Polytechnic Tutoring Center

Final Exam REVIEW– CM 1013, Fall 2021

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The Exam is designed to test concepts, not exact knowledge so please do not worry if some questions seem outside of what you have learned. Watch the solution video when uploaded to see the method of solving each of these problems. The main focus is to understand the approach to problem solving.

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1. Calculate the enthalpy change for the reaction: (Hess Law)
$C(graphite) + 2H_2(g) + 1/2O_2(g) \rightarrow CH_3OH(l)$
Using the following information:
$C(graphite) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393.5$ kJ/mol
$H_2(g) + 1/2O_2(g) \rightarrow H_2O(l)$ $\Delta H = -285.8$ kJ/mol
$CH_3OH(l) + 3/2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ $\Delta H = -726.4$ kJ/mol

2. Using only the equations below, calculate the molar heat of formation of nitrous acid $HNO_2(aq)$.
$NH_4NO_2(aq)$ ---> $N_2(g) + 2H_2O(\ell) \Delta H° = -320.1$ kJ
$NH_3(aq) + HNO_2(aq)$ ---> $NH_4NO_2(aq) \Delta H° = -37.7$ kJ
$2NH_3(aq)$ ---> $N_2(g) + 3H_2(g) \Delta H° = +169.9$ kJ
$2H_2(g) + O_2(g)$ ---> $2H_2O(\ell) \Delta H° = -571.6$ kJ

3. What is the amount of heat necessary to raise the temperature of 12.0 g of water from 15.4 °C to 93.0 °C? (The specific heat of water is 4.184 J/(g*°C) (Bomb Cal)

4. Which of the following elements has the lowest electronegativity? (Periodic table Trends)
A) Cl
B) K
C) He
D) Na
E) Rb

5. Which of the following is a polar covalent bond? (Inter and Intramolecular forces)
A) K-Cl
B) K-Br
C) Cr-Cr
D) Cl-Cl
E) S-Cl

6. The electron configuration for Mn is (Periodic Table)

7. A silicon atom (Si) has ____ unpaired electron(s) and is ____. (Periodic Table)
A) 7, diamagnetic
B) 2, paramagnetic
C) 4, diamaganetic
D) 1, paramagnetic

8. A quantity of 1.535 g of methanol (CH3OH) was burned in a constant-volume bomb calorimeter. Consequently, the temperature of the water rose from 20.27 °C to 26.87 °C. If the heat capacity of the bomb calorimeter was 1.75 kJ/°C, calculate the molar heat of combustion of methanol. (Bomb Cal)

9. Which of the following processes is endothermic? (Physical Process, Energy)
A) $O_2(g) + 2H_2(g) \rightarrow 2H_2O(g)$
B) $H_2O(g) \rightarrow H_2O(l)$
C) $3O_2(g) + 2CH_3OH(g) \rightarrow 2CO_2(g) + 2H_2O(g)$
D) $I_2(s) \rightarrow I_2(g)$

10. Which of the species listed below is not isoelectronic with the others? (Periodic Trends)
A) O^-
B) F^-
C) Mg^{+2}
D) Na^+
E) N^{-3}

11. What is the formal charge of the sulfur atom in the structure of SO_4^{-2}? (Lewis Dot Structure)
A) 0
B) -1
C) +1
D) +2

12. What is the formal charge of the sulfur atom in the structure of SO_2? (Lewis Dot Structure)
A) 0
B) -1
C) +1
D) +2

13. Which of the elements listed below has the highest ionization energy? (Periodic Trends)
A) Cs
B) Ga
C) K
D) P
E) As

14. What is the molecular geometry of NH_3? (VSEPR)

15. Which one of the following compounds does not follow the octet rule? (Lewis Dot structure)
A) NF_3
B) CF_4
C) SCl_6
D) AsH_3
E) CH_4

16. What is the molecular geometry of SF4? (VSEPR)
A) linear
B) bent
C) trigonal planar
D) trigonal pyramidal
E) distorted tetrahedral

17. What is the molecular geometry of $CO3^{2-}$? (VSEPR)
A) linear
B) bent
C) trigonal planar
D) trigonal pyramidal
E) distorted tetrahedral

18. What is the molecular geometry of H2S? (VSEPR)
A) linear
B) bent
C) trigonal planar
D) trigonal pyramidal
E) distorted tetrahedral

19. Determine the hybridization of the central atom in the compound PCl5. (VESPR)
A) sp3d
B) sp3
C) sp3d2
D) sp
E) sp2

20. Which of the following sets of quantum numbers is not allowed? (Quantum Numbers)
A) n = 2, l = 2, ml = 0
B) n = 3, l = 1, ml = -1
C) n = 2, l = 0, ml = 0
D) n = 3, l = 2, ml = 0
E) n = 2, l = 1, ml = 1

21. In Ba(CN)2, the bonding is: (Inter and intra molecular forces)
A) ionic
B) covalent
C) both ionic and covalent
D) neither ionic nor covalent

