

Name

KEY

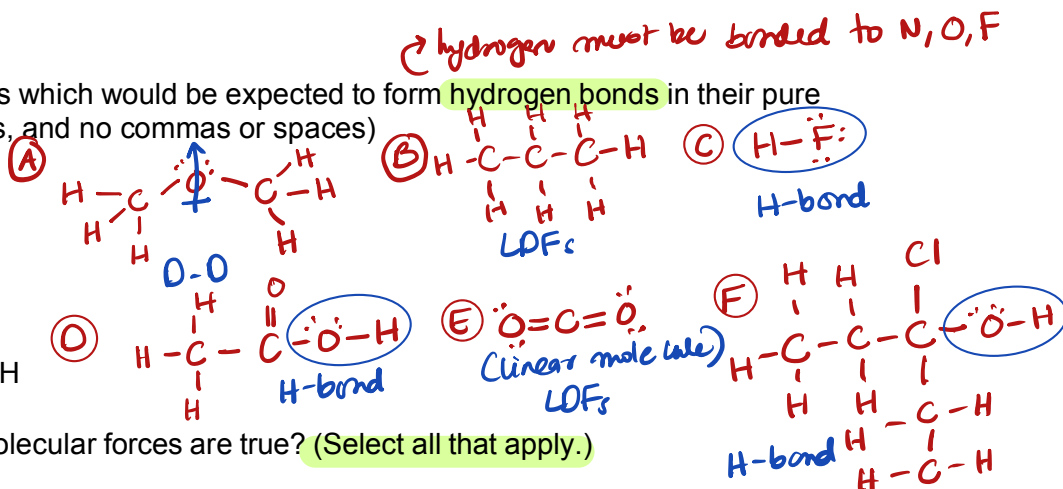
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1. This recitation worksheet is for the exam 1 review.
2. You **do not** need to submit it to Gradescope.
3. The answer key has been posted with this worksheet to eLC.
4. The **recitation in the exam week (February 6-9) is still mandatory**. The attendance will be recorded.

1. Select all the compounds which would be expected to form hydrogen bonds in their pure liquid state: (Answer with letters, and no commas or spaces)

CDF

- A. CH_3OCH_3
 B. C_3H_9 C_3H_8
 C. HF
 D. $\text{CH}_3\text{CO}_2\text{H}$
 E. CO_2
 F. $(\text{C}_2\text{H}_5)_2\text{CClOH}$



2. Which statements about intermolecular forces are true? (Select all that apply.)

BC

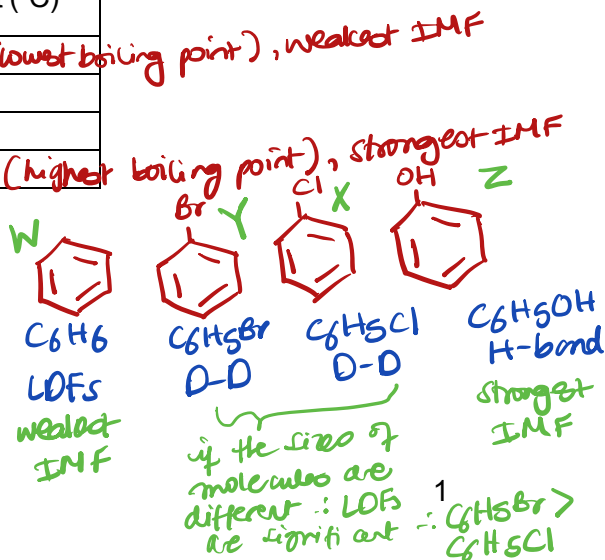
- A. Hydrogen bonding occurs between any molecule that has H ~~X~~ *H must be bonded to N, O, F*
- B. The strength of London dispersion forces depends on the size and the polarizability of an atom or molecule ✓
- C. Dipole-induced dipole interaction occurs between polar and nonpolar molecules ✓
- D. London dispersion forces only occur in nonpolar molecules ~~X~~ *occurs in all molecules*
- E. ionic and covalent interactions are also considered as intermolecular interactions ~~X~~
↓ they are intramolecular forces

3. Boiling points of four different liquids are given below. The possible liquids are C_6H_6 , $\text{C}_6\text{H}_5\text{Br}$, $\text{C}_6\text{H}_5\text{OH}$, and $\text{C}_6\text{H}_5\text{Cl}$. Assign the given compound letter to the corresponding liquid according to their boiling points.

