

SOUTH PLAINS MATH & SCIENCE COMPETITION

CHEMISTRY 2

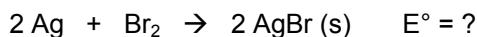
General Information:

- Check to see that you have written your name on the label and that the test name on the label matches the name on this booklet.
- **DO NOT** open the test booklet and **DO NOT** start until the proctor says "begin."
- Each individual exam period will be 45 minutes and each exam contains 40 multiple choice questions.
- Students are allowed to use a non-programmable battery operated calculator during the individual and team exams.
- Students are encouraged to write on the exam booklet. Scratch paper and pencils will also be provided.
- Students will not be permitted to leave the test room while the test is in progress. If a student finishes early, he/she must remain in the test room until the exam period is completed.
- If you need to ask a question during the test, raise your hand and the proctor will come to you.
- There is no penalty for skipping a problem. The exam scores will be determined by the number of correct answers. All ties will be broken by awarding the place to the contestant who has the most consecutive correct answers before a problem is missed.
- **Students may NOT keep the test booklet.**

CHEMISTRY 2

- What is the order of increasing energy for the four orbitals 4s, 2p, and 3d in the neutral calcium atom?
 - $2p < 3p < 3d < 4s$
 - $4s < 3d < 3p < 2p$
 - $2p < 3p < 4s < 3d$
 - $4s < 2p < 3p < 3d$
 - $3p < 2p < 4s < 3d$
- Which of the following would have a Lewis structure most like that of CO_3^{2-} ?
 - O_3
 - CO_2
 - C_2O_3
 - NO_3^{1-}
 - SO_3^{2-}
- The reaction $\text{CaO (s)} + \text{H}_2\text{O (l)} \rightarrow \text{Ca (OH)}_2 \text{ (s)}$ is spontaneous at 25°C and the reverse reaction is spontaneous at some high temperature. This means that
 - $\Delta H > 0, \Delta S > 0$.
 - $\Delta H < 0, \Delta S > 0$.
 - $\Delta H > 0, \Delta S = 0$.
 - $\Delta H > 0, \Delta S < 0$.
 - $\Delta H < 0, \Delta S < 0$.
- If you inflated a balloon at sea level where the pressure is 29.7 inches of Hg and then carried it to a mountain top, where the pressure is 18.3 inches of Hg, by what factor would the volume of the balloon change? (Assume a constant pressure.)
 - 29.7/18.3
 - $(29.7-18.3)/29.7$
 - $(29.7-18.3)/18.3$
 - 18.3/29.7
 - 1.0 (no change)
- In an electric fuel cell using the reaction
$$\text{CH}_4 \text{ (g)} + 2\text{O}_2 \text{ (g)} \rightarrow \text{CO}_2 \text{ (g)} + 2\text{H}_2\text{O (l)}$$
 - chemical energy is converted directly to electrical work.
 - carbon is reduced.
 - oxygen is oxidized.
 - CH_4 and O_2 both react at the same electrode.
 - oxygen is the catalyst for the reaction.
- A substance is a blue crystalline solid at 25°C and decomposes at 300°C to give a white powdery solid and another volatile product. The blue solid dissolves in water to give a conducting solution. What is the blue solid?
 - CuSO_4
 - $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
 - Cu
 - Cu_2S
 - an alloy of Cu & Ag
- One gram of which of the following contains the largest number of molecules?
 - CH_4
 - NH_3
 - HNO_3
 - N_2
 - H_2O
- A particular radioactive series starts with ^{235}U and ends with the stable ^{207}Pb . In the overall process, how many alpha and beta particles are emitted?
 - 8 alpha, 6 beta
 - 14 alpha, 10 beta
 - 7 alpha, 10 beta
 - 8 alpha, 10 beta
 - 7 alpha, 4 beta
- The total number of structurally isomeric alcohols with the formula $\text{C}_4\text{H}_9\text{OH}$ is
 - one
 - two
 - three
 - four
 - five
- Approximately stoichiometric amounts of reactants are allowed to react. Given sufficient time to reach equilibrium, the reaction will "go to completion" (that is, the reactions will be almost entirely converted to products) if (K is the equilibrium constant)?
 - K is very small.
 - K is much larger than one.
 - K is much closer to one.
 - $\Delta G = 0$.
 - ΔG is a large positive number.
- Which of the following slightly soluble salts would not be soluble in a strong acid (like HClO_3)?
 - PbCO_3
 - CaF_2
 - PbSO_4
 - Ag_3PO_4
 - $\text{AgC}_2\text{H}_3\text{O}_2$

