5.8.3. CONNECTIONS AND APPLICATIONS

Example 5.65 Graph analysis

The graph depicts the sea level in the Bay of Fundy in a period of 36 hours.

https://www.geogebra.org/calculator/n2ueypx6

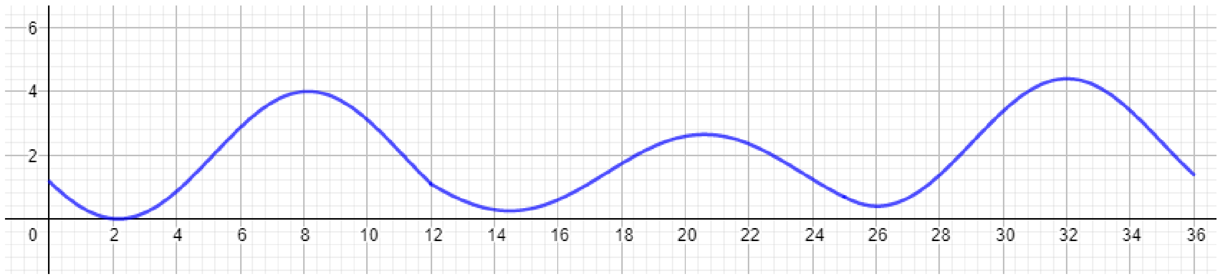

Figure 5.88

Determine:

- **a)** The tides
- **b)** The maximum sea level
- **c)** The sea level at t=10 hours, t=18 hours, t=32 hours.
- **d)** At what times was the sea level equal to 2 meters
- **e)** All intervals when the sea level was increasing

Solution:

a) The increase of the sea level indicates flood, so flood occurs in the following approximate intervals $[2,8],[14,20.5],[26,32]$.

The decrease of the sea level indicates ebb, so ebb occurs in the following approximate intervals $[0,2],[8,14],[20.5,26],[32,36]$.

b) The maximum sea level is the highest point on the graph, which occurs at time $t=32$. The corresponding sea level is 4.2 m.

c) To find the sea level at given points, read the y-coordinate of points on the graph at $t=10, t=18, t=32$, like this:

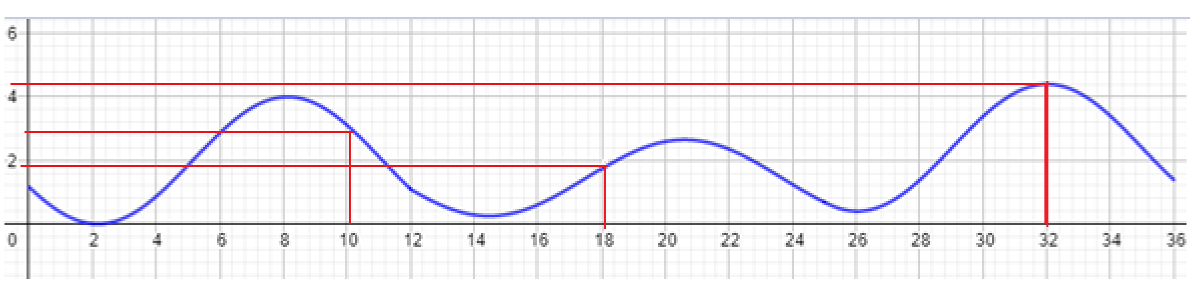

Figure 5.89 The corresponding points are approximately $(\mathbf{10},\mathbf{2.8}),(\mathbf{18},\mathbf{2}),(\mathbf{32},\mathbf{4.4})$.

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d) To find the times corresponding to the sea level of 2 meters, draw the line $y = 2$ and read the x-coordinates of all intersection points. The solutions are approximately: $t = 5, t = 11, t = 18, t = 23, t = 29, t = 35$.

e) The increasing sea level intervals are equivalent to flood, solved in part a).

Example 5.66

Find more limits applications in Google spreadsheets on link https://docs.google.com/spreadsheets/d/1ca0GpGKnrTfz2yHVk38PG-_abBrfGGZW4MBnbp6SDIw/edit?usp=sharing

Example 5.67

Hydrostatic pressure

https://phet.colorado.edu/sims/html/under-pressure/latest/under-pressure_en.html

Using the link above, we will examine some properties of the hydrostatic pressure formula.

