

2020 加拿大初级化学奥林匹克 (JCCO)

1. [单选题]

1	JUNIOR CANADIAN CHEMISTRY OLYMPIAD																2	
Periodic table and data sheet																		
3	4												5	6	7	8	9	10
Li 6.941 Lithium	Be 9.012 Beryllium												B 10.81 Boron	C 12.01 Carbon	N 14.01 Nitrogen	O 16.00 Oxygen	F 19.00 Fluorine	Ne 20.18 Neon
11	12												13	14	15	16	17	18
Na 22.99 Sodium	Mg 24.31 Magnesium												Al 26.98 Aluminum	Si 28.09 Silicon	P 30.97 Phosphorus	S 32.07 Sulfur	Cl 35.45 Chlorine	Ar 39.95 Argon
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
K 39.10 Potassium	Ca 40.08 Calcium	Sc 44.96 Scandium	Ti 47.87 Titanium	V 50.94 Vanadium	Cr 52.00 Chromium	Mn 54.94 Manganese	Fe 55.85 Iron	Co 58.93 Cobalt	Ni 58.69 Nickel	Cu 63.55 Copper	Zn 65.38 Zinc	Ga 69.72 Gallium	Ge 72.61 Germanium	As 74.92 Arsenic	Se 78.96 Selenium	Br 79.90 Bromine	Kr 83.80 Krypton	
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
Rb 85.47 Rubidium	Sr 87.62 Strontium	Y 88.89 Yttrium	Zr 91.22 Zirconium	Nb 92.91 Niobium	Mo 95.96 Molybdenum	Tc (98) Technetium	Ru 101.1 Ruthenium	Rh 102.9 Rhodium	Pd 106.4 Palladium	Ag 107.9 Silver	Cd 112.4 Cadmium	In 114.8 Indium	Sn 118.7 Tin	Sb 121.8 Antimony	Te 127.6 Tellurium	I 126.9 Iodine	Xe 131.3 Xenon	
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
Cs 132.9 Cesium	Ba 137.3 Barium	La 138.9 Lanthanum	Hf 178.5 Hafnium	Ta 180.9 Tantalum	W 183.9 Tungsten	Re 186.2 Rhenium	Os 190.2 Osmium	Ir 192.2 Iridium	Pt 195.1 Platinum	Au 197.0 Gold	Hg 200.6 Mercury	Tl 204.4 Thallium	Pb 207.2 Lead	Bi 208.0 Bismuth	Po (209) Polonium	At (210) Astatine	Rn (222) Radon	
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	
Fr (223)	Ra (226)	Ac (227)	Rf (261) Rutherfordium	Db (262) Dubnium	Sg (266) Seaborgium	Bh (264) Bohrium	Hs (277) Hassium	Mt (268) Meitnerium	Ds (269) Darmstadtium	Rg (272) Roentgenium	Cn (285) Copernicium	Nh (284) Nihonium	Fl (289) Flerovium	Mc (288) Moscovium	Lv (292) Livermorium	Ts (294) Tennessine	Og (294) Oganesson	
58		59	60	61	62	63	64	65	66	67	68	69	70	71				
Ce 140.1 Cerium		Pr 140.9 Praseodymium	Nd 144.2 Neodymium	Pm (145) Promethium	Sm 150.4 Samarium	Eu 152.0 Europium	Gd 157.3 Gadolinium	Tb 158.9 Terbium	Dy 162.5 Dysprosium	Ho 164.9 Holmium	Er 167.3 Erbium	Tm 168.9 Thulium	Yb 173.0 Ytterbium	Lu 175.0 Lutetium				
90		91	92	93	94	95	96	97	98	99	100	101	102	103				
Th 232.0 Thorium		Pa 231.0 Protactinium	U 238.0 Uranium	Np 237.0 Neptunium	Pu (244) Plutonium	Am (243) Americium	Cm (247) Curium	Bk (247) Berkelium	Cf (251) Californium	Es (252) Einsteinium	Fm (257) Fermium	Md (258) Mendelevium	No (259) Nobelium	Lr (262) Lawrencium				