24. The standard free energy of formation of AgBr (s) is -22.9 kcal/mol. What is the standard potential of a cell with the overall reaction: (Faraday constant: $F = 23.06$ kcal / volt)



- a. $+0.16$ v b. $+0.50$ v c. $+0.99$ v d. -22.9 v e. $+1.99$ v
25. A 0.946 g sample of a compound is dissolved in 150 g of water to give a solution with a freezing point of -0.065°C . What is the molecular weight of the compound? ($K_f = 1.86$ deg / molal)
- a. 180 b. 150 c. 97 d. 14.6 e. 6.31
26. The hydrogen atom energy levels are given by $E = -R_H/n^2$, where $R_H = 2.18 \times 10^{-18}$ joule. What is the wavelength of the second Lyman transition ($n = 3$ to $n = 1$). ($h = 6.63 \times 10^{-34}$ j • sec; $c = 3 \times 10^8$ m/sec)
- a. 7.27×10^{-19} m b. 1.03×10^{-5} m c. 1.37×10^{-7} m d. 1.03×10^{-7} m e. 2.42×10^{-19} m
27. For the reaction $2 \text{HI} \rightleftharpoons \text{H}_2 + \text{I}_2$, $K_c = 0.010$. How many moles of I_2 are there at equilibrium, starting with 0.30 mole of HI?
- a. 0.0015 b. 0.003 c. 0.150 d. 0.046
e. No solution possible: volume of container not given.
28. When acetylene (C_2H_2) burns in air, the products are CO_2 and H_2O (l). If one mole of C_2H_2 is burned with 64.0 g of O_2 , what is the theoretical yield of CO_2 ?
- a. 70.4 g b. 176 g c. 88.0 g d. 44.0 g e. 58.7 g
29. Which has the highest percentage of oxygen?
- a. NaHCO_3 b. $(\text{NH}_4)_2\text{SO}_4$ c. $\text{Na}_2\text{S}_2\text{O}_3$ d. H_2O_2
30. Arrange the following in order of increasing mass:
- w. 1 molecule of I_2
x. 4.0×10^{23} molecules of C_4H_{10}
y. 6.02×10^{23} molecules of CO
z. 1 mole of P_2O_5
- a. w, y, x, z b. y, w, z, x c. z, x, y, w d. x, y, w, z
31. Several groups of students from Texas High were hired by Polymer Company, Inc. to mass 33.0 g of a sample of sodium thiosulfate. Their data is listed below.

