

Practice Test Questions 10

Nonmetals Part 1 (Hydrogen and Acids)

1.

 - (a) Give the symbol (including mass number) for each of the three isotopes of hydrogen.
 - (b) Other than “because it’s always been done that way”, why is hydrogen the only element that has different names for its isotopes?
2. Fill in the blanks in the sentences below.

 - (a) A Brønsted acid is a proton _____.
 - (b) A Lewis base is an electron-pair _____.
 - (c) An example of a Lewis acid that is not also a Brønsted acid is _____.
 - (d) In the reaction between Cr^{3+} and water, _____ is the Lewis acid and _____ is the Lewis base. The pH of this solution will be _____ seven. (*greater than, less than or approximately equal to?*)
 - (e) When comparing two Brønsted acids, the stronger acid will have a _____ pK_a value than the weaker acid.
 - (f) $[\text{Co}(\text{OH}_2)_6]^{3+}$ is _____ acidic than $[\text{Co}(\text{OH}_2)_6]^{2+}$.
3. Write a balanced chemical equation for a Brønsted acid-base reaction between a hydride ion and water.
4. Use Lewis diagrams to explain why a solution of $\text{Fe}(\text{NO}_3)_3(\text{aq})$ has a pH significantly below 7.
5. For each of the following pairs of ions, indicate which you would expect to be a stronger Lewis acid and justify your answer.

 - (a) Al^{3+} ($r = 53 \text{ pm}$; $\chi(\text{Al}) = 1.61$) vs. Fe^{3+} ($r = 65 \text{ pm}$; $\chi(\text{Fe}) = 1.83$)
 - (b) Mg^{2+} ($r = 72 \text{ pm}$; $\chi(\text{Mg}) = 1.31$) vs. Sc^{3+} ($r = 75 \text{ pm}$; $\chi(\text{Sc}) = 1.36$)
 - (c) Ag^+ ($r = 115 \text{ pm}$; $\chi(\text{Ag}) = 1.93$) vs. Na^+ ($r = 99 \text{ pm}$; $\chi(\text{Na}) = 0.93$)

6. For each of the following substances, indicate whether it would make a good Lewis acid, a good Lewis base or neither. Briefly, explain each choice.
- CH₄
 - PH₃
 - F₂
 - Fe³⁺
7. Boric acid (H₃BO₃) contains a boron atom with three oxygen atoms attached. Each oxygen atom also has a hydrogen atom attached.
- Draw a Lewis diagram for boric acid.
 - Identify the geometry of the central boron atom and of each oxygen atom.
 - Draw a diagram showing the geometry and bond angles of boric acid.
 - Boric acid is a Lewis acid. Draw a reaction equation showing the Lewis acid-base reaction of boric acid with the hydroxide ion. Use curly arrows to show the movement of electrons.
8. For each of the following pairs of reagents:
- draw a Lewis diagram for each reagent
(each CH₃ is attached to the central atom by a bond to C)
 - identify the Lewis acid and the Lewis base
 - draw a Lewis diagram of the product
- SbCl₅ + (CH₃)₂S →
 - (CH₃)₃Al + (CH₃)₃P →
9. Show, using appropriate Lewis diagrams, that the reaction of sulfur trioxide with water is a Lewis acid-base reaction. Identify the Lewis acid and the Lewis base.
10. Acid HX has a pK_a of 5. Acid HY has a pK_a of 10. Which acid is stronger? How much stronger is it?
- 11.
- HCl is a strong acid. What does that tell you about its pK_a value? What does that tell you about a solution described as HCl(aq)?
 - A solution of NaOH(aq) is titrated with a standardized solution of HCl(aq). If it takes 36.25 mL of 0.1234 M HCl to react with 25.00 mL of NaOH(aq), what is the concentration of NaOH(aq)?

12. Two unlabeled reagent bottles were left with two peeled off old labels: one marked calcium and the other marked calcium hydride.

- Bottle **X** contains small chunks of shiny grey solid suspended in mineral oil.
- Bottle **Y** contains a dull grey powder suspended in mineral oil.

Answer the following questions so that you can put a correct, new label on each bottle.

- (a) Judging from the physical appearance, give an educated guess as to what was in bottle **X** and what was in bottle **Y**.
- (b) Write a balanced chemical equation for the reaction of calcium with water.
- (c) Write a balanced chemical equation for the reaction of calcium hydride with water.
- (d) Since the reactions in (b) and (c) give the same products (a solid and a gas), you decide to use these reactions to confirm which unknown is which. You are able to accurately collect all products so that you know exactly how much of each is produced and you are able to clean off all mineral oil so that you know exactly what mass of each unknown you started with.

Assuming that the unknown was the limiting reagent in both cases, measuring which product would give you the best answer as to which bottle contains calcium and which bottle contains calcium hydride? Explain your answer from a stoichiometry point of view.