Problem 1:

First step: Write down everything you are given, what assumptions you can make, and everything the problem asks for.

Given: yi=20.0 m Δx=40.0 m vi=20.0 m/s θ= 30o above the horizon

Next our assumptions : ay=g there is no mention of resistive forces so ax=0

Lastly what is the problem asking for: yf=?

Next step: What equations can help us get to the answer? Or rather what equation has yf in it along with the other information given?

The work energy theorem should NOT be used here as we are not concerned with final velocity. This leaves the Kinematic equations. Like we stated earlier we are not concerned with final velocity so we should look for the kinematic equation that does not involve final velocity. The only kinematic equation that is close to what we want is xf=xi + vit+ ½ at2. By adapting the equation in the y direction and by using gravity as our acceleration we have the modified equation yf = yi + (vy)it - ½ gt2.

(vy)i

vx

vi

30o

However we do not have the time t and therefore we cannot compute the answer. At this point we need to realize that the time it takes for the projectile to complete its travel in the y direction is equal to the time it takes to complete its travel in the x direction. We need to solve for t in the x direction. Since there is no acceleration in the x direction (vx)f=(vx)I so we’ll just designate it as vx. By rearranging the terms of the equation vx=Δx/Δt into Δt= Δx/vx we can solve for t. BUT we can’t just put in 20.0 m/s as our vx. We have to break our initial velocity along the x and y axes. See crudely made figure below.

Remember our vx is constant but our vy is not so we need to designate it as (vy)i  (this becomes important later in the problem).To find vx we need to use the trig identity cosine(θ)=Adjacent/Hypotenuse. By setting vx as our adjacent, vi as our hypotenuse, and 30.0o as our angle θ then rearranging the terms we end up with vx= vicos(30.0o). We know that vi=20.0 m/s so vx=(20.0 m/s)cos(30.0o)= 17.3 m/s. Plugging that into our Δt=Δx/vx and given that Δx = 40.0 m we can calculate t = (40.0 m)/(17.3 m/s) = 2.31 s.

Now we’re getting close! But before we plug t into our yf = yi + (vy)it - ½ gt2 equation we need to remember that because we are doing this calculation in the y direction we must use the y component of vi (see crudely made figure above). To find vy we need to use the trig identity sine(θ)=Opposite/Hypotenuse. By setting vy as our opposite, vi as our hypotenuse, and 30.0o as our angle θ then rearranging the terms we end up with vx= visin(30.0o). We know that vi=20.0 m/s so vx=(20.0 m/s)sin(30.0o)= 10.0 m/s. Now we can plug in all our known values to find the answer.

Last step: yf = yi + (vy)it - ½ gt2

yf = (20.0 m)+ (10.0 m/s)(2.31 s) - ½ (9.8 m/s2)(2.31 s)2 = 17.0 m

Important note: I set my gravity to 9.81 m/s and kept my values to four decimal places before rounding to the answer so I got 16.9 m/s as my answer which is what was on the answer sheet. If you did the equation as shown above it would be 16.95311 m/s which would round up to 17.0 m/s. This small difference shouldn’t matter on a test.