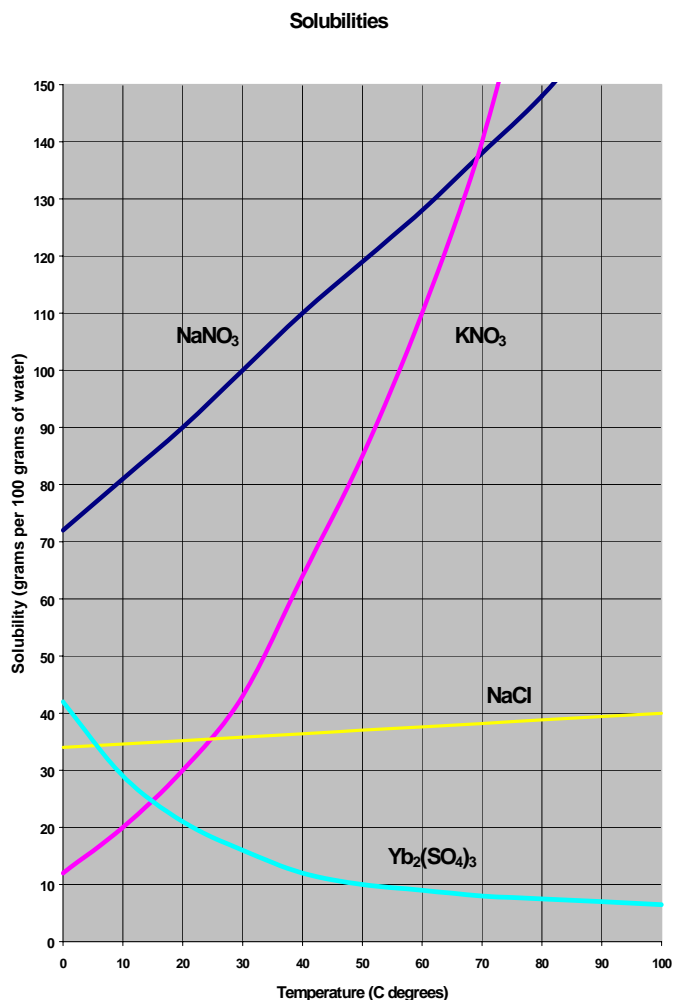
Group A:	35.2 g	35.3 g	35.3 g	35.2 g
Group B:	33.5 g	33.5 g	33.4 g	33.5 g
Group C:	40.5g	53.5 g	35.3 g	30.2 g

Which group of students had good Precision and poor Accuracy?

- a. Group A b. Group B c. Group C
32. Sodium tetraborate, $\text{Na}_2\text{B}_4\text{O}_7$, is produced according to the unbalanced equation:
- $$\text{H}_3\text{BO}_3 + \text{NaOH} \Rightarrow \text{H}_2\text{O} + \text{Na}_2\text{B}_4\text{O}_7$$
- How many grams of Boric acid, H_3BO_3 , are needed to make $150,000$ grams of $\text{Na}_2\text{B}_4\text{O}_7$?
- a. 47.91 grams b. 5.39×10^{-3} c. 50096 grams d. 184157.36 grams

33. Magnesium can be reacted with Iodine to form magnesium iodide. How many grams of magnesium iodide can be formed from 8.06 grams magnesium and 63.46 grams iodine?
 a. 75.5grams b. 8.16 grams c. 51.34 grams d. 102.68 grams

For questions 34 – 35 use the solubility graph below.



34. According to the solubility graph, at 30°C, which of the following compounds is the most soluble in 100 grams of water?
 a. NaCl b. Yb₂(SO₄)₃ c. KNO₃ d. NaNO₃
35. According to the graph, 110 grams of KNO₃ dissolves at what temperature?
 a. 30°C b. 40°C c. 60°C d. 70°C
36. The molarity of a solution in which 15.5g NaOH is dissolved in 0.100L of solution is _____?
 a. 620 M b. 3.88 M c. 2.58 M d. 0.155 M
37. How many grams of ZnCl₂ are needed to make 25.0 mL of 0.105 M ZnCl₂ solution?
 a. 0.24 g b. 0.36 g c. 2.6 g d. 4.2 g

38. What is the percent composition of sulfur by mass in this sample: 64 g S and 152 g Na?
a. 29.6% b. 42.1% c. 0.296% d. 70.3%
39. What is the percent composition of hydrogen by mass in C₃H₈?
a. 18.2 % b. 82% c. 50.0% d. 72.0%
40. The following equation can be balanced with which set of coefficients?
_____ Fe₂O₃ + _____ CO → _____ CO₂ + _____ Fe
a. 1, 2, 4, 3 b. 3, 3, 2, 1 c. 2, 3, 3, 2 d. 1, 3, 3, 2 e. 1.3, 3, 3

End of Test