Liquid	Boiling Point (°C)
W	80 (lowest b.p.)
X	132
Y	156
Z	182 (highest b.p.)

D

- A. $W = C_6H_5OH$, $X = C_6H_5Br$, $Y = C_6H_5Cl$, $Z = C_6H_6$
 B. $W = C_6H_5Cl$, $X = C_6H_5Br$, $Y = C_6H_5OH$, $Z = C_6H_6$
 C. $W = C_6H_5OH$, $X = C_6H_5Cl$, $Y = C_6H_6$, $Z = C_6H_5Br$
☒ D. $W = C_6H_6$, $X = C_6H_5Cl$, $Y = C_6H_5Br$, $Z = C_6H_5OH$
 E. $W = C_6H_6$, $X = C_6H_5Br$, $Y = C_6H_5Cl$, $Z = C_6H_5OH$



*Note: when comparing different molecules with LDFs arrange them according to molar mass

4. Which is the correct order of boiling points for BaCl_2 , H_2 , CO_2 , HF , Ne , SO_2 ?

C

- A. $\text{HF} > \text{BaCl}_2 > \text{SO}_2 > \text{CO}_2 > \text{Ne} > \text{H}_2$
- B. $\text{HF} > \text{BaCl}_2 > \text{CO}_2 > \text{SO}_2 > \text{Ne} > \text{H}_2$
- C. $\text{BaCl}_2 > \text{HF} > \text{SO}_2 > \text{CO}_2 > \text{Ne} > \text{H}_2$
- D. $\text{H}_2 > \text{Ne} > \text{CO}_2 > \text{SO}_2 > \text{HF} > \text{BaCl}_2$
- E. $\text{BaCl}_2 > \text{HF} > \text{CO}_2 > \text{SO}_2 > \text{Ne} > \text{H}_2$



① $\text{BaCl}_2 = \text{metal} + \text{non-metal} = \text{ionic compound}$
 ⑥ $\text{H}-\text{H} = \text{diatomic (non-polar) LDFs}$

④ $\ddot{\text{O}} = \text{C} = \ddot{\text{O}} = \text{linear (non-polar) LDFs}$

② $\text{H}-\text{F} = \text{H-bond}$

⑤ $\text{Ne} = \text{LDFs}$

solid

5. Which statement(s) is/are false about viscosity and surface tension? Select all that apply.

BD

- A. Both viscosity and surface tension decrease with increasing temperature ✓
- B. As intermolecular forces increase, viscosity increases but surface tension decreases ✗
- C. Viscosity depends on molecular size and shape ✓
- D. Ethylene glycol ($\text{HOCH}_2\text{CH}_2\text{OH}$) has lower surface tension and viscosity compared to water ✗
- E. All the above statements are false

6. Rank the compounds in order of increasing viscosity. viscosity is related to the strength of IMF. the stronger the IMF the higher the viscosity & vice versa

E < B < C < D < A

- A. $\text{HOCH}_2\text{CH}_2\text{OH}$ LDFs, O-O, H-bond
- B. CH_3OCH_3 LDF, O-O
- C. $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$ LDF, O-O
- D. $\text{CH}_3\text{CH}_2\text{OH}$ H-bond
- E. C_2H_6 LDF only

7. CCl_4 is a non-polar (nonpolar/polar) molecule which has London dispersion forces (London dispersion forces/ dipole-dipole interactions) as intermolecular interactions.

CHCl_3 is polar (nonpolar/polar) molecule which has dipole-dipole interactions (London dispersion forces/dipole-dipole interaction/ both London dispersion and dipole-dipole interactions).

The boiling point of CCl_4 is higher (higher/lower) than the boiling point of CHCl_3 because the

London dispersion forces are stronger (stronger/weaker) in CCl_4 due to the higher (higher/lower) molar mass of a CCl_4 than CHCl_3 .

8. Which of these describes the changes in forces of attraction that occur as H_2O changes phase from a liquid to a vapor?