原子质量单位 Atomic mass unit	1.66054×10 ⁻²⁷ kg
阿伏伽德罗常数 Avogadro's number	6.022×10 ²³
电子电荷量 Charge of an electron	1.60218×10 ⁻¹⁹ C
法拉第常数 Faraday's constant	96485 C mol ⁻¹
理想气体常数 Gas constant	8.3145 J K ⁻¹ mol ⁻¹
电子质量 Mass of an electron	9.1094×10 ⁻³¹ kg
光速 Speed of light	2.99792458×10 ⁸ ms ⁻¹
普朗克常数 Plank Constant	6.62637×10 ⁻³⁴ Js

1 atm = 101325 Pa
1 bar = 100000 Pa
0 °C = 273.15 K

8

Low-dose aspirin (C₉H₈O₄) is known to prevent heart attacks. Low-dose aspirin often comes in 81 mg tablets. If a person consumes one 81 mg tablet, how many moles of aspirin would they be consuming?

低剂量的阿司匹林(C₉H₈O₄)通常为 81 mg 的片剂，可以预防心脏病。如果一个人吃掉一片 81 mg 的片剂，那他会消耗多少摩尔的阿司匹林？

(1分) ★ 标记

☐ A. 2.22×10³

☐ B. 4.50×10⁻⁴

☐ C. 4.50×10⁻¹

☐ D. 1.5×10⁻³

☐ E. 2.22

2. [单选题]

Which of the following chemical equations is properly balanced?

以下化学方程式配平正确的是哪个？

(1分) ★ 标记



3. [单选题]

Calculate the mass of sodium chloride (NaCl) required to prepare a 3.00 M solution in water using a 200 mL volumetric flask?

在 200mL 容量瓶中制备 3.00 M 的 NaCl 水溶液，计算需要氯化钠 (NaCl) 的质量是多少？

(1分) ★ 标记

☐ A. 13.80g

☐ B. 34.80g

☐ C. 35.06g

☐ D. 21.27g

☐ E. 3.51g

4. [单选题]

The density of benzene (C_6H_6) at $20\text{ }^\circ\text{C}$ is 0.8765 g/cm^3 . What is the volume of 1 mole of benzene at $20\text{ }^\circ\text{C}$?

$20\text{ }^\circ\text{C}$ 时苯 (C_6H_6) 的密度为 0.8765 g/cm^3 。在同样温度条件下, 1 摩尔苯的体积是多少?

(1分) ★ 标记

☐ A. 89.1L

☐ B. 68.5mL

☐ C. 36.4mL

☐ D. 68.5L

☐ E. 89.1mL

5. [单选题]

Classify each observation as a physical or a chemical property and tally them.

将下列每个观察结果按照物理或化学性质进行分类并记录。

Observation 1: Bubbles form on a piece of metal when it is dropped into acid.

观察结果 1: 金属遇酸表面会生成气泡。

Observation 2: The color of a crystalline substance is blue.

观察结果 2: 某结晶物质的颜色为蓝色。

Observation 3: A shiny metal melts at 820°C .

观察结果 3: 有光泽的金属熔点为 820°C 。

Observation 4: The density of a solution is 1.34 g/cm^3 .

观察结果 4: 某溶液密度为 1.34 g/cm^3 。

(1分) ★ 标记

☐ A.

3 chemical properties and 1 physical prop

3 个属于化学性质, 1 个属于物理性质

☐ B.

2 chemical properties and 2 physical properties

2 个属于化学性质, 2 个属于物理性

☐ C.

1 chemical property and 3 physical properties

1 个属于化学性质, 3 个属于物理性

☒ D.

4 physical properties

4 个都属于物理

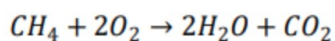
☐ E.

4 chemical properties

4 个都属于化学性

6. [单选题]

Several general types of chemical reactions can occur based on what happens when going from reactants to products. What is the type of the following reaction?



