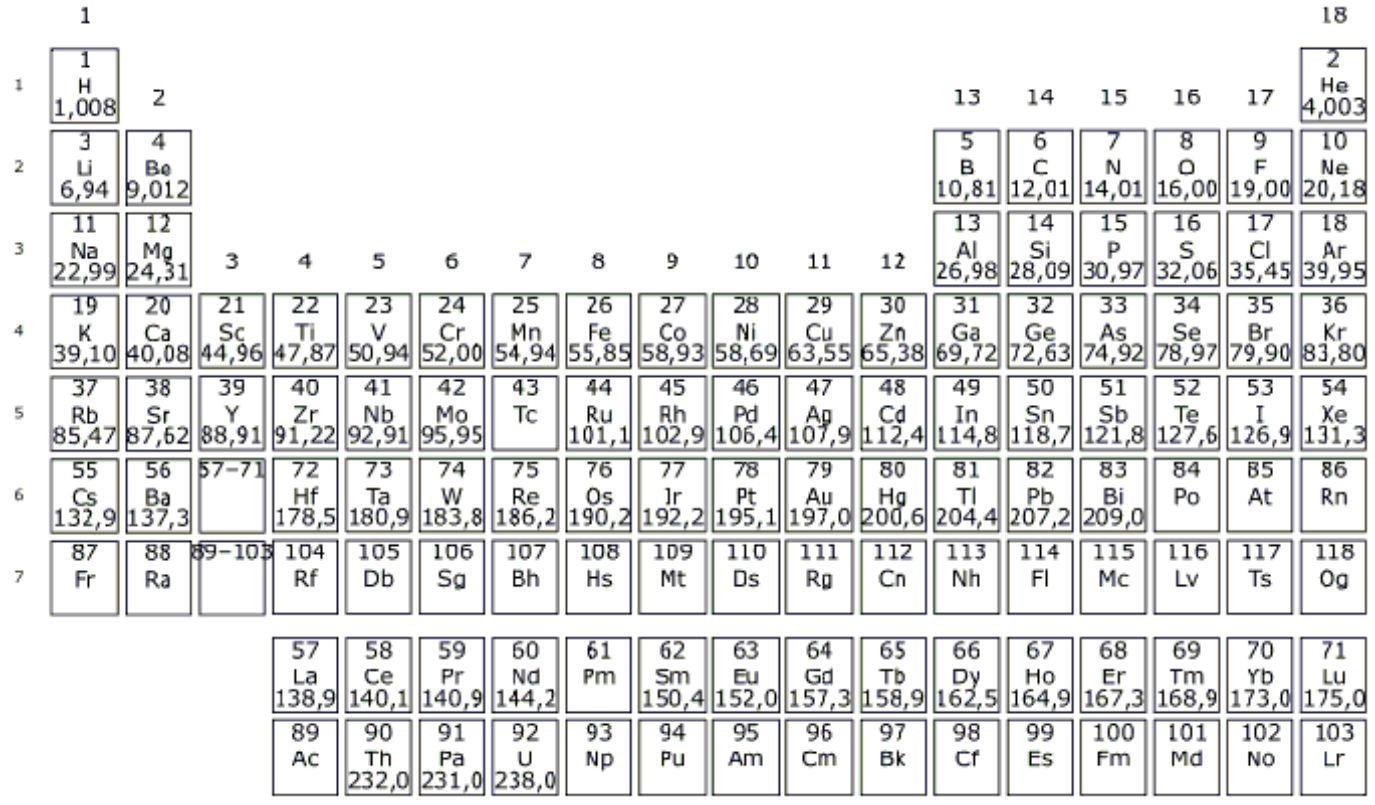
Booklet A **KIM101E** **Midterm-2** **Jan. 04, 2025**

Group Number	:	Surname	:	Signature
List Number	:	Name	:	
Student Number	:	e-mail	:	



$c = 2.998 \times 10^{8}$ m s^{-1} $g = 9.8$ m s^{-2} $h = 6.626 \times 10^{-34}$ J s $R_H = 2.179 \times 10^{-18}$ J 0°C = 273 K

$N_A = 6.022 \times 10^{23}$ 1 cal = 4.184 J 1 m = 10^9 nm = 10^{10} Å = 10^{12} pm 1 g = 10^3 mg = 10^6 μg

1 atm = 760 mmHg = 760 torr = 101325 Pa = 101.325 kPa = 1.01325 bar

$R = 0.08206$ L atm mol^{-1} K^{-1} $= 0.08314$ L bar mol^{-1} K^{-1} $= 8.314$ J mol^{-1} K^{-1} $= 8.314$ L kPa mol^{-1} K^{-1}

1 Newton (N) = 1 kg m s^{-2} 1 Joule (J) = 1 N m = 1 kg m^2 s^{-2} 1 Watt (W) = 1 J s^{-1}

For water c = 4,184 J g^{-1} K^{-1}

1) A helium-filled balloon is set to begin a journey early in the morning when the temperature is 15°C. By mid-afternoon, the temperature rises to 30°C. Assuming the pressure remains constant at 1.00 atm, calculate the work done by the helium gas (in joules) for each mole during this process.

