

JPS Science League: Chemistry I

Kevin Yang and Elisha Zhao

Entrance Exam

Instructions: There are 25 test questions that will determine your placement. You will be given 50 minutes for this exam. Points will not be taken off for wrong answers so you are encouraged to answer every question. Good luck and have fun!

- 1) Something really small can be very important. The prefix "pico" is used to indicate something very small. What power of 10 is equivalent to "pico".
a) -3 b) -9 c) -12 d) -15
- 2) Kevin found the following statements on a piece of crumpled paper lying on the ground.
A) Mass is conserved
B) Moles are conserved
C) Volume is conserved
D) Molecules are conserved

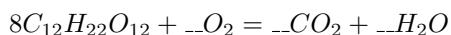
Which is (are) always true for a chemical reaction?

- a) A only b) B only c) A and B d) B and D only
- 3) Elisha was studying Chem Lab for Science Olympiad by attempting to match different compounds with their names. Can you help her figure out which compound has the correct name paired with it?
a) Sodium Dioxide and NO_2 b) Nitrogen Oxide and NO_2 c) Ozone and O_3 d) Carbon Bioxide and CO_2
- 4) Kevin often gets hungry at midnight. Often times, he goes to the fridge to find something tasty to eat. 2 days ago, he picked up some calcium nitrate for a small snacc. Can you help him figure out what the chemical formula for calcium nitrate?
a) $CaNO_3$ b) $Ca(NO_3)_2$ c) $CaNO$ d) $Ca(NO_2)_2$
- 5) After eating some calcium nitrate, Kevin thought it wasn't very tasty so he decided to try out sodium sulfate. Can you figure out the ratio of the masses of sodium and sulfur in sodium sulfate?
a) 1.52 b) 1.25 c) 0.86 d) 1.43
- 6) Elisha found a bucket of glucose sugar in Mr. D room. (Don't ask why that bucket exists) Can you find out how many moles of H would you find in 5.2 kg of $C_6H_{12}O_6$.
a) 243.2 b) 346.4 c) 28.9 d) 173.2
- 7) It turns out that Kevin placed that bucket in Mr. D's room. We don't actually know why he did it but after we asked him, he informed us that he also made a bucket of sucrose($C_{12}H_{22}O_{12}$). Kevin wasn't exactly sure how much sucrose he put in the bucket but he was sure that he put 3.6 kg of carbon atoms. Can you help him figure out how many moles of sucrose he has?
a) 15 b) 25 c) 30 d) 300
- 8) The US National Chemistry Olympiad is something extremely fun but not exactly easy. While taking the USNCO, Kevin had to perform an experiment to determine the molarity of acid in a beaker. To do so, he decided to titrate 5 individual samples of acid from the beaker. As a result he found the molarity is: 4.53 ± 0.002 , 2.45 ± 0.005 , 8.43 ± 0.001 , 5.23 ± 0.002 , and 6.45 ± 0.001 . Is Kevin accurate and/or precise?
a) Accurate and Precise b) Accurate, Not Precise c) Precise, Not Accurate d) Not Accurate, Not Precise

- 9) Every day when you're walking down the street, everybody that you meet has an original point of view. And I say - Hey! What a wonderful kind of day! If we could learn to work and play and get along with each other to analyze some compounds with polyatomic ions. One day when Elisha was walking down the street, she found some barium dichromate $BaCr_2O_7$. Can you help her figure out how many sodium ions would be in sodium dichromate?
- a) 2 b) 3 c) 1 d) Not enough info given
- 10) Kevin has lump of francium and a jar of water. Out of boredom, he decided to place the lump of francium into the jar of water. He realizes that after all of the francium has reacted, he was left with francium hydroxide and hydrogen gas. Can you help Kevin figure out what is the product side of the balanced molecular equation of the reaction?
- a) $2FrOH + H_2$ b) $FrOH + H_2$ c) $2FrOH + 2H$ d) $FrOH + 2H_2$
- 11) Elisha has a lot of different metal and liquids. She decided to mix up different metals with different liquids. Which of the following reactions would be possible?
- a) Potassium and Copper II Nitrate b) Copper and Aluminium Nitrate c) Gold and Copper II Nitrate d) Potassium and Sodium Nitrate

Use the following information for Questions #12 and #13: One day while doing nothing at a SciOly study session, as always, Kevin remembered his bucket of sucrose. He realized that he needed a way to get rid of it so he decided to burn the sucrose. By using a blowtorch to set the sucrose on fire, Kevin lets it completely burn away.

