Recitation Worksheet Three: Exam One Review

Name:

MyID:

Textbook:

Chemistry & Chemical Reactivity
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Instructions:

- This recitation worksheet is a review for Exam One.
- Exam coverage: Ch. 5.3, 11, 12, 14.1-14.4
- You **do not** need to submit it to Gradescope.
- The answer key has been posted with this worksheet to eLC.
- The **recitation session during the exam week (September 9-12) is still mandatory**. Your attendance will be recorded.
- A periodic table and formula sheet are attached to the end of this worksheet.

1. Pick the **most significant** IMF/bond for the following compounds (or compounds pair).
   A. dipole-dipole forces
   B. ion-induced dipole forces
   C. hydrogen bond
   D. ion-dipole forces
   E. dispersion forces
   F. ionic bond

   I. LiI
   II. CH_3OH
   III. CH_3CH_3
   IV. CH_2F_2
   V. between LiI and H_2O

2. Which of the following statements is **not** consistent with the properties of a molecular solid?
   A. a compound that conducts electricity when molten
   B. a low melting solid
   C. a solid formed by the combination of two nonmetallic elements
   D. a solid that is a nonconductor of electricity

3. Ethanol (C_2H_5OH) has a normal boiling point of 78.3 °C and, ΔH_{vap} = 39.3 kJ/mol. What is the vapor pressure of ethanol at 50.0 °C? Keep 3 significant figures.

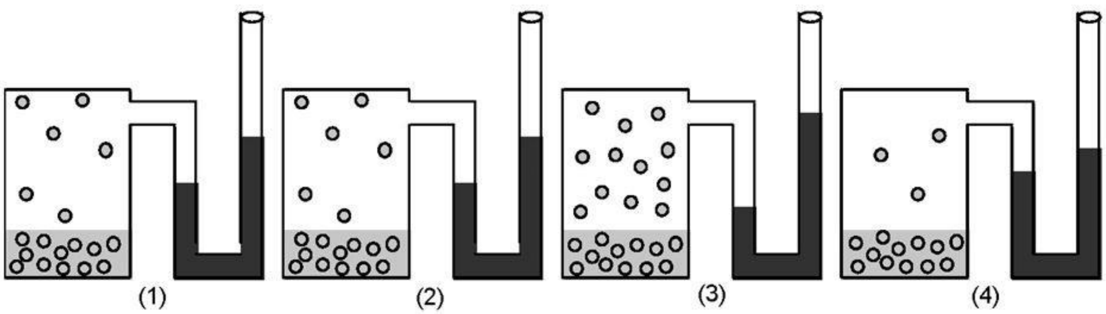
Torr

4. How many atoms are in one face-centered cubic unit cell of a metal?

A. 1
B. 2
C. 3
D. 4

5. If figure (1) represents the vapor pressure of water at 25 °C, which figure represents the vapor pressure of ethanol, CH_3CH_2OH at 25 °C?

A. figure (2)
B. figure (3)
C. figure (4)



6. Which of the following statements is **false**?

A. Vapor pressure occurs in a closed container when the rate at which molecules are leaving the liquid phase and entering the gas phases is equal to the rate at which gas molecules are returning to the liquid phase
B. Evaporation can occur below the boiling point because even then some molecules have enough kinetic energy to escape
C. Evaporation decreases at low temperature because then a lower percentage of molecules have enough energy to escape
D. At a given temperature molecules in the gas phase have more energy than molecules in the liquid phase
E. The stronger the noncovalent binding forces, the faster a liquid will evaporate

