Problems:

Note: Follow each step of the problem solving process. When problems are assigned, there will be specific instructions for each problem on the required documentation of the solution to be submitted.

1. Hanging String (Maier JComp Psy 1931; 45)

You walk into a room and see two strings hanging from the ceiling. The strings must be tied together. Although they are long enough to tie together at some height, they are too short by several feet for you to grasp one and still reach the other. In the room there is a table with a set of keys, a flashlight, a book of matches and a pliers. How can you tie the strings together? You may not stand on the table.

Begin by making a diagram to fully understand the situation.

2. Egg Drop Problem-Developing an Algorithm

You work in a 55 story building and are given two identical eggs. You have to determine the highest floor from which an egg can be dropped without breaking. You are allowed to break both eggs in the process. However, you have only 10 drop opportunities to do this. (Assume that the outcome of dropping an egg from a given floor will always be the same, either it breaks or it does not.)

Devise a strategy which will both allow you to determine the floor from which the egg will break within the 10 drop constraint.

Comments: Analyze the problem below. Explore different approaches in devising your plan. Test at the extremes.

Solve the as best you can and generalize the approach to the solution. This problem takes some thought and self-learning. Try different strategies and build on them.

Figure on at least one half-hour make a good effort. Time should be spent in multiple sessions. If it gets to be more than an hour though, reconsider what you are doing.

Document your work with figures and a typed narrative.

3. March Madness

The NCAA (March Madness) tournament begins with 68 teams. It is a single elimination tournament (i.e. one loss and the team goes home) leading to the National Champion.

How many games are played in the tournament?

4. Pizza

You and a friend are sharing a pizza. You want the most. It takes you X seconds to eat a unit of pizza and it takes your friend Y seconds. You can eat only one slice at a time. You cannot reach for a new slice until you've finished the one you're eating. The pizza must be cut into equal slices. If both you and your friend reach for the last slice at the same time, your friend gets it. How many slices should there be to give you the most pizza?

Explore the problem for some estimations, then develop a strategy.

5. Precise Measurement of Time
Using only a 4 minute hourglass and a 7 minute hourglass, determine the most efficient way to measure exactly nine minutes.

6. Effect of Wind on Airplane Flight

When there is a wind blowing, does a round trip by airplane to California take more time, less time or the same time?

7. Bird and Thomas the Tank Engine

Two train engines (Thomas and Edward) are on the mainline track, facing each other. The trains are initially separated by 100 miles. There is a bird perched at the front of Thomas.

The trains begin to move at the same time. Each moves at 10 miles/hr. Just as both engines go in motion, the bird flies from Thomas at a speed of 25 miles/hr toward Edward. When the bird reaches Edward, it reverses direction and flies back to Thomas. The bird continues to go back and forth until Thomas and Edward meet.

What is the total distance will the bird have traveled when Thomas and Edward meet?

Analyze the situation above, show your thinking, heuristics, and approach and give your best solution or estimate of a numerical value. No collaboration. Do your initial thinking on other paper and present your work neatly.

8. Population
In a country in which people only want girls every family continues to have children until they have a girl. If they have a boy, they have another child. If they have a girl, they stop. What is the proportion of boys to girls in the country?

9. Horseracing

You have 25 horses. How many races will it take to determine the fastest two horses? You do not have a timer and can run only 5 horses at a time.

10. Marbles

You have 9 marbles. One of them is heavier than the others. You also have a 2 pan balance as shown below. What is the minimum number of weighings required to identify the heavier ball. Show your work.

11. Space Exploration

Imagine that you are part of a space exploration mission flying from a space station orbiting the moon to a base on the moon itself. An instrument malfunction causes you to crash on the daylight side about 120 km base as soon as possible. Your spaceship is in need of repair and your survival depends upon reaching the moon base as soon as possible. Of the 15 items which were not damaged in the crash of the spacecraft, which would be the most important for the 120 km trip.

Rank the items from the most important (1) to the least important. Your ratings will be compared to the NASA experts and the class.

