Name ___________________________________ per_____ date___________ mailbox_______

The Problem: The Water Shortage Crisis

A Growing Global Concern & Problem

Watch: Documentary Dean Kamen - "making science relevant"

Water scarcity already effects every continent. Around **1.2 billion** people, or almost one-fifth of the world's population, live in areas of physical scarcity to water, and another 500 million people are approaching this situation. Another 1.6 billion people, or almost one quarter of the world's population, face economic water shortage (where countries lack the necessary infrastructure to take water from rivers and aquifers).

Water scarcity is among the main problems to be faced by many societies and the World in the 21st century. Water usage has been growing at more than twice the rate of population increase in the last century, and, although there is no global water scarcity as such, an increasing number of regions are chronically short of water. It is not just the third-world either, consider the periodic water shortage crises in California. As our world population grows, as the uncertainty of *Climate Change* looms, the question of where potable, contaminant free water will come from and the rising cost seems inevitable. What does seem certain, is that new users of fresh water are coming online everyday and with an increasing demand, as the third world seeks the same luxuries, we in the western world *(New Paltz)* seem to take all to readily for granted.

Water scarcity is both a natural and a human-made phenomenon. There is enough freshwater on the planet for seven billion people but it is distributed unevenly and too much of it is wasted, polluted and unsustainably managed.

Drinking water, also known as **potable water**, is water safe enough for drinking and food preparation. It is water safe for human consumption. Water that is not potable may be made potable by **filtration** or **distillation**, or by other less practical means. Worldwide roughly half the people in hospital beds are there due to the consumption of unsafe drinking water sources, which may have been contaminated by Salmonella typhi, Shigella, Campylobacter, Vibrio cholerae, Pseudomonas and/or other pathogenic organisms. These diseases can all be fatal and exact the greatest death toll on younger child.

Sources:

- Human Development Report 2006. UNDP, 2006
- Coping with water scarcity. Challenge of the twenty-first century. UN-Water, FAO, 2007
- Center for Disease Control, http://www.cdc.gov

What are two common practices used to purify water making it *potable?*

1.__________________ & __________________

What are two of Dean Kamen's inventions*?*

2.__________________ & __________________

3. What inspired Dean Kamen to engineer the Slingshot? What problem was he trying to solve?

____
____
____

4. Who ultimately benefits from his invention?

____
____

5. Worldwide how many people are stricken with illness and end up in hospital beds directly due to contaminated drinking water?

____

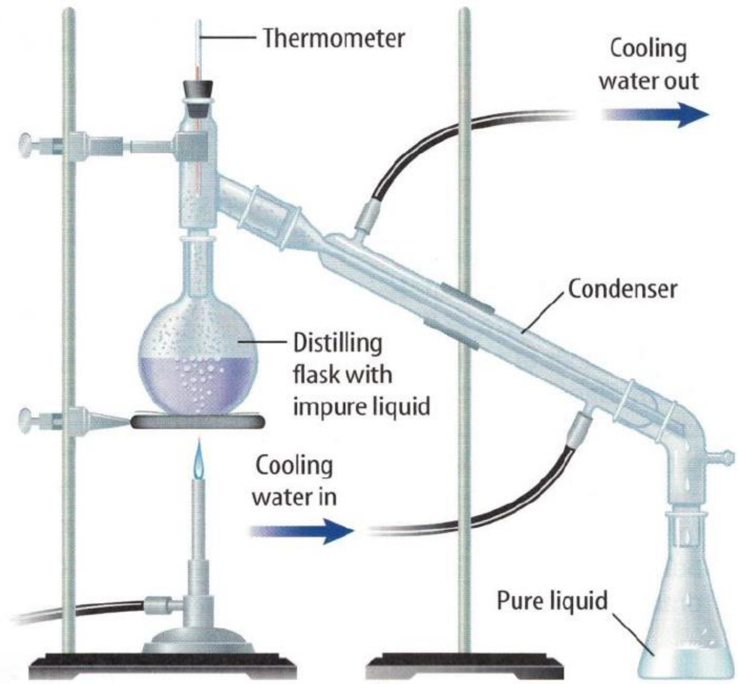
How might the Western World (countries like the US) make an impact on the looming "*Water Crisis*" through innovation (invention) and/or scientific contribution?
Consider what you learned from the video. Phrase in the form of a hypothesis.

