Recitation Worksheet (Optional Extra Practice)

Name:

MyID:

Textbook:

Chemistry & Chemical Reactivity
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Instructions:

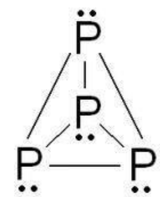
- This recitation worksheet is optional extra practice for 12.1-12.3, 12.5 and 14.1-14.4.
- You **do not** need to submit it to Gradescope.
- The answer key has been posted with this worksheet to eLC.
- A periodic table and formula sheet are attached to the end of this worksheet.

1. Classify the following solids as either:

   A. Molecular solid
   B. Metallic solid
   C. Ionic solid
   D. Network covalent solid

   For your answer insert one of the choices A – D in the answer box. Example, if the answer is metallic, then the answer is choice B.

[ ]	A. $Ca_3(PO_4)_2$
[ ]	B. P_4 (<u>hint:</u> melting point 44.1 °C)
[ ]	C. SiO_2
[ ]	D. Naphthalene ($C_{10}H_8$)
[ ]	E. C (*s*, graphite)
[ ]	F. Caffeine ($C_8H_{10}N_4O_2$)
[ ]	G. Fe



2. Covalent bonding occurs in both molecular and covalent network solids. Which of these statements best explains why these two kinds of solids differ so greatly in their hardness and melting points?

   A. The molecules in molecular solids have stronger covalent bonding than covalent- network solids do.
   B. The molecules in molecular solids are held together by weak intermolecular interactions.
   C. The atoms in covalent-network solids are more polarizable than those on molecular solids.
   D. Molecular solids are denser than covalent network so

3. In the following solid pairs, which substance has the **higher** melting point?

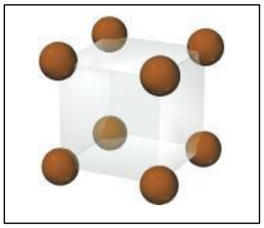
   A. Pd or HOOH

   B. $SiCl_4$ or $SiBr_4$

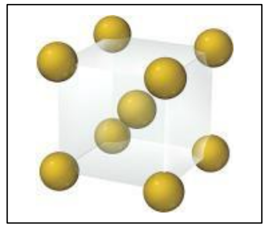
   C. KF or HF

   D. C (*s*, diamond) or K

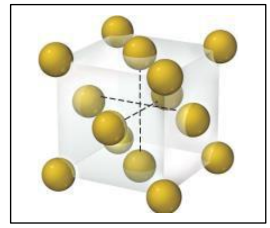
4. Nickel is a hard silver-white metal which occurs as face-centered cubic crystal, while polonium is a radioactive metal that occurs as a simple cubic crystal, and tungsten is a rare earth metal that occurs as a body-centered cubic crystal. Examine the images A – C below and answer the following questions:



A



B



C

I. Tungsten metal crystal unit cell is (choose one of images A – C) ______

II. Nickel has ______ atoms in its unit cell (insert numerical value, example: 1, 2, 3, etc.)

III. The coordination number of unit cell in a polonium crystal is ______ (insert numerical value, example: 1, 2, 3, etc.)

IV. Image C matches the description for ______ (Choose either Ni, W, or Po. Write the chemical symbol in the answer box and NOT the full name of the element).

5. Arrange the solid compounds below in order of **increasing** melting points.

Ar(*s*), CCl_4(*s*), LiCl(*s*), C_4H_9OH(*s*)

A. LiCl(*s*) < C_4H_9OH(*s*) < CCl_4(*s*) < Ar(*s*)
B. Ar(*s*) < CCl_4(*s*) < C_4H_9OH(*s*) < LiCl(*s*)
C. CCl_4(*s*) < LiCl(*s*) < Ar(*s*) < C_4H_9OH(*s*)
D. C_4H_9OH(*s*) < LiCl(*s*) < CCl_4(*s*) < Ar(*s*)
E. Ar(*s*) < C_4H_9OH(*s*) < CCl_4(*s*) < LiCl(*s*)

6. You are given a set of ions: Na^+, K^+, Ca^{2+}, Mg^{2+}, F^-, Br^-, O^{2-}, and S^{2-}. Which cation and which anion do you expect to combine to form the highest melting ionic compound? Insert your answer as a formula, example **NaCl**.

