[PRINT]

CIE4305 Coastal Dynamics I (2017-2018),
ZHI LI, 3/6/18 at 7:40:18 PM CET

Question 1: *Score 2/2*

In each of the below sketches, there is one phenomenon that dominates over the others. In each of the below sketches a different phenomenon dominates.

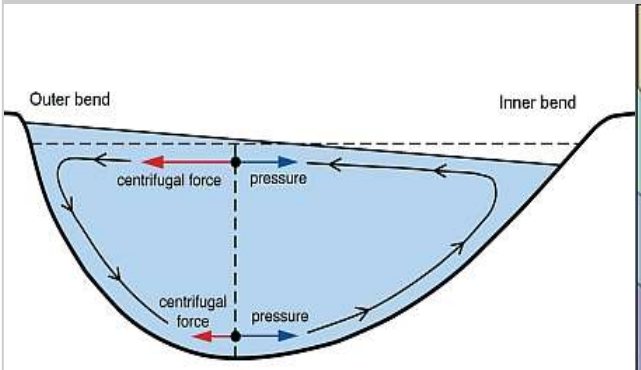
Select which phenomenon dominates in which sketch?

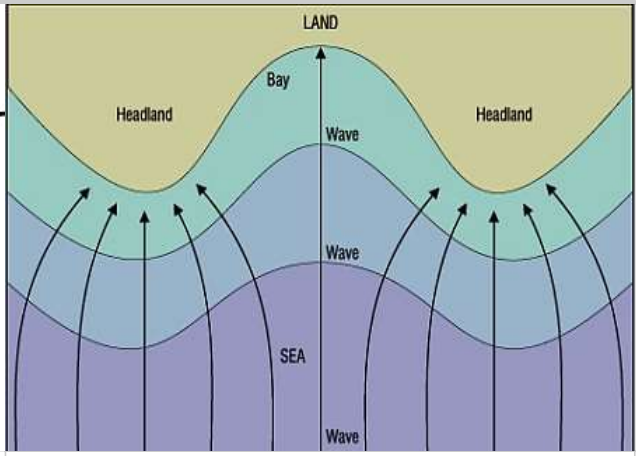
Your response	Correct response
Curvature induced flow	

✔ **Grade:** 1/1.0

Your response	Correct response
Refraction	

✔ **Grade:** 1/1.0



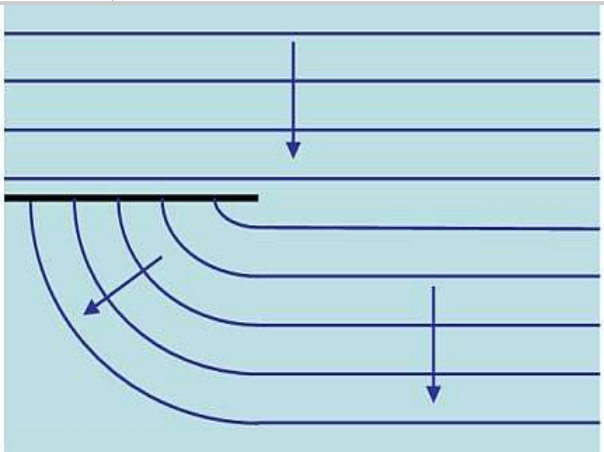


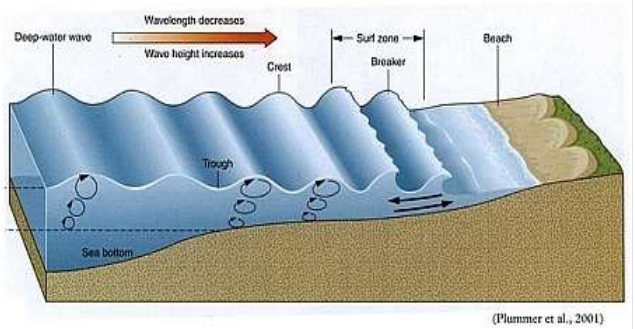
Your response	Correct response
Diffraction	

✔ **Grade:** 1/1.0

Your response	Correct response
Shoaling	

✔ **Grade:** 1/1.0





✔ Total grade: 1.0×1/4 + 1.0×1/4 + 1.0×1/4 + 1.0×1/4 = 25% + 25% + 25% + 25%

Feedback:

Shoaling refers to the change of the wave height with a variation in water depth (the wave propagation speed changes).

