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TAMS Tournament 2011 Chemistry Exam Answer Sheet

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TAMS Tournament 2011 Chemistry Exam

1. The name of the compound with the condensed structural formula, $\text{CHCCHBrCH}_2\text{Br}$, is

- A) 3,4-bromo-1-butene
- B) 3,4-dibromo-1-butyne
- C) 1,2-dibromo-3-butyne
- D) 3,4-dibromo-1-butene
- E) 1,2-dibromo-1-butyne

2. How many hydrogen atoms are contained in 30 grams of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$?

- A) 1.8×10^{24}
- B) 2.3×10^{24}
- C) 1.0×10^{23}
- D) 1.2×10^{24}
- E) 3.5×10^{23}

3. Predict the products when you mix silver nitrate (s) and potassium chloride (s) with enough water to dissolve both.

- A) $\text{KNO}_3(\text{aq})$, $\text{AgCl}(\text{aq})$
- B) $\text{KAg}(\text{aq})$, $\text{NO}_3\text{Cl}(\text{aq})$
- C) $\text{ClNO}_3(\text{aq})$, $\text{K}_2\text{O}(\text{aq})$
- D) $\text{KNO}_3(\text{s})$, $\text{AgCl}(\text{aq})$
- E) $\text{KNO}_3(\text{aq})$, $\text{AgCl}(\text{s})$

4. How many moles of hydrogen are present in a 13.36 liter container at a pressure of 914 torr at 91.8°C ?

- A) 0.375 mol
- B) 0.965 mol
- C) 0.536 mol
- D) 0.751 mol
- E) 1.180 mol

5. The half-life of ^{137}Ce is 35 years. How many grams of ^{137}Ce must be produced now to have a sample containing 60 grams of ^{137}Ce 180 years from now?

- A) 2120 grams
- B) 2220 grams
- C) 3120 grams
- D) 1000 grams
- E) 6300 grams

6. Which of the following gives off a reddish tint as it burns?

- A) Iron
- B) Lead
- C) Lithium
- D) Potassium
- E) Cesium

7. Which substance, when released into water, creates an acidic solution?

- A) He
- B) CO₂
- C) NO₃
- D) Ne
- E) NH₄

8. Under which conditions will a gas behave the most ideally?

- A) Low pressure, high temperature
- B) Low temperature, high pressure
- C) Low pressure, low temperature
- D) High temperature, high pressure
- E) Gases always behave ideally

9. What is the electron configuration of a sodium atom that is in an excited state?

- A) $1s^2 2s^2 2p^6$
- B) $1s^2 2p^6 3s^2$
- C) $1s^2 2s^2 2p^6 3s^1$
- D) $1s^2 2s^2 2p^6 3s^2$
- E) $1s^2 2s^2 2p^6 3p^1$

10. Which of the following electron shapes best describes a ClF₃ molecule?

- A) Angular
- B) Trigonal planar
- C) Trigonal bipyramidal
- D) T-shaped
- E) See-saw

11. Which organic compound has the highest boiling point?

- A) Ethanamide
- B) Acetic Acid
- C) Propanol
- D) Acetone
- E) Methyl Ethyl Ether

12. How many mL of 8.00 M HCl are needed to prepare 150 mL of a 1.60 M HCl solution?

- A) 30 mL
- B) 24 mL
- C) 18.8 mL
- D) 12 mL
- E) 15 mL

13. The reaction $A \rightarrow B$ is second order in A. Which plot will be linear?

- A) [A] vs. time
- B) $\ln[A]$ vs. time
- C) $1/[A]^2$ vs. time
- D) $1/[A]$ vs. time
- E) None of the above

