EmSAT Achieve Chemistry

Public Test Specification

Test Description: EmSAT Achieve Chemistry assesses the extent to which the test taker is ready to study chemistry at the college or university level. It is a computer-based exam where test sections, questions, and options are randomized. The tests are timed by the computer. Test-takers can see how much time they have throughout the exam.

Test Duration:	90 minutes
Questions:	50 questions
Content Areas:	Matter and its properties Energy, force, and conservation
Task Types:	Multiple Choice, Multi-select, Fill-in the-Blank, and Drag and Drop

EmSAT Achieve Chemistry	
Score	**Score Descriptors**
1500+	Demonstrates comprehensive knowledge in general Chemistry. Understands related concepts, laws and principles. Evaluates quantitative and qualitative data thoroughly. Understands complex models and makes appropriate predictions. Solves most quantitative and qualitative problems skillfully.
1300 – 1475	Demonstrates very broad knowledge in general Chemistry. Understands related concepts, laws and principles. Very competently evaluates quantitative and qualitative data. Solves familiar problems and most new quantitative and qualitative problems.
1100 – 1275	Demonstrates broad knowledge in general Chemistry. Shows sound understanding of most concepts and applies them in some contexts. Analyzes quantitative and qualitative data competently. Solves most basic and familiar problems and some new problems.
900 – 1075	Demonstrates reasonable knowledge in general Chemistry. Shows adequate comprehension of most basic concepts but with limited ability to apply them. Demonstrates some analysis or evaluation of quantitative and qualitative data. Solves some basic or routine problems but shows limited ability to deal with new or difficult situations.
700 – 875	Demonstrates limited knowledge in general Chemistry. Shows a partial comprehension of basic concepts but a weak ability to apply them. Shows some ability to manipulate data and solve basic or routine problems.
500 – 675	Demonstrates little knowledge in general Chemistry. Shows weak comprehension of basic concepts with little evidence of application. Has minimal ability to manipulate data and little ability to solve problems.
< 500	Demonstrates almost no knowledge in general Chemistry. Shows no or very weak understanding of any concepts or principles. Gives responses that are mostly incomplete or unrelated.

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Appendix 1: Content Areas

Content Area 1: Matter and its properties (55% – 65%)

- Meaning of what chemistry is and its scope
- Scientific process
- Units of measurement and conversion between them
- Sources errors and uncertainty in measurements
- Classification of matter
- Changes of matter
- Atomic theories
- Atomic structure
- Atomic spectra and their applications
- Atomic composition
- Periodic table and how elements properties determined based on their locations
- Periodicity
- Volume, temperature, pressure, and amount of a gas
- Relationships among the four quantities of a gas and their calculations
- Characteristics of solutions and factors affecting solubility
- Properties of solutions (qualitatively and quantitively)
- Electronic composition of the carbon atom
- Diversity of organic compounds in terms of shape, size, and chemical and physical properties
- Classifications of organic compounds in terms of functional groups
- Types of organic reactions and their applications

Content Area 2: Energy, force and conservation (35% – 45%)

- Ionic, polar, and nonpolar covalent bonds
- Shapes of molecules
- The concept of the mole and its applications (stoichiometry)
- Percent composition of a compound
- Empirical and molecular formulas of a compound
- Percent yield
- Acids and bases (strong and weak)
- The concept and use of pH scale
- The concept of neutralization (titration)
- Common ion effect, buffer solutions, and solubility
- Meaning of oxidation and reduction, redox reactions, and activity series
- Redox reactions to produce electricity and manufacture electrolytic and galvanic cells
- Factors affecting the reaction rate
- Chemical equilibrium
- Energy changes during chemical reactions and/or physical changes
- Hess's law and how it can be used to predict the occurrence of the chemical reaction

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Appendix 2: Sample Items

1. Compared to the charge of a proton, the electron charge is

مقارنة بشحنة البروتون، فإن شحنة الإلكترون تكون

A. equal and of opposite sign — مساوية وذات إشارة معاكسة

B. smaller and of opposite sign — أصغر وذات إشارة معاكسة

C. greater and of the same sign — أكبر ولها نفس الإشارة

D. equal and of the same sign — مساوية ولها نفس الإشارة

2. Chlorine atom is in an excited state. When an electron in this atom jumps from the fourth to the third shell, energy is _____ .

ذرة كلور في حالة مستثارة. عندما يتحرك إلكترون في هذه الذرة من مستوى الطاقة الرابع إلى مستوى الطاقة الثالث، فإن الطاقة تكون قد _____ .

