KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

CHEMISTRY DEPARTMENT

FINAL EXAM

TEST CODE

000

COURSE

CHEM101 - 051

STUDENT NUMBER: _____

NAME : _____

SECTION NUMBER: _____

INSTRUCTIONS

1. Type your student number, name, and section number on the *EXAM COVER* page.
2. Type your student number, section number, and your name on your *EXAM ANSWER* form.
3. With your pencil, bubble your student number, your section number, and test code number on the *EXAM ANSWER* form.
4. With your pencil, bubble your answer's selections on the *EXAM ANSWER* form. You must not give more than *ONE* answer per question.
5. The Exam *DURATION* is 160 min.
6. Return the *ANSWER* form to the proctor of the exam when you have finished.

Important constants

Gas Constant (R)	= 0.0821	L.atm/(mol.K)
	= 8.31	J/(mol.K)
	= 8.31 x 10^7	g.cm^2/(sec^2.mol.K)
Planck's Constant (h)	= 6.626 x 10^{-34}	J.sec/particle
	= 6.626 x 10^{-34}	kg.m^2/(sec.particle)
Velocity of light (c)	= 2.998 x 10^8	m/sec
Avogadro's number (N)	= 6.022 x 10^{23}	particles/mole
Bohr's Constant (R_H)	= 2.179 x 10^{-18}	J/particle
Faraday (F)	= 96485	Coulombs
Specific heat of H_2O	= 4.18	J/(g.^{o}C)

PERIODIC TABLE OF THE ELEMENTS

IA																	VIII A
1 **H** 1.0079	IIA											IIIA	IVA	VA	VIA	VIIA	2 **He** 4.0026
3 **Li** 6.941	4 **Be** 9.0122											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305	IIIB	IVB	VB	VIB	VIIB		VIIIB		IB	IIB	13 **Al** 26.982	14 **Si** 28.086	15 **P** 30.974	16 **S** 32.066	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.867	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.845	27 **Co** 58.933	28 **Ni** 58.693	29 **Cu** 63.546	30 **Zn** 65.39	31 **Ga** 69.723	32 **Ge** 72.61	33 **As** 74.922	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.80
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 **La*** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **Ac**** (227)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (264)	108 **Hs** 265	109 **Mt** (268)	110 **Uun** (269)	111 **Uuu** (272)	112 **Uub** (277)	113	114	115	116	117	118

58 ***Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 165.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
90 ****Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

1. The elements in Group 7A are known by what name?
    A) halogens
    B) transition metals
    C) alkali metals
    D) alkaline earth metals
    E) noble gases

2. The Lewis structure for a chlorate ion, ClO_3^-, should show ____ single bond(s), ____ double bond(s), and ____ lone pair(s).
    A) 3, 0, 10
    B) 2, 1, 9
    C) 2, 1, 8
    D) 3, 0, 9
    E) 2, 1, 10

3. Aluminum is a lightweight metal (density = 2.70 g/cm^3) used in aircraft construction, high-voltage transmission lines, beverage cans, and foils. What is its density in kg/m^3?
    A) 2.70×10^3 kg/m^3
    B) 2.70×10^4 kg/m^3
    C) 4.30×10^3 kg/m^3
    D) 8.2×10^2 kg/m^3
    E) 1.30×10^3 kg/m^3

4. For which of the following calculations is 1.3×10^{10} the correct answer?
    A) $(5.1 \times 10^4) \times (2.5 \times 10^5)$
    B) $79{,}500 \div (2.5 \times 10^2)$
    C) $(7.0 \times 10^{-3}) - (8.0 \times 10^{-4})$
    D) $145.75 + (2.3 \times 10^{-1})$
    E) $(1.0 \times 10^{10}) \times (1.3 \times 10^{10})$

5. The total volume of seawater is 1.5×10^{21} L. Assume that seawater contains 3.1 percent sodium chloride by mass and that its density is 1.03 g/mL. Calculate the total mass of sodium chloride in grams.
   A) 4.8×10^{22} g
   B) 4.6×10^{21} g
   C) 4.8×10^{19} g
   D) 1.2×10^{20} g
   E) 2.8×10^{19} g

6. Chromium (III) sulfite would have the formula:
   A) $Cr_2(SO_3)_3$
   B) $Cr_3(SO_4)_2$
   C) Cr_2SO_3
   D) Cr_3SO_4
   E) $CrSO_4$