7. How much heat (in kJ) is absorbed when 475 g of water initially at −23.5 °C is heated to 218 °C?

ΔH_{fus} of water = 334 J/g
ΔH_{vap} of water = 2257 J/g
C of ice = 2.09 J/g·°C
C of water = 4.18 J/g·°C
C of steam = 2.09 J/g·°C

kJ

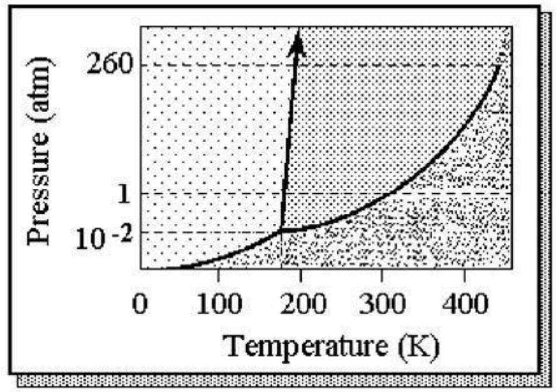
8. Which of these compounds has the largest lattice energy?

$MgCO_3$ Na_2CO_3 $Al_2(CO_3)_3$

A. Na_2CO_3
B. $MgCO_3$
C. $Al_2(CO_3)_3$
D. They all have the same lattice energy.
E. Not enough information is available to determine which is largest.

9. The phase diagram of a substance is shown below. The approximate normal boiling point of this substance is

A. 180 K.
B. 190 K.
C. 300 K.
D. 430 K.



10. A kitchen pressure cooker operates at 1.70 atm. The ΔH_{vap} of water is 40.7 kJ/mol. What is the boiling point of water in the pressure cooker?

K

11. Which of the following is most likely to have the highest viscosity and surface tension at 25°C?

A. C_6H_{14}
B. $HOCH_2CH_2OH$
C. C_3H_7OH
D. C_7H_8
E. $C_3H_5(OH)_3$

12. Predict the order in which boiling points of these hydrides *decrease* (highest boiling point first, lowest last):

PH_3, AsH_3, SbH_3

A. PH_3, AsH_3, SbH_3
B. AsH_3, SbH_3, PH_3
C. SbH_3, AsH_3, PH_3
D. PH_3, SbH_3, AsH_3
E. SbH_3, PH_3, AsH_3

13. Which one of these substances does not exist in the indicated solid type?

A. graphite – network
B. Na – metallic
C. SiO_2 (Quartz) – molecular
D. NaCl – ionic
E. diamond – network

14. A sample of octane in equilibrium with its vapor in a closed 1.0-L container has a vapor pressure of 50.0 torr at 45°C. The container's volume is increased to 2.0 L at constant temperature and the liquid/vapor equilibrium is reestablished. What is the vapor pressure?

A. > 50.0 torr
B. 50.0 torr
C. 25.0 torr
D. The mass of the octane vapor is needed to calculate the vapor pressure.
E. The external pressure is needed to calculate the vapor pressure.

15. Assume 12,500 J of energy is added to 2.0 moles (36 grams) of H2O as an ice sample at 0°C. The molar heat of fusion is 6.02 kJ/mol. The specific heat of liquid water is 4.18 J/g °C. The specific heat of water vapor is 1.90 J/g °C. The molar heat of vaporization is 40.6 kJ/mol. The resulting sample contains which of these?

A. water and water vapor
B. ice and water
C. only water
D. only water vapor
E. only ice

16. Which of these involves a change in temperature during the phase transition?

A. condensation of water
B. vaporization of ammonia
C. fusion of ethanol
D. all of the above
E. none of the above

17. Closed system A consists of liquid acetone in equilibrium with its own vapor at 30°C. System B is like System A, except that the volume of liquid, the area of the liquid surface, and the volume of the vapor space above the liquid are all twice as large as System A, and the temperature is only 15°C. Identify the statement among the following that is **false**.