根据从反应物到生成物所发生的变化，可将化学反应分为几类。

$\text{CH}_4 + 2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{CO}_2$ 属于下列哪一类型的化学反应？

(1分) ★ 标记

☐ A.

Synthesis

化合反应

☐ B.

Neutralization

中和反应

☐ C.

Decomposition

分解反应

☐ D.

Single replacement

置换反应

☐ E.

Combustion

氧化反应

7. [单选题]

What is the correctly balanced form of the chemical reaction depicted in the figure below?

关于下图所示化学反应，方程式配平正确的是哪一个？

Element A (元素 A) : ●

Element B (元素 B) : ○

Element C (元素 C) : ○



(1分) ★ 标记

☐ A. $AB_4 + 4C \rightarrow AB_2 + C_4B_2$

☐ B. $AB_4 + 2C_2 \rightarrow AC_2 + 2CB_2$

☐ C. $4BA + 2C \rightarrow AB_2 + 2CB_2$

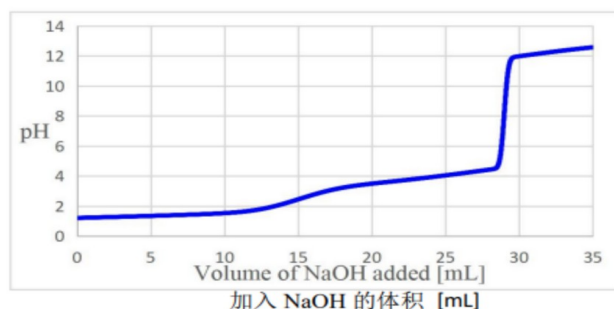
☐ D. $AB_4 + 4C \rightarrow AB_2 + 2C_2B$

☐ E. $4BA + 2C_2 \rightarrow 2AB_2 + 2C_2B$

8. [单选题]

A chemist titrated aqueous oxalic acid with sodium hydroxide and recorded the pH on the graph below. Estimate the pH at the last equivalence point observed for this titration. Use the titration curve below.

一名化学家用氢氧化钠溶液滴定草酸溶液，并记录了该过程的 pH 变化，如下图所示。利用下面的滴定曲线图，估算在此滴定过程中到达第一个化学计量点时的 pH 值。



(1分) ★ 标记

☐ A. 1.0

☐ B. 4.0

☐ C. 8.0

☐ D. 13.0

☐ E. 29.0

9. [单选题]

Chemical oxygen generators can provide oxygen for breathing in case of emergency in aircrafts and submarines. The oxygen source is usually an inorganic superoxide, chlorate or perchlorate. If 138.5 grams of potassium perchlorate is decomposed inside an oxygen generator, ($\text{KClO}_4 \rightarrow \text{KCl} + 2\text{O}_2$). How many grams of dioxygen are produced? (assume a yield of 100% for the above reaction)

化学氧气生成器可以在紧急情况下为飞机和潜艇提供氧气。氧气来源通常为无机过氧化物、氯酸盐或者高氯酸盐。如果氧气生成器中分解了 138.5 克高氯酸钾 ($\text{KClO}_4 \rightarrow \text{KCl} + 2\text{O}_2$)，那么会生成多少克的氧气？（假设上述化学反应的产率为 100%）

(1分) ★ 标记

☐ A. 8☐ B. 16☐ C. 32☐ D. 64☐ E. 128

10. [单选题]

Assuming ideal gas behavior for the reaction in question 9, at 25°C and 1 bar, what would be the volume of dioxygen (O_2) produced?

假设第 9 题中的化学反应为理想气体状态，即 25°C，1 bar，那么生成的氧气 (O_2) 体积是多少？

(1分) ★ 标记

☐ A. 24.8L☐ B. 49.6L☐ C. 99.2L☐ D. 49.6mL☐ E. 24.8mL

11. [单选题]

The *molality* (m) of a solution is defined as the number of moles of solute per kilogram of solvent. The dissolution of chemical saltpetre (potassium nitrate, KNO_3) in water is a strongly endothermic reaction. This chemical process has been used in Middle Ages to chill water, wine and other beverages indirectly. If a basin containing 60 kg of water and 6 kg of saltpetre were used to cool drinks, what would be the *molality* of the KNO_3 solution?

