li < Na < O < C < B

16. Which of the following is a correct set of quantum number for an electron in a 4 f orbital?

(a) $n = 5$, $l = 3$, $m_l = +1$, $m_s = -½$
(b) $n = 4$, $l = 2$, $m_l = 0$, $m_s = +½$
(c) $n = 4$, $l = 3$, $m_l = 4$, $m_s = +½$
(d) $n = 4$, $l = 3$, $m_l = +1$, $m_s = -½$
(e) $n = 5$, $l = 2$, $m_l = -1$, $m_s = -½$

17. Which of the following electron configurations is correct for copper?

(a) [Ar] $4s^2$ $3d^9$
(b) [Ar] $4s^2$ $4d^8$
(c) [Kr] $4s^1$ $3d^{10}$
(d) [Kr] $4s^2$ $3d^9$
(e) [Ar] $4s^1$ $3d^{10}$

18. An electron moves from the n=6 to the n=1 quantum level and emits a photon with an energy of -2.119×10^{-18} J. How much energy must the atoms absorb to move an electron from n=1 to n=6? What is the wavelength of this energy?

(a) 2.119×10^{-18} J, 9.38×10^{-8} m
(b) 4.238×10^{-18} J, 3.20×10^{-17} m
(c) -2.119×10^{-18} J, 9.38×10^{-8} m
(d) -4.238×10^{-18} J, 3.20×10^{-17} m
(e) -2.119×10^{-18} J, 3.20×10^{-17} m

19. Of the atoms listed below, which has the smallest radius?

(a) Al
(b) P
(c) As
(d) Te
(e) Na

20. Ethylene glycol, used as a coolant in automotive engines, has a specific heat capacity of 2.42 J/(g·K). Calculate *q* when 3.65 kg of ethylene glycol is cooled from 132°C to 85°C.

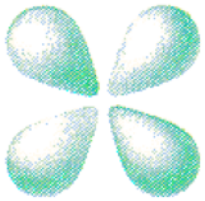
(a) -420 kJ
(b) -1900 kJ
(c) -99 kJ
(d) -0.42 kJ
(e) -4.2×10^{-6} kJ

21. Listed below are the energies for the sequential ionizations of an atom. Based on these values determine which element was being ionized.

	IE_1	IE_2	IE_3	IE_4	IE_5	IE_6	IE_7
Energy (kJ/mol)	787.2	1577.2	3231.4	4356.3	16091.2	19784.3	23782.6

(a) Aluminium
(b) Sodium
(c) Silicon
(d) Chlorine
(e) Sulfur

22. To the right is an image of an atomic orbital. What is the biggest possible magnetic quantum number(m_l) that this orbital could have?



(a) 0
(b) 1
(c) 2
(d) 3
(e) 4

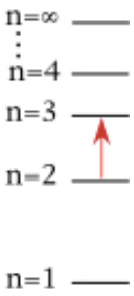
23. Which sequence has ions properly ranked in order of their increasing ionic radii: K^+, P^{3-}, S^{2-}, Cl^-?

(a) $K^+ < Cl^- < S^{2-} < P^{3-}$
(b) $K^+ < P^{3-} < S^{2-} < Cl^-$
(c) $P^{3-} < S^{2-} < Cl^- < K^+$
(d) $Cl^- < S^{2-} < P^{3-} < K^+$
(e) $Cl^- < S^{2-} < K^+ < P^{3-}$

24. Which of the following atoms has the greatest number of valence electrons?

(a) Si
(b) Te
(c) Br
(d) Rb
(e) In

25. In the transition on the right, an electron moves from n=_ level to n=_ level. Energy is___in this process and electron moves ___ the nucleus.



(a) 2, 3, emitted, closer
(b) 2, 3, absorbed, further from
(c) 2, 3, emitted, further from
(d) 2, 3, absorbed, closer
(e) 3, 2, emitted, closer

26. A system initially has an internal energy *E* of 501 J. It undergoes a process during which it releases 111 J of heat energy to the surroundings, and does work of 222 J. What is the final energy of the system, in J?

(a) 168 J
(b) 390 J
(c) 612 J
(d) 834 J
(e) cannot be calculated with the information given

27. Which of the following equations represents the correct formation equation for lead nitrate, $Pb(NO_3)_2(s)$?

(a) $Pb(s) + 1/2N_2(g) + 3O_2(g) \rightarrow Pb(NO_3)_2(s)$
(b) $Pb(s) + N_2(g) + 3O_2(g) \rightarrow Pb(NO_3)_2(s)$
(c) $Pb(s) + 1/2N_2(g) + 3/2O_2(g) \rightarrow Pb(NO_3)_2(s)$
(d) $Pb(l) + N_2(g) + 3O_2(g) \rightarrow Pb(NO_3)_2(s)$
(e) $Pb(l) + 1/2N_2(g) + 3O_2(g) \rightarrow Pb(NO_3)_2(s)$