14. What is the total number of valence electrons in the chlorate ion, ClO_3^- ?

- A) 24
- B) 26
- C) 28
- D) 30
- E) 32

15. How many isomers have the molecular formula C_7H_{16} ?

- A) 10
- B) 9
- C) 5
- D) 7
- E) 8

16. Which of these elements has the greatest electronegativity?

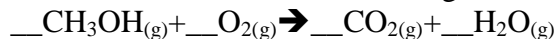
- A) Boron
- B) Carbon
- C) Oxygen

- D) Fluorine
 - E) Hydrogen
17. How is the vapor pressure of a liquid affected when the quantity of liquid is tripled at constant temperature?
- A) The vapor pressure is tripled
 - B) The vapor pressure is one-third its original value
 - C) The vapor pressure stays the same
 - D) The vapor pressure may increase or decrease
 - E) None of the above
18. Which piece of equipment would best measure 10 mL of a liquid as precisely as possible?
- A) 20 mL beaker
 - B) 20 mL graduated cylinder
 - C) 20 mL conical piece
 - D) 20 mL volumetric flask
 - E) 20 mL burette
19. Oxygen, which is 16 times denser than hydrogen, diffuses
- A) 1/16 times faster
 - B) 4 times faster
 - C) 16 times faster
 - D) 1/4 times faster
 - E) None of the above
20. Analysis of a compound known to contain only C, H, and O gives this analysis: 38.5% C, 10.3% H, and 51.3% O. What is the empirical formula of the compound?
- A) $C_6H_{12}O_6$
 - B) $C_4H_{16}O_5$
 - C) $CH_{16}O_9$
 - D) $C_9H_3O_8$
 - E) $C_5H_{16}O_5$
21. Which of the following elements has the lowest first ionization energy?
- A) Al
 - B) Mg
 - C) Li
 - D) K
 - E) Fe

22. What is the standard enthalpy of formation of CaO if 300 kJ is evolved when 28 g of CaO is formed by combustion of calcium?

- A) -600.8 kJ/mol
- B) -300.4 kJ/mol
- C) +600.8 kJ/mol
- D) +300.4 kJ/mol
- E) None of the above

23. Find the number of moles of methanol in the following combustion reaction:



- A) 1
- B) 3
- C) 2
- D) 5
- E) 4

24. Which type of solid would result in the lowest molar heat of fusion?

- A) Ionic
- B) Network covalent
- C) Molecular
- D) Metallic
- E) Polar

25. Which equation represents an oxidation-reduction reaction?

- A) $\text{H}_2\text{SO}_4 + 2\text{NH}_3 \rightarrow (\text{NH}_4)_2\text{SO}_4$
- B) $\text{H}_2\text{SO}_4 + \text{Na}_2\text{CO}_3 \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2$
- C) $2\text{K}_2\text{CrO}_4 + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{Cr}_2\text{O}_7 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$
- D) $2\text{H}_2\text{SO}_4 + \text{Cu} \rightarrow \text{CuSO}_4 + 2\text{H}_2\text{O} + \text{SO}_2$
- E) None of the above

26. Which of the following is isoelectronic with CO_2 ?

- A) NO_2^-
- B) NO_2^+
- C) NO_2
- D) O_3
- E) H_2O

27. 10.0 mL of a solution of potassium hydroxide was titrated with a 0.10 M solution of hydrochloric acid. 13.5 mL of the acid was required for neutralization. Calculate the concentration of the potassium hydroxide solution.

- A) 0.22 M
- B) 0.32 M
- C) 0.14 M
- D) 0.09 M
- E) 0.25 M

28. Carbon is found in the highest oxidation state in which of these classes of organic compounds?

- A) Carboxylic acids
- B) Alcohols
- C) Aldehydes
- D) Ketones
- E) Alkynes

29. In the reaction ${}_4\text{Be}^9 + \text{X} \rightarrow {}_6\text{C}^{12} + {}_0\text{n}^1$, the X represents

- A) Alpha particle
- B) Beta particle
- C) Electron
- D) Proton
- E) Gamma radiation

30. Which of the following reactions produces a decrease in system entropy?

- A) $\text{N}_2\text{O}_4(\text{g}) + \text{heat} \rightarrow 2\text{NO}_2(\text{g})$
- B) $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g})$
- C) $\text{CHCl}_3(\text{l}) \rightarrow \text{CHCl}_3(\text{g})$
- D) $\text{Br}_2(\text{s}) \rightarrow \text{Br}_2(\text{l})$
- E) $\text{O}_2(\text{g}) \rightarrow \text{O}_2(\text{l})$

31. 50 grams of MgCl_2 dissolve in 18 moles of H_2O . Given a K_b of $0.5^\circ\text{C}\cdot\text{kg}/\text{mol}$, what is the boiling point of the solution?

- A) 100.5°C
- B) 101.0°C
- C) 102.5°C
- D) 103.0°C
- E) 103.5°C

32. A reaction occurs between potassium iodide ($2\text{KI}_{(\text{aq})}$) and lead nitrate ($\text{Pb}(\text{NO}_3)_{2(\text{aq})}$). What is the precipitate, if any, that forms?