B

- A. H—O bonds break as H—H and O—O bonds form in phase change IMFs are broken not bonds
- B. Hydrogen bonds between H_2O molecules are broken ✓
- C. Covalent bonds between H_2O molecules are broken ✗
- D. Ionic bonds between H^+ ions and OH^- ions are broken ✗
- E. Covalent bonds between H^+ ions and H_2O molecules become more effective ✗

9. Under what conditions does capillary action occur?

→ capillary action depends on the balance between cohesive forces (IMFs between liquid molecules) & adhesive forces (IMFs between liquid & the surface of a tube as an example)

C

- A. When the cohesive forces are greater than the adhesive forces
 B. When the cohesive and adhesive forces are equal
 C. When the cohesive forces are weaker than the adhesive forces
 D. All of the answers are correct
 E. None of the answers are correct

If adhesive forces > cohesive forces then capillary action occurs

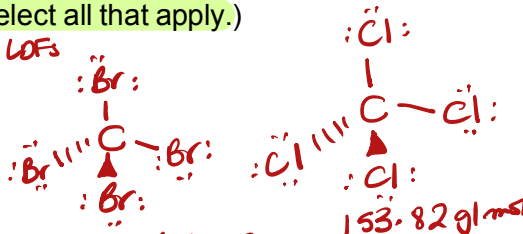
10. Which statement(s) below are correct regarding CBr_4 and CCl_4 ? (Select all that apply.)

BD

- A. CBr_4 is more volatile than CCl_4 X
 B. CBr_4 has a higher boiling point than CCl_4 ✓
 C. CBr_4 has weaker intermolecular forces than CCl_4 X
 D. CBr_4 has a lower vapor pressure than CCl_4 ✓
 E. All the above statements are correct

Both molecules are non-polar (tetrahedral geometry) - both have LDFs

$\text{CBr}_4 > \text{CCl}_4$ LDFs



larger molecule ∴ ↑ strength of LDFs

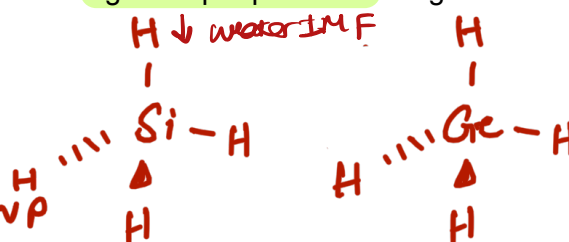
11. Select the pair of compounds in which the substance with the higher vapor pressure at a given temperature is listed first

VP = vapor pressure

B

- A. C_7H_{16} and C_5H_{12}
 B. SiH_4 and GeH_4
 C. H_2O and H_2S (H-S bonds are non-polar)
 D. $\text{CH}_3\text{CH}_2\text{OH}$ and H_3COCH_3

$\text{Ge} > \text{Si}$ in atomic size ∴ weaker LDF in $\text{SiH}_4 = \uparrow \text{VP}$



12. The heat of vaporization of hexane is 30.8 kJ/mol. The boiling point of hexane at a pressure of 1.00 atm is 68.9 °C. What is the boiling point in K at a pressure of 0.50 atm? Keep 2 significant figures.

320 K

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

$\Delta H_{\text{vap}} = 30.8 \text{ kJ/mol}$
 $P_1 = 1.00 \text{ atm}$
 $T_1 = 68.9^\circ\text{C} + 273.15 = 342.1 \text{ K}$
 $P_2 = 0.50 \text{ atm}$
 $T_2 = ?$

$$\ln(0.50) = \frac{3.08 \times 10^4 \text{ J/mol}}{8.314 \text{ J/mol}\cdot\text{K}} \left(\frac{1}{342.1} - \frac{1}{T_2}\right)$$

$$\frac{1}{T_2} = \frac{1}{342.1} - \frac{(\ln 0.50 - \ln 1.00) \times 8.314 \text{ J/mol}\cdot\text{K}}{3.08 \times 10^4 \text{ J/mol}}$$

$$\frac{1}{T_2} = 3.11022662 \times 10^{-3} \text{ K}^{-1} \therefore T_2 = 321.151997 \text{ K} \approx 320 \text{ K}$$

13. What is the heat of vaporization of a compound that has a vapor pressure of 120 mm Hg at 12.3 °C and a vapor pressure of 250 mm Hg at 43.6 °C?