溶液的质量摩尔浓度 (m) 即每千克溶剂中溶质的物质的量。化学硝石 (硝酸钾, KNO_3) 溶于水为吸热反应。在中世纪, 该化学反应曾被用于冷却水、酒和其他饮品。如果使用装有 60 kg 水和 6 kg 硝酸钾的水盆来冷却饮料, 那么 KNO_3 溶液的质量摩尔浓度是多少?

(1分) ★ 标记☐ A. 0.989m☐ B. 1.978m☐ C. 0.495m☐ D. 1.177m☐ E. 5.982m

12. [单选题]

For a reaction $A + B \rightarrow \text{Products}$, the rate law is: $v = k[A]^2[B]$. For gas containers with the same volume, which mixture would have the highest rate of reaction according to this rate law?

对于一个化学反应 $A + B \rightarrow \text{生成物}$ ，速率定律为： $v = k[A]^2[B]$ 。根据此定律，对于体积相同的气体容器，下列哪种混合物的反应速率最快？

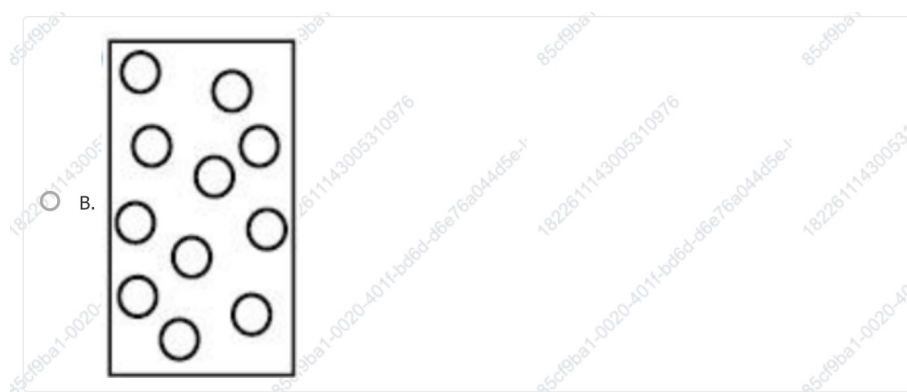
Legend: compound A ○

图示： 化合物 A

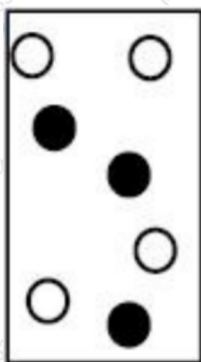
compound B ●

化合物 B

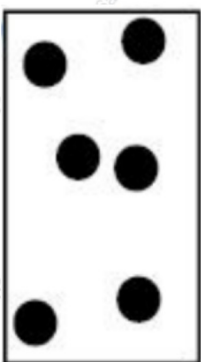
(1分) ★ 标记



☐ D.



☐ E.



13. [单选题]

Two moles of liquid water initially at 274 K are mixing with two moles of liquid water initially at 362 K in a perfectly insulated container. Assume that the molar heat capacity of liquid water is constant and independent of temperature. Calculate the final equilibrium temperature of the water after mixing.

在完全绝热的容器中，将 2 mol 初始状态为 274K 的液态水与 2 mol 初始状态为 362K 的液态水进行混合。假设液态水的摩尔热容恒定且与温度无关。计算混合后水的最终平衡温度。

(1分) ☐ 标记

☐ A. 298K

☐ B. 308K

☐ C. 318K

☐ D. 328K

☐ E. 358K

14. [单选题]

In the compound X_2O_3 , the electron configuration of the element X is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$. Which of the following element correspond to X ?