A. Evaporation and condensation rates are equal in A
B. Evaporation and condensation rates are equal in B
C. Evaporation rate in A is greater than evaporation rate in B
D. Vapor pressure in B is greater than vapor pressure in A
E. Condensation rate in A is greater than condensation rate in B

18. Which of these pairs is arranged with the particle of higher polarizability listed first?

A. CF_4, CCl_4
B. H_2O, H_2Se
C. C_6H_{14}, C_4H_{10}
D. NH_3, NF_3
E. None of these choices is correct.

19. Which of the responses includes all of the examples that can form hydrogen bonds with water molecules?

I. Na^+ II. CH_3COOH III. C_2H_6 IV. CH_3NH_2

A. I and II
B. I and III
C. II and III
D. II and IV
E. III and IV

20. Which one of these involves ion-dipole interactions?

A. Na^+ and Cl^-
B. H^+ and F^-
C. Na^+ and Mg^{2+}
D. two water molecules
E. Na^+ and H_2O

21. Gold crystallizes in an face-centered cell arrangement. What is the density of gold in g/cm^3 if the edge length of a gold unit cell is 409 pm? (1 cm = 10^{10} pm).

[ ] g/cm^3

22. Which of the compounds below is expected to have the
    1. **highest** vapor pressure?

    [ ]

    2. **lowest** melting point?

    [ ]

    3. **highest** viscosity?

    [ ]

A. (CH3)3COH
B. $CH_3CH_2CH_2CH_2OH$
C. $(CH_3)_2CHCH_2OH$
D. $OHCH_2CH_2CH_2OH$
E. $OHCH_2CHOHCH_2OH$

23. What is the amount of energy in kJ required to convert 17.0 g of solid tin metal (118.71 g/mol) at 55 °C to the liquid phase at 540 °C.

Melting point of tin = 231.93 °C
Boiling point of tin =2602 °C
Specific heat of tin (solid) = 0.2177 J/g.°C
Specific heat of tin (liquid) = 0.2093 J/g.°C
ΔHvap = 296.1 kJ/mol
ΔHfus = 7.03 kJ/mol

[ ] kJ

24. Nickel (58.693 g/mol) crystallizes in a face-centered cubic lattice. The density of it is 8.91 g/cm^3. What is the volume of a single unit cell in **nm^3**? (1 nm = 1×10^{-9} m)

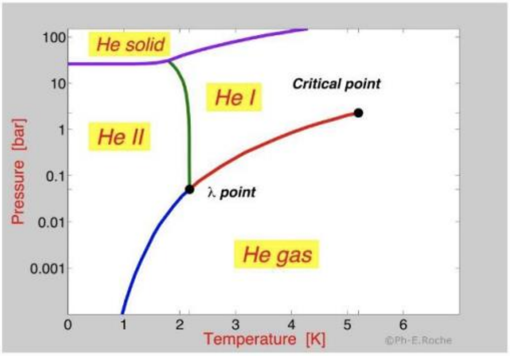
[ ] nm^3

25. Both ice and silicon dioxide can form tetrahedral bonding arrangements in the solid phase. Ice is _______, while silicon dioxide is _______.

A. a molecular solid; a metallic solid
B. a molecular solid; an ionic solid
C. a network covalent solid; a molecular solid
D. a molecular solid; a network covalent solid
E. an ionic solid; a network covalent solid

26. Helium exhibits two liquid phases, He I, and He II, a superfluid. When does helium become a solid, at atmospheric pressure?

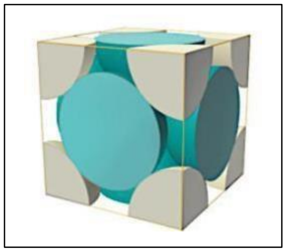
A. 6 K
B. 4 K
C. 2 K
D. <1 K
E. Helium cannot become a solid at atmospheric pressure

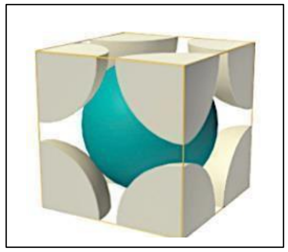


27. For a particular liquid, raising its temperature from 339 K to 365 K causes its vapor pressure to double. What is the enthalpy of vaporization of this liquid? (R = 8.3145 J/(K·mol))