E

- A. 12.28 kJ/mol
 B. 25.2 kJ/mol
 C. 11.32 kJ/mol
 D. 43.6 kJ/mol
 E. 17.62 kJ/mol

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

$\Delta H_{\text{vap}} = ?$
 $P_1 = 120 \text{ mmHg}$
 $T_1 = 12.3 + 273.15 = 285.5 \text{ K}$
 $P_2 = 250 \text{ mmHg}$
 $T_2 = 43.6 + 273.15 = 316.8 \text{ K}$

$$\ln\left(\frac{250}{120}\right) = \frac{\Delta H_{\text{vap}}}{8.314 \text{ J/mol}\cdot\text{K}} \left(\frac{1}{285.5} - \frac{1}{316.8}\right)$$

$$\therefore \Delta H_{\text{vap}} = \frac{(\ln 250 - \ln 120) \times 8.314 \text{ J/mol}\cdot\text{K}}{\left(\frac{1}{285.5} - \frac{1}{316.8}\right)} = 1.7633348 \times 10^4 \text{ J/mol} \approx 17.63 \text{ kJ/mol}$$

14. Equilibrium vapor pressure of benzene (C_6H_6) at various temperatures are given below.
Keep 3 significant figures.

Temperature ($^{\circ}C$)	Vapor Pressure (mmHg)
7.6	40.
26.1	100.
60.6	400.
80.1	760.

$1 \text{ torr} = 1 \text{ mmHg}$

- A. What is the **normal boiling point** of benzene? \rightarrow temperature at which the vapor pressure of benzene is 760 torr or 760 mmHg or 1 atm

80.1 $^{\circ}C$

$$\Delta H_{\text{vap}} = ? \quad P_1 = 760 \text{ mmHg}, T_1 = 353.3 \text{ K}, P_2 = 400 \text{ mmHg}, T_2 = 333.8 \text{ K}$$

- B. Calculate the molar enthalpy of vaporization of benzene in kJ/mol using the normal boiling point and the vapor pressure value of 400. mmHg at 60.6 $^{\circ}C$. *using the clausius-clapeyron equation*

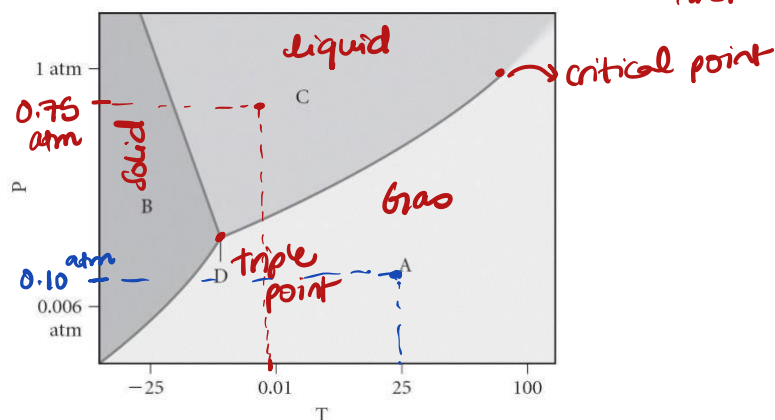
32.3 kJ/mol

$$\ln\left(\frac{400.}{760.}\right) = \frac{\Delta H_{\text{vap}}}{8.314 \frac{\text{J}}{\text{mol} \cdot \text{K}}} \left(\frac{1}{353.3} - \frac{1}{333.8}\right)$$

$$\therefore \Delta H_{\text{vap}} = 3.2273164 \times 10^4 \frac{\text{J}}{\text{mol}}$$

$$\sim 32.3 \frac{\text{kJ}}{\text{mol}}$$

15. Assign the appropriate labels to the phase diagram shown below.

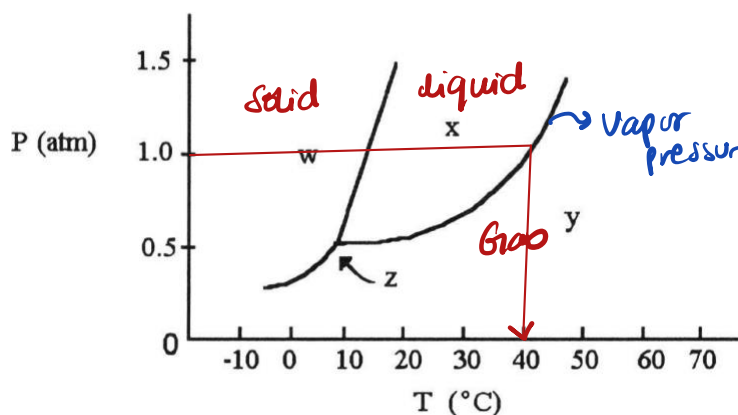


B

- A. A = liquid, B = solid, C = gas, D = critical point
B. A = gas, B = solid, C = liquid, D = triple point
 C. A = gas, B = liquid, C = solid, D = critical point
 D. A = solid, B = gas, C = liquid, D = triple point
 E. A = liquid, B = gas, C = solid, D = critical point