在化合物 X_2O_3 中，元素 X 的核外电子排布式为 $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$ 。

以下哪个元素是元素 X?

(1分) ★ 标记

☐ A. Al

☐ B. V

☐ C. Cr

☐ D. Sc

☐ E. Fe

15. [单选题]

Which of the following correctly lists the order of **increasing** electrical conductivity of an aqueous solution by dissolving 1.0 mole of following substances respectively into water to make 1.0 liter of solution?

将 1.0 mol 选项中的物质分别溶解于水，以制备 1.0 L 溶液，水溶液电导率从小到大排列正确的是下列哪一项？

(1分) ★ 标记

☐ A. $CH_3OH < CH_3COOH < AgCl < CaCl_2 < HCl$

☐ B. $CH_3COOH < CH_3OH < CaCl_2 < HCl < AgCl$

☐ C. $CH_3OH < AgCl < CH_3COOH < HCl < CaCl_2$

☐ D. $AgCl < CH_3OH < CH_3COOH < CaCl_2 < HCl$

☐ E. $CH_3OH < CH_3COOH < HCl < AgCl < CaCl_2$

16. [单选题]

Which of the following accurately represents a trend in electronegativity?

以下哪项可以准确表示元素的电负性变化趋势？

(1分) ★ 标记

☐ A. $N > O > F$

☐ B. $Ne > F > O$

☐ C. $F > S > O$

☐ D. $F > S > O$

☐ E. $Cl > Br > I$

17. [单选题]

Which of the following compounds is containing covalent and ionic bonds?

下列哪个化合物既含有共价键又含有离子键？

(1分) ★ 标记

☐ A. HBr

☐ B. KCl

☐ C. H_2O

☒ D. KNO_3

☐ E. SiO_2

18. [单选题]

One mole of uranium-238 is slowly decaying. If the kinetics of this process is first order, after how many half-lives there is only 0.125 moles of uranium-238 left?

1 mol 的铀-238 正在缓慢衰变。如果此过程遵循一级动力学反应，那么最后只剩下 0.125 mol 的铀-238，中间经历了多少个半衰期？

(1分) ★ 标记

☐ A. 3

☐ B. 12

☐ C. 8

☐ D. 4

☐ E. 9

19. [单选题]

Archimedes principle states: "When an object is completely submerged, the volume of the displaced water equals the volume of the object." A 200 mL graduated cylinder was filled with exactly 100 mL of water before a 27.0 gram copper block is added to the cylinder.

What volume should the cylinder read if the block is completely submerged by water?

The density of copper is 8.96 g/cm^3 .

阿基米德原理：“如果一个物体完全浸没在水中，它排开水的体积等于物体本身的体积。”现在将 100 mL 的水注入 200 mL 的量筒中，然后在量筒内加入 27.0 g 的铜块。如果铜块完全被水浸没，那么此时从量筒上读取的体积是多少？

已知铜的密度为 8.96 g/cm^3 。

(1分) ★ 标记

☐ A. 103mL

☐ B. 130mL

☐ C. 127mL

☐ D. 142mL

☐ E. 124mL

20. [单选题]

A sample of an unknown compound with formula of C_xH_y was combusted with excess amount of oxygen, the reaction produced 132.001g of carbon dioxide and 72.064g of water. Based on the information given, this unknown compound is

一化合物的分子式为 C_xH_y ，它在足量的氧气中燃烧，生成 132.001g 二氧化碳和 72.064g 水。根据以上信息可推断，该化合物为

(1分) ★ 标记

☐ A. CH_4

☐ B. C_2H_6

☐ C. C_3H_8

☐ D. C_4H_{10}

☐ E. C_8H_{18}

21. [单选题]

Which of the following molecules has a tetrahedral molecular geometry?

下列哪个分子具有四面体构型？

(1分) ★ 标记

☐ A. SF_4

☐ B. CH_4

☒ C. XeF_4

☐ D. BF_3

☐ E. H_2CO

22. [单选题]

How many structural isomers does a compound with molecular formula of C_4H_{10} have?

