1. **Determining the problem or question**. - In this step, you (the researcher) must decide what it is that you will be studying. This sounds like a simple procedure, but it is actually very important. It identifies exactly what you wish to learn and it allows you to focus only on that material.

2. **Development of a hypothesis**. - The hypothesis is not a just a random guess to solve your problem. Instead, the hypothesis is an Educated Guess. In other words, it involves researching the problem and finding out what other people have learned, and using that information to help devise an answer. An important aspect of the hypothesis is that it should answer the original question, and it should be testable!

3. **Design an experiment to test the hypothesis**. - Design an experiment whose results will either support or disprove your hypothesis. If your hypothesis is supported, then the results of your experiment will indicate that your hypothesis is correct. However, this does not mean that your hypothesis is 100%, beyond a shadow of a doubt, correct. There may be other factors that will influence the results that you haven't tested. Therefore, it is important to say that the hypothesis is **supported**; you should never say that it is proven! However, the results of your experiment can prove your hypothesis wrong. There should be at least two groups in your experiment. The first group is the experimental group. This group is the group that has the factor that is being tested (Experimental Variable). It is easy to identify the experimental variable, since it is usually stated in the hypothesis. The second group is the control group. The control group is identical to the experimental group in every way, except that they lack the experimental variable. (Everything else should be the same. If there were other differences, then they would invalidate the results of the experiment.)

4. **Conduct the experiment and collect the data**. - Run the experiment that you have so carefully constructed. In this step, you will be measuring the dependent variable. The dependent variable is the thing that is being observed or measured. Any pieces of information that you collect regarding the dependent variable are called DATA.

5. **Draw Conclusions from your data**. - Here, it is stated directly whether the hypothesis was supported or disproven. If your hypothesis is supported, it should be retested, since one of the basic foundations of the scientific method is that it is repeatable. The more an experiment is repeated, the more valid the results are. However, if there is a hypothesis that is supported by many experiments and a lot of data, we call that hypothesis a **theory**. The word theory is often misused in everyday language. Theory and hypothesis are *not* synonyms; a hypothesis is just an educated guess that may have been supported once or twice by an experiment. A theory was once a hypothesis, but is now supported by a lot of data and is accepted as being correct, unless new information is discovered to disprove it.

1. Suppose you work for a Blabbit Labs, the developer of many different pharmaceutical products. Your research division has stumbled across a new drug that you believe cures male pattern baldness. Before you can start selling the drug, you must demonstrate to the U.S. Food and Drug Administration that the drug is effective.
   a. What is the question being asked?

   b. What is the hypothesis?

You design an experiment with 500 men who have been diagnosed with male pattern baldness. They are divided up into two groups, group A men receiving the drug while group B men receive a placebo, **a drug that is known not to effect baldness**. The drug is referred to as the **experimental variable**, since this is what is being tested. As a hint, the hypothesis will usually identify the experimental variable of a study. In this study, the men receive the drug or a placebo once a day. All of the men will have the number of hairs per square inch of scalp measured in a clinic once per week. The number of hairs per square inch will be the dependent variable since this variable depends on the effectiveness of the experimental variable. The **dependent variable** is also what we use to determine if the experimental variable is actually acting according to the hypothesis and the data collected will usually tell what the dependent variable is.

Men in group A belong to the **experimental group**, since they received the experimental variable. Men in group B belong to the **control group**. The control group is important since it gives the researchers something to compare the experimental group to. For instance, if the men in the experimental group were shown to have hair growth, then that would indicate that the hypothesis was supported and the drug grows more hair. However, if the control group also grew hair, then something in the environment besides the drug was responsible for hair growth.

c. Define dependent (response) and independent (experimental) variables?

d. Compare and contrast the experimental and control group.

Educated Guess

The composition of a hypothesis is essentially a creative process, but is should be done based on existing knowledge of the subject matter. For example, if you were experimenting with ways to speed up a certain reaction, doing background reading on the relevant subjects is vital to composing a suitable hypothesis. If you didn't know anything about chemistry, you may assume that extreme cold will speed up the reaction, when the reverse is actually true. Make an educated guess that provides a solution to the problem to compose a hypothesis.

Testable

One important requirement of a scientific hypothesis is that it is testable. The most common reason for coming up with a hypothesis is for use in a test, so an un-testable hypothesis is useless. For example, the hypothesis "Our universe has a parallel universe beside it that we can't see or interact with" is possibly true, but unfortunately can never be tested. Whilst it may seem credible because it can't be disproved, it is no more credible than any other unverifiable statement, such as "the moon's orbit is controlled by an invisible dinosaur with imperceptible puppet strings". For this reason, hypotheses must be testable.

Falsifiable

Another requirement of a scientific hypothesis is that it can be proven incorrect. This may seem to be an extension of testability, but this is not the case. For example, the hypothesis "There is intelligent life on planets other than Earth" can be proven correct if someone detects a broadcast from another planet or if a space probe lands on a planet with intelligent life. However, disproving this hypothesis is not possible. Even if there are no alien transmissions received or no space probe lands on a planet with intelligent life there could still be intelligent life out there. This hypothesis is not valid because it cannot be falsified.