16. Refer to the phase diagram in question 15. If you start at 0.75 atm and 0 $^{\circ}C$, and move to 0.10 atm and 25 $^{\circ}C$, you will move from the **liquid** phase to the **gas** phase.

17. According to the phase diagram shown below, what is the normal boiling point in °C?



↓ temperature a liquid when
the vapor pressure = 1 atm
↓ determined from the
vapor pressure curve
(vaporization curve)

D

- A. 10
- B. 20
- C. 30
- ☒ D. 40
- E. 50

18. Match the items below with each of the following statements:

I. Covalent network solids

II. Metals

III. Intermolecular forces

IV. Ionic bonding

BE

A

C

DE

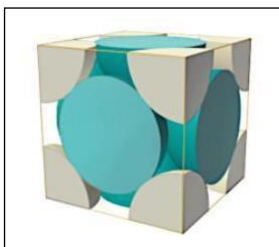
- A. High mobility of electrons throughout the solid
- B. Network of covalent bonds
- C. Attractive forces that exist in molecular crystals
- D. Type of bonding in CaI_2
- E. High melting point and poor electrical conductivity

19. Which of these forms a molecular solid?

B

- A. CaO Ionic
- ☒ B. $\text{C}_{10}\text{H}_{22}$
- C. C, graphite covalent network
- D. Gold metallic

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



FCC



BCC



Simple cubic

21. Match the terms below with the statements.

(Crystalline solids CS, Amorphous solids AS, Unit cell UC, Crystal lattice CL, Body centered cubic BCC, Face centered cubic FCC, Simple cubic SC) (Answer with the letters not the names).

A. A cubic unit cell has four atoms per unit cell: FCC

B. The smallest repeating unit in the crystal lattice: UC

C. A unit cell that has an atom in the body: BCC

D. NaCl and Glucose belong to this category: CS

E. The atoms in this unit cell have a coordination number of 6: SC

22. Which of the ionic compound would you expect to have the highest melting point? *depends on the magnitude of lattice energy (the ↑ the lattice energy the ↑ the melting point)*

C

- A. $\overset{+1}{\text{K}}\overset{-1}{\text{Br}}$
- B. $\overset{+1}{\text{Li}}\overset{-1}{\text{F}}$
- C. $\overset{+2}{\text{Mg}}\overset{-2}{\text{O}}$
- D. $\overset{+1}{\text{Na}}\overset{-1}{\text{Cl}}$
- E. $\overset{+2}{\text{Ca}}\overset{-1}{\text{Cl}}_2$

↓
determined by

↓
magnitude of ionic charges (more important)

↓
ionic size

23. What type of solid will each of the substances form in its solid state? Choices to consider are metallic, ionic, network, or molecular solids.

Molecular

A. C_3H_9 *Forms MOE when it crystallizes*

Ionic

B. MgO *(metal + non-metal = ionic compound)*

Metallic

C. Fe *(Group 8)*

network

D. C (diamond)

Ionic

E. NaNO_3 *(metal + non-metal = ionic compound)*

Metallic

F. Al

Chapter 12 – Chemical Kinetics



24. The average rate of disappearance of A_2 in the reaction $A_2 + B_3 \rightarrow AB_2$ (unbalanced) is found to be 0.235 M/s over a certain interval of time. What is the rate of disappearance of B_3 during this interval?

0.313

$$\text{M/s } 4 \times -\frac{1}{3} \frac{\Delta[A_2]}{\Delta t} = -\frac{1}{4} \frac{\Delta[B_3]}{\Delta t} \times 4$$

$$\therefore \frac{\Delta[B_3]}{\Delta t} = \frac{4}{3} \frac{\Delta[A_2]}{\Delta t} = \frac{4}{3} \times 0.235 = 0.313 \text{ M/s}$$

25. For the reaction $3A + 5B \rightarrow 3C + 2D$, at a particular instant in time, the rate of change of C is 0.0566 M/s. What is the rate of change of B?