- A) 2KNO_3
- B) PbI
- C) PbK
- D) $2\text{I}(\text{NO}_3)$
- E) No precipitate

33. Which of the following will most likely increase the solubility of NaCl in water?

- A) Reducing the temperature of water
- B) Raising the temperature of water
- C) Reducing the molality of solution
- D) Raising the molality of solution
- E) Raising the molarity of solution

34. All of the following are true regarding the activated complex except

- A) It represents the highest energy state achieved during the course of a reaction.
- B) It is not consumed during the course of the reaction.
- C) It is very unstable.
- D) It is formed before reactant bonds are completely broken.
- E) It is formed before product bonds are completely formed.

35. What is the only way to change the value of the equilibrium constant for acid-base reactions?

- A) Increase the concentration of the reactants
- B) Increase the pH of the reactants
- C) Decrease the concentration of the reactants
- D) Decrease the pH of the reactants
- E) Change the temperature of the solution

36. Which of the following is true of the Heisenberg principle?

- A) Both position and momentum of an electron cannot be known at the same
- B) Matter has both particle and wave properties
- C) Electrons revolve around the nucleus in true orbits
- D) Electrons are located in orbitals
- E) Both A & D

37.



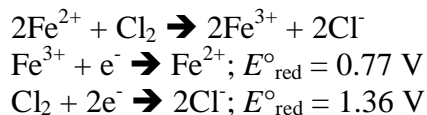
If 2 moles of Al and 6 moles of HCl react according to the above equation, then how many moles of electrons are transferred during the redox reaction?

- A) 1
- B) 2
- C) 3
- D) 5
- E) 6

38. Which of the following functional groups is defined by two hydrocarbon chains linked by oxygen atoms?

- A) Ethers
- B) Esters
- C) Ketones
- D) Aldehydes
- E) Carboxylic acids

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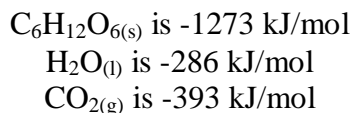
The standard potential difference of an electrochemical cell using the overall reaction above is ____.

- A) 0.18 V
- B) 0.59 V
- C) 1.05 V
- D) 2.13 V
- E) 2.90 V

40. Which of the following values solely determines whether a reaction is spontaneous?

- A) Heat of formation
- B) Enthalpy change
- C) Entropy
- D) Kinetic Energy
- E) None of the above

41. You are given the reaction $\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$ where the heat of formation for



What is the heat of formation for the whole reaction?

- A) 2801 kJ
- B) -5437 kJ
- C) -2801 kJ
- D) 5437 kJ
- E) Cannot be determined

42. How much time will be required for a sample of tritium to lose 75% of its radioactivity given that the half-life of tritium is 12.26 years?

- A) 24.5 years
- B) 12.3 years
- C) 49.0 years
- D) 5.1 years
- E) 10.2 years

43. A closed mixture of helium, hydrogen, and carbon dioxide gases are at a pressure of 1200 torr in a 4 L container. There are a total of 24 moles of gas molecules in the container. If the helium concentration is 2 moles/L and the hydrogen concentration is 1.5 moles/L, which of the following expresses the partial pressure of the carbon dioxide?

- A) 50 torr
- B) 100 torr
- C) 150 torr
- D) 500 torr
- E) 700 torr

44. A substance possessing a characteristically low vapor pressure can be expected to have ____.

- A) A relatively small heat of vaporization
- B) A relatively high rate of evaporation
- C) Extremely weak intermolecular forces
- D) Extremely high kinetic energy
- E) A relatively high boiling point

45. Which of the following is NOT true regarding carbon nanotubes?

- A) They can be divided into single-walled or multi-walled
- B) Their chiral angles determine what nanotube species are present
- C) They can be metallic or semi-conducting
- D) They are aligned by van der Waals forces
- E) There are only zigzag and armchair species

46. What is the general formula for alkynes?

- A) C_nH_{2n-2}
- B) C_nH_{2n-1}
- C) C_nH_{2n}
- D) C_nH_{2n+1}
- E) C_nH_{2n+2}

47. The specific heat of a substance is approximately $0.5 \text{ cal/g-}^\circ\text{C}$. If 30 calories of heat are absorbed by 15 g of the substance at 30°C , its temperature will become ____.

- A) 19°C
- B) 32°C
- C) 34°C
- D) 60°C
- E) 90°C

48. Which of the following is the smallest representative particle of helium?

- A) Atom
- B) Ion
- C) Neutron
- D) Proton
- E) Electron

49. Which of the following is a diatomic molecule?

- A) N_2O
- B) $C_6H_{12}O_6$
- C) SO_3
- D) NO
- E) N_2O_5

50. Which group is least reactive?

- A) Halogens
- B) Alkali metals
- C) Alkaline earth metals
- D) Noble gases
- E) Chalcogens