7. Experiments with the cathode ray tube (discharge tube) have shown
   A) that all forms of matter contain electrons
   B) that all the nuclei contain protons
   C) that alpha particles are heavier than protons
   D) that all positive rays were actually protons
   E) that Beta particles are heavier than electrons

8. Which of the following contain the same number of electrons?
   1. $^{27}Al^{3+}$ 2. $^{11}B^{3+}$ 3. $^{40}Ca^{2+}$ 4. $^{14}N^{3-}$

   A) 1 and 4
   B) 1 and 2
   C) 2 and 3
   D) 2 and 4
   E) 1 and 3

9. According to VSEPR theory, which one of the following molecules should be *nonlinear*?
   A) SO_2
   B) CO_2
   C) $BeCl_2$
   D) C_2H_2
   E) KrF_2

10. What is the formal charge on the oxygen atom in N_2O?
    [Note: The atomic order is N–N–O]
    A) -1
    B) +1
    C) 0
    D) +2
    E) -2

11. Calculate the maximum mass of P_2I_4 that can be produced from 5.00 g of P_4O_6 and 8.00 g of I_2 according to the equation:
    $$5\ P_4O_6\ +\ 8\ I_2\ \rightarrow\ 4\ P_2I_4\ +\ 3\ P_4O_{10}$$

    A) 8.98 g
    B) 5.00 g
    C) 10.4 g
    D) 8.00 g
    E) 13.0 g

12. A compound containing only sulfur and nitrogen has 30.5% nitrogen by mass and has the molecular mass between 182 and 194 g/mol. What is the molecular formula of the compound?
    A) S_4N_4
    B) S_2N_9
    C) S_3N_7
    D) S_5N_2
    E) S_2N_2

13. Which statement is FALSE about the sulfur dioxide molecule?
    A) The lone pair of electron on the sulfur atom is in a sp hybrid orbital
    B) It is a polar molecule showing resonance structures
    C) The sulfur atom is sp2 hybridized
    D) The molecule has two sigma and one pi bond
    E) The pi bond in the molecule is formed using unhybridized p orbitals

14. The shape of PO_3^{3-} and the hybridization of phosphorus in PO_3^{3-} are respectively
    A) trigonal pyramid and sp^3
    B) trigonal planar and sp^2
    C) tetrahedral and sp^3
    D) T-shaped and dsp^3
    E) square planar and dsp^2

15. Which is NOT correct for the H_2^- ion.
    A) Bond order is 1
    B) Bond order is ½
    C) The electron configuration is $(\sigma_{1s})^2(\sigma_{1s*})^1$
    D) The electron configuration is the same as that of He_2^+
    E) Has a lower bond strength than H_2 molecule

16. Arrange the following species in order of increasing stability: Li_2, Li_2^+, Li_2^-.
    A) $Li_2^- = Li_2^+ < Li_2$
    B) $Li_2 > Li_2^+ < Li_2^-$
    C) $Li_2^+ = Li_2 < Li_2^-$
    D) $Li_2^- < Li_2^+ < Li_2$
   E) $Li_2^- = Li_2^+ = Li_2$

17. Which of the following molecules has the smallest bond energy?
    A) Br_2
    B) Cl_2
    C) O_2
    D) N_2
    E) CO

18. How many grams of Na_2SO_4 are required to make 3.50L of 0.0500 M Na_2SO_4?
    A) 24.9
    B) 99.4
    C) 811
    D) 2.86
    E) 408

19. Which of the following equations does NOT represent an oxidation-reduction reaction?
    A) $2NaCl + Pb(NO_3)_2 \rightarrow PbCl_2 + 3NaNO_3$
    B) $3Al + 6HCl \rightarrow 3H_2 + AlCl_3$
    C) $2H_2O \rightarrow 2H_2 + O_2$
    D) $2NaI + Br_2 \rightarrow 2NaBr + I_2$
    E) $Cu(NO_3)_2 + Zn \rightarrow Zn(NO_3)_2 + Cu$

20. Choose the reducing agent in the following redox reaction.
    $$Cr_2O_7^{2-} + H_2S \rightarrow Cr^{3+} + S$$
    A) H_2S
    B) $Cr_2O_7^{2-}$
    C) Cr^{3+}
    D) S
    E) H_2O