-0.0943

$$\text{M/s } 5 \times -\frac{1}{5} \frac{\Delta[B]}{\Delta t} = \frac{1}{3} \frac{\Delta[C]}{\Delta t} \times 5$$

$$-\frac{\Delta[B]}{\Delta t} = \frac{5}{3} (0.0566) = -0.0943 \text{ M/s}$$

↓ sign is very important when we calculate the rate of change but for appearance/disappearance or production/consumption the sign is not included

26. Consider the following rate law: $\text{Rate} = k[A]^m[B]^n$. How are the exponents m and n determined?

E

- A. by using the balanced chemical equation
- B. by using the subscripts for the chemical formulas
- C. by using the coefficients of the chemical formulas
- D. by educated guess
- E. by experiment

↓ m is the order of the reaction with respect to A
n is the order of the reaction with respect to B
Reaction orders can only be determined experimentally

$$\text{Rate} = k[A]^v[B]^w[C]^x$$

27. For a reaction $A + B + C \rightarrow P$, the following initial rate data were obtained:

① order of the reaction with respect to B (reactions I & II)
First order with respect to B $\therefore w = 1$

② order of the reaction with respect to A (II & III)
First order with respect to A $\therefore v = 1$

	A	B	C	rate
I	0.10 M	0.10 M	0.10 M	0.15 M/sec
II	0.10 M	0.20 M	0.10 M	0.30 M/sec
III	0.20 M	0.20 M	0.10 M	0.60 M/sec
IV	0.40 M	0.20 M	0.20 M	1.20 M/sec

③ to determine C (using reactions III & IV)

$$\frac{\text{Rate of IV}}{\text{Rate of III}} = \frac{k[A]_V[B]_V[C]^x}{k[A]_{III}[B]_{III}[C]_{III}^x}$$

$$\frac{1.20}{0.60} = \frac{[0.40][0.20][0.20]^x}{[0.20][0.20][0.10]^x}$$

$$1 = 2^x$$

taking log of both sides

$$\log 1 = x \log 2$$

$$\therefore x = 0$$

A. What is the rate law? Rate =

$$k[A]^1[B]^1[C]^0 = k[A][B]$$

Strategy for steps 1: choose 2

Experiments where the concentrations of A & C do not change & track the change in rate so you choose the one of B

B. What is the order of this reaction? (answer 0, 1, or 2)

2

Add the orders with respect to each reactant = 1 + 1 + 0 = 2

C. What is the unit of the rate constant k?

$M^{-1} s^{-1}$

$$k = \frac{\text{Rate}}{[A][B]} = \frac{\frac{M}{s}}{M \cdot M} = M^{-1} s^{-1}$$

D. What is the numerical value of k?

15

Using reaction IV

$$k = \frac{1.20 \text{ M/sec}}{[0.40][0.20]} = 15 \text{ M}^{-1}\text{s}^{-1}$$

28. The rate expression for a particular reaction is $\text{rate} = k[A]^2[B]^3$. If the initial concentration of B is increased from 0.1 M to 0.2 M, the initial rate will increase by which of these factors?

D

- A. 2
- B. 3
- C. 6
- ☒ D. 8
- E. 9

$$\frac{\text{Rate 2}}{\text{Rate 1}} = \frac{k[A]^2[0.2]^3}{k[A]^2[0.1]^3}$$

$$\frac{\text{Rate 2}}{\text{Rate 1}} = \frac{8}{1}$$

$$\text{Rate 2} = 8 \times \text{Rate 1}$$

29. The reaction $3A + 4B \rightarrow P$ is second order in A and first order in B. What is the rate law for this reaction?

$$\text{Rate} = k[A]^2[B]$$

30. The reaction $A \rightarrow P$ is first order. The rate constant k is 0.21 s^{-1} . If the concentration of A is 0.45 M at the end of 45 seconds, what is the initial concentration of A? Keep 2 significant figures.