A. released — انبعثت

B. absorbed — امتصت

C. disappeared — اختفت

D. converted to electricity — تحولت إلى كهرباء

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Appendix 2: Sample Items

3. One of the most important properties of mixtures is that they _____ .

واحدة من أهم خصائص المخاليط _____.

A. may have different proportions of their components — يمكن أن يكون لديها نسب مختلفة من مكونتها

B. have fixed proportions of their components — ذات نسب تركيب ثابتة

C. can be separated only by chemical means — لا يمكن فصلها إلا بالوسائل الكيميائية

D. are very reactive and unstable — تكون نشطة وغير مستقرة

4. The statements below explain why magnesium is preferred over zinc to protect underground iron pipes in terms of reactivity **except** for _____ .

توضح العبارات أدناه لماذا يفضل المغنيسيوم على الزنك لحماية أنابيب الحديد تحت الأرض من حيث التفاعلية **باستثناء** العبارة _____.

A. Zinc is more active than magnesium — الزنك هو أكثر نشاطا من المغنيسيوم

B. Magnesium atoms lose electrons more easily than zinc atoms — تفقد ذرات المغنيسيوم الإلكترونات بسهولة أكبر من ذرات الزنك

C. Magnesium oxidized more readily than zinc — المغنيسيوم يتأكسد بسهولة أكبر من الزنك

D. Magnesium is more active than zinc — المغنيسيوم هو أكثر نشاطا من الزنك

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Appendix 2: Sample Items

5. Calculate the mass percent of aluminum in the compound below.

(Round your answer to the nearest whole number)

ما نسبة الكتلة المئوية للألمنيوم في المركب أدناه.

(قرب إجابتك إلى أقرب عدد صحيح)

$$Al_2(SO_4)_3$$

Answer = _____ % = الإجابة

6. Which of the following equations represents sublimation?

ما المعادلة التي تمثل عملية التسامي؟

A. $CO_2(s) \rightarrow CO_2(g)$

B. $Hg(l) \rightarrow Hg(s)$

C. $CH_3OH(g) \rightarrow CH_3OH(l)$

D. $CH_4(l) \rightarrow CH_4(g)$

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Appendix 2: Sample Items

7. Given the equation representing a nuclear reaction in which X represents a nuclide:

بالنظر إلى معادلة التفاعل النووي الذي تمثل فيه X نواه لعنصرٍما:

$$^{235}_{92}U + ^{1}_{0}n \rightarrow X$$

Which nuclide is represented by X?

ما هي النواة X؟

A. $^{236}_{92}U$

B. $^{234}_{92}U$

C. $^{235}_{93}Np$

D. $^{236}_{92}Np$

8. Which of the following terms used as a measure of the average kinetic energy of the particles in a sample?

أي من المصطلحات التالية يُستخدم كمقياس لمتوسط الطاقة الحركية للجسيمات في عينةٍ ما ؟

A. temperature درجة الحرارة

B. pressure الضغط

C. volume الحجم

D. chemical energy الطاقة الكيميائية

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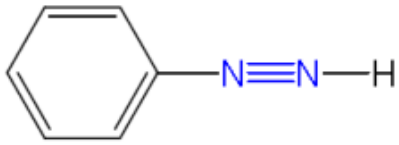
Appendix 2: Sample Items

9. What is the total number of electrons shared in the bonds between the two nitrogen atoms in the following molecule

ما عدد الإلكترونات المشتركة في الروابط بين ذرتي النيتروجين في المركب أدناه



A. 6

B. 2

C. 3

D. 8

10. An elevator at shopping mall has a maximum load of 1600 *lb*.

How many 75 *kg* persons can use the elevator at the same time?
(1 *lb* = 0.45359237)

مصعد في مركز للتسوق حمولته القصوى تبلغ 1600 *lb*

كم عدد الأشخاص الذين يمكنهم استخدام المصعد في آن واحد إذا افترضنا أن متوسط كتلة الشخص هي 75 *kg* ؟
(1 *lb* = 0.45359237)

Answer = [ ] = الإجابة

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Appendix 2: Sample Items

11. The gold foil experiment led to the discovery of the _____ .

أدت تجربة رقاقة الذهب إلى اكتشاف _____.