Name	Your Ranks
Box matches	
Food concentrate	
Eighteen meters of nylon rope	
Parachute silk	
Solar-powered heating unit	
Two .45 caliber pistols	
One case of powdered milk	
Two tanks of oxygen	
Stellar map (of the Moon's constellations)	
Self-inflating life raft	
Magnetic compass	
Fifteen liters of water	
Signal flares	
First-aid kit	
Solar-powered FM Walkie Talkie	

12. Gumballs

You are in charge of a manufacturing process that makes 5 colors of gumballs: red, blue, green, yellow and orange. Each color is made on a separate machine. A properly made gumball weighs 5 grams. One machine is malfunctioning and is making gumballs that weigh 5.1 grams, a waste of material. Your boss brings you bags of each of the 5 colors. His instruction is to determine which machine is malfunctioning. He gives you a scale (like the lab scales) and orders you to determine, **with only 1 weighing**, which machine is defective.

13. CO_2 Emissions from an Automobile
(Ref: Brockman

How much carbon dioxide does a typical automobile emit in one year?

1. Define:

Knowns
Unknowns
Understand the meaning of each piece of information.
Form of the answer

Assumptions

Gasoline fully combusted with oxygen
$C_8H_{18} + 12.5O_2 \rightarrow 8CO_2 + 9H_2O$
Density of gasoline750 kg/m^3
1 mile/gallon = 0.42 km/L
1 mile =1.61 km
Drive 50 miles/day Efficiency: 25 miles/gallon

2. Explore

Concept Map

Initial: Identify and Diagram the heart of the heart of the problem
Experiment to identify the role of the other information. See how they are related to each other.

3. Plan

Make a more detailed concept map
Link together a series of steps of the different parts of the problem.
Substitute the units into the series and see if the steps lead to the expected units of CO2 emitted

4 Implement the plan

Follow the concept map
Do the easy steps first
Apply quantitative information with units

5. Check

Does the answer make physical sense?
Watch the units

5. Generalize

How does this answer compare to your expectation.

Part 1

Make a preliminary concept map.

The preliminary map may only have a few boxes, showing the major steps

Explore the assumptions

This will allow you to recognize relationships to chain together different aspects

Use them to make a detailed concept map

Use this concept map as a guide to do the calculations

Pay attention to the units

Part 2. Analysis of your work and calculations.

1. Review the descriptions of each of problem solving steps in the handout.

2 Compare your concept map with the one below.

Identify the heart of the problem in your map

Rearrange the boxes so that the supporting concepts feed into the heart of the problem

Redraw your diagram if needed (It is important for you to physically modify the diagram, rather than simply comparing the two visually)

3 Trace the method of solving the problem through the concept chart.

After you understand each step in words, then write the equations for each step.

Only then, substitute the numbers into the equations, keeping track of units. Use the assumptions on the other side of the page.

Do 1 step at a time and show your work carefully organized.

4. Write a one page analysis using your original diagram and the one below. The focal point of the essay is to write down your original thinking when you did the assignment and compare it to your current understanding. The objective is to understand and improve your problem solving skills.

5. Hand in the revised concept map, the carefully arranged calculations and the essay.

14. Candle Production Rate of a Beehive(Additional Data Needed)

Bees are busy day and night collecting nectar, converting it to honey and then some of the honey to wax. The heavier wax is necessary to physically support the hive. This question asks you to determine, by calculation, how long it takes a hive of bees to make a beeswax candle.

A beeswax candle will, in the presence of excess oxygen, fully burn to carbon dioxide and water. A pure beeswax candle was allowed to burn for 30 minutes. The carbon dioxide gas was collected. The volume of this gas was measured at L at a temperature of 18 ^{o}C. The candle was then allowed to burn until the flame went out, an additional 90 hours. The mass of the remaining stub was 60 g. How long did it take a hive of 20,000 bees to make enough wax for this candle?

Initial Assignment: (1.) Explore and (2) Plan an approach to this problem. Unless you are familiar with the habits of bees, you may need to do some research to understand the process. Be sure to understand the physical meaning of all of the information below before proceeding. Describe in writing the meaning and usefulness of each piece of information that you use. Construct a detailed concept map. Bring 2 copies (one to hand-in and the second for collaboration with your group

Second Step: Revise a concept diagram based on input from the group and submit the consensus for the group. These group maps will be shared with the other groups.

Third Step: Fill in the appropriate data into the concept map. Do the calculations individually. Check your work.

Information:

$PV = nRT$ R L-atm/ mole-^{o}K

A hive of 20,000 bees can produce 0.34 kg of honey in a natural setting.

It requires 8 g of honey to produce 1 g of wax.

The molecular formula for beeswax is $C_{46}H_{92}O_{2.}$

1 kg of wax (formed into a comb in the hive) can structurally support a hive of 22 kg.