- 12) Can you help Kevin identify what kind of reaction is the burning of sucrose?
- a) Double Replacement b) Stable c) Single Replacement d) Reduction and Oxidation
- 13) Knowing the unbalanced molecular equation of the reaction is the following, can you help Kevin figure out the sum of the missing coefficients?



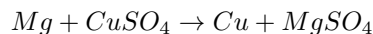
- a) 284 b) 276 c) 312 d) 262
- 14) The alchemists of the old has always been trying to make gold out of metals. Elisha was walking down the street one day when she accidentally found the Philosopher's Stone. With this, she was able to turn everything metal into gold. Which of the following particles was discovered using the element gold in some form?
- a) α b) β c) γ d) A proton
- 15) Kevin is pretty confused about the rules of orbital notation. Can you help him determine which of the following rules is correct for orbital notation?
- I) Each orbital must be filled with different spins
 II) Within a single subshell, an orbital must be completely full before moving to the next orbital
 III) Each subshell has $2n + 1$ orbitals
 IV) There can be only two electrons in each orbital
- a) I only b) I and IV c) I and II d) III and IV
- 16) Kevin is getting pretty lazy at writing questions. Here is just a normal problem. > Implying the other problems weren't normal enough. In a cation, which is the comparison between the number of electrons(e) and protons(p)?
- a) $e < p$ b) $e = p$ c) $e < p$ d) Cannot be determined
- 17) Elisha was testing random compounds that she found in various different chemistry rooms. For one of the compounds, she realizes it was 36% carbon, 32% oxygen, and 32% helium. Don't worry if this isn't a real compound but what is the empirical equation of the compound?
- a) $C_3O_2H_8$ b) $C_4O_3H_8$ c) C_3OH_8 d) $C_1O_1H_2$
- 18) Did you know that farts are made of methane? At least thats what Kevin thinks. By using a super high tech laser set up, Kevin was able to collect 120 g of methane gas(CH_4). If Kevin were to burn his collection of methane gas into carbon dioxide and water vapor, how many grams of CO_2 would he end up with.

- a) 7.48 b) 329.25 c) 215.34 d) 440.1

19) Kevin almost did something extremely bad. He almost had the thought of just copying the previous year's test questions. But due to his high sense of honor and pride, Kevin decided to ask you the following questions. Which one of the elements in the answer below is most reactive with water.

- a) *K* b) *Mg* c) *Mn* d) *Ge*

20) Man, Kevin has really been using himself alot in these questions. That's kinda really bad because when he started making these tests, he told himself he would use the two captains equally. To make up for this, Kevin decided perform a chemical reaction.(Don't ask why) The chemical equation is:



What type of reaction is this?

- a) Double replacement b) Reduction and Oxidation c) Single Replacement d) Combustion

21) Elisha was able to extract some potassium from a banana. She consequently mixed the potassium with a solution of copper II sulfate. The potassium will react with the copper II sulfate in a single replacement reaction. What is the sum of the coefficients, when all coefficients are reduced to the simplest whole number?

- a) 2 b) 3 c) 4 d) 5

22) Kevin has an element with an electronic configuration of $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^2$. What type of element is it?

- a) Nonmetal b) Transition Metal c) Metalloid d) Alkali Metal

23) Okay I have seriously ran out of creativeness. No jokes anymore. Just facts. For ionization energy, if one were to go down a column, what would happen?

- a) Decrease b) Increase c) Stay the same d) Cannot be determined

24) Suppose that Kevin has a cup of ice of 10 g at $-3^\circ C$. He wants to heat it up to $25^\circ C$. How much energy would Kevin have to put into the ice in order to raise it up to the desired temperature? The specific heat of water is $4.184 \frac{J}{g \cdot ^\circ C}$, the specific heat of ice is $2.108 \frac{J}{g \cdot ^\circ C}$, the heat of fusion for water is $333.55 \frac{J}{g}$, and the heat of vaporization for water is $2257 \frac{J}{g}$.

- a) 1109.24 b) 23679.24 c) 4444.74 d) 5564.56

25) We know that ice floats on water. What would be the slope of the solid/liquid phase change line?

- a) Positive b) Zero c) Infinity/DNE d) Negative