Chem Honors Lab
The Burning Candle
[30 pts]

Name _____
Lab Partner _____
Date _____ **Period** _____

Purpose: The purpose of this investigation is to explore what happens to a candle when it burns. This apparently mundane event is a surprisingly complex process. You will perform tests and make observations to determine the series of events that takes place in the burning of the candle. Three important questions we want to think about are:

1. *What is needed for a candle to burn?*
2. *What are the reactants and products of the reaction?*
3. *What is the process by which the wax (paraffin, $C_{20}H_{42}$) goes from solid reactant to its products?*

Procedure: Do the following investigations. **Record all observations on this sheet in PENCIL!!!!.** Sometimes you will be asked to make **interpretations** of your results. Don't feel that you must draw your conclusions right after doing the investigation—we will be discussing many of them in class.

1) **[2 pts] Mass change:** Determine the change in mass of the candle after it burns for 15 minutes.
   a) Use a balance to find the mass of the unlit candle and a cardboard square. Remove from balance.
   b) Put down a piece of paper to catch any spilled wax and make cleanup easier.
   c) Light your candle. Once the wax of the candle begins to melt, drip a small amount of wax on the center of the cardboard. Use this drop of wax to attach the candle upright on the cardboard. After burning the candle for about 15 minutes, mass the candle/cardboard again.
   Mass of candle/cardboard when unlit = _____ (to two decimal points)
   Mass of candle/cardboard after burning = _____ Mass lost = _____

   Interpretation: (When a candle is burned, the mass of the candle decreases. Why?)

2) **[2 pts] Carbon (soot) test:** Use a microtip spatula to obtain a *tiny* amount of powdered carbon (soot). Carefully drop the tiny pinch of the carbon into the wax bowl around the wick of a second used, **UNLIT** candle. Light the candle. Make sure the bowl does not break open.
   Observations: (observe the motion of the carbon in the molten [liquid] wax.**)**

   Interpretation (Why is the molten wax moving?):

3) **[2 pts] Water Drop test:**
   Use a medicine dropper to place 5 to 10 drops of water into the bowl of molten wax of a strongly-lit candle (do *not* drop the water onto the wick!). Clean out the bowl before continuing.
   Observations:

   Interpretation: *(What must the molten wax do at the wick that the water prevents?)*

4) **[1 pt] Extinguishing the flame**: (Class demo)
   a) I will invert a 500-mL Erlenmeyer flask over the burning candle. Record time required to extinguish the flame and observe the inside of the beaker.
   b) I'll relight the flame and repeat using a 1000-mL flask.

   Time required for 500-mL flask _____ **Time required for 1000-mL flask** _____
   Interpretation: *(What gas in the air is needed as a reactant to support combustion? Which time is longer? Why is the time for one flask longer than for the other?)*

5) **[2 pts] Cobalt Chloride Test:**
   a) Light your candle. While the candle is still burning, invert a 600 ml *beaker* over the flame and allow it to go out. Lift the beaker and swipe the condensation inside with a piece of cobalt chloride paper.

      color of test paper when tested liquid on inside of beaker: _____
   b) I will dip a pieces of blue cobalt chloride paper into a variety of liquids. Observe colors. (Class demo.)

      in acetone: _____ *in water*: _____ *in alcohol*: _____ *in oil*: _____
   Interpretation *(What is one product of the combustion of a candle? Evidence? What are the elements in this product and what reactants did they come from?)*:

6) **[1 pt] Lime water test:** *(Class demo)*
   a) I will place 10 mL of lime water solution into a 250 mL Erlenmeyer flask & swirl. Observe.
   b) I will invert a 2nd 250 mL flask over the burning candle to collect the gases coming off. Turning it it upright, I will add 10 mL of lime water solution to the flask, stopper it and shake the solution. Observe.
   c) Using a glass tube or straw, I will blow into the first 250 mL Erlenmeyer flask containing lime water solution.