Refraction refers to the fact that wave crests tend to become parallel to the depth contours and thus wave rays become more and more normal to the depth contours (Why does this happen? Does this happen at deep water too?). This leads to convergence or divergence of the wave rays and, consequently, the wave height changes.

Diffraction occurs if obstructions to the wave propagation or abrupt changes in the bottom contours are present, causing a large (initial) variation of wave energy along a wave crest which leads to transfer of energy along the wave crests.

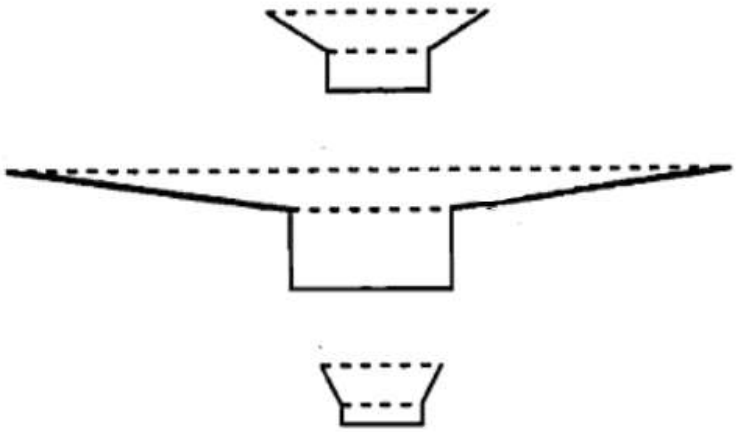
A river bend is an example of a curvature induced flow, a difference in water level across the channel axis is required to balance the centrifugal force, but a net flow is induced by the mismatch of the height at which the net hydrostatic force and the centrifugal force act.

Theory: sections 5.2.2 (Shoaling), 5.2.3 (Refraction), 5.2.4 (Diffraction) and 5.7.6 (Residual currents)

Question 2: *Score 2/2*

Consider the below sketches of basin geometries in which the dotted lines indicate the LW and HW marks.

The vertical and horizontal scales are not identical but are the same in all three sketches.



Correct

Which sketch shows the geometry that most strongly enhances flood-dominance?

Your Answer: the lower sketch

Feedback: Ebb-dominance means that the ebb has higher maximum velocities and a shorter duration than the flood, whereas flood dominance refers to higher velocity, shorter duration floods. A large tidal amplitude and shallow channels enhance flood dominance. A large intertidal storage volume (as compared to channel volume) enhances ebb-dominance.

Theory: section 5.7.4 (Tidal asymmetry)

Question 3: *Score 3/3*

A student explains the generation of the undertow as follows: “In a depth-averaged sense, the

Your response	Correct response
onshore	

Grade: 1/1.0

directed wave force in breaking waves is compensated by a hydrostatic pressure force due to a higher water level

Your response	Correct response
closer to the coast	

Grade: 1/1.0

.

However, the point of action of the wave force is located

Your response	Correct response
higher	

Grade: 1/1.0

in the water column than of the

Your response	Correct response
offshore	

Grade: 1/1.0

directed pressure force .

Hence, higher in the water column the flow is

Your response	Correct response
onshore directed	

Grade: 1/1.0

and closer to the bed the flow is

Your response	Correct response
offshore directed	

Grade: 1/1.0

.”

Fill in the blanks so that the sentence is correct.

Total grade: 1.0×1/6 + 1.0×1/6 + 1.0×1/6 + 1.0×1/6 + 1.0×1/6 + 1.0×1/6 = 17% + 17% + 17% + 17% + 17% + 17%
Feedback:

For a river bend, you could explain the circulation current as follows. The centrifugal force is directed outward, as the bend restricts the flow to have a straight path. To compensate this outward directed force, an inward directed force is required. The hydrostatic pressure force is directed from high water to low water, so a high water level in the outer bend is needed to provide the inward directed force. To understand why the hydrostatic pressure force is located higher in the water column, you should look to the distribution of the hydrostatic pressure and the centrifugal force over depth.

A comparable analysis could be made for the explanation of the generation of undertow. Now the onshore directed wave force is compensated by an hydrostatic pressure force due to a set-up of the water level close to the coast. Where in the vertical is the point of action of the wave-induced force located? Could you now explain for this case the direction of the circulation current?

