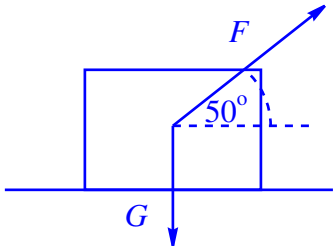
1. Two forces act on a box. Let $\overrightarrow{G}$ represent the force of gravity pulling down with 5.0 Newtons and $\overrightarrow{F}$ the force of a rope pulling at an angle of 50^0 to the horizontal with 9.0 Newtons .

   (a) Draw a diagram of this situation.



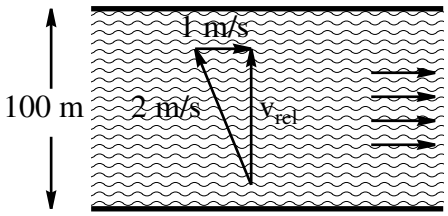
   (b) Express $\overrightarrow{F}$ and $\overrightarrow{G}$ in component form.
   $F_x = 9\cos 50 = 5.8$ N and $F_y = 9\sin 50 = 6.9$ N.
   So $\overrightarrow{F} = 5.8\overrightarrow{i} + 6.9\overrightarrow{j}$ N and $\overrightarrow{G} = -5.0\overrightarrow{j}$ N

   (c) Find the resultant force, $\overrightarrow{F} + \overrightarrow{G}$, in component form and in magnitude/direction form. Will the box be lifted off the ground?
   $\overrightarrow{F} + \overrightarrow{G} = 5.8\overrightarrow{i} + 6.9\overrightarrow{j} + (-5.0\overrightarrow{j}) = 5.8\overrightarrow{i} + 1.9\overrightarrow{j}$ N in component form. The resultant force has magnitude $\sqrt{5.8^2 + 1.9^2} = 6.1$ N and direction $\theta = \tan^{-1}(1.9/5.8) = 18.1^0$ above the horizontal. Since the vertical component of the resultant force is positive the box will be lifted up.

2. A swimmer can swim at a rate of 2 m/s. She swims in a river that flows at 1 m/s.

   (a) Suppose she swims directly downstream for 100 m and then swims back upstream for 100 m? How long does this take? (Hint: You need to find her velocity relative to the bank of the river in each case.)
   Downstream $v_{rel} = 2 + 1 = 3$ m/s. Upstream $v_{rel} = 2 - 1 = 1$ m/s
   $\Delta x = vt \Rightarrow t = \Delta x/v$ so downstream $t = 100/3 = 33$ s and upstream $t = 100/1 = 100$ s.
   Total time is 133 s

   (b) Suppose the river is 100 m wide and she decides to swim directly across the stream and back? How long will this take? (Hint: She will need to aim upstream a bit in order to travel straight across. What is her velocity relative to the bank now?)



   $v_{rel} = \sqrt{2^2 - 1^2} = 1.73$ m/s

   $t = \Delta x/v = 100/1.73 = 58$ s
   Total time is $58 + 58 = 116$ s

3. A ferry leaves port traveling due east at 5.0 m/s for 10 minutes. It then turns north and travels at 10.0 m/s for 20 minutes. Find the total displacement of the ferry (both distance and bearing).

   Displacement east $\Delta x = vt = 5.0(10 \times 60) = 3000$ m $= 3$ km
   Displacement north $\Delta x = vt = 10.0(20 \times 60) = 12000$ m $= 12$ km
   Total displacement is $\sqrt{3^2 + 12^2} = 12.3$ km
   Direction is $\tan\theta = 12/3 = 4 \Rightarrow \theta = 76^o \Rightarrow$ bearing $= 90^o - 76^o = 014^o$

4. Another ferry leaves port traveling east and accelerating from rest at a uniform rate of 0.015 m/s^2 for 10 minutes. The ferry then turns north accelerating from rest at a rate of 0.015 m/s^2 but this time for 20 minutes.

   (a) During the eastward leg of the journey what velocity has the ferry achieved after accelerating for 10 minutes? How far has the ferry traveled in 10 minutes?
   Velocity: $\Delta v = at = (0.015)(10 \times 60) = 9$ m/s $\Rightarrow v = 9$ m/s
   Displacement: $\Delta x = \bar{v}t$ and $\bar{v} = (0 + 9)/2 = 4.5$ m/s
   so $\Delta x = 4.5(10 \times 60) = 2700$ m $= 2.7$ km

   (b) During the northward leg of the journey what velocity has the boat achieved after accelerating for 20 minutes? How far has the ferry traveled in 20 minutes?
   Velocity: $\Delta v = at = (0.015)(20 \times 60) = 18$ m/s $\Rightarrow v = 18$ m/s
   Displacement: $\Delta x = \bar{v}t$ and $\bar{v} = (0 + 18)/2 = 9$ m/s
   so $\Delta x = 9(20 \times 60) = 10800$ m $= 10.8$ km

   (c) What is the total displacement of the ferry (both distance and bearing)
   Total displacement is $\sqrt{2.7^2 + 10.8^2} = 11.1$ km
   Direction is $\tan\theta = 10.8/2.7 = 4 \Rightarrow \theta = 76^o \Rightarrow$ bearing $= 90^o - 76^o = 014^o$