1. **Fill in the Blanks or Circle the correct Answer (20 points)**
2. **TRUE / FALSE:** The formula for shallow water wave celerity is
3. Give the equation for average energy per unit wave along-crest width: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. For a steady state wave field, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ remains constant as the wave propagates into shallow water.
5. Circle each of the processes that ***can*** increase the wave height:

**REFRACTION / SHOALING / BREAKING**

1. **TRUE /FALSE:** The process of wave refraction causes a reduction in wave height as oblique waves travel into shallower waters over *straight and parallel contours*.
2. Energy in a wave travels at the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ velocity.
3. **TRUE /FALSE:** As waves travel from deep water into intermediate water and through on to shallow water, the wave height continuously grows due to shoaling.
4. Particle displacements under a wave decay with depth governed by what function? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
5. The three types of breaking on beaches are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on mildly sloping beaches, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on intermediate to steep sloping beaches, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on steep to really steep beaches.
6. **TRUE / FALSE:** The formula for shallow water wavelength can be used in 3 meters water depth if the wave period is 12 seconds.

**Problems: Show all your work:**

1. (**80 pt total**) In **deep water, a 12 s** wave has an angle of **45 degrees**. Nearer the shore, at a **depth of 10m**, the wave is measured by a bottom mounted velocity meter. The maximum orbital velocity at the bottom in the **x-direction** (***u*-velocity component**) is found to be **m/s**. (Recall that in general the horizontal velocity is given as:

Assume that the bottom contours are straight and parallel to the shoreline.

(You will need to apply all the Law’s, and identities that we covered to solve this problem)

y,*v*

x,*u*

\\\///\\\///\\\///shoreline\\\///\\\//\\\/

***Show all steps and all work!***

1. **(10 pts)** At the 10m depth location, what is the maximum horizontal particle velocity at the bed in ***the direction of the wave propagation***, ?

(**hint**: in addition to the wave theory you will need to remember some trigonometry for this: cos = adj/hyp; sin = opp/hyp … If you do not know where to start move on to part b) and the rest of the exam and come back to it.)

1. **(10 pts)** ***Assuming*** that in part a) you get a **maximum horizontal velocity** (in the direction of wave propagation) at the bed of **U = 0.80 m/s**, what is the wave height at the location?
2. **(10 pts)** What is the deep water wave height?
3. **(5pts)** At what depth is this wave considered to be in “deep” water?
4. **(10pts)** At what depth is this wave “shallow” water and what is the associated wave height and wavelength (hint: ***think shallow water dispersion and when checking for breaking* assume kappa = 0.80**)?
5. **(20 pts)** In the sketch below:
   1. ***qualitatively*** draw 3 sets of wave orbitals (**each set** **showing orbitals from the surface to the bottom**) 1) deep water, 2) 10m water depth. 3) shallow water

**SHALLOW**

**10m**

* 1. **Compute** the ***surface*** horizontal and vertical

***particle displacements*** (u, w) at each of the 3 locations:

|  |  |  |  |
| --- | --- | --- | --- |
| SURFACE | Shallow | 10m | Deep |
| Horizontal |  |  |  |
| Vertical |  |  |  |

* 1. **Compute** the ***near bed*** horizontal and vertical

bottom ***particle*** ***displacements*** (u, w) at each of the 3 locations:

**DEEP**

|  |  |  |  |
| --- | --- | --- | --- |
| BOTTOM | Shallow | 10m | Deep |
| Horizontal |  |  |  |
| Vertical |  |  |  |

1. **(15 pts)** How large will the wave height be and in what depth will the wave break? Starting from Energy Conservation for linear waves, ***derive*** the formula for the water depth in which a wave is predicted to break. (**assume kappa = 0.80**) then calculate . (***SHOW EACH STEP and STATE ALL YOUR ASSUMPTIONS AS YOU MAKE THEM!)***

Equation Sheet

L=wavelength; k=wave number; h= water depth;

σ=Angular wave frequency; T=period; C=wave celerity; Cg=group velocity

|  |  |
| --- | --- |
|  |  |
| Wave Profile |  |
| Wave Length |  |
| Wave Celerity |  |
| Group Velocity |  |
| 1. Horizontal particle Velocity |  |
| 1. Vertical particle Velocity |  |
| 1. Horizontal Particle acceleration |  |
| 1. Vertical Particle acceleration |  |
| 1. Horizontal particle displacement |  |
| 1. Vertical particle displacement |  |
| Sub-surface Pressure |  |

cos = adj/hyp

sin = opp/hyp