A. nucleus — النواة
B. neutron — النيوترون
C. electron — الإلكترون
D. cathode ray — اشعة المهبط

12. Which particles are found in the nucleus of an atom?

ما المكونات الموجودة في نواة الذرة؟

A. protons and neutrons — البروتونات والنيوترونات
B. protons and electrons — البروتونات والإلكترونات
C. neutrons and electrons — النيوترونات والإلكترونات
D. protons — البروتونات

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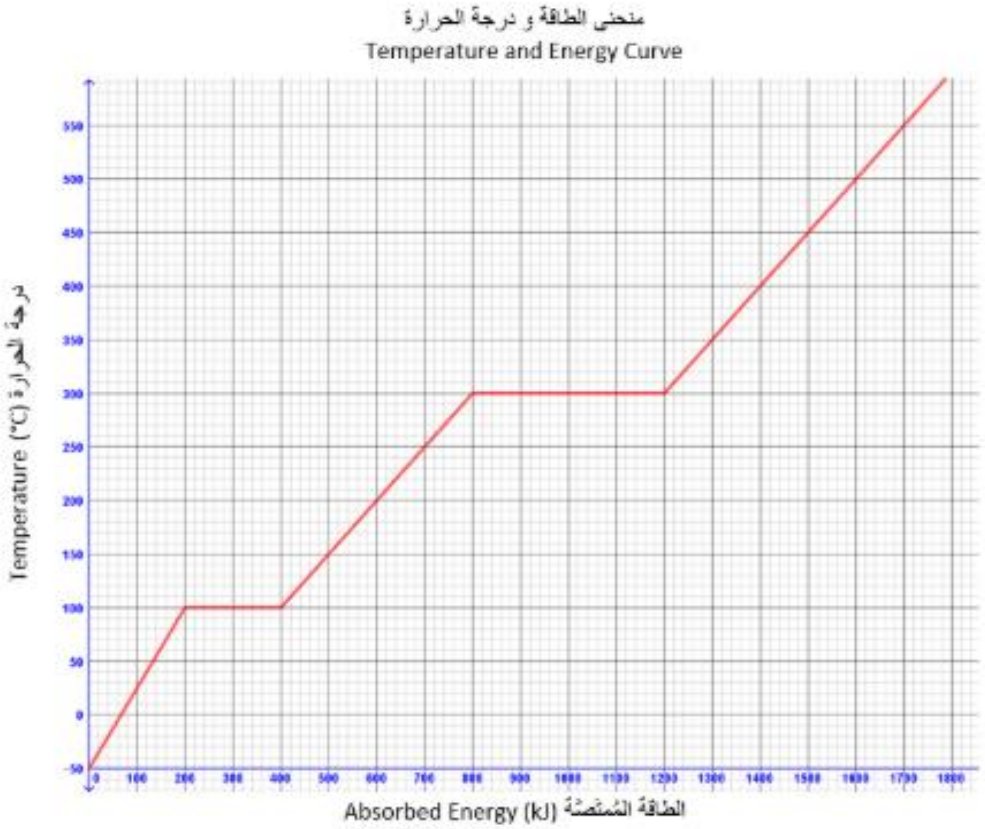
Appendix 2: Sample Items

13.

The below graph for a substance being heated from −50 °C to 600 °C .

الرسم البياني أدناه يمثل عملية تسخين ماده من −50 °C إلى 600 °C



If 600 *kJ* of heat are removed from the substance when it is at 350 °C, what will be the state and temperature of the substance?

تم تبريد الماده عن طريق سحب ما مقداره 600 *kJ* من الحراره عندما كانت درجة حرارتها 350 °C ما حاله الماده الفيزيائية و درجة حرارتُها؟

A. liquid at 250°C — سائله عند 250°C

B. gas at 250 °C — غازيه عند 250 °C

C. solid at 200 °C — صلبة عند 200 °C

D. liquid at 200 °C — سائله عند 200 °C

14. The equilibrium constant *K* for the following reaction is $1.5 \times 10^{+5}$

إذا علمت أن ثابت الإتزان K للتفاعل أدناه يساوي $1.5 \times 10^{+5}$

$$X \rightleftharpoons Y$$

Based on the above information, the reaction at equilibrium will **always** have _____ .

استنادا إلى المعلومات المذكورة أعلاه، التفاعل عند الإتزان سوف يكون **دائماً** لديه _____.

A. large amount of product Y — كمية كبيرة من المادة الناتجة Y

B. large amount of reactant X — كمية كبيرة من المادة المتفاعلة X

C. 75% product of Y and 25% reactant X — 75% من المادة الناتجة Y و25% من المادة المتفاعلة X

D. 50% product of Y and 50% reactant X — 50% من المادة الناتجة Y و50% من المادة المتفاعلة X

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15. A student conducted a titration by adding 12.0 *mL* of $NaOH(aq)$ of unknown concentration to 16.0 *mL of* 0.15 *M* $HCl(aq)$.

What is the molar concentration of the $NaOH(aq)$?