7. Polonium crystallizes in a simple cubic cell unit. If the edge length of the unit cell is 336 pm, calculate the density of polonium in g/cm^3. (1 cm = 1 x 10^{10} pm, molar mass of Po = 209 g/mol).

g/cm^3

8. A diamond unit cell has a volume of 0.0454 nm^3. If the density of diamond is 3.52 g/cm^3, how many carbon atoms are in a unit cell of diamond? (1 cm = 1 x 10^7 nm, molar mass of carbon = 12.01 g/mol).

A. 11 atoms
B. 20 atoms
C. 10 atoms
D. 14 atoms
E. 8 atoms

9. Among the options shown, which chemical formula is paired with an **incorrect** crystal type? Select all that apply. Insert letters without spaces or commas, example**: ABCD**.

A. I_2, Molecular
B. C_2H_6, Covalent Network
C. C (graphite), Molecular
D. NaF, Ionic
E. Cu, Metallic

10. Which of these statements is **false**?

A. Molecular solids generally have lower melting points than covalent solids.
B. Metallic solids exhibit a wide range of melting points because metallic bonds cover a wide range of bond strength.
C. The metallic solid can be viewed as positive ions closely packed in a sea of valence electrons.
D. Most molecular solids melt at lower temperatures than metallic solids.
E. The interactions among the molecules in molecular solids are generally stronger than those among the particles that define either covalent or ionic crystal lattices.

11. Which statement is true regarding the different types of cubic unit cells? Select all that apply. Insert letters without spaces or commas, example**: ABCD**.

A. Simple cubic unit cell has two atoms per unit cell whereas body centered cubic unit cell has four atoms per unit cell
B. A fraction of a corner sharing atom is 1/8 in face centered cubic unit cell
C. The coordination number for body centered cubic is 12
D. A fraction of face sharing atom is 1/2 in face centered cubic unit cell
E. None of these statements are true

12. Which of these ionic solids has the **highest** melting point?

A. CaF_2
B. KCl
C. $LiCl$
D. $NaCl$
E. MgF_2

13. You are provided with an unknown solid and you inspect its physical properties to find that it has a melting point of 1127 °C, soluble in water, does not conduct heat or electricity as a solid, and is very hard. Given these properties, which of the following choices matches the physical properties of the unknown substance?

A. CoF_2
B. CO_2
C. Li
D. C (s, diamond)
E. SiO_2
F. $CHCl_3$

14. Nickel has a face-centered cubic structure and has a density of 8.90 g/cm^3. What is the volume of the unit cell in cm^3?

X 10 cm^3

15. Classify each of the solids as A) covalent, B) ionic, C) metallic, or D) molecular solids. *The answer on your answer sheet should be a **letter** corresponding to the chemical compound listed below.*

I. Solid ethanol (CH_3CH_2OH)

II. Sodium iodide

III. Pure potassium

IV. Silicon dioxide

16. Carbon monoxide is observed to melt at -205℃, whereas carbon dioxide sublimates at -78.5 °C. The absence of which IMF explains why carbon dioxide cannot become a liquid at atmospheric pressure?

A. London Dispersion Forces
B. Ion-Dipole
C. Dipole-Dipole
D. Hydrogen-Bonding

17. If gold crystallizes in a face-centered cubic arrangement and the edge length of the unit cell is 4.08 Å. What is the density of gold in g/cm^3?

g/cm^3

18. Classify each of the solids below as A) ionic solid, B) network covalent solid, C) metallic, or E) molecular solid

i. Barium chloride

ii. Krypton

iii. Ruthenium

iv. Snow

v. C (Diamond)

19. Which of the following statements regarding crystalline solids is **true**?

I. Molecules or atoms in molecular solids are held together via ionic bonds.
II. Metallic solids have atoms in the points of the crystal lattice.
III. Ionic solids have formula units in the point of the crystal lattice.
IV. Molecules in covalent-network solids are connected via a network of covalent bonds.

