Q- A wave on a string is described by $D(x,t)$ = (3.0 cm) sin[2 π(1 + x/(2.1 m) - t/(0.2 s))].
(a) In what direction is this wave traveling?

The equation can be written as

$$D(x,t) = (3.0cm)\sin\left[2\pi\left(1 + \frac{x}{2.1m} - \frac{t}{0.2s}\right)\right] \qquad \text{---------- (1)}$$

Or $$D(x,t) = (3.0cm)\sin\left[\left(\frac{2\pi}{2.1m}\right)x - \left(\frac{2\pi}{0.2s}\right)t + 2\pi\right]$$

Now as we know that at a moment the phase angle decrease in the direction of wave motion and here if t is constant with x the phase angle is increasing this says us that the wave is traveling in negative x direction.

(b) What are the wave speed, the frequency, and the wave number?

Comparing above equation with standard wave equation we get

K = $\frac{2\pi}{\lambda} = \frac{2\pi}{2.1m}$ gives wavelength λ = 2.1 m

And $\omega = \frac{2\pi}{T} = \frac{2\pi}{0.2s}$ gives T = 0.2 s

Hence the wave speed

c = $\frac{\lambda}{T} = \frac{2.1}{0.2} = 10.5$ m/s

Frequency

$$n = \frac{1}{T} = \frac{1}{0.2} = 5 \text{ Hz}$$

and the wave number

K = $\frac{2\pi}{\lambda} = \frac{2\pi}{2.1m} = 2.992$ m^{-1}

(c) At t = 0.50 s, what is the displacement of the string at x = 0.20 m?

Substituting the values for x and t in equation (1) we get

$$D(x,t) = (3.0cm)\sin\left[2\pi\left(1 + \frac{0.20}{2.1m} - \frac{0.50}{0.2s}\right)\right]$$

Or $$D(x,t) = (3.0cm)\sin[-2.81\pi] = (3.0cm)\sin[-506^0] = 3.0*(-.563) = -1.69 \text{ cm}$$