分子式为 C_4H_{10} 的化合物有多少个同分异构体?

(1分) ★ 标记

☐ A. 6

☐ B. 2

☐ C. 4

☐ D. 3

☐ E. 5

23. [单选题]

A mixture of chromium and zinc weighing 1.000 g was reacted with an excess of hydrochloric acid. After all the metals in the mixture reacted, 618 mL of wet hydrogen gas was collected over water at 25°C and 103160 Pascal. Determine the mass percent of Zn in the metal sample. (CrCl_3 and ZnCl_2 were produced and the vapour pressure of water at 25°C is 3160Pa)

质量为 1.000 g 的铬锌混合物与过量盐酸进行反应。混合物中的所有金属完全反应后，在 25°C 、103160 Pa 的水蒸气上方收集到 618 mL 湿氢气。计算金属样品中 Zn 的质量百分比。（已知产物中还有 CrCl_3 和 ZnCl_2 ， 25°C 时水的蒸汽压为 3160 Pa）

(1分) ★ 标记

☐ A. 22.9%

☐ B. 77.1%

☐ C. 67.4%

☐ D. 28.9%

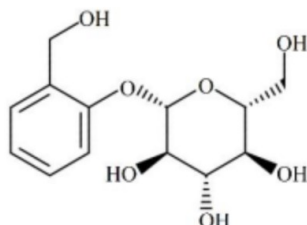
☐ E. 71.1%

24. [单选题]

The molecule below is sometimes used as a substitute to aspirin. It is found in leaves and bark from the willow tree and has been used for its health effects for at least 2,000 years.

Which of the following molecular formula is the correct one for the molecule below ?

下图中的分子有时用作阿司匹林的替代物，广泛存在于柳树的叶子和树皮中，应用于医学领域已有 2000 年的历史。以下哪项是该物质的分子式？



Salicin 水杨苷

(1分) ★ 标记

☐ A. $C_{13}H_{18}O_7$

☐ B. $C_{12}H_{20}O_7$

☐ C. $C_{12}H_{16}O_7$

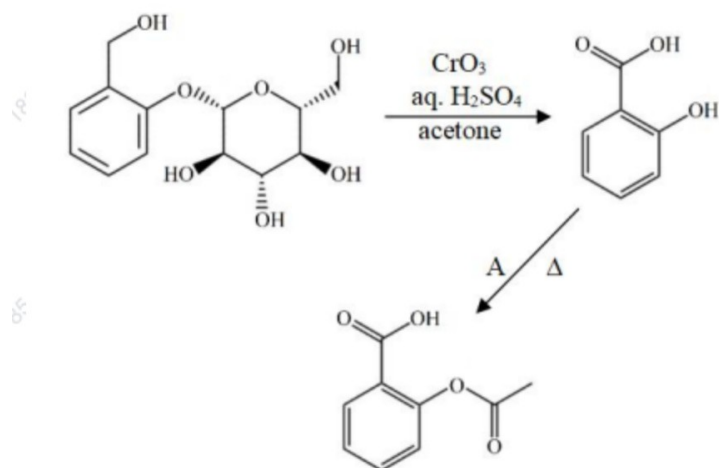
☐ D. $C_{13}H_{13}O_7$

☐ E. $C_{13}H_{13}O_7$

25. [单选题]

The synthesis of aspirin (acetylsalicylic acid) using salicin as starting material is shown in the reaction scheme below:

利用水杨苷来合成阿司匹林（乙酰水杨酸）的反应过程如下所示：



Which of the following compounds could be used as reagent A?

下列哪种化合物可用作试剂 A？

☐ A. $\text{CH}_3\text{COOCH}_3$

☐ B. $\text{CH}_3\text{OCH}_2\text{CH}_3$

☐ C. $\text{CH}_3\text{COOCH}_2\text{CH}_3$

☐ D. $(\text{CH}_3\text{CO})_2\text{O}$

☐ E. CO_2