Directions for the setup of the experiment.

i. Open the link
ii. In the lower left corner, pick the first model (one fossette and one pool).
iii. In the upper right corner tick the grid option (as to measure the water depth)
iv. Pour water into the pool to the brim
v. Drag and drop the barometer to measure the pressure above the pool and in the pool
vi. First try the air pressure above the pool:

1) When the depth increases, the pressure ___________.
2) What is the atmospheric pressure (the pressure at 0 m, in pool level)?
3) Fill out the table:

Water depth (X)	Water pressure (Y)
0	
1	
2	
3	

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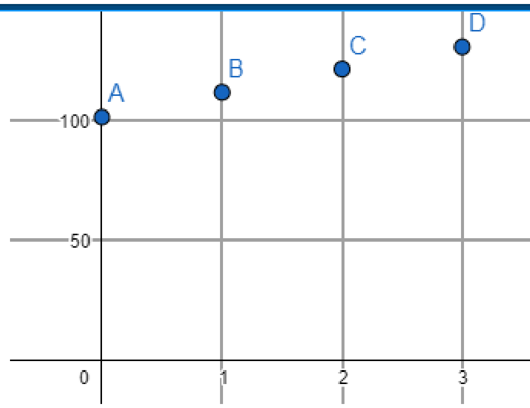

4) The points are shown in Geogebra. What can you notice about the points? Is there a pattern? Explain your reasoning.

____-

The hydrostatic pressure formula is:

$$p_{hyd}(h) = p_{atm} + \rho g h$$

where ρ is the liquid density, g is the Earths gravitational constant (9.81 m/s^2), and h is the depth.

5) Given the salt water density is $\rho = 1025 \frac{kg}{m^3}$, the atmospheric pressure is $p_{atm} = 101325\ Pa$ and $g = \frac{9.81m}{s^2}$, determine the hydrostatic pressure at:

a) 10 m
b) 15 m
c) 30 m?

6) The world record in deep sea diving (without injury) is 214 m. With conditions described above ($\rho = 1025 \frac{kg}{m^3}, p_{atm} = 101325\ Pa, g = \frac{9.81m}{s^2}$) determine the pressure at the given depth.

7) What is the percent increase in water pressure at depth 214 m when compared with atmospheric pressure?

Solution:

1) When the depth increases, the pressure **increases**.

2) What is the atmospheric pressure is 101.326 kPa, so 101 326 Pa.

3) Fill out the table:

Water depth (X)	Water pressure (Y)
0	101.326
1	111.126
2	120.926
3	130.726

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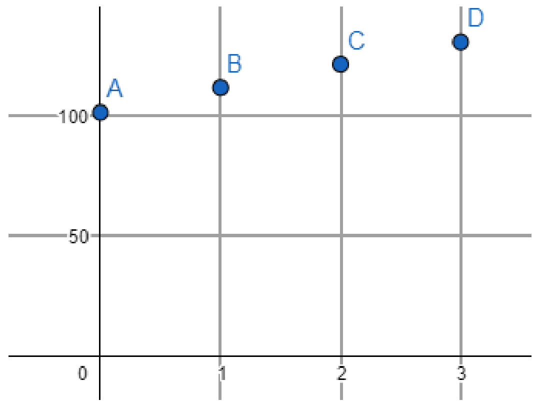

4) When the points from table in part 3) are graphed in a coordinate plane, a pattern can be seen.
All the points seem to lie on the same line. This means that the pressure at various depths can be determined from the graph, by extending the line.

5) Given the formula $p_{hyd}(h) = p_{atm} + \rho g h$ and all the known constants, plug in the numbers to calculate the pressure:
   a) h = 10 m, $p_{hyd}(10) = 101\,325 + 1025 \cdot 9{,}81 \cdot 10 = 201\,887\ Pa$
   b) h= 15 m, $p_{hyd}(15) = 101\,325 + 1025 \cdot 9{,}81 \cdot 15 = 252\,153\ Pa$
   c) h= 30 m, $p_{hyd}(30) = 101\,325 + 1025 \cdot 9{,}81 \cdot 30 = 402\,982\ Pa$

6) To calculate the pressure, plug in h = 214 m into the equation:

$$p_{hyd}(214) = 101\,325 + 1025 \cdot 9{,}81 \cdot 214 = 2\,253\,148\ Pa$$

7) To find the percent increase, calculate the quotient $\frac{p_{hyd}(214)}{p_{atm}} = 22.23$

So, the pressure at depth 214 m is 22.23 times greater than the atmospheric pressure. This is a percent increase of 2123%!

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