أجرى طالب عملية المعايرة بإضافة 12.0 *mL* من محلول $NaOH(aq)$ غير معروف التركيز إلى 16.0 *mL* من محلول $HCl(aq)$ الذي تركيزه 0.15 *M*

ما تركيز $NaOH(aq)$؟

A. 0.2 M

B. 2.0 M

C. 0.15 M

D. 2.4 M

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Appendix 2: Sample Items

Item	Key
1	A
2	A
3	A
4	A
5	16
6	A
7	A
8	A
9	A
10	9
11	A
12	A
13	A
14	A
15	A

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Appendix 3: Formulas

Common Units: الوحدات الشائعة

الرمز Symbol	إسم الوحدة Name	الكمية Quantity
m	meter	Length طول
g	gram	Mass كتلة
Pa	Pascal	Pressure ضغط
K	kelvin	Temperature درجة الحرارة
mol	mole	Amount of substance كمية المادة
J	joule	Energy, work, amount of heat طاقة، عمل، كمية الحرارة
s	second	Time زمن
min	minute	Time زمن
h	hour	Time زمن
d	day	Time زمن
y	year	Time زمن
L	liter	Volume حجم
ppm	parts	Parts per million concentration التركيز لكل جزء في المليون
M	molarity	Solution concentration تركيز المحلول

Units Conversion: التحويل بين الوحدات:

طول Length	كتلة Mass	حجم Volume	الحرارة و الطاقة Tem. & Energy	الضغط Pressure
1 cm = 10 mm 1 m = 100 cm 1 m = 1000 mm 1 km = 1000 m 1 ft = 12 in 1 yard = 3 ft 1 mile = 5280 ft 1 in = 2.54 cm 1 yd = 0.914 m 1 km = 0.621 miles	1 g = 1000 mg 1 kg = 1000 g 1 mg = 1000 µg 1 lb = 16 oz 1 kg = 2.20 lb 454 g = 1 lb 1 ton = 907.2 kg	1 mL = 1 cm^3 1 dL = 100 mL 1 L = 10 dL 1 L = 1000 mL 1 pint = 2 cups 1 qt = 4 cups 1 gallon = 4 qts 946 mL = 1 qt 1 L = 1.06 qt	K = °C + 273.15 °C = (F - 32) x 5/9 1 cal = 4.184 J	1 psi = 0.068 atm 1 atm = 101.325 kPa 1 atm = 760 mmHg 1 atm = 1.01325 bar 1 mmHg = 1 torr

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Constants: *ثوابت:*

اسم الثابت *Name of the constant*	*قيمة الثابت* *Value of the constant*
Planck's constant (h) ثابت بلانك Speed of light (c) سرعة الضوء Avogadro's number (N_A) عدد أفوجادرو Faraday constant (ℱ) ثابت فارادي Atomic mass unit amu (u) وحدة الكتلة الذرية	6.626×10^{-34} J s 2.998×10^{8} m/s 6.022×10^{23} mol^{-1} 9.65×10^{4} C/mol $1.66053040 \times 10^{-27}$ Kg
Gas constants (R) ثابت الغاز	8.314 J mol^{-1} K^{-1} 62.36 L torr mol^{-1} K^{-1} 0.08206 atm mol^{-1} K^{-1}
STP conditions الظروف المعيارية (القياسية)	1.000 atm 0.00 °C
Boltzmann constant (*k*) ثابت بولتزمان	1.38×10^{-23} JK^{-1}
1 mol of ideal gas at (STP) مول واحد من الغاز عند	22.4 L
Specific Heat of water (l) الحرارة النوعية للماء (سائل)	4.18 J/g°C
Specific Heat of water (g) الحرارة النوعية للماء (غاز)	2.02 J/g°C
Specific Heat of water (s) الحرارة النوعية للماء (صلب)	2.05 J/g°C
Heat of fusion of water حرارة الانصهار للماء	6.01 kJ/mol
Heat of vaporization of water حرارة التبخر للماء	40.7 kJ/mol
Rydberg Constant (R) ثابت ريدبيرج	1.0974×10^{7} m^{-1}

Subatomic Particles : *الجسيمات دون الذرية :*

الإسم Name	الرمز Symbol	الكتلة Mass (kg)	الشحنة Charge (C)
proton	p^+	1.673×10^{-27}	$+1.602 \times 10^{-19}$
electron	e^-	9.109×10^{-31}	-1.602×10^{-19}
neutron	n^0	1.675×10^{-27}	0

