Physics **Mechanical Equilibrium--Force as a Vector**

Write-out the solutions to the following problems on a separate piece of graph paper; first graphically, *then* analytically. Choose an appropriate scale so that each graph should takes up *at least* one-half of a page.

1. A student is pulling a 250-N sled at a constant speed with a force of 100 N with a rope over his shoulder that makes an angle of 35° to the ground.

a) What is the horizontal component of this force? What is the force of friction that acts on the sled?

b) What is the vertical component of this force? What is the normal force?

2) A sign is supported on the side of a building with a cable at an angle of 20° from the vertical and horizontally with a boom. The tension in the cable is 500 newtons.

a) What is the weight of the sign?

b) What force does the boom exert on the sign?

3) A kite weighs 1 newton. It flies in the wind with the kite string pulling with a force of 2 newtons at an angle of 45° to the horizontal.

a) How great a force does the wind exert on the kite?

b) In what direction is this force relative to the ground?

4) A picture weighs 10 newtons. It is hung with a picture wire from a nail. The two ends of the wire form an angle θ to the horizontal.

a) What is the total force acting on the picture?

b) What is the total force acting on the nail?

c) What is the total upwards (vertical) force acting on the nail?

d) What is the total upwards force acting on the picture?

e) Make a free-body force diagram of the forces acting at the point where the wire touches the nail for two different values of the angle θ, 60°, and then 6°.

f) Find the tension of the wire graphically; first at 60°, and then for 6°.

g) Find the tension of the wire using analytical methods. Explain why fairly strong picture wire may be needed to support even a fairly lightweight pictur1?

5. Your car is stuck in the mud, far from a telephone but 10 meters from a big tree. You have a strong rope and are very clever. You tie the rope to the car bumper and to the tree and the you lift up on the center of the rope with a force of 100 newtons and lift the chain 25 cm.

a) What angle does the rope make with the ground when you are lifting up on the rope?

b) What force is exerted on the bumper of the car?