54. (a) The frequency is $f = 1/T = 1/4$ Hz, so $v = f\lambda = 5.0$ cm/s.

(b) We refer to the graph to see that the maximum transverse speed (which we will refer to as u_m) is 5.0 cm/s. Recalling from Ch. 12 the simple harmonic motion relation $u_m = y_m\omega = y_m 2\pi f$, we have

$$5.0 = y_m\left(2\pi\,\frac{1}{4}\right) \quad \Longrightarrow \quad y_m = 3.2 \text{ cm} \ .$$

(c) As already noted, $f = 0.25$ Hz.

(d) Since $k = 2\pi/\lambda$, we have $k = 10\pi$ rad/m. There must be a sign difference between the t and x terms in the argument in order for the wave to travel to the right. The figure shows that at $x = 0$, the transverse velocity function is $0.050 \sin\frac{\pi}{2}t$. Therefore, the function $u(x,t)$ is

$$u = 0.050 \sin\Big(\frac{\pi}{2}\,t - 10\pi x\Big)$$

with lengths in meters and time in seconds. Integrating this with respect to time yields

$$y = -\frac{2(0.050)}{\pi}\cos\Big(\frac{\pi}{2}\,t - 10\pi x\Big) + C$$

where C is an integration constant (which we will assume to be zero). The sketch of this function at $t = 2.0$ s for $0 \le x \le 0.20$ m is shown.