SOLUBILITY RULES *قواعد الذائبية*

SOLUBLE ذائب	INSOLUBLE غير ذائب
All Nitrates, Acetates, Ammonium and Group I salts All Chlorides, Bromides, and Iodides, except Silver, Lead, and Mercury (I) All Fluorides except Group II, Lead (II), and Iron (III) All Sulfates except Calcium, Strontium, Barium, Mercury, Lead (II), and Silver	All Carbonates and Phosphates except Group I and Ammonium All Hydroxides except Group I, Strontium, and Barium All Sulfides except Group I, II, and Ammonium All Oxides except Group I

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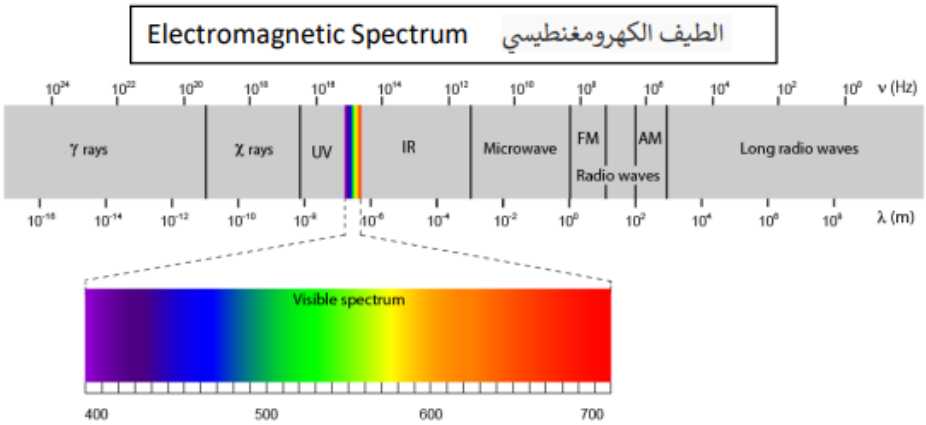
Appendix 3: Formulas

H 2.1																	He
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	Ar
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.8	Ni 1.8	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	Kr 3.0
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	Xe 2.6
Cs 0.7	Ba 0.9	La 1.1	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Ti 1.8	Pb 1.8	Bi 1.9	Po 2.0	At 2.2	Rn 2.4
Fr 0.7	Ra 0.7	Ac 1.1	Unq	Unp	Unh	Uns	Uno	Une									

Electronegativity الكهروسلبية

Ce 1.1	Pr 1.1	Nd 1.1	Pm 1.1	Sm 1.1	Eu 1.1	Gd 1.1	Tb 1.1	Dy 1.1	Ho 1.1	Er 1.1	Tm 1.1	Yb 1.1	Lu 1.2
Th 1.3	Pa 1.5	U 1.7	Np 1.3	Pu 1.3	Am 1.3	Cm 1.3	Bk 1.3	Cf 1.3	Es 1.3	Fm 1.3	Md 1.3	No 1.3	Lr



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Equations: بعض القوانين و المعادلات:

$$PV = nRT$$

$$P_A = P_{\text{total}} \times X_A, \text{ where } X_A = \frac{\text{moles A}}{\text{total moles}}$$

$$P_{total} = P_A + P_B + P_C + \dots$$

$$n = \frac{m}{M}$$

$$K = °C + 273$$

$$D = \frac{m}{V}$$

$$KE \text{ per molecule} = \frac{1}{2}mv^2$$

$$\frac{Rate_1}{Rate_2} = \sqrt{\frac{M_2}{M_1}}$$

$$q = mc\Delta T$$

$$\Delta S^\circ = \sum S^\circ \text{ products} - \sum S^\circ \text{ reactants}$$

$$\Delta H^\circ = \sum \Delta H_f^\circ \text{ products} - \sum \Delta H_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$
$$= -RT \ln K$$
$$= -nFE^\circ$$

$$I = \frac{q}{t}$$

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}, \text{ where } a\,A + b\,B \rightleftarrows c\,C + d\,D$$

$$K_p = \frac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$$

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$K_b = \frac{[OH^-][HB^+]}{[B]}$$

$$K_w = [H^+][OH^-] = 1.0 \times 10^{-14} \text{ at } 25°C$$
$$= K_a \times K_b$$

$$pH = -\log[H^+],\ pOH = -\log[OH^-]$$

$$14 = pH + pOH$$

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

$$pK_a = -\log K_a,\ pK_b = -\log K_b$$

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

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

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

$$E = \frac{hc}{\lambda}$$

$$v = {}^{c}/_{\lambda}$$

$$E = R_E\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$F_e = k_e\frac{Q_1 Q_2}{r^2}$$

$$P_{solution} = P_1x_1 + P_2x_2 + \cdots$$

$$\Delta T_{solution} = K_b \cdot m_{solute}$$

$$\Delta T_{solution} = K_f \cdot m_{solute}$$