A) +124.7 J B) +1.23 J C) -187.0 J D) -124.7 J E) -1.23 J

2) A 3.51 g sample of benzene (C_6H_6) is burned in excess oxygen inside a bomb calorimeter. The temperature of the calorimeter rises from 25.00°C to 37.18°C. If the heat capacity of the calorimeter and its contents is 12.05 kJ/°C, calculate the ΔH for burning 1.25 moles of benzene at constant volume and 25.00°C. The reaction is as follows:

$C_6H_6(\ell) + O_2(g) \rightarrow CO_2(g) + H_2O(\ell)$ (unbalanced)

A) -4080.6 kJ B) -3266.1 kJ C) -2920.5 kJ D) 4082.7 kJ E) 1462.7 kJ

3) Put the following molecules in the order of increasing boiling point: LiCl, N_2, C_3H_7OH, C_4H_8

A) $N_2 < LiCl < C_3H_7OH < C_4H_8$

B) $LiCl < C_4H_8 < C_3H_7OH < N_2$

C) $N_2 < C_4H_8 < C_3H_7OH < LiCl$

D) $LiCl < C_4H_8 < N_2 < C_3H_7OH$

E) $C_3H_7OH < C_4H_8 < N_2 < LiCl$

Booklet A

4) Given the reactions below, calculate $\Delta_r H°$ for the following reaction: $2\ MnO_2\ (s) + CO\ (g) \rightarrow Mn_2O_3\ (s) + CO_2\ (g)$

Reaction	$\Delta_r H°$
$MnO_2\ (s) + CO\ (g) \rightarrow MnO\ (s) + CO_2\ (g)$	-150.6 kJ/mol
$Mn_3O_4\ (s) + CO\ (g) \rightarrow 3\ MnO\ (s) + CO_2\ (g)$	-54.4 kJ/mol
$3\ Mn_2O_3\ (s) + CO\ (g) \rightarrow 2\ Mn_3O_4\ (s) + CO_2\ (g)$	-142.3 kJ/mol

A) -347.3 kJ B) -389.1 kJ C) -104.5 kJ D) -46.1 kJ E) -217.5 kJ

5) At 20.0°C, the vapor pressure of compound X is 17.5 mmHg, and at 80.0°C, it increases to 355.1 mmHg. Calculate the normal boiling point of compound X.

A) 57°C B) 99°C C) 157°C D) 330°C E) 372°C

6) A 125 g stainless steel ball-bearing (c_p = 0.5 J $g^{-1}°C^{-1}$) at 525°C is dropped into 75 mL water at 28.5°C in an open Styrofoam cup. As a result, the water is brought to a boil when the temperature reaches 100°C. What mass of water vaporizes while the boiling is continuous? (for water d = 1 g/mL, $\Delta_{vap}H°$ = 40.6 kJ/mol H_2O)

A) 13.9 g B) 1.39 g C) 1.84 g D) 20.5 g E) 2.5 g

7) After drawing the correct Lewis dot structure for the NO_2^- , determine the number of double bond(s), lone pairs of electrons on the molecule, and the formal charge of the center atom?"

A) 2 double bonds, 16 lone pairs electrons, the formal charge of the center atom is 1+
B) 1 double bond, 12 lone pairs electrons, the formal charge of the center atom is 0
C) 1 double bond, 6 lone pairs electrons, the formal charge of the center atom is 0
D) 1 double bond, 8 lone pairs electrons, the formal charge of the center atom is 1+
E) 1 double bond, 9 lone pairs electrons, the formal charge of the center atom is 1-

8) Which of the following molecules has the smallest bond angles?

I. PCl_3 II. CCl_4 III. HCN IV. XeF_4 V. SO_2

A) I B) II C) III D) IV E) V

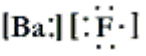
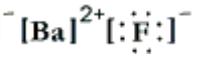
9) When the hybridization types listed below are matched with the hybridization of the central atoms of the given molecules, which hybridization type remains unmatched?

The hybridization types: sp, sp^2, sp^3, sp^3d, sp^3d^2

Molecules: XeF_4, $TeCl_4$, XeF_3^+, BeF_2, NO_2^-

A) sp^3d B) sp^3 C) sp^2 D) sp E) sp^3d^2

10) Which of the following represents barium fluoride's most accurate Lewis dot structure?

A) 
B) **F–Ba–F**
C) 
D) 
E) 

11) Which of the followings are diamagnetic?