      observations of flask a (air): _____

      observations of flask b (candle): _____

      observations of flask c (exhaling): _____

   Interpretation *(What substance must be produced both by burning a candle and by human respiration? Evidence? What are the elements in this product and what reactants did they come from?)*:

7) **[2 pts] <u>Testing wicks:</u>**
   a) Try lighting some candle wax without a wick.
   b) Try lighting a wick (piece of string) without candle wax surrounding it. How long does it burn?
   c) Lay an OLD, USED candle on its side and stick a toothpick, copper wire and yarn into it to see if they would act as good wicks. Use only 0.5-1 cm of each object

   Observations *(Does wax alone burn? Is the wick alone good? Which objects can maintain a flame?)***:**

   Interpretations *(How does the wick keep the flame burning without itself burning up?)*:

8) **[2 pts] <u>The relighting candle:</u>**
   Light your candle and make sure it is burning strongly. Hold another lit candle in your hand. Blow out the standing candle and quickly hold lit candle flame about an inch from the wick in the column of "smoke" emanating from the candle. (*Don't touch the wick with the lit candle!*).
   Observations:

   Conclusion: *(What chemical property does the smoke have? What part of the candle has the same property? What must the "smoke" be— what substance and state of matter?)*

9) **[4 pts] <u>Metal Gauze:</u>**
   Obtain a square of metal gauze without a central ceramic pad.
   The metal gauze draws heat away from the flame (metal conducts heat). The flame cannot get through the gauze because there is no heat to sustain it. Instead, the substances present will come through and let us see what is in the different regions in the flame.
   a) Hold the gauze near the top of the flame in the orange region. Observe color of smoke. Use a lit splint to try to light the smoke. Does it light?
   b) Lower the gauze until it is just above the wick. What color is the smoke now? Can you light it with the lit splint? Where is it coming from? Observe the shape of the flame around the wick. What is happening in the center?

   Observations *(Describe what you see in the above steps)*:
   a)

   b)

   Interpretation: *What is the substance in the dark orange region of the flame (what substance—element—that you have seen in another part of the lab does this look like)? What is in lighter part of flame (where else in the lab did you see smoke with the same properties)?*

Write-up: [30 pts total] Each person must write up his/her own lab to hand in.
IMPORTANT: *Make sure you are careful about copying. You may help each other with the questions, but each person must write answers on his/her own—do not dictate to each other. Discuss first together and then write separately.*

Observations & Interpretations: [18 pts] Written neatly on lab sheets above. Be complete and specific.

Post-Lab Questions: *Answer in complete sentences (in your OWN WORDS!) on separate sheet of paper. Staple your answers behind the lab handout.*

For help with interpretations and answering these questions, go to the following webpage. Read the description and watch the video before answering the questions below:
http://www.thenakedscientists.com/HTML/content/kitchenscience/exp/-25aeab656d/

1) [10 pts] Suppose you are a molecule of wax (paraffin) in a candle. Using the CER model, write a story describing what happens to you, starting with the ignition of the wick and ending with what happens to you in the dark, blue, and orange regions. Try to trace out your journey step-by-step. Write out this overall chemical reaction (rewrite on separate sheet):

$$C_{20}H_{42} + \underline{\quad\quad} \longrightarrow \underline{\quad\quad} + \underline{\quad\quad}$$

Reactants Products

Be descriptive. At each new step of your journey, describe your properties—your motion, your state, and your relative temperature. Make sure you follow yourself through all physical and chemical changes, and make sure to specify what you end up as.

Your answer should be a few paragraphs long. Write your story in the "first person" (You are a wax molecule) and be as creative as you want. However, make sure you are scientifically correct and descriptive. Make sure to connect evidence and reasoning to each stage of your journey. Be sure to explain how tests that interrupt the process show what must be happening when the process does occur.

2) [2 pts] To light a candle, it is necessary to add some heat (the match) to get the reaction to start. If the reaction requires heat to get started, how does a candle continue to burn on its own once the match is removed? *(What is one non-material product of this reaction?)*

3) [2 pts extra credit] What is a Davy Lamp? Describe its construction, its purpose, and how it works.