22. The formal charge on the nitrogen atom in the nitrate ion is: (Lewis Dot structure)
A) +2
B) +1
C) 0
D) -1
E) -2

23. The bond angles in the H3O+ ion are: (Lewis Dot structure, VESPR)
A) 120°
B) 90°, 120°
C) 109°
D) 90°
E) 180°

24. Which of the following molecules has a dipole moment? (Lewis Dot structure)
A) H2
B) CO2
C) F2
D) SO2
E) BF3

25. A certain gas expands in volume from 2.0 L to 24.5 L at constant temperature. Calculate the work done by the gas if it expands against a constant pressure of 5 atm. (Gas laws)
A) -112.5 J
B) 1.24 x 10^4 J
C) -1.14 x 10^4 J
D) 113 J
E) 1.14 x 10^4 J

26. Which of the following has the greatest density, at 25 oC and 1.0 atm. (Gas laws)
A) CH4
B) O3
C) C2H4
D) H2

27. What is the oxidation number of Cl in Pb(ClO3)2? (Redox Chem)
A) +8
B) +7
C) +5
D) -7
E) -8

28. What is the enthalpy change (ΔH) for the following reaction? (Energy)
$CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$
BE (C-H) = 1074 kJ/mol
BE (H-Cl) = 802 kJ/mol
BE (C-Cl) = 499 kJ/mol
BE (Cl-Cl) = 940 kJ/mol

A) -103 kJ/mol
B) -109 kJ/mol
C) 275 kJ/mol
D) 713 kJ/mol
E) 103 kJ/mol

29. How many milliliters of a 0.75 M H_3PO_4 solution is needed to neutralize 600 mL of a 0.25 M $Ba(OH)_2$ solution? (Strong Acid & Strong Base interaction)
A) 50.0 mL
B) 66.7 mL
C) 133.3 mL
D) 200.0 mL

30. What volume of water must be added to 300 mL of 0.75 M HCl to dilute the solution to 0.25 M? (Dilution)
A) 900 mL
B) 600 mL
C) 300 mL
D) 930 mL

31. A 1.25 g sample of ore containing iron pyrite (FeS_2) was pulverized and ignited in air, producing $Fe_2O_3(s)$ and $SO_2(g)$. If the Fe_2O_3 produced weighed 0.516 g, what is the percent composition of Fe? (Mass Percentage)
A) 28.9 %
B) 36.1%
C) 14.4%
D) 41.3%

32. A sample of gas occupies 3.00 L at 760 torr. What volume will the gas occupy if the pressure is changed to 1.45 atm and the temperature remains constant? (Gas law)
A) 2.07 L
B) 0.48 L
C) 4.35 L
D) 2280 L
E) 1570 L

33. The set of quantum numbers that correctly describes an electron in a 3s orbital is: (Quantum numbers)
A) n = 3; l = 0; ml = 0; ms = +1/2 or -1/2
B) n = 3; l = 2; ml = -2, -1, 0, 1, or 2; ms = +1/2 or -1/2
C) n = 3; l = 1; ml = -1, 0, or 1; ms = +1/2 or -1/2
D) n = 4; l = 0; ml = -1, 0, or 1; ms = +1/2 or -1/2
E) None of the above

34. What is the ground state electron configuration of copper (Cu)? (Periodic table trends)
A) [Ne] $4s^2 3d^9$
B) [Ar] $4s^2 3d^9$
C) [Kr] $4s^1 3d^{10}$
D) [Ar] $4s^1 3d^{10}$
E) None of the above

35. Which of the following compounds would be most likely to dissolve in CCl4? (Inter and intra molecular forces)
A) I2
B) H2O
C) C8H18
D) Compounds A and C
E) Compounds B and C

36. Which of the following is a nonelectrolyte? (Aqueous Solutions)
A) HCl
B) H2SO4
C) HF
D) NH3
E) (NH2)2CO

37. What is the order of increasing atomic radius for the elements K, Ca, Ga, P? (Trends)
A) P, Ga, Ca, K
B) Ga, P, Ca, K
C) K, Ca, P, Ga
D) Ca, K, Ga, P

38. What is the order of increasing ionic radius for the ions K+, P3-, S2-, Cl- ? (Trends)
A) K+, Cl-, S2-, P3-
B) K+, P3-, S2-, Cl-
C) P3-, S2-, Cl-, K+
D) Cl-, S2-, P3-, K+
E) Cl-, S2-, K+, P3-

39. Which of the following has the highest first ionization energy? (trends)
A) F
B) Cl
C) I
D) K
E) Li

40. If 280 g of diatomic nitrogen and 15 g of diatomic hydrogen are reacted together to produce NH3, what is the maximum number of grams of NH3 that could be produced? (Stoichiometry)
A) 47.6 g
B) 84.5 g
C) 92.2 g
D) 103.4 g

41. An organic compound was analyzed and found to contain 55.8% C, 7.03% H, and 37.2% O. A 1.44 g sample of the compound was vaporized and found to occupy 530 cm^3 at 100^oC and 740 torr. What is the correct molecular formula of the compound?