Theory: section 5.7.6 (Residual currents) and 5.5.6 (Vertical structure of the wave-induced currents)

Question 4: *Score 0/2*

Consider the following equation valid for a small tide in a prismatic channel:

$$\underbrace{\frac{\partial^2 \eta}{\partial t^2}}_{1} - \underbrace{gh\frac{\partial^2 \eta}{\partial x^2}}_{2} + \underbrace{\frac{gh}{D}\frac{\partial \eta}{\partial t}}_{3} = 0$$

Incorrect

where D is the tidal diffusion coefficient (a function of g, h, and a friction coefficient), η is the surface elevation, g is the acceleration of gravity and h is the water depth.

If term 1 were to be left out, the solution for tidal propagation in a basin of a certain length would be:

Your Answer: a standing wave

Feedback: The full equation in this question has elements of the classical wave equation and of a diffusive equation. If term 1 were to be left out, friction dominates in the basin and the equation would represent a wave with amplitudes that reduce towards the end of the basin. If term 3 were to be left out, inertia dominates the flow and a standing wave is the result.

Theory: section 5.7.3 (Tidal propagation into basins)

Question 5: *Score 1/2*

The below diagram schematically shows the propagation of the high water (HW) along a basin (horizontal axis) in time (vertical -axis).
The vertical tide at sea is symmetrical.
The basin geometry is such that flood-dominance is enhanced.
The special case of a tidal bore is expected to occur.

A line that could depict the propagation of the low water (LW) in this case is a line connecting points:

Your response	Correct response
C	

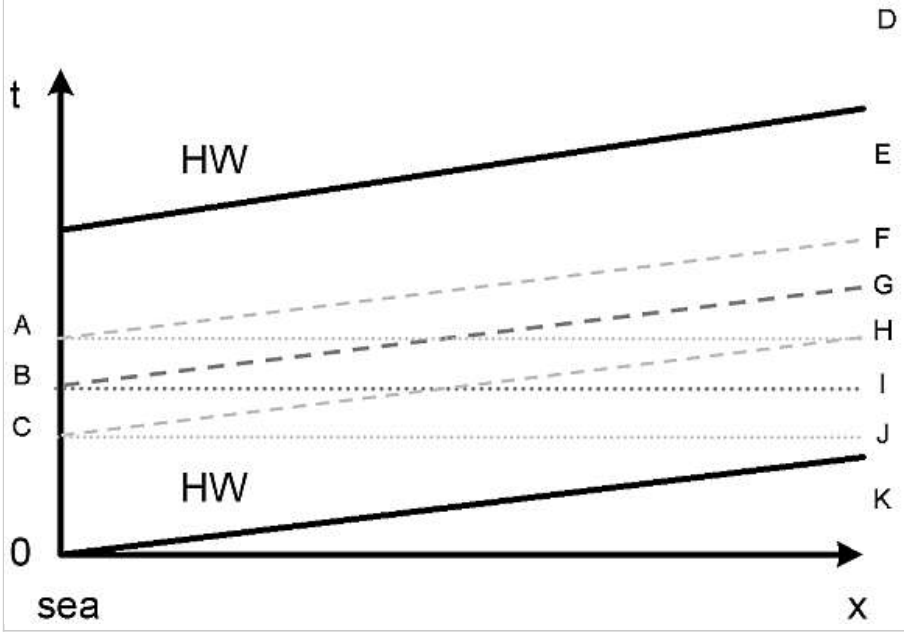
Grade: 0/1.0

to

Your response	Correct response
D	

Grade: 1/1.0

Note that the lines in the figure are intended for visual guidance only; they are not the only choices. For instance, you can choose A-D.



Total grade: 0.0×1/2 + 1.0×1/2 = 0% + 50%
Feedback:

Ebb-dominance means that the ebb has higher maximum velocities and a shorter duration than the flood, whereas flood dominance refers to higher velocity, shorter duration floods.

Ebb-dominance occurs when the falling period is larger than the rising period. Vice versa for flood-dominance. What does this mean for the speed of the low tide and the high tide? In which case is the high tide faster and is which case the low tide?

A tidal bore occurs under certain bathymetric and hydrodynamic conditions, such that the rising period becomes very small.