A. 27 kJ/mol
B. 221 kJ/mol
C. 3 kJ/mol
D. 307 kJ/mol
E. 149 kJ/mol

28. Label each of the unit cells below (Insert FCC for face-center cubic; BCC for body-center cubic; or simple cubic)

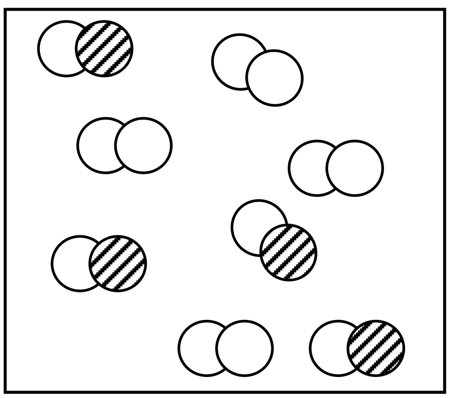




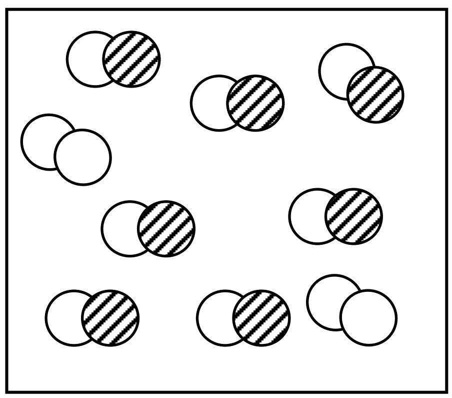
29. The diagrams represent mixtures of NO(g) and O_2(g). These two substances react as follows:

$$2\ NO(g) + O_2(g) \longrightarrow 2\ NO_2(g)$$

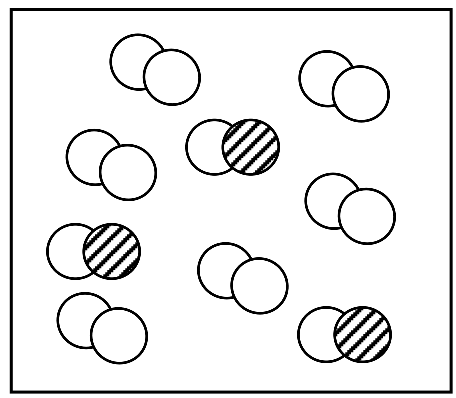
It has been determined experimentally that the rate is second order in NO and first order in O2. Which of the mixtures will have the fastest initial rate?



Mixture 1



Mixture 2



Mixture 3

A. Mixture 1
B. Mixture 2
C. Mixture 3
D. All the reaction mixtures have the same initial rate.

30. The reaction 2 $NO(g) + O_2(g) \rightarrow 2 NO_2(g)$ has the rate law: Rate = $k[NO]^2[O2]$. If the concentration of NO is reduced by a factor of two and concentration of O_2 stays the same, the rate will

A. double
B. quadruple
C. Reduce by a factor of four
D. Reduce by a factor of two
E. Remain the same

31. For the reaction 8 $H_2S(g)$ + 4 $O_2(g) \longrightarrow$ 8 $H_2O(g)$ + $S_8(g)$ how does the rate of disappearance of $H_2S(g)$ compare to the rate of consumption of $O_2(g)$?

A. The rate of disappearance of $H_2S(g)$ is ½ the rate of consumption of $O_2(g)$.
B. The rate of disappearance of $H_2S(g)$ is the same rate consumption of $O_2(g)$.
C. The rate of disappearance of $H_2S(g)$ is 8 times the rate consumption of $O_2(g)$.
D. The rate of disappearance of $H_2S(g)$ is 4 times the rate of consumption of $O_2(g)$.
E. The rate of disappearance of $H_2S(g)$ is twice the rate of consumption of $O_2(g)$.