6. Critical thinking question:

____
____
____
____
____
____
____

Distillation The process for separating substances in a mixture by evaporating a liquid and recondensing its vapor is **distillation.** It usually is done in the laboratory using an apparatus similar to that shown in **Figure 14.** As you can see, the liquid vaporizes and condenses, leaving the solid material behind.

Two liquids having different boiling points can be separated in a similar way. The mixture is heated slowly until it begins to boil. Vapors of the liquid with the lowest boiling point form first and are condensed and collected. Then, the temperature is increased until the second liquid boils, condenses, and is collected. Distillation is used often in industry. For instance, natural oils such as mint are distilled.



1.Question (read above):

What might happen if we were to heat the distilling flask too rapidly. Will we get only the desired liquid in our collection beaker?

____

____

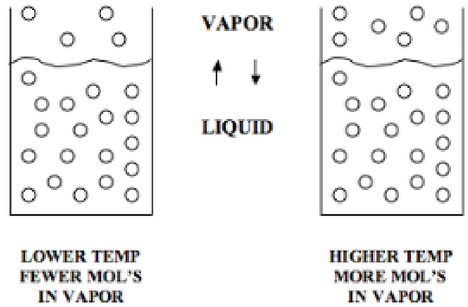
Distillation

Distillation is a commonly used method for purifying liquids and separating mixtures of liquids into their individual components. Familiar examples include the distillation of fermentable things like rice, potatoes or grains into alcohols for spirits such as gin or vodka. Distillation is also used for the separation of crude oil into useful products such as gasoline and heating oil. In the organic lab, distillation is used for purifying solvents and liquid reaction products, the typical of which is often water. To understand distillation, first consider what happens when heating a liquid. At any temperature, some molecules of a liquid possess enough kinetic energy to escape into the vapor phase (***evaporation***) and some of the molecules in the vapor phase return to the liquid ***(condensation)***.

With distillation, a system is set up by which molecules of a liquid are turned into vapor and then liquid again based upon their (***specific heat)***. At higher temperatures, more molecules possess enough kinetic energy to escape, which results in a greater number of molecules being present in the vapor phase. If the liquid is placed into a closed container with a pressure gauge attached, one can obtain a measure of the degree of vaporization. This pressure is defined as the vapor pressure of the compound, and can be measured at different temperatures. This is very useful in the separation of various petroleum compounds from oil or to simply separate water from contaminants because of their varying specific heats and vapor pressures.

2.Question (read above):
What are three things that the distillation process is beneficial for separating out of mixture?

____________________, ____________________, ____________________



The definition of ***boiling point*** (BP) of a substance is the temperature at which the vapor pressure of the liquid equals the pressure surrounding the liquid and the liquid changes into a vapor. The BP of a liquid varies depending upon the surrounding environmental pressure. Boiling point of a liquid in an open container is the temperature at which its vapor pressure equals atmospheric pressure. A liquid in a partial vacuum has a lower boiling point than when that liquid is at atmospheric pressure. A liquid at high pressure has a higher boiling point than when that liquid is at atmospheric pressure. For a given pressure, different liquids boil at different temperatures. This can be seen by looking at the BP of water at different pressures. Atmospheric pressure decreases with increasing altitude so the BP of water is found to be about 95° C in Denver, Colorado which is at about 5300' feet above sea level. Atop a 10,000' foot mountain the BP of water would be approximately 90° C.