A. I
B. II
C. III
D. IV
E. None of the above statements are tru

20. For the reaction A + 2 B $\longrightarrow$ 2 C, the rate of the reaction is 1.76×10^{-5} M/s at the time when [A] = 0.3580 M.

A. What is the rate of formation of C?

[ ] M/s

B. What will [A] be 1.00 min later?

[ ] M

C. How long will it take for [A] to change from 0.3580 M to 0.3500 M assuming the rate remains at 1.76×10^{-5} M/s?

[ ] s

21. The following data are obtained for the initial rates of the reaction in the reaction A + 2 B + C ⟶ 2 D + E.

Experiment	**Initial [A]**	**Initial [B]**	**Initial [C]**	**Initial Rate**
1	1.40	1.40	1.00	R1
2	0.70	1.40	1.00	R2 = $\frac{1}{2}$ x R1
3	0.70	0.70	1.00	R3 = $\frac{1}{4}$ x R2
4	1.40	1.40	0.50	R4 = 16 x R3
5	0.70	0.70	0.50	R5 = ?

A. What are the reaction orders with respect to A, B, and C?

$$\text{Rate} = K\,[A]^{\boxed{}}\,[B]^{\boxed{}}\,[C]^{\boxed{}}$$

B. What is the value of R5 in terms of R1? Express your answer for R5 as a fraction of R1.

$$R5 = \frac{\boxed{}}{\boxed{}} \text{ X R1}$$

22. If a reaction is first order with a rate constant of $5.48 \times 10^{-2}\ s^{-1}$, how long is required for 3/4 of the initial concentration of reactant to be used up?

A. 25.3 s
B. 36.5 s
C. 6.3 s
D. 18.2 s
E. 50.6 s

Formula Sheet

Length
1 kilometer = 0.62137 mile
1 inch = 2.54 centimeters (exactly)
1 Ångstrom = 1×10^{-10} meter

Energy
1 joule = 1 $kg \cdot m^2/s^2$
1 calorie = 4.184 joules
1 Calorie = 1 kilocalorie = 1000 calories
1 L·atm = 101.325 joules

Pressure
1 pascal = 1 N/m^3 = 1 $kg/m \cdot s^2$
1 atmosphere = 101.325 kilopascals = 760 mm Hg = 760 torr = 14.70 lb/in^2
1 bar = 1×10^5 Pa (exactly)

Temperature
0 K = −273.15°C
K = °C + 273.15
°C = (5/9)(°F − 32)

Mass
1 kg = 2.205 lbs

Volume
1 mL = 1 cm^3 = 1 cc

Constants
$c = 2.998 \times 10^8$ m/sec
$h = 6.626 \times 10^{-34}$ $J \cdot sec^{-1}$
R = 0.08206 L·atm/mol·K = 8.314 J/mol·K
Specific heat of water = 4.184 J/g·K
Mass of an electron: 9.109×10^{-31} kg
Mass of a proton: 1.673×10^{-27} kg
RH = 2.18×10^{-18} J
Specific heat of water = 4.184 J/g·K
STP = 273.15 K and 1 atm
Avogadro's number: 6.022×10^{23}

Equations
d (density) = m/V
$P_1V_1=P_2V_2$
$V_1/T_1=V_2/T_2$
$P_1V_1/n_1T_1=P_2V_2/n_2T_2$
$PV=nRT$
$(P + a(n^2/V^2))\cdot(V - nb) = nRT$
molar mass (M) = mRT/PV
density (d) = MP/RT
$x_A = n_A/n_{tot} = P_A/P_{tot} = V_A/V_{tot}$
$P_{tot} = P_A + P_B + \ldots$
$n_{tot} = n_A + n_B + \ldots$

$$\mu_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{Rate\ of\ effusion\ A}{Rate\ of\ effusion\ B} = \sqrt{\frac{MW_B}{MW_A}}$$