5700

M

$$\ln[A]_t = -kt + \ln[A]_0$$

$$\ln[0.45] = -0.21(45) + \ln[A]_0$$

$$-7.985 = -9.45 + \ln[A]_0$$

$$\ln[A]_0 = 8.6514$$

$$[A]_0 = e^{8.6514}$$

$$[A]_0 = 5718.6743$$

31. A first-order reaction has 25% reactant left at the end of 50 seconds. Keep 2 significant figures.

A. What is the length of the half-life of this reaction?

25

Seconds

$$t_{1/2} = \frac{\ln 2}{k} \quad \text{you need to determine k first}$$

$$\textcircled{1} [A]_t = 0.25 \quad [A]_0 = 1.0 \quad t = 50 \text{ sec}$$

$$\ln \frac{[A]_t}{[A]_0} = -kt \quad \therefore \ln \left(\frac{0.25}{1.0} \right) = -k(50)$$

$$k = 0.027726$$

$$\textcircled{2} t_{1/2} = \frac{\ln 2}{0.027726} = 25 \text{ sec}$$

B. For the reaction above, if the initial concentration is 0.44 M, what is the concentration after 90 seconds?

0.036

M

$$\ln[A]_t = -kt + \ln[A]_0$$

$$\ln[A]_t = -0.027726(90) + \ln[0.44]$$

$$\ln[A]_t = -3.31631$$

$$[A]_t = 0.0363 \text{ M}$$

32. A first-order reaction has 1/3 reactant left at the end of 60 seconds. What is the length of the half-life of this reaction? Keep 2 significant figures. ① Determine the value of k

38

Seconds

$$\ln [A]_t = -kt + \ln [A]_0$$

$$\ln \left[\frac{1}{3} \right] = -k(60) + \ln [1]$$

$$k = 0.01831020481$$

② Calculate the half-life of the reaction

$$t_{1/2} = \frac{\ln 2}{k} \rightarrow t_{1/2} = \frac{\ln 2}{0.01831020481}$$

$$\therefore t_{1/2} = 37.8557 \sim 38 \text{ seconds}$$

33. Experiment shows that the reaction below is first order: $A \rightarrow P$

Answer the questions based on the kinetic information in the table. Keep 2 significant figures.

You can consider this as the initial concentration

this can be as the concentration at time t

Time (s)	$\ln[A]$
1.0	-1.659
2.0	-2.209

$\ln [A]_t = -kt + \ln [A]_0$
below are the values for the natural log of reactant 'A' \therefore you can plug them directly into the equation

0.55 s⁻¹

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

$$-2.209 = -k(1.0) + (-1.659) \leftarrow$$

$$k = 0.55 \text{ s}^{-1}$$

$$\ln [A]_{2.0} = -k(2.0 - 1.0) + \ln [A]_{1.0}$$

0.33

M

B. What was the initial concentration of A?

$$\ln [A]_t = -kt + \ln [A]_0$$

$$-2.209 = -0.55(2) + \ln [A]_0$$

$$\ln [A]_0 = -1.109$$

$$[A]_0 = 0.32988868 \sim 0.330 \text{ M}$$

0.037

M

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

$$\ln [A]_t = -0.55(4) + \ln [0.330]$$

$$\ln [A]_t = -3.30866$$

$$[A]_t = e^{-3.30866} = 0.036566 \text{ M}$$

$$\sim 0.037 \text{ M}$$

1.3

Sec.

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

$$t_{1/2} = \frac{\ln 2}{k} = \frac{\ln 2}{0.55} = 1.260267 \text{ sec}$$

$$\sim 1.3$$

34. The kinetics of the reaction $2A \rightarrow P$ is studied. It is in second order and the rate constant is $0.132 \text{ M}^{-1}\text{s}^{-1}$. If the initial concentration of A is 0.50 M , what is the concentration of A at the end of 3 minutes? Keep 2 significant figures.

0.039

M

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

$$\frac{1}{[A]_t} = 0.132 \text{ M}^{-1}\text{s}^{-1} \left(3 \text{ min} \times \frac{60 \text{ s}}{1 \text{ min}} \right) + \frac{1}{[0.50]}$$

$$\frac{1}{[A]_t} = 25.76 \rightarrow \text{taking the reciprocal of } \frac{1}{[A]_t}$$

$$\therefore [A]_t = 0.0388199 \sim 0.039 \text{ M}$$

35. The reaction $A \rightarrow B + C$ is second order in A. When $[A]_0 = 0.300 \text{ M}$, the reaction is 40.0% complete in 45.0 minutes. Calculate the value of the rate constant. Keep 3 significant figures.