____3.Question (read above):
If we **increase** the pressure on a liquid, *such as water*, what happens to the temperature at which it will boil and turn into vapor?

a. it will decrease to below 100° C
b. it will increase to above 100° C
c. water boils at 100° C and thus stays the same
d. pressure has no effect on boiling point (3)pt

____4.Question (read above):
If we **decrease** the pressure on a liquid, *such as water*, what happens to the temperature at which it will boil and turn into vapor?

a. it will decrease to below 100° C
b. it will increase to above 100° C
c. water boils at 100° C and thus stays the same
d. pressure has no effect on boiling point (3)pt

5.Question:

The whole point of a distiller is to distill water, a process called distillation. Boiling the water into vapor can be costly and time consuming. We might speed the process of vaporization up by creating a vacuum, and thus decreasing pressure. How might we then increase the rate at which we turn our vaporized, water vapor (free of contaminates) back into liquid water by condensation?

Hint: temperature

____

____

With some engineering, we might also do this to the pressure at the receiving flask end.

____

____

LABEL THE FOLLOWING:

1 -**Vapors** (evaporated water)

2 - **Distilling flask**

3 - Cooling **water out** (to promote condensation)

4 - Cooling **water in** (to promote condensation)

5 - **Distillate**

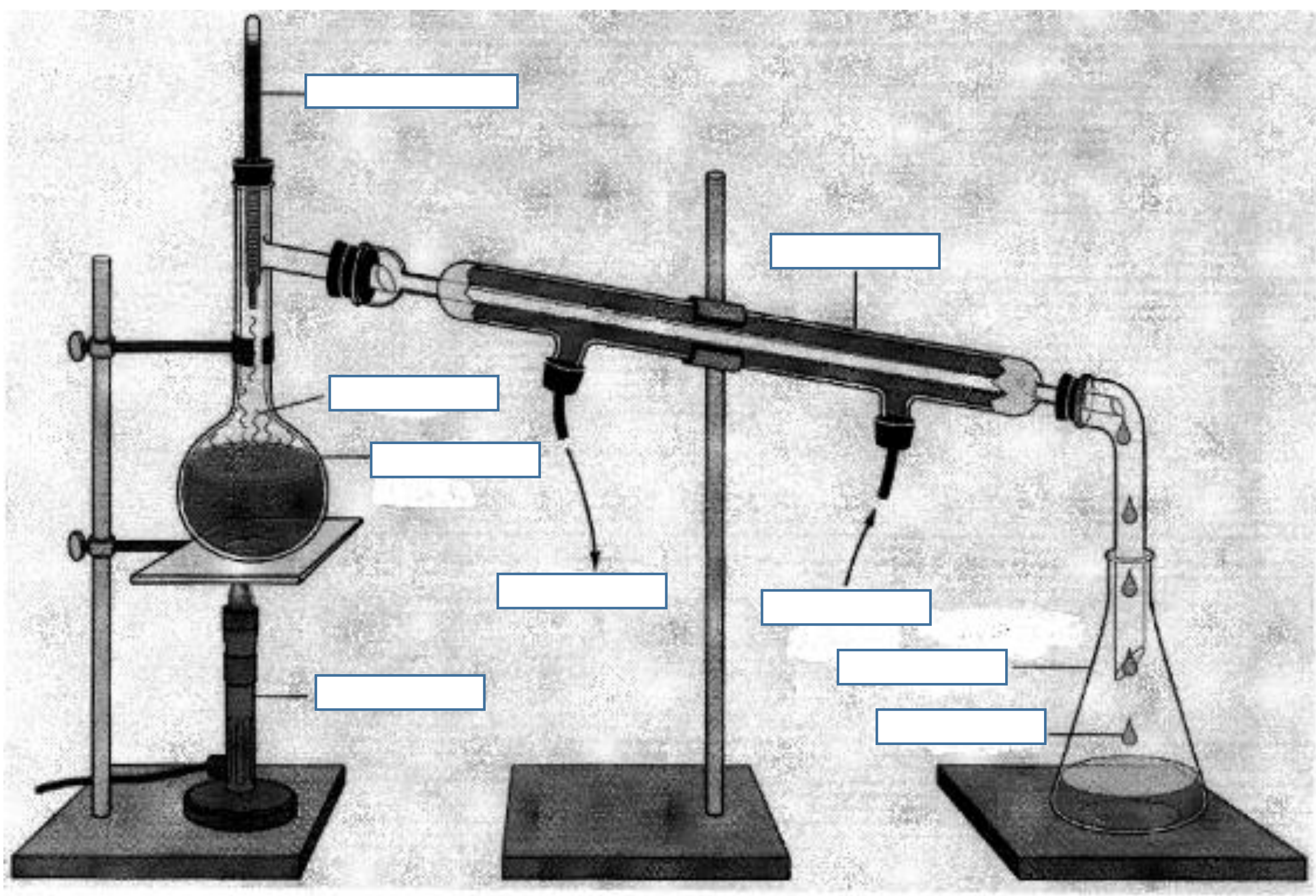
5 - **Condenser**

6 - **Thermometer**

7 - **Receiving flask**

8 - Bunsen **burner**

9 - **solution** / mixture / contaminated water / etc.



LABORATORY PROCEEDURE & DATA

The scenario:

You recently chose to enroll in the Peace Corp. After training you and your coworkers teamed up with members from the Red Cross, having recently deployed to a small village in South Central America. You are here to administer vaccinations to the local farming populous and all is going well until, disaster strikes! A hurricane has unexpectedly turned westward and slammed into the coast moving inland across Brazil. All flights have been grounded, which has delayed your teams resupply for the foreseeable future. Worse yet last night major flooding tipped over the communities potable drinking water container, which was sweep away, along with much of your supplies and any suitable drinking water. Those supplies contained iodine tablets for killing microbes in water so it could be fit for consumption and your team's water purifier kit was also sweep away. What will you do? Miraculously somehow your handy distillation kit has survived the flood waters intact.

WARNING – Goggles must be worn. Lab equipment will be **HOT** and we are generating steam. Boiling water only reaches 100° C, however steam can be many of degrees **HOTTER!**

Step 1. LISTEN AND FOLLOW DIRECTIONS – Goggles must be warn CHECK BOX

Step 2. Assign tasks to individual lab group members ☐

Step 2b. record the pH of the "contaminated tap water" prior to distillation: ___________ ☐

Step 3. Assemble your distillation setup as instructed and as seen in the above diagram. ☐

Step 4. Measure out 250 ml of contaminated water for distilling flask ☐

Step 5. Turn on water hose to condenser. 1 for supply / 1 to the drain ☐

Step 6. Record water **temperature** at the start of experiment in flask, here: ____________ ☐

Step 7. Assemble Bunsen burner and then wait for approval to light it. ☐

Step 8. Light burner, start boiling & **record time**, here: __________________. ☐

Step 9. Monitor temperature. ☐

Record time, here: _____________ and **temperature**_____________ when it **"levels off"** ☐