I. N_2 II. N_2^+ III. N_2^- IV. N_2^{2-} V. N_2^{2+}

A) I and V B) I, IV, and V C) II and III D) I and III E) II, III, and IV

12) Manganese crystallizes in the same cubic lattice structure as copper. The edge length of manganese's unit cell is 5% larger than that of copper. Given that the density of copper is 8.92 g/cm³, calculate the density of manganese.

A) 9.38 g/cm^3 B) 7.32 g/cm^3 C) 6.66 g/cm^3 D) 4.45 g/cm^3 E) 3.58 g/cm^3

Booklet A

13) Arrange the crystal lattice energies of the following compounds in ascending order.
Na_2O, MgO, K_2O, KF

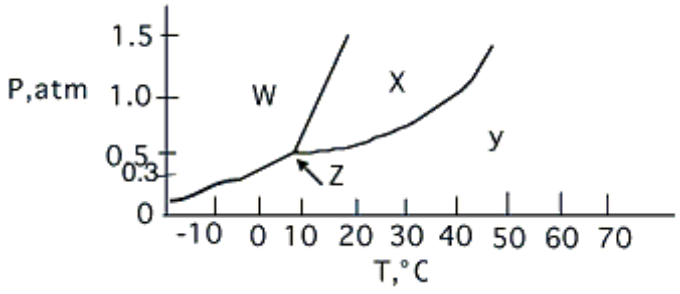
A) $MgO > Na_2O > K_2O > KF$
B) $KF > K_2O > Na_2O > MgO$
C) $MgO > K_2O > Na_2O > KF$
D) $KF > Na_2O > K_2O > MgO$
E) $KF > MgO > K_2O > Na_2O$

14) Which of the following correctly describes London dispersion forces?

I. London dispersion forces are attractive forces existing even in electrically neutral substances.
II. London dispersion forces are intermolecular attractive forces operating in all molecules.
III. London dispersion forces are the attractive forces that exist in non-polar gases.
IV. London dispersion forces apply only to non-polar atoms and/or molecules.
V. London dispersion forces arise from the instantaneous dipole moment due to the motion of electrons in a molecule or atom.

A) I, III, and IV B) IV and V C) I, III, IV, V D) I, II,III, V E) I and V

15) Below is a phase diagram for a compound. According to this diagram, suppose a solid is originally at 0.3 atm and 0ºC. If it is first pressurized to 1.0 atm and then subsequently heated to 60ºC, what will happen to it?



A) It will sublime directly to gas.
B) It will melt and end up as a liquid.
C) It will first melt, and then boil, ending up as a gas.
D) It will sublime to gas, then compress to a liquid and end up in the liquid phase.
E) No phase change will happen. It will just stay solid.

16) A sample of 23.0 g naphthalene ($C_{10}H_8$) was added to benzene (C_6H_6) and the resulting solution has a boiling point of 83.7ºC. How many milliliters of benzene were used to prepare the solution if the normal boiling point of benzene is 80.1ºC and its density is 0.877 g/mL? (K_b = 2.53 $K.kg.mol^{-1}$ for benzene and naphthalene is a non-ionic solid.)

A) 109 mL B) 126 mL C) 207 mL D) 236 mL E) 144 mL

17) When LiCl is dissolved in water, the mol fraction of LiCl is 0.09. What is the molality of the solution?

A) 4.46 mol kg^{-1} B) 5.00 mol kg^{-1} C) 5.49 mol kg^{-1} D) 9.89 mol kg^{-1} E) 0.09 mol kg^{-1}

18) A KCl solution is prepared by dissolving 25.0 g KCl in 250.0 g of water at 25 °C. What is the vapor pressure of the solution if the vapor pressure of water at 25 °C is 23.76 mmHg?

A) 21.6 mmHg B) 22.7 mmHg C) 23.2 mmHg D) 24.9 mmHg E) 20.6 mmHg

19) Under a CO (g) pressure of 1 atm, 0.0354 mg of CO (g) dissolves in 1 mL H_2O at 0°C. What will the molarity of CO be in a saturated solution at 0°C when the CO pressure is 0.00036 atm?

A) 4.5×10^{-7} M B) 1.6×10^{-3} M C) 1.3×10^{-5} M D) 2.9×10^{-4} M E) 3.2×10^{-3} M

20) Which of the following molecules has an electron group geometry that differs from the others?

A) TeF_4 B) XeF_3^+ C) ClF_3O_2 D) SeO_4^{2-} E) $SnCl_5^-$

Answer Key
Testname: MIDTERM-2-EN-A

1) D
2) A
3) C
4) E
5) B
6) C
7) C
8) D
9) B
10) E
11) A
12) C
13) A
14) D
15) C
16) E
17) C
18) B
19) A
20) D