Solution to Problem 130G

(1) As with all simple harmonic motions, the maximum acceleration, a, is given by $\omega^2 h$ where ω is the radian frequency of the waves and $h = 1m$ is the amplitude of the waves. We also know from the analysis of waves on an infinitely deep ocean that the radian frequency of the waves, ω, and the wavelength of the waves, λ, are related by

$$\omega = \left(\frac{2\pi g}{\lambda}\right)^{\frac{1}{2}}$$

Putting these two relations together we have that

$$a = \frac{2\pi g h}{\lambda}$$

and since $h = 1m$ and $\lambda = 10m$ it follows that

$$\frac{a}{g} = \frac{2\pi}{10} = 0.628$$

(2) The analysis of waves on an infinitely deep ocean also demonstrated that the amplitude of the waves decays exponentially with depth below the mean surface level. Consequently the amplitude will be one tenth of the value at the surface at a depth, d, where

$$e^{-kd} = 0.1$$

where $k = 2\pi/\lambda$ is the wavenumber of the waves. Consequently

$$d = \frac{\lambda}{2\pi}\ln 10 = \frac{10\ln 10}{2\pi} = 3.66m$$