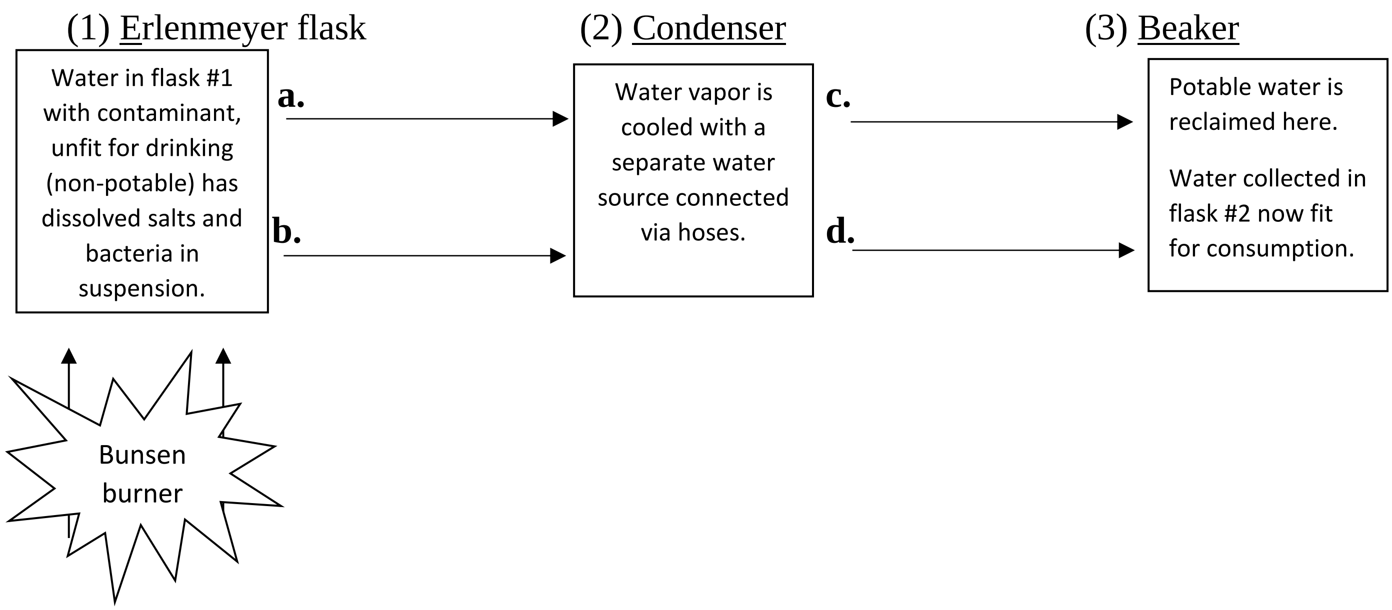
Step 10. Shut down Bunsen burner ☐

Record final time _____________ and **temperature**_____________ ☐

Step 11. Record the amount of distillate (distilled H_2O) in milliliters recovered ____________ ☐

Step 11b. Record the pH of the "potable water" reclaimed: _____________ ☐

Below is a conceptual schematic of a distiller and the distillation process.
Label on the arrow **a. & c.** the phase change of matter
Label on the arrow **b. & d.** with the state of matter
Follow step below



Fill in the blanks below:

1. First the water is ________________ with heat energy from the Bunsen burner.
2. Label arrow **(a)** with the appropriate phase change of matter terminology.
   condensation, evaporation, boiling, melting, vaporization

3. Label arrow **(b)** with the appropriate state of the matter. **solid, liquid, gas**
   Water is given a particular/ special name here.
   This is typically referred to as, and is also called _______________________.

4. Label arrow **(c)** with the appropriate phase change of matter terminology.
   condensation, evaporation, boiling, melting, vaporization

5. Label arrow **(d)** with the appropriate state of the matter. **solid, liquid, gas**
   The water is given a particular/ special name here. (refer to prelab diagram.)
   This is called _______________________.

VIDEO LINKS

Dean Kamen – Inventor of the Slingshot (Water Purification Device) - Watch any and or all of the following:
Go to my website and then follow the links or copy and paste URL into your browser.

- **Slingshot - GE FOCUS FORWARD**
  https://youtu.be/hMODuTBFpPo

- **Slingshot water purifier**
  An affordable, effective water purifier for any area.
  Atlas Initiative Group Inc. is a not for profit organization.
  https://youtu.be/Uk_T9MiZKRs

- **SLINGSHOT TRAILER**
  https://vimeo.com/126189332

If you have Netflix search

- SLING SHOT / Dean Kamen
  http://www.netflix.com/watch/80045628?trackId=13752291&tctx=0%2C0%2C30158779
  Time (0-22 min) & (108min-end) are most relevant.