



## 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 exam is adaptive. Exam content and difficulty is customized to the individual test taker. When a test taker answers a question correctly, they will be given more difficult content; when they answer a question incorrectly, they will be given easier content. This process of continuous adjustment delivers optimized content for each test taker throughout the exam, maximizing their opportunity to perform at their best and providing a more accurate measure of their ability. Test takers should do their best to answer each question correctly; once a question is answered, they will not be able to go back and change the answer.

<b>Test Duration:</b>	90 minutes
<b>Questions:</b>	40 questions
<b>Content Areas:</b>	Matter and its properties, Energy, Force, and Conservation
<b>Task Types:</b>	Multiple Choice, Multi-select, Fill-in the-Blank, and Drag and Drop

EmSAT Achieve Chemistry	
Score	Score Descriptors
1500 - 2000	<b>High Proficiency:</b> students at this level are well-prepared for first-year chemistry courses at the university level.
1100-1475	<b>Proficient:</b> students at this level are at a satisfactory level of preparation to begin first-year chemistry courses at the university level.
900-1075	<b>Borderline Proficient:</b> students at this level are minimally prepared for first-year chemistry courses at the university level and may need additional support in some areas.
700-875	<b>Basic:</b> students at this level do not have sufficient mastery of prerequisite knowledge for first-year courses in chemistry at the university level and will likely need some additional support in some chemistry's topics.
500-675	<b>Needs Improvement:</b> students at this level need additional instructional support in basic chemical concepts and skills before beginning any first-year chemistry courses.
< 500	<b>Little knowledge of basic science:</b> students at this level lack knowledge and skills of basic science concepts.



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### Appendix 1: Content Areas

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

- 
- |   |   |
|---|---|
| <ul style="list-style-type: none"><li>• Meaning of what chemistry is and its scope</li><li>• Scientific process</li><li>• Units of measurement and conversion between them</li><li>• Sources errors and uncertainty in measurements</li><li>• Classification of matter</li><li>• Changes of matter</li><li>• Atomic theories</li><li>• Atomic structure</li><li>• Atomic spectra and their applications</li><li>• Atomic composition</li><li>• Nuclear change</li><li>• Radioactivity</li><li>• Molecular geometry</li><li>• Periodic table and how elements properties determined based on their locations</li><li>• Periodicity</li></ul> | <ul style="list-style-type: none"><li>• Volume, temperature, pressure, and amount of a gas</li><li>• Relationships among the four quantities of a gas and their calculations</li><li>• Characteristics of solutions and factors affecting solubility</li><li>• Properties of solutions (qualitatively and quantitatively)</li><li>• Electronic composition of the carbon atom</li><li>• Diversity of organic compounds in terms of shape, size, and chemical and physical properties</li><li>• Classifications of organic compounds in terms of functional groups</li><li>• Types of organic reactions and their applications</li></ul> |
|---|---|
- 

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

- 
- |   |  |
|---|--|
| <ul style="list-style-type: none"><li>• Ionic, polar, and nonpolar covalent bonds</li><li>• Shapes of molecules</li><li>• The concept of the mole and its applications (stoichiometry)</li><li>• Percent composition of a compound</li><li>• Empirical and molecular formulas of a compound</li><li>• Percent yield</li><li>• Acids and bases (strong and weak)</li><li>• The concept and use of pH scale</li><li>• The concept of neutralization (titration)</li><li>• Common ion effect, buffer solutions, and solubility</li></ul> | <ul style="list-style-type: none"><li>• Meaning of oxidation and reduction, redox reactions, and activity series</li><li>• Redox reactions to produce electricity and manufacture electrolytic and galvanic cells</li><li>• Factors affecting the reaction rate</li><li>• Chemical equilibrium</li><li>• Energy changes during chemical reactions and/or physical changes</li><li>• Hess's law and how it can be used to predict the occurrence of the chemical reaction</li></ul> |
|---|--|
-



## EmSAT Achieve Chemistry Public Test Specification

### 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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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 مكوناتها
- 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 نشاطاً 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 نشاطاً من الزنك



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### Appendix 2: Sample Items

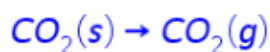
5. Calculate the mass percent of aluminum in the compound below. ما نسبة الكتلة المئوية للألومنيوم في المركب أدناه.  
(Round your answer to the nearest whole number) (قرب إجابتك إلى أقرب عدد صحيح)



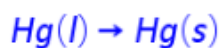
Answer =  % = الإجابة

6. Which of the following equations represents sublimation? ما المعادلة التي تمثل عملية التسامي؟

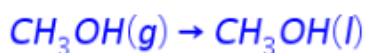
A.



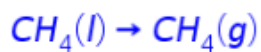
B.



C.



D.



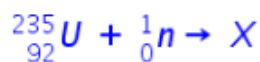


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### Appendix 2: Sample Items

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

بالنظر إلى معادلة التفاعل النووي الذي تمثل فيه  
X نواه لعنصر ما:



Which nuclide is represented by X?

ما هي النواة X؟

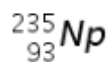
A.



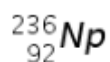
B.



C.



D.



