

Practice Test Questions 7

More Metals and Ionic Solids

1. Answer the following questions by filling in the blanks.
For elements and compounds, write both the name and symbol. e.g. lithium (Li)
- (a) The correct name for CoBr_2 is _____.
 - (b) The two cations that contribute the most to the hardness of water are _____ and _____.
 - (c) Aluminium has very similar properties to one of the alkaline earth metals. That alkaline earth metal is _____.
 - (d) Copper(I) nitride has the molecular formula _____.
 - (e) Aluminium metal does not react with air because it is coated with a thin layer of _____.
 - (f) Give an example of a metal oxide that reacts with both acid and base. _____
 - (g) A major contaminant that must be removed from bauxite before it can be used to produce aluminium metal is _____.
 - (h) The gas produced as a by-product in the industrial production of aluminium metal is _____. *Write the formula (not the name).*
 - (i) The precipitate formed when $\text{CO}_2(\text{g})$ is bubbled through a solution of $\text{Ba}(\text{OH})_2(\text{aq})$ is _____. *Write the formula (not the name).*
 - (j) The surface of the resin used in water softeners has a _____ charge.

2. Complete the following table.

Chemical Formula	Name
Na_2O	
Li_2S	
CoCl_3	
	magnesium nitride
	chromium(II) iodide
	titanium(IV) bromide

3. Write a balanced equation for each of the following reactions and name all products.
Include all states of matter.

- | | |
|-----------------------------------|--------------------------------|
| (a) Na and I ₂ (s) | (b) Li and N ₂ |
| (c) Li and O ₂ | (d) K and H ₂ O |
| (e) Ca and O ₂ | (f) Mg and H ₂ O |
| (g) Ga(l) and Br ₂ (l) | (h) CaCO ₃ and heat |
| (i) MgCO ₃ and HCl(aq) | |

4. Write a balanced chemical equation for each of the following reactions.
If no reaction occurs, write "NO REACTION" instead.
Include states of matter.

- (a) Bromine is poured over aluminium.
- (b) Aluminium metal is added to a test tube containing concentrated aqueous sodium hydroxide solution.
- (c) Aluminium oxide reacts with excess aqueous acid.
- (d) Aluminium oxide is added to concentrated aqueous NaOH.
- (e) Calcium carbonate is added to an aqueous solution of hydrochloric acid.
- (f) Magnesium carbonate is heated until it decomposes.

5. A student fills several test tubes with an aqueous solution of hydrochloric acid (HCl(aq)). To each test tube, she adds one solid. Write a balanced chemical equation for each reaction.
Include all states of matter.

- (a) Beryllium oxide is added to aqueous hydrochloric acid.
- (b) Sodium carbonate is added to aqueous hydrochloric acid.
- (c) Potassium metal is added to aqueous hydrochloric acid.

6. If you were the lab instructor for the student in Question 5, which of her three experiments would cause you most concern? Why?
There is more than one reasonable answer to this question.

7.

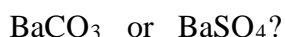
- (a) What is hard water?
- (b) Explain how/why water becomes hard.
Your answer should involve at least one balanced chemical equation.
- (c) Why do deposits build up in pots and kettles which are regularly used to heat hard water?
- (d) What can be done to avoid these deposits? Explain the underlying chemistry.

(e) The deposits can be removed using any acidic cleaner (vinegar, CLR, etc.). Use one or more balanced chemical equations to demonstrate what happens when an acidic cleaner is added to a pot or kettle containing these deposits. *You may use $H^+_{(aq)}$ as a generic acid or you may use any acid of your choice in your answer. Include states of matter.*

8. In the lime-soda process for the softening of water, the first step involves the addition of calcium hydroxide to a solution containing calcium ions and hydrogen carbonate ions. Write a balanced chemical equation for this reaction, including the states of matter of all chemical species.

Hint: What happens if you react the hydrogen carbonate ion with hydroxide?

9. Given that $Ba^{2+}_{(aq)}$ is highly toxic, which of the compounds below would make a more effective rat poison? Briefly, justify your answer. Your justification should include at least one balanced chemical equation.



10. The group 13 metals react readily with oxygen. This would seem to imply that aluminium products should rust easily; however, they do not. Why don't aluminium products rust?

11. Suppose that you want to generate hydrogen gas by reacting aluminium metal with acid. You have a piece of aluminium metal, and bottles of concentrated HCl (12 mol/L) and HNO₃ (16 mol/L). Which acid should you use and why?

12. One of the students accidentally "returned" beryllium oxide to the aluminium oxide jar and has been sent to you to ask if this problem can be fixed without having to throw out the whole jar of now-contaminated aluminium oxide.

(a) Give the chemical formulas for beryllium oxide and aluminium oxide:

(b) The student proposes using a method that they learned in their CHEM 1000 class which removed iron(III) oxide from aluminium oxide before the aluminium oxide was electrolyzed to make pure aluminium. Describe this method for purification of the aluminium oxide.

(c) Will the student's suggestion work to separate beryllium oxide and aluminium oxide? Why or why not?

13. You are given a mixture of $\text{Al}_2\text{O}_3(\text{s})$ and $\text{CuO}(\text{s})$. Explain how you could separate these two compounds and recover both as solids.

Your answer must include balanced chemical equations with states of matter.

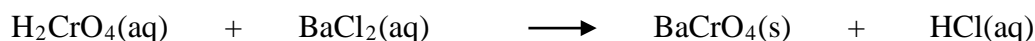
14. Assume that you have access to any materials/equipment you've used in the Chemistry 1000 lab. Your answer may not violate any safety regulations!

- (a) You're given two vials, each containing a white salt. You're told that one vial contains barium chloride and the other contains potassium chloride. How do you determine which salt is which? **Briefly**, explain how your method will tell you which is which.
- (b) You're given two vials, each containing a metal. You're told that one vial contains aluminium and the other contains gallium. How do you determine which metal is which? **Briefly**, explain how your method will tell you which is which.
- (c) You're given two vials, each containing a solid sample of metal. You're told that one vial contains calcium and the other contains zinc. How do you determine which metal is which? **Briefly**, explain how your method will tell you which is which.

15. Calcium carbonate (CaCO_3 , 17.67 g) is heated to $1000\text{ }^\circ\text{C}$ and releases carbon dioxide.

- (a) Write a balanced chemical equation describing this reaction. Include states of matter
- (b) The carbon dioxide is collected in a container at $24.5\text{ }^\circ\text{C}$ and 0.987 bar ambient pressure. Under these conditions, what volume of carbon dioxide is formed?

16. The reaction below occurs when chromic acid (H_2CrO_4) is added to a solution of barium chloride.



- (a) Balance the reaction equation above.
- (b) A solution is prepared by dissolving 3.75 g of solid barium chloride in water. To this solution was then added 75.00 mL of 1.25 M H_2CrO_4 . Determine the maximum mass of barium chromate (BaCrO_4) that could be produced.
- (c) Suggest one reason why BaCl_2 is soluble in water but BaCrO_4 isn't.

17. Aluminium metal is prepared by electrolysis of aluminium oxide using a carbon anode. This process produces carbon dioxide as a byproduct.

- (a) Write a balanced chemical equation (including states of matter) for this reaction.
- (b) Calculate the mass of carbon dioxide produced for every metric ton (1000 kg) of aluminium prepared according to this method. (This does not, of course, include carbon dioxide generated by burning fuels in order to generate the necessary energy for this reaction.)

Give your answer with three significant figures.