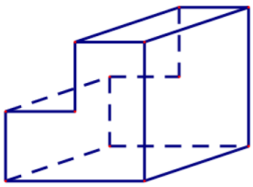
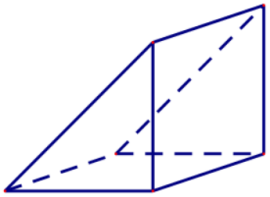
Problem 1. Archimedes' principle

The Archimedes' principle states that a body immersed in a fluid experiences a buoyant force equal to the weight of the fluid it displaces. However, it is not a fundamental theorem in fluid mechanics. Indeed the buoyant force is induced by the pressure difference exerted on the surface of a floating object. In this problem we will study the nature of Archimedes' principle.

1. Place a cube in water. Try to calculate the net pressure on the cube. Compare your result with Archimedes' principle.
2. Now consider a stair shaped object. Calculate the net pressure on it.



3. Consider a wedge-shaped object. Calculate the net pressure on it.



4. With the experience you gain in parts 2 and 3, try to verify Archimedes' principle for an arbitrarily shaped object.

Problem 2. The lever principle
Suppose that you were born in the ancient Greek, and you were trying to prove the lever principle.

1. By the symmetry principle, two objects with the identical mass can be safely loaded on an equal-arm lever. Try to promote the case to a lever with the arm-length-ratio 2:1.

Figure 1: Equal arm lever and 2:1 arm lever

2. Now try to prove the lever principle in the general case (p/q arm with p and q co-prime integers. You can ignore the irrational ratio).

Problem 3. Free fall acceleration

Suppose that you were living in the 16th century (a hundred year before Newton was born). There were people who believed the velocity of a free fall object was proportional to the distance it passed. Now, please make your own argument to convince them that they were wrong.

(You can do this by reductio ad absurdum. There must be something contradicting to our common sense.)

Problem 4. Atoms

1. Consider an ideal gas. How should the pressure p depend on n, the number of atoms per unit volume, and a certain average of the speed v of an atom? Should it vary more, or, less, rapidly than linearly?

2. If the atoms of all objects are perpetually in motion, how can there be any permanent objects, such as fossil imprints?

3. Chemists have found that the molecules of rubber consist of folded chains of atoms. Explain why a rubber band becomes warm when it is stretched. What should happen to a rubber band which is supporting a given weight, if it is heated?

Problem 5. Feynman's lectures on Physics

Now you have read the beginning three chapters of Feynman lectures on Physics. Write down an essay with a few paragraphs about your thoughts on these lectures. For example, you might discuss in your essay which parts touch or impress you most in the beginning three lectures.