21. The cover is tightly sealed on a 2.0 L soda bottle at 27.0ºC and 748 mm Hg. If the bottle is heated to 100.0ºC, what is the pressure inside the bottle?
    A) 930 mm Hg
    B) 210 mm Hg
    C) 620 mm Hg
    D) 63 mm Hg
    E) 1300 mm Hg

22. The composition (in mole percent) of the atmosphere is 78.1% N_2, 21.0% O_2, and 0.9% Ar. What is the partial pressure of each gas when the barometric pressure is 754.1 mm Hg?
    A) N_2 = 589 mm Hg, O_2 = 158 mm Hg, Ar = 7 mm Hg
    B) N_2 = 78.1 mm Hg, O_2 = 21.0 mm Hg, Ar = 0.9 mm Hg
    C) N_2 = 244 mm Hg, O_2 = 244 mm Hg, Ar = 244 mm Hg
    D) N_2 = 405 mm Hg, O_2 = 234 mm Hg, Ar = 293 mm Hg
    E) N_2 = 21.1 atm, O_2 = 6.5 atm, Ar = 0.3 atm

23. How many unit cells share an atom which is located at a face of a unit cell?
    A) 2
    B) 3
    C) 4
    D) 6
    E) 8

24. Iron packs in a body-centered cubic structure. If an iron atom has a radius of 126 pm, what is the distance between atoms at two opposite corners of the unit cell? (note: a line drawn between the points would go through the center of the unit cell)
    A) 4(126 pm) = 504 pm
    B) 2(126 pm) = 252 pm
    C) $\dfrac{\sqrt{3}}{2}$(126 pm) = 109 pm
    D) $\sqrt{2}$(126 pm) = 178 pm
    E) $\sqrt{3}$(126 pm) = 218 pm

25. The vapor pressure of a liquid depends on
    A) the temperature of the liquid.
    B) the surface area of the liquid.
    C) the volume of the liquid.
    D) partial pressures of other gases over the liquid.
    E) both the temperature and the surface area of the liquid.

26. Based on the given reaction, what energy change occurs when 1.2 moles of CH_4 reacts?

$$CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl \quad \Delta H = -434 \text{ kJ.}$$

    A) 5.2×10^5 J are released.
    B) 5.2×10^5 J are absorbed.
    C) 3.6×10^5 J are released.
    D) 3.6×10^5 J are absorbed.
    E) 4.3×10^5 J are absorbed.

27. Which of the following statements about the closest packing sphere in ionic solids is FALSE?
    A) For spheres of a given diameter, tetrahedral holes are larger than octahedral holes.
    B) The packing is done in a way that minimizes repulsion among ions with like charges.
    C) The packing arrangement maximizes electrostatic attractions among oppositely charged ions.
    D) Trigonal holes are so small that they are never occupied.
    E) All the statements in this question are correct.

28. The triple point of iodine is at 90 torr and 114 °C and the density of solid iodine is greater than that of liquid I_2. This means that
    A) liquid I_2 cannot have a vapor pressure less than 90 torr.
    B) the melting point of I_2 at 25 atm is less than that at 1 atm.
    C) liquid I_2 is present at 110 °C and 90 torr.
    D) liquid I_2 cannot exist above 114 °C.
    E) liquid I_2 is present at 114 °C and 80 torr.

29. Use the following graph of vapor pressure of $CHCl_3$ to estimate the normal boiling point.
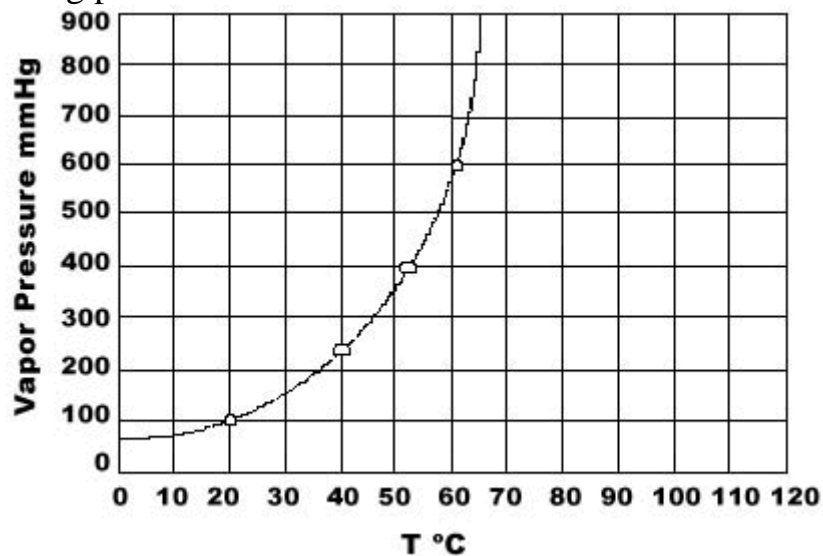
A) 64 °C
B) 60 °C
C) 70 °C
D) 50 °C
E) 19 °C