28. Which of the following equations represents the correct formation equation for hydrogen sulfide, $H_2S(g)$?

(a) $S(s) + H_2(g) \rightarrow H_2S(g)$
(b) $S(l) + H_2(g) \rightarrow H_2S(g)$
(c) $S(g) + H_2(g) \rightarrow H_2S(g)$
(d) $1/8S(s) + 1/2H_2(g) \rightarrow H_2S(g)$
(e) $1/8S_8(s) + H_2(g) \rightarrow H_2S(g)$

29. Calculate *q* when 28.6 g of water is heated from 22.0°C to 78.3°C.

(a) 0.385 kJ
(b) 9.37 kJ
(c) 1.61 kJ
(d) 1.61×10^3 kJ
(e) 6.74 kJ

30. A 275 g sample of nickel at 100.0°C is placed in 100.0 mL of water at 22.0°C. What is the final temperature of the water? Assume that no heat is lost to or gained from the surroundings. Specific heat capacity of nickel = 0.444 J/(g·K)

    (a) 39.6 °C
    (b) 40.8 °C
    (c) 61.0 °C
    (d) 79.2 °C
    (e) 82.4 °C

31. Sand is converted to pure silicon in a three step process. The third step is

    $SiCl_4(g) + 2Mg(s) \rightarrow 2MgCl_2(s) + Si(s) \quad \Delta H = -625.6$ kJ

    What is the enthalpy change when 25.0 mol of $SiCl_4$ is converted to elemental silicon?

    (a) -25 kJ
    (b) -7820 kJ
    (c) -3.13×10^4 kJ
    (d) -1.56×10^4 kJ
    (e) none of the above

32. Use the following data to calculate the standard heat (enthalpy) of formation, $\Delta H_f°$, of manganese(IV) oxide, $MnO_2(s)$.

    $2MnO_2(s) \rightarrow 2MnO(s) + O_2(g) \quad \Delta H = 264$ kJ
    $MnO_2(s) + Mn(s) \rightarrow 2MnO(s) \quad \Delta H = -240$ kJ

    (a) -504 kJ
    (b) -372 kJ
    (c) -24 kJ
    (d) 24 kJ
    (e) 504 kJ

33. Calculate the $\Delta H°_{rxn}$ for the following reaction. (See table for data).

$$SiO_2(s) + 4HCl(g) \rightarrow SiCl_4(g) + 2H_2O(g)$$

Compound	$SiO_2(s)$	$SiCl_4(g)$	$HCl(g)$	$H_2O(g)$	$H_2O(l)$
$\Delta H_f°$	-910.9 kJ/mol	-657.0 kJ/mol	–92.3 kJ/mol	–241.8 kJ/ mol	–285.8 kJ/ mol

(a) 139.5 kJ
(b) –139.5 kJ
(c) 104.4 kJ
(d) -104.4 kJ
(e) 137.4 kJ

34. A common laboratory reaction is the neutralization of an acid with a base. When 50.0 mL of 0.500 M HCl at 25.0°C is added to 50.0 mL of 0.500 M NaOH at 25.0°C in a coffee cup calorimeter, the temperature of the mixture rises to 28.2°C. What is the heat of reaction per mole of acid? Assume the mixture has a specific heat capacity of 4.18 J/(g·K) and that the densities of the reactant solutions are both 1.00 g/mL.

(a) 54 kJ
(b) 1300 kJ
(c) 570 kJ
(d) 27 kJ
(e) > 100 kJ

35. Use Hess's Law to calculate the enthalpy change for the following reaction. Make sure the reaction is balanced.

$$\_\_WO_3(s) + \_\_H_2(g) \rightarrow \_\_W(s) + \_\_H_2O(g) \quad \Delta H = ?$$

from the following data:

$2W(s) + 3O_2(g) \rightarrow 2WO_3(s)$ $\Delta H = –1685.4$ kJ
$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\Delta H = –477.84$ kJ

(a) 252.9 kJ
(b) 364.9 kJ
(c) 1207.6 kJ
(d) 0.0 kJ
(e) 125.9 kJ

36. Calculate the $\Delta H°_f$ for CaO from the information given. Make sure the reaction is balanced (See table for data).

Compound	**$CaCO_3(s)$**	**$CaO(s)$**	**$CO_2(g)$**	**$H_2O(g)$**
$\Delta H_f°$	-1206.9 kJ/mol	?	–393.5 kJ/mol	–241.8 kJ/mol

$$\_\_CaCO_3(s) \rightarrow \_\_CaO(s) + \_\_CO_2(g) \qquad \Delta H = 178.3 \text{ kJ}$$

(a) 139.5 kJ
(b) -2235.5 kJ
(c) -635.1 kJ
(d) 2235.5 kJ
(e) -178.3 kJ

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