0.0494

$$M^{-1}min^{-1} \quad \frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$$

$$\frac{1}{[0.180]} = k(45) + \frac{1}{[0.300]}$$

$$k = 0.04938 \sim 0.0494 \text{ M}^{-1} \text{ min}^{-1}$$

means that 60.0% of A is left after 45.0 minutes
 $\therefore [A]_t = 0.300 \times \frac{60.0}{100} = 0.180 \text{ M}$

36. The reaction $A \rightarrow B + C$ is known to be zero order in A with a rate constant of 0.033 M/s at 25°C . An experiment was run at 25°C where $[A]_0 = 0.95 \text{ M}$. Keep 2 significant figures.

0.29

M

A. What is $[A]$ after 20 seconds?

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

$$[A]_t = -0.033(20) + 0.95 = 0.29 \text{ M}$$

0.66

M

B. What is $[B]$ after 20 seconds?

Starting conc of reactant A = 0.95 M

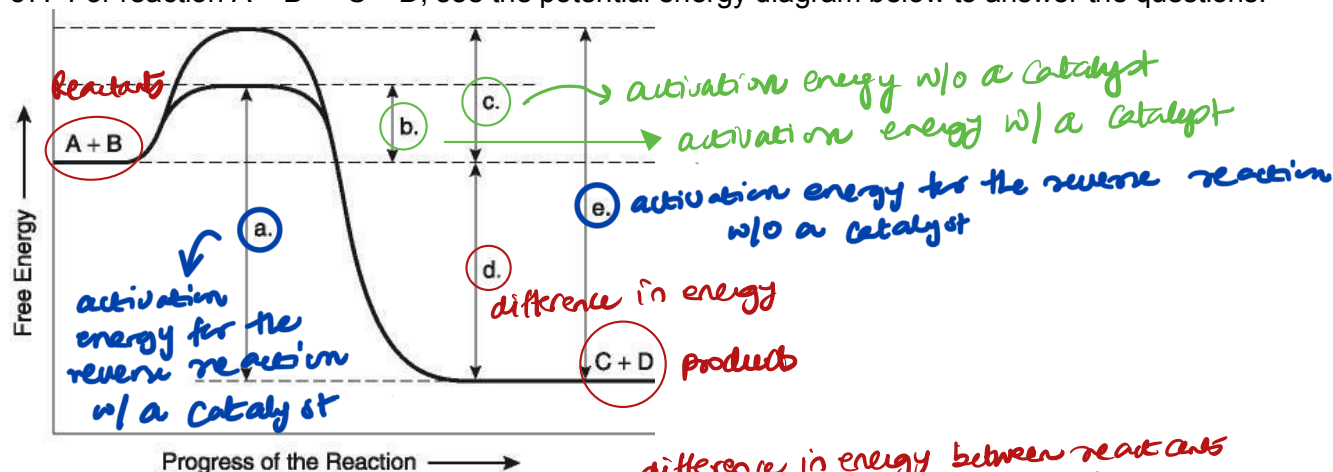
conc of A after 20 sec = 0.29 M

$$\therefore \Delta[A] = 0.95 - 0.29 \text{ M}$$

$$\Delta[B] = \Delta[A] \times \frac{1 \text{ mol B}}{1 \text{ mol A}}$$

$$= 0.66 \times \frac{1}{1} = 0.66 \text{ M}$$

37. For reaction $A + B \rightarrow C + D$, see the potential energy diagram below to answer the questions:



d

A. Which letter shows the change in energy for the overall reaction?

c

B. Which letter shows the activation energy without a catalyst?

b

C. Which letter shows the activation energy with a catalyst?

↓
 Catalysts lowers activation energy by providing an alternative mechanism in which the rate-determining step has a lower activation energy

38. Determine the activation energy for the reaction. Keep 2 significant figures.

Temperature (°C)	Rate Constant (M ⁻¹ s ⁻¹)
330	0.98
550	1.60

E_a =

9200

J

Text

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

$$\ln\left(\frac{1.60}{0.98}\right) = \frac{E_a}{8.314} \left(\frac{1}{603} - \frac{1}{823} \right)$$

$$E_a = \frac{(\ln 1.60 - \ln 0.98) \times 8.314}{\left(\frac{1}{603} - \frac{1}{823} \right)}$$

$$= 9193.55 \text{ J}$$

$$\sim 9200 \text{ J}$$