30. Nickel has a face-centered cubic unit cell. The density of Ni is 6.84 g/cm³. Calculate the atomic radius of Ni. [Atomic mass of Ni = 58.69 amu].
A) 136 pm
B) 3.85 x 10⁻⁸ cm
C) 3.89 x 10⁻²² cm
D) 3.85 pm
E) 385 pm

31. Use the following data to determine the molar heat of vaporization of chlorine.

T (°C)	-84.5	-71.2	-47.3
P (mmHg)	40.0	100.0	400.0

    A) 21,800 J
    B) 34,700 J
    C) 317 J
    D) 712 J
    E) 9.99 kJ

32. The first-order X-ray diffraction of a NaCl crystal occurs at 23.0°. The distance between the layers is 282 pm. The wavelength of X- ray used is
    A) 0.220 nm
    B) 0.152 nm
    C) 0.425 nm
    D) 0.081 nm
    E) 0.051 nm

33. For which of the following reactions is the enthalpy change equal to the third ionization energy of vanadium?
    A) $V^{2+}(g) \rightarrow V^{3+}(g) + e^-$
    B) $V^{3+}(g) + e^- \rightarrow V^{2+}(g)$
    C) $V(g) \rightarrow V^{3+}(g) + 3e^-$
    D) $V^{2-}(g) + e^- \rightarrow V^{3-}(g)$
    E) $V^{3+}(g) \rightarrow V^{4+}(g) + e^-$

34. Which element will display an unusually large jump in ionization energy values between I_3 and I_4, its third and fourth ionization energies?
    A) Al
    B) Na
    C) Mg
    D) Si
    E) P

35. The ionization energy of a certain element is 412 kJ/mol. However, when the atoms of this element are in the first excited state, the ionization energy is only 126 kJ/mol. Based on this information, calculate the wavelength of light emitted in a transition from the first excited state to the ground state.
    A) 4.19×10^2 nm
    B) 3.50×10^6 nm
    C) 4.19×10^5 nm
    D) 3.50×10^2 nm
    E) 1.50×10^3 nm

36. What is the percent $CdSO_4$ by mass in a 1.00 molal aqueous $CdSO_4$ solution?
    A) 17.3 %
    B) 20.8 %
    C) 24.4 %
    D) 0.00100 %
    E) 0.100 %

37. The solubility of CO_2 gas in water
    A) increases with increasing gas pressure.
    B) increases with decreasing gas pressure.
    C) decreases with increasing gas pressure.
    D) is not dependent on pressure.
    E) is not dependent on temperature.

38. Which of the following aqueous solutions has the highest boiling point?
    K_b for water is $0.52\,^{\circ}C/m$.

    I. 0.2 m KCl   II. 0.2 m Na_2SO_4 III. 0.2 m $Ca(NO_3)_2$

    A) II and III
    B) II
    C) I
    D) III
    E) I and II

39. What is the molar mass of toluene if 0.85 g of toluene depresses the
    freezing point of 100. g of benzene by $0.47\,^{\circ}C$? K_f of benzene is
    $5.12\,^{\circ}C/m$.
    A) 93 g/mol
    B) 78 g/mol
    C) 11 g/mol
    D) 82 g/mol
    E) 930 g/mol

40. The osmotic pressure of a 0.010 M $MgSO_4$ solution at $25\,^{\circ}C$ is 0.318
    atm. Calculate i, the van't Hoff factor, for this $MgSO_4$ solution.
    A) 1.3
    B) 0.013
    C) 1.5
    D) 2.0
    E) 76.8

Answer Key

1. A
2. A
3. A
4. A
5. A
6. A
7. A
8. A
9. A
10. A
11. A
12. A
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33. A
34. A
35. A
36. A
37. A
38. A
39. A
40. A