Theory: section 5.7.4 (Tidal asymmetry)

Question 6: *Score 0/2*

Which hydrodynamic conditions may enhance the export of fine sediment:

Your response	Correct response
Choice 2: a shorter duration of HW slack than of LW slack: FALSE Choice 4: a longer flood duration than ebb duration: FALSE	

Grade: 0/1.0

Total grade: 0.0×1/1 = 0%
Feedback:

Flood-dominant systems tend to import sediment. In that case, the flood duration is shorter than the ebb duration. Further, fine sediment import is enhanced if the duration of HW slack is longer than of LW slack, as fines need time to settle. Under the opposite conditions, the export of fine sediments is enhanced.

Theory: section 5.7.4 (Tidal asymmetry, subsection "(Preview of) the relevance to sediment transport")

Question 7: *Score 2/2*

We consider a tidal wave for which the horizontal and vertical tide consist of an M2 component only.
Slack water from flood to ebb occurs around around mid-tide.
What does this mean for the phase between horizontal and vertical tide? If more answers are possible, choose the most probable answer.

Correct

Your Answer: There is no phase difference

Feedback: Slack water is the name used for tidal flow reversal (i.e. almost no tidal flow velocities at that moment in time). If the flood and ebb velocities are maximum around high and low water respectively, the velocity and the water level are in phase. Note that the period of the M2 tidal component equals 12 hours and 25 minutes.

Theory: sections 5.7.1 (Definitions) and 5.7.2 (Tidal propagation along the shore)

Question 8: *Score 1/1*

For a tidal wave with a purely standing character, what is the water level during flow reversal from ebb to flood? **Correct**

Your Answer: Low water

Feedback: For a tidal wave with a progressive character, the flood and ebb velocities are maximum around high and low water respectively; the velocity and the water level are in phase. For a tidal wave with a standing character, the water level lags behind the flow velocity with a phase difference of 90 degrees.

Theory: sections 5.7.1 (Definitions) and 5.7.2 (Tidal propagation along the shore)

Question 9: *Score 1/1*

Consider a long, funnel-shaped estuary with a constant depth.
Reflection and friction can be ignored.

At the location where the width is 60% of the width of the entrance, what is the tidal range compared to the tidal range at sea?

Tidal range at the considered location =

Your response	Correct response
1/sqrt(0.6)	

Grade: 1/1.0

x tidal range at sea

Tip: You can write a mathematical expression in the text box (e.g. 1/5*20, sqrt(16) , 2^2 are all equivalent to 4 and all those answers are accepted).
Attention: Use the point as a decimal separator!

Total grade: 1.0×1/1 = 100%
Feedback:
In case of gradual changes in width bs and depth h (no reflection on the sides or on a sill) and in the absence of friction, the energy is conserved along the channel axis:

$$\mathrm{Encb}_s = \text{constant}$$
$$\hat{\eta}^2 \sqrt{gh}\, b_s = \text{constant}$$

Based on this equation, you should be able to answer this question.

Theory: section 5.7.3 (Tidal propagation into basins, subsection "Width convergence and shoaling")

Question 10: *Score 2/2*

A tidal wave is propagating in a prismatic channel.
The horizontal tide leads the vertical tide with a quarter period.
This could mean that we are dealing with a:

Your response	Correct response
Choice 1: short basin: TRUE Choice 3: perfect standing wave: TRUE Choice 6: diffusive wave: FALSE	

Grade: 1/1.0

Total grade: 1.0×1/1 = 100%
Feedback:

For a perfect standing wave, high water slack around high water occurs for flow reversal from flood to ebb. This means that the horizontal tide leads the vertical tide with a quarter period. This perfect standing wave is more likely for a short basin and if the wave is not diffusive, so if friction is negligible.

And what is the phase lead for a friction-dominated flow in a long, straight basin?

Theory: section 5.7.3 (Tidal propagation into basins)

Question 11: *Score 1/1*

Name the most important overtide in a semi-diurnal tidal environment by its internationally agreed abbreviations. Remember to put letters in capitals.

Correct

Your Answer: M4

Feedback: Tidal distortion and asymmetry can be described by the inclusion of higher harmonics, tidal periods that do not originate from a tidal forcing period but are integer fractions (1/2, 1/3, etc) of the period of the basic astronomical constituents generated by the attraction forces of earth, moon and sun. For that reason they are named overtides. The most important overtide in a semi-diurnal tidal environment is the M4 (quarter-diurnal, 6.21-hr period) tide.

Theory: section 5.7.5. (Overtides)