M1-SOAC TD2b

Chapter 2: Surface Waves
Deep and Shallow Water waves

Question a:

For **a canal** of depth 5 m, calculate the phase speed and group speed for waves of wavelength (i) 1 m, (ii) 100 m.

Question b:

If you **throw a stone of diameter D** into deep water, most of the energy will be transformed into a gravity wave of wavelength $2D$. Show that the ring that spreads from the impact after time t will have diameter $(gDt^2/\pi)^{1/2}$.

Question c:

You want to **tow a barge in a (shallow-water) canal**, using horses which maximum walking speed is 4 m/s. The resistance is greatly reduced if you can lift the boat so that it rides its own bow wave.
What is the maximum depth of the canal for which this trick is possible?

Question d:

A storm out at sea produces waves which propagate to the coast. Show that the wave period is given by:

$$\tau = 2\pi L/gt$$

where L is the distance to the storm and *t* is the time elapsed since it occurred.

You measure that the wave period is six seconds. One hour later you measure it to be five seconds.
1) How long ago did the storm occur?
2) How far out to sea is the storm?

Question e:

Waves arrive at a shallow beach. Further from the coast the waves have a wavelength of 20 m and a height of 50 cm, and the water is 5 m deep.
1) Near the coast, at a depth of 1 m, what is the wavelength?
2) Near the coast, at a depth of 1 m, what is the wave height?

Question f:

Arriving at the coast, the ocean swell has a period of 7s.
Use the chart provided to trace the arrival of the waves over a variable bathymetry. Trace three successive wave fronts, calculating each time the distance travelled over the next wave period. Then trace the rays, perpendicular to the wave fronts and comment on the dispersion of energy. Where are the biggest waves to be found?