32. Consider the reaction: $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$. If the rate of $\Delta[H_2]/\Delta t$ is 0.030 mol $L^{-1}s^{-1}$, then $\Delta[NH_3]/\Delta t$ is

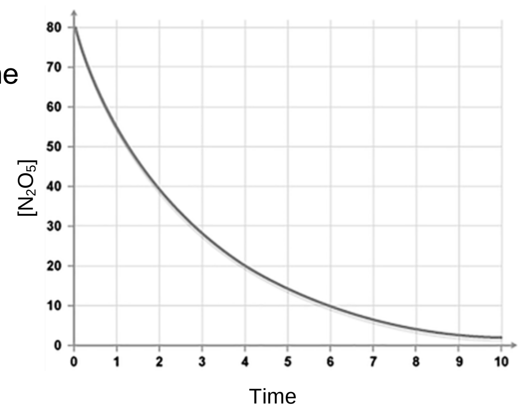
A. −0.045 mol L^{-1} s^{-1}
B. −0.030 mol L^{-1} s^{-1}
C. −0.020 mol L^{-1} s^{-1}
D. −0.010 mol L^{-1} s^{-1}
E. None of these choices are correct.

33. When the reaction A → B + C is studied, a plot of ln[A]*t* vs. time gives a straight line with a negative slope. What is the order of the reaction?

A. Zero
B. First
C. Second
D. Third
E. More information is needed to determine the order.

34. Using the graphical representation below of the concentration of N_2O_5 versus time for the reaction $N_2O_5(g) \rightarrow NO_3(g) + NO_2(g)$, which of the statements is **false**?

A. The decomposition of N_2O_5 follows zero order kinetics.
B. It takes about 2 minutes for N_2O_5 to decrease to half of its original concentration.
C. The half-life of this reaction is independent on the original concentration of N_2O_5.
D. The rate for this reaction can be expressed as rate = $k\,[N_2O_5]$



35. Which of the statements is true concerning the reaction given below?

$$2\ H_2S(g) + O_2(g) \rightarrow 2\ S(s) + 2\ H_2O(g)$$

A. The rate law is Rate = $k[H_2S]^2[O2]$.
B. The reaction is second-order in $H_2S(g)$ and first-order in $O_2(g)$.
C. The reaction is first-order in $H_2S(g)$ and second-order in $O_2(g)$.
D. The rate law is Rate = $k[H_2S][O_2]$.
E. The rate law must be determined by experiments.

36. For the reaction A + B + C → products, this initial-rate data were obtained for five experiments.

$[A]_0$ (mol/L)	$[B]_0$ (mol/L)	$[C]_0$ (mol/L)	Initial Rate (mol/(L·s))
0.40	0.40	0.20	0.0160
0.20	0.40	0.40	0.0080
0.60	0.10	0.20	0.0015
0.20	0.10	0.20	0.0005
0.20	0.20	0.40	0.0020

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

A. 0, 1, 1
B. 1, 2, 1
C. 1, 1, 1
D. 1, 2, 0
E. 0, 2, 1

37. Carbon-14, which is present in all living tissue, radioactively decays via a first-order process. A one-gram sample of wood taken from a living tree gives a rate for carbon-14 decay of 13.6 counts per minute. If the half-life for carbon-14 is 5720 years, how old (in years) is a wood sample that gives a rate for carbon-14 decay of 11.9 counts per minute?