Scope

Whilst not a requirement for a hypothesis, it is also important to think about how all-encompassing a hypothesis is. Most hypotheses can never really be proven correct, they just appear more likely/unlikely with each test. For example, the hypothesis "Any two objects dropped from the same height will hit the ground at the same time without air resistance" can be shown to be probably correct (as it was on the moon). However, two objects could be discovered tomorrow which behave differently, thereby disproving the hypothesis. Despite this difficulty in truly proving things, reducing the scope of your hypothesis renders your results meaningless. For example, saying "These two specific objects fall at the same rate without air resistance" doesn't have any scope (it only refers to two things). It is better to have a broad hypothesis that isn't quite definitely proven than a narrow hypothesis that is conclusively true.

For each of the statements below determine if it is a good scientific hypothesis or not and explain why using the information above.

1. Light travels slower in glass than in air.
2. Love is more important than knowledge.
3. All objects fall 4.9 meters during the first second after release in a vacuum.
4. The universe is filled with neutrinos, which have no mass, no charge, and do not interact with ordinary matter.
5. Vanilla tastes better than chocolate.
6. The majority of Americans prefer vanilla to chocolate.
7. All human actions are predestined.
8. The Earth revolves around the Sun.
9. The surface of Earth is (nearly) spherical.
10. There is intelligent life (other than Humans) somewhere in the Universe.
11. Plants produce oxygen.
12. There are pink elephants.

Identifying Controls & Variables

Smithers thinks that a special juice will increase the productivity of workers. He creates two groups of 50 workers each and assigns each group the same task. (in this case they're supposed to staple a set of papers). Group A is given the special juice to during while they work. Group B is not given the special juice. After an hour, Smithers counts how many stacks of papers each group has made. Group A made 1587 stacks, Group B made 2113 stacks.

1. What is the Control Group
2. What is the independent variable
3. What is the dependent variable
4. What should Smithers' conclusion be?
5. How could this experiment be improved?

Homer notices that his shower is covered in a strange green slime. His friend Barney tells him that coconut juice will get rid of the green slime. Homer decides to check this out by spraying half of the shower with coconut juice. He sprays the other half of the shower with water. After 3 days of "treatment" there is no change in the appearance of the green slime on either side of the shower.

6. What was the initial observation?
7. What is the control group?
8. What is the independent variable?
9. What is the dependent variable?
10. What should Homer's conclusion be?

Bart believes that mice exposed to radio-waves will become extra strong (maybe he's been reading too much Radioactive Man). He decides to perform an experiment by placing 10 mice near a radio-wave source for 5 hours. He compared these 10 mice to another 10 mice that had not been exposed to radio-waves. His test consisted of a heavy block of wood that blocked the mouse from getting to its food. Bart found that 8 out of 10 of the mice exposed to radio-waves were able to push the wood block out of the way whereas 7 out of 10 of the mice not exposed to radio-waves were able to do the same.

11. What is the control group?
12. What is the independent variable
13. What is the dependent variable
14. What should Bart's conclusion be?
15. How could Bart's experiment be improved?

Krusty was told that a certain itching powder was the newest best thing on the market, it even claims to cause 50% longer lasting itches. Interested in this product, he buys the itching powder and compares it to his usual product. One test (Subject A) is sprinkled with the original itching powder, and another test (Subject B) was sprinkled with the Experimental itching powder. Subject A reported having itches for 30 minutes and Subject B for 45 minutes.

16. What is the control group
17. What is the independent variable
18. What is the dependent variable
19. Explain whether or not the data supports the advertisements claim about its product. How could you improve this experiment?

Lisa is working on a science project. Her task is to answer the question: "Does Rogooti (a hair product) affect the speed of hair growth?" Her family is willing to volunteer for the experiment.

20. Describe how Lisa would perform this experiment. Identify the control group, the independent variable, and the dependent variable in your description.

Scientific Method – Senses Lab

Hypothesis:_____

Procedures:

Two students, one who drops the ruler and one that catches the ruler are present. Both students can use the results of the student who catches the ruler.

The student, who is dropping the ruler, holds the top of ruler vertical at the 30 cm end. The student, who is catching the ruler, puts the top of their index finger at the 0 cm mark and their thumb on the other side of the ruler. This lets the student grab or pinch the ruler. The catching student has their fingers close to the ruler, but not touching it. Once the other student drops the ruler, the catcher tries to catch the ruler with their same fingers. The highest point on the ruler where the catching student's index finger is, is recorded on the handout. Repeat three times.

Sight: The student who catches the ruler puts their finger on the 0 cm mark. The dropping student drops the ruler without any other clues. The catcher tries to grab the ruler once it is dropped. Record your results in the data table below. Repeat three more times.

Touch: The student who catches puts their finger on the 0 cm mark and closes his/her eyes. The student who drops the ruler taps the catcher on the arm and drops the ruler at the same time. Once the catcher's arm is touched, they try to grab the ruler. Record your results in the data table below. Repeat three more times.

Sound: The student who catches puts their finger on the 0 cm mark and closes his/her eyes. The student who drops the ruler says "now" and drops the ruler at the same time. Once the catcher hears "now," they try to grab the ruler. Record your results in the data table below. Repeat three more times.

Trial	Sight	Touch	Sound
1			
2			
3			
4			
Average			

Analysis: Answer the following questions:

1. What is the independent variable? What is the dependent variable?
2. Which sense was fastest? Which sense was slowest?
3. Did the ruler drop to the floor during any of the trials?
4. What would you call this when the ruler dropped to the floor?
5. Were the results of your trials the same as the class average?
6. Why did you perform four trials for each sense?

Graphing: Create a bar graph with the average number on the y-axis and the sense on the x-axis.

Conclusion: (remember to state whether the results support or reject your hypothesis)