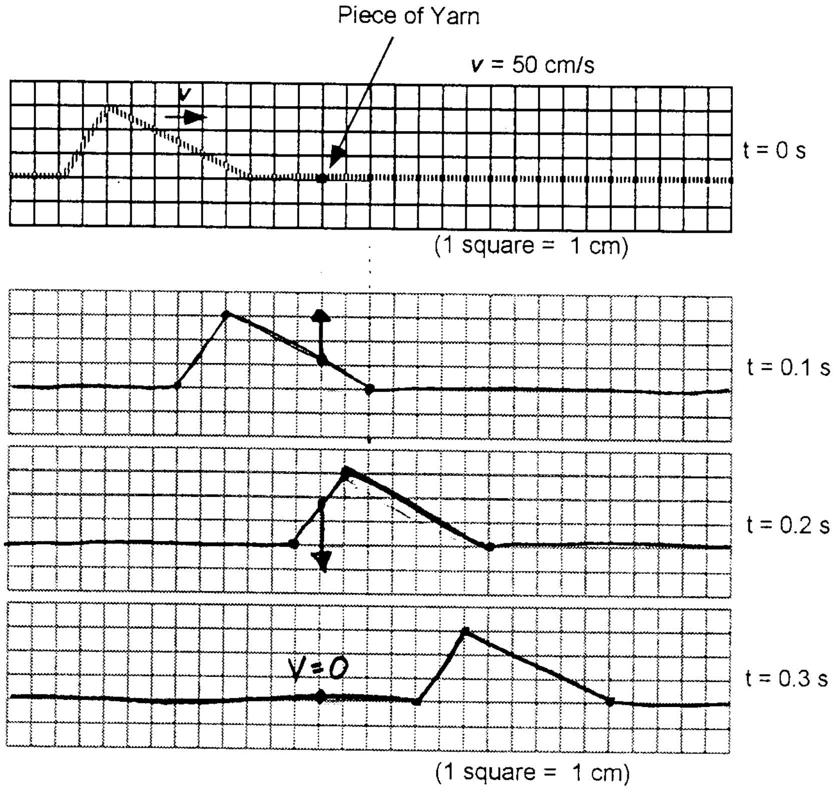
Physics 123
Spring 2000

Supplemental Problem 1

Name SOLUTION
Tutorial Section ______

A. The pulse shown at right travels on a spring with a constant speed of 50 cm/s. A piece of yarn is tied to the spring at the position shown.



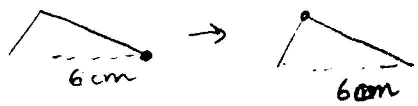
i. In the space provided at right draw the shape of the spring at the instants $t = 0.1$ s, $t = 0.2$ s, and $t = 0.3$ s. Be sure to include the piece of yarn in your drawing.

ii. Draw an arrow on the piece of yarn to represent the direction of the velocity vector of the piece of yarn at $t = 0.1$ s, $t = 0.2$ s, and $t = 0.3$ s. If the velocity of the piece of yarn is zero at any time state that explicitly. Explain your reasoning.

At t=0.1s the yarn is moving up and at t=.2s it is moving down – it stays at the same x position on the string. At t=.3s it is not moving up or down. The velocity vector on the way down is larger since it traveled the same distance in a less amount of time.

iii. Determine the instantaneous velocity for the piece of yarn at t = 0.1 s, t = 0.2 s, and t = 0.3 s. Indicate magnitude and direction. (*Hint*: Consider the average velocity of the piece of yarn as it moves up and as it moves down.) Explain your reasoning.

t=.1s { As the yarn moves up it's average velocity is $\frac{\Delta y}{\Delta t}$
∴ $\Delta y = 3$ cm and it takes .12s to move to the peak (since the pulse moved 6 cm and it's velocity is 50 cm/s which gives $\frac{6\text{cm}}{50\text{cm/s}} = .12$ s)



∴ Ave V = $\frac{3\text{cm}}{.12\text{s}}$ = 25 cm/s up
since the slope is const on the way up the ave V is the same as the inst V.

t=.2s { similarly on the way down it travels 3 cm in $\frac{2\text{cm}}{50\text{cm/s}}$ (=.04s)
so $V_{ave} = V_{inst}$ = 75 cm/s down. (same dist in 1/3 the ∆t)

t=.3s { At t=.3s the inst V is 0 since it does not move.

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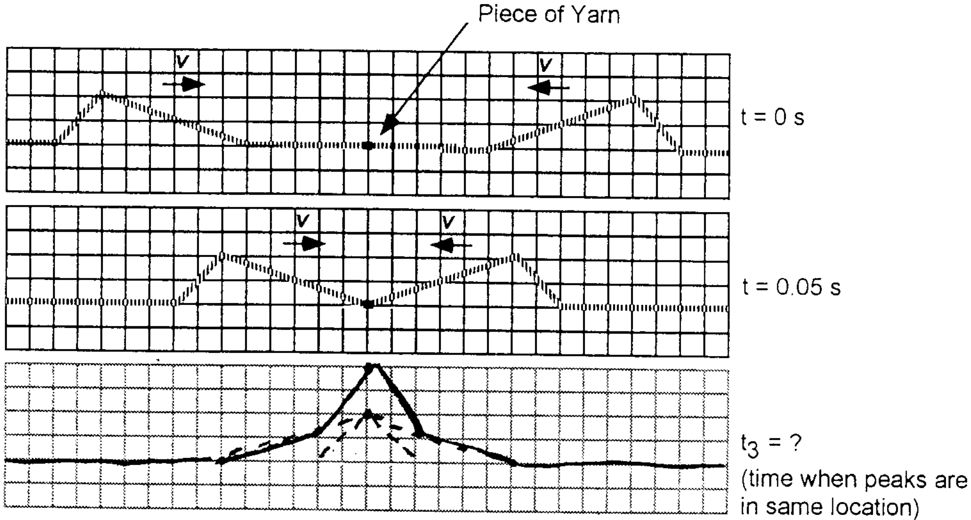
B. Consider a new situation in which two pulses approach each other on a spring. The pulses are shown at two instants. (The spring in this case is different from the spring in part A.)



(1 square = 1 cm)

i. Determine the speed of the two pulses. Explain your reasoning.

Both pulses traveled 5cm in 0.05s ∴ Their speeds are 100 cm/s. Both should have the same speed since they are on the same spring.

ii. Determine the time, t_3, when the peaks of the pulses are at the same location along the spring.

Both peaks need to move 6cm for them to match up ∴ each pulse needs to move 6cm (from posit at t=

$\Delta t = \frac{6cm}{100 cm/s} = \frac{\Delta x}{V} = .06s$ ∴ $t_3 = .05s + .06s = .11s$

iii. Sketch the shape of the spring at t_3 on the figure above.

Using superposition we get the sketch above.

iv. Determine the average velocity of the piece of yarn from t = 0.05 s to $t = t_3$. Explain your reasoning.

Average velocity is $\frac{\vec{\Delta y}}{\Delta t}$ and $\vec{\Delta y}$ for the piece of yarn is 4 cm − 0 cm = 4 cm up and Δt = .06s

so $\vec{V}_{Ave}$ = 67 cm/s up.