Years

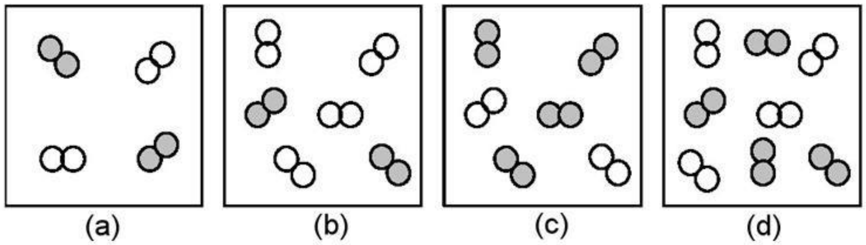
38. The bromination of acetone occurs according to: $CH_3COCH_3 + Br_2 \rightarrow CH_3COCH_2Br + Br^-$ and is catalyzed by H_3O^+. The rate of disappearance of bromine was measured for several different concentrations of acetone, bromine, and H_3O^+ at a certain temperature:

	$[CH_3COCH_3]$	$[Br_2]$	$[H_3O^+]$	Rate of disappearance of $[Br_2]$
1.	0.3	0.05	0.05	$5.7x10^{-5}$
2.	0.3	0.1	0.05	$5.7x10^{-5}$
3.	0.3	0.06	0.10	$1.2x10^{-4}$
4.	0.4	0.05	0.2	$3.1x10^{-4}$
5.	0.4	0.05	0.3	$4.6x10^{-4}$

What is the rate law for the reaction? (Note: make sure to consider H_3O^+ as part of the reaction)

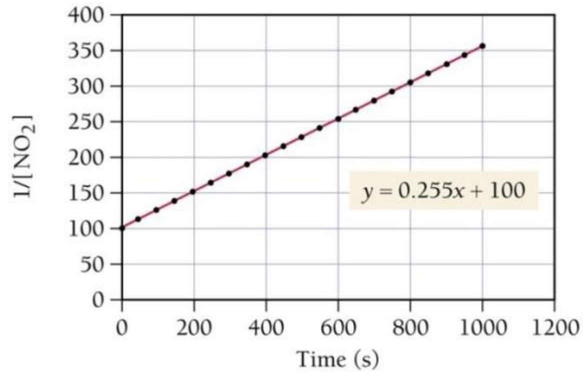
A. Rate = $k[CH_3COCH_3]\,[Br_2]$
B. Rate = $k[CH_3COCH_3]\,[H_3O^+]$
C. Rate = $k[CH_3COCH_3]\,[Br_2]\,[H_3O^+]$
D. Rate = $k[CH_3COCH_3]^2$
E. Rate = $k[CH_3COCH_3]^2\,[H_3O^+]$

39. The relative initial rates of the reaction $A_2 + B_2 \rightarrow$ products in vessels (a)-(d) are 1:1:4:4. Unshaded spheres represent A_2 molecules, and shaded spheres represent B_2 molecules present at the beginning of the reaction. What is the overall order of the reaction?



A. 0
B. 1
C. 2
D. 3

40. Consider the following graph, which depicts the change in the concentration of NO over time.



If the initial concentration of NO_2 is 0.010 M, how long will it take for the NO_2 concentration to decrease to 10.% of its initial concentration?

[ ] s

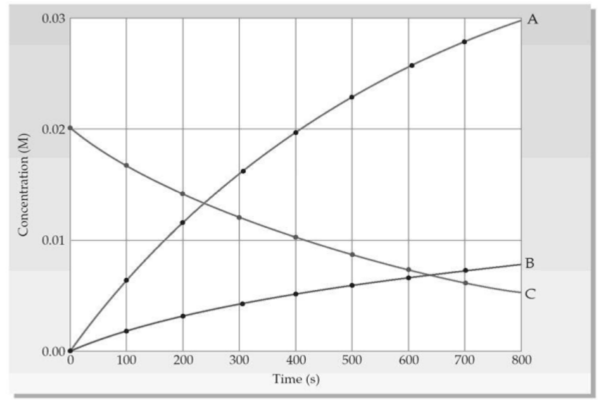
41. In a second order reaction:
   I) the sum of the exponents in the rate law is equal to two.
   II) at least one of the exponents in the rate law is a two.
   III) the half-life is dependent on the initial concentration of the reactant species.
   IV) the half-life is independent of the initial concentration of the reactant species.
   V) *k* can be expressed as $M^{-2}\ s^{-1}$ or $M^{-2}\ min^{-1}$.

