Flipping Physics Lecture Notes:

2018 #4 Free Response Question - AP Physics 1 - Exam Solution
http://www.flippingphysics.com/ap1-2018-frq4.html

This is a Short Answer Question.

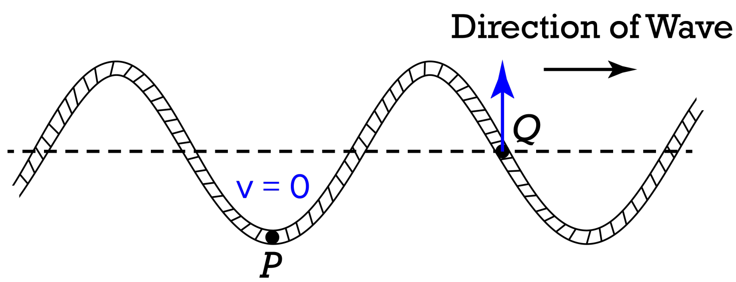
A transverse wave travels to the right along a string.

(a) Two dots have been painted on the string. In the diagrams below, those dots are labeled P and Q.

i. The figure below shows the string at an instant in time. At the instant shown, dot P has maximum displacement and dot Q has zero displacement from equilibrium. At each of the dots P and Q, draw an arrow indicating the direction of the instantaneous velocity of that dot. If either dot has zero velocity, write "v = 0" next to the dot.

Just before this instant in time P was moving downward, just after this time P will be moving up, therefore, right now point P is at rest. (Just like an object thrown upward in free fall is at rest at its maximum height.)

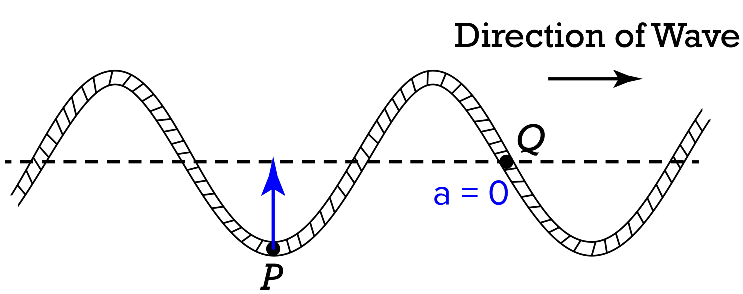
Just before this instant in time Q was moving up, just after this time A will still be moving up, therefore, right now point Q is moving up.



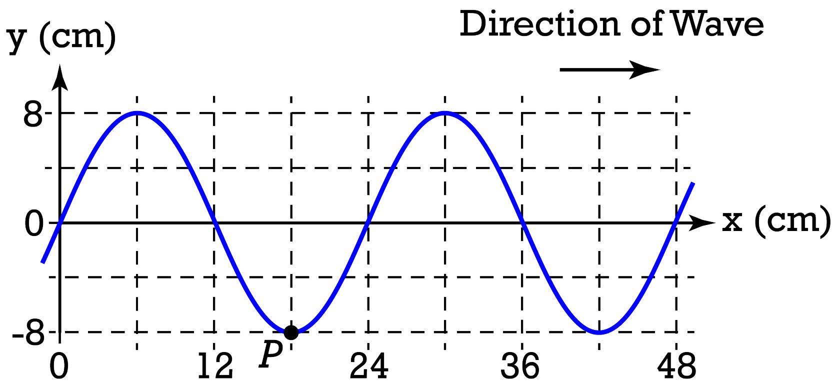
ii. The figure below shows the string at the same instant as shown in part (a)i. At each of the dots P and Q, draw an arrow indicating the direction of the instantaneous acceleration of that dot. If either dot has zero acceleration, write "a = 0" next to the dot.

Just before this time P was moving down, just after this time P will be moving up, therefore, the change in velocity of P is upward and point P has an upward acceleration. (Just like an object thrown upward in free fall has a downward acceleration at its maximum height.)

In order to fully understand point Q, remember that individual points on a mechanical wave move in simple harmonic motion. Because Q is at the equilibrium position, Q is moving at its maximum velocity and point Q has zero acceleration. Point Q's acceleration is zero at this specific instant in time because, before this time its acceleration is upward, and after this time its acceleration is downward, therefore, at this instant in time, its acceleration is zero.



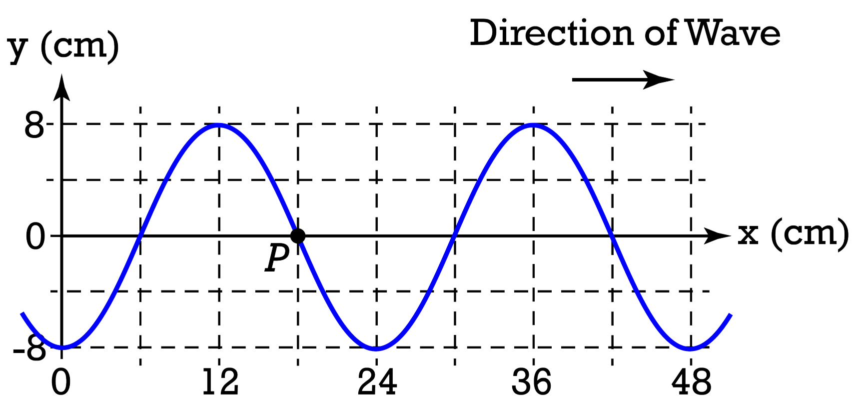
The figure below represents the string at time t = 0, the same instant as shown in part (a) when dot P is at its maximum displacement from equilibrium. For simplicity, dot Q is not shown.



(b)

i. On the grid below, draw the string at a later time t = T/4, where T is the period of the wave.

The time for a period is one full cycle. During one full cycle the wave will move one wavelength, λ, or 24 cm. Therefore, during one fourth of a full cycle the wave will have gone a distance of one fourth of a wavelength or 24cm/4 = 6 cm. The shape of the wave will not change.



ii. On your drawing above, draw a dot to indicate the position of dot P on the string at time t = T/4 and clearly label the dot with the letter P.

Point P will stay on the wave at x = 18 cm; therefore, it will move up to y = 0.

(c) Now consider the wave at time t = T. Determine the distance traveled (not the displacement) by dot P between times t = 0 and t = T.

During one full cycle, point P will start at y = -8 cm, move up to y = +8 cm, and then back down to y = -8 cm. Therefore, point P will have moved a distance equal to four times 8 cm or 32 cm.

A few notes about grading:
You can gain all 7 points for this problem without writing out any calculations or explanations.

- 4 points in part (a), 1 for each item they specifically ask you for and do not require explanation.
- 2 points in part (b), 1 for each item they specifically ask you for and do not require explanation.
- 1 point in part (c) again with no explanation or calculation.
    - For part (c) you can write just 32 cm (with units) and get full credit.