$Q = C \times \Delta T = c_{specific} \times m \times \Delta T$
$Q = n \times \Delta H$ (kJ/mol) $= m \times \Delta H$ (kJ/g)
$w = -P\Delta V$
$\Delta E = q + w$
$\Delta H° = \Sigma n\Delta Hf°(products) - \Sigma n\Delta Hf°(reactants)$
$\Delta H° = \Sigma n\Delta H°(bonds\ broken) - \Sigma n\Delta H°(bonds\ formed)$
$E=hv$
$c=\lambda v$
$\lambda = h/mv$

$$\Delta E = -2.18 \times 10^{-18} J\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$C_g = kP_g$
$P_{solution}=P_{solvent}\ X_{solvent}$
$P_{solution}=\sum P_j=\sum P_jX_j$
$\Delta T_b = K_b m i$
$\Delta T_f = K_f m i$
$\pi = MRTi$

<u>Thermodynamic and Electrochemistry</u>

$S = k_b \times \ln(W)$
$k_b = 1.381 \times 10^{-23}$ J/K
$\Delta S = q_{rev}/T$
$\Delta S_{surr} = q_{surr}/T = -q_{rev}/T$
$\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr}$
$\Delta S°_{rxn} = \Sigma v S°_{products} - \Sigma v S°_{reactants}$
$\Delta H°_{rxn} = \Sigma v H°_{products} - \Sigma v H°_{reactants}$
$\Delta G°_{rxn} = \Sigma v G°_{products} - \Sigma v G°_{reactants}$
$\Delta G = \Delta H - T\Delta S$
$\Delta G = \Delta G° + RT \cdot \ln Q$
R=8.314 J/mol.K
$\Delta G° = -RT \cdot \ln K$
$\Delta G= -nFE_{cell}$
F = 96485 J/(V·mol e^-)
$E°_{cell} = RT/nF \ln K$
$E°_{cell} = (0.0257/n) \ln K = (0.0592/n) \log K$
$E_{cell} = E°_{cell} - (RT/nF) \ln Q$
$E_{cell} =E°_{cell} - (0.0257/n) \ln Q$
Electrolysis: Q (total charge) = I × t = n × F

<u>Integrated Rate Laws & half-life</u>

$$\ln\frac{[A]}{[A]_0} = -kt$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

$$[A] = -kt + [A]_0$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{k}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

$$ln\frac{k_2}{k_1} = -\frac{\mathrm{E_a}}{\mathrm{R}}(\frac{1}{\mathrm{T_2}} - \frac{1}{\mathrm{T_1}})$$

Equilibrium and Acid / Base

$K_P = K_c \times (RT)^{\Delta n}$

pH = $-\log[H_3O^+]$

$K_w = 1.0 \times 10^{-14}$ at 25 °C

$K_w = [H_3O^+] \times [OH^-]$

$K_w = K_a \times K_b$

$pK_a = -\log[K_a]$

Buffer: pH = $pK_a + \log \frac{[A^-]}{[HA]}$

$$ln\frac{K_2}{K_1} = \frac{\Delta H^\circ_{rxn}}{R}(\frac{1}{T_1} - \frac{1}{T_2})$$

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.01																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc [97]	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
37 Cs 132.91	56 Ba 137.33		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]		104 Rf [267]	105 Db [268]	106 Sg [269]	107 Bh [270]	108 Hs [269]	109 Mt [277]	110 Ds [281]	111 Rg [282]	112 Cn [285]	113 Nh [286]	114 Fl [290]	115 Mc [290]	116 Lv [293]	117 Ts [294]	118 Og [294]

57 La 138.91	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 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
89 Ac [227]	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]