[ ]

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

42. Shown is a concentration versus time plot for a reaction involving gases A, B, and C. Which equation best represents the reaction?

A. $4\ A(g) \rightarrow B(g) + 2\ C(g)$
B. $4\ A(g) + B(g) \rightarrow 2\ C(g)$
C. $2\ C(g) \rightarrow 4\ A(g) + B(g)$
D. $2\ C(g) + B(g) \rightarrow 4\ A(g)$



43. The second-order reaction $2\ Mn(CO)_5 \rightarrow Mn_2(CO)_{10}$ has a rate constant equal to 3.0×10^9 L/mol·s at 25 °C. If the initial concentration of $Mn(CO)_5$ is 2.0×10^{-5} mol/L, how long will it take (in seconds) for 90.% of the reactant to disappear?

s

44. A first order reaction is observed to be 87.5% complete in 1200 s. What is the half-life in seconds for this reaction?

[ ] s

45. For question 45, a first-order reaction, how long does it take in seconds to reach 95% completion?

[ ] s

46. Data is collected for the reaction A → B + C, demonstrating a straight line with a positive slope when plotted as 1/[A] vs time. The reaction exhibits (select all the apply, use the letters with no commas):

A. a half-life independent of concentration
B. a half-life inversely proportional to concentration
C. a half-life directly proportional to concentration
D. a half-life proportional to k
E. a half-life inversely proportional to k
F. 0th order kinetics
G. 1st order kinetics
H. 2nd order kinetics

47. Photochemical reactions depend upon the reactants absorbing radiation. Hydrogen and chlorine will react to produce hydrochloric acid if sunlight is present. What is the order of this reaction?

$$H_2\,(g) + Cl_2\,(g) \rightarrow 2\,HCl$$

A. 0th order
B. 1st order
C. 2nd order
D. There is not enough information to determine the reaction order

48. The decomposition of ammonia to nitrogen gas and hydrogen gas on a platinum wire follows zero order reaction kinetics. If the concentration of ammonia is doubled, then the rate of the reaction

A. Stays the same
B. Doubles
C. Quadruples
D. Becomes zero

49. The rate law for the chemical reaction

$$5\,Br^-(aq) + BrO_3^-(aq) + 6\,H^+(aq) \rightarrow 3\,Br_2(aq) + 3\,H_2O(l)$$

has been determined experimentally to be Rate = $k[Br^-][BrO_3^-][H^+]^2$. What is the overall order of the reaction?

A. 1
B. 2
C. 3
D. 4
E. 5

50. At a given temperature, a first-order reaction has a rate constant of $2.5 \times 10^{-3}\ s^{-1}$. How long will it take for the reaction to be 35% complete?

A. 420 s
B. 1600 s
C. 1400 s
D. 74 s
E. 170 s

51. Experiment shows that the reaction below is first order: A $\rightarrow$ P Answer the questions based on the kinetic information in the table.

Time (s)	ln[A]
1.0	–1.659
2.0	–2.209

A. What is the **numerical** value of the rate constant for this reaction?

$\boxed{}$ s^{-1}

B. What was the initial concentration of A?

$\boxed{}$ M

C. What would the concentration of A be after 4.0 seconds?

$\boxed{}$ M

D. What is the half-life (in seconds) for this reaction?

$\boxed{}$ 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 = 2.998×10^8 m/sec
h = 6.626×10^{-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)
$w = -P\Delta V$
$\Delta E = q + w$
$\Delta H° = \Sigma n\Delta Hf°(products) - \Sigma n\Delta Hf°(reactants)$
$\Delta H° = \Sigma n\Delta H°(bonds\ broken) - \Sigma n\Delta H°(bonds\ formed)$
$E=h\nu$
$c=\lambda\nu$
$\lambda = h/mv$

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

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

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

<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]