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 عينة ما ؟

A.

temperature

درجة الحرارة

B.

pressure

الضغط

C.

volume

الحجم

D.

chemical energy

الطاقة الكيميائية

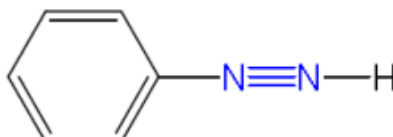


## EmSAT Achieve Chemistry Public Test Specification

### 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



## EmSAT Achieve Chemistry Public Test Specification

### Appendix 2: Sample Items

13.

The below graph for a substance being heated from  $-50^{\circ}\text{C}$  to  $600^{\circ}\text{C}$ .

الرسم البياني أدناه يمثل عملية تسخين مادة من  $-50^{\circ}\text{C}$  إلى  $600^{\circ}\text{C}$



If 600 kJ of heat are removed from the substance when it is at  $350^{\circ}\text{C}$ , what will be the state and temperature of the substance?

تم تبريد المادة عن طريق سحب ما مقداره 600 kJ من الحرارة عندما كانت درجة حرارتها  $350^{\circ}\text{C}$  ما حالة المادة الفيزيائية ودرجة حرارتها؟

- A. liquid at  $250^{\circ}\text{C}$  سائلة عند  $250^{\circ}\text{C}$
- B. gas at  $250^{\circ}\text{C}$  غازية عند  $250^{\circ}\text{C}$
- C. solid at  $200^{\circ}\text{C}$  صلبة عند  $200^{\circ}\text{C}$
- D. liquid at  $200^{\circ}\text{C}$  سائلة عند  $200^{\circ}\text{C}$



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

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



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 المتفاعلة X و 25% من المادة الناتجة Y |
| D. | 50% product of Y and 50% reactant X | 50% من المادة الناتجة Y و 50% من المادة المتفاعلة X |



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### Appendix 2: Sample Items

15. A student conducted a titration by adding 12.0 mL of  $\text{NaOH(aq)}$  of unknown concentration to 16.0 mL of 0.15 M  $\text{HCl(aq)}$ . What is the molar concentration of the  $\text{NaOH(aq)}$ ?
- أجرى طالب عملية المعايرة بإضافة 12.0 mL من محلول  $\text{NaOH(aq)}$  غير معروف التركيز إلى 16.0 mL من محلول  $\text{HCl(aq)}$  الذي تركيزه 0.15 M. ما تركيز  $\text{NaOH(aq)}$ ؟

- A.
- B.
- C.
- D.



## EmSAT Achieve Chemistry Public Test Specification

### 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



## EmSAT Achieve Chemistry Public Test Specification

### 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 <sup>3</sup> 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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### Appendix 3: Formulas



#### Constants:

#### ثوابت:

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

#### Subatomic Particles :

#### الجسيمات دون الذرية :

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





## EmSAT Achieve Chemistry Public Test Specification

### Appendix 3: Formulas



#### Equations:

بعض القوانين و المعادلات:

$PV = nRT$ $P_A = P_{\text{total}} \times X_A, \text{ where } X_A = \frac{\text{moles A}}{\text{total moles}}$ $P_{\text{total}} = P_A + P_B + P_C + \dots$ $n = \frac{m}{M}$ $K = ^\circ\text{C} + 273$ $D = \frac{m}{V}$ $KE \text{ per molecule} = \frac{1}{2}mv^2$ $\frac{\text{Rate}_1}{\text{Rate}_2} = \sqrt{\frac{M_2}{M_1}}$	$q = mc\Delta T$ $\Delta S^\circ = \sum S^\circ \text{ products} - \sum S^\circ \text{ reactants}$ $\Delta H^\circ = \sum \Delta H_f^\circ \text{ products} - \sum \Delta H_f^\circ \text{ reactants}$ $\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$ $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ $= -RT \ln K$ $= -nFE^\circ$ $I = \frac{q}{t}$
$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}, \text{ where } aA + bB \rightleftharpoons cC + dD$ $K_p = \frac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$ $K_a = \frac{[H^+][A^-]}{[HA]}$ $K_b = \frac{[OH^-][HB^+]}{[B]}$ $K_w = [H^+][OH^-] = 1.0 \times 10^{-14} \text{ at } 25^\circ\text{C}$ $= K_a \times K_b$ $\text{pH} = -\log[H^+], \text{ pOH} = -\log[OH^-]$ $14 = \text{pH} + \text{pOH}$ $\text{pH} = \text{p}K_a + \log \frac{[A^-]}{[HA]}$ $\text{p}K_a = -\log K_a, \text{ p}K_b = -\log K_b$	$\ln[A]_t - \ln[A]_0 = -kt$ $\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt$ $t_{1/2} = \frac{0.693}{k}$ $E = \frac{hc}{\lambda}$ $v = c/\lambda$ $E = R_E \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$ $F_e = k_e \frac{Q_1 Q_2}{r^2}$ $P_{\text{solution}} = P_1x_1 + P_2x_2 + \dots$ $\Delta T_{\text{solution}} = K_b \cdot m_{\text{solute}}$ $\Delta T_{\text{solution}} = K_f \cdot m_{\text{solute}}$