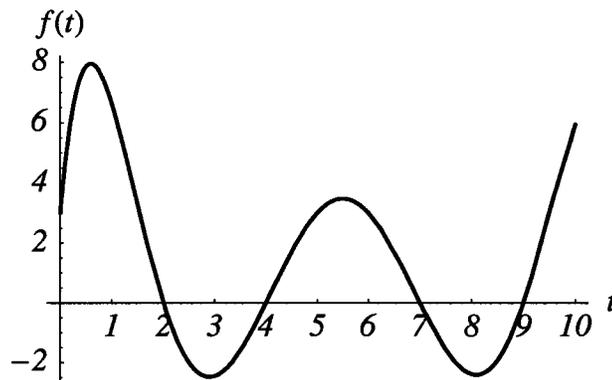1. The graph of the function f is shown below. Justify your answers for each of the questions below.

$f(t)$

(a) On what intervals is the area function $_0A_f$ increasing?

when $f > 0$ $\Rightarrow$ $(0,2), (4,7), (9,10)$

(b) On what intervals is the area function $_0A_f$ decreasing?

when $f < 0$ $\Rightarrow$ $(2,4), (7,9)$

(c) At what values of x does $_0A_f$ have a local maximum? local minimum?

• local max at $x = 2, 7$

• local min at $x = 4, 9$

(d) At what values of x does $_0A_f$ have an absolute maximum? absolute minimum?

• abs. max at $x = 7$ or 10 (depending on the relative value of $\int_7^9 f(t)\,dt$ and $\int_9^{10} f(t)\,dt$)

• abs. min at $x = 0$

(e) On what intervals (approximately) is the area function $_0A_f$ concave up?

when f increasing $\Rightarrow$ $(0,1), (3,5.5), (8,10)$

(f) On what intervals (approximately) is the area function $_0A_f$ concave down?

when f decreasing $\Rightarrow$ $(1,3), (5.5,8)$

2. Let $f(t) = \cos t$ and consider the area function ${}_0A_f(x)$ on the domain $0 \leq x \leq 4\pi$.

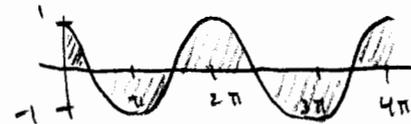   (a) On what intervals is the area function positive?

   $$(0, \pi), \ (2\pi, 3\pi)$$

   (b) On what intervals is the area function negative?

   $$(\pi, 2\pi), \ (3\pi, 4\pi)$$

   (c) At what values of x is the area function zero?

   $$x = 0, \pi, 2\pi, 3\pi, 4\pi$$

3. Let $r(t)$ be the rate (in barrels per hour) of oil flowing through an oil pipeline pumping station t hours after noon on a particular day. Describe each of the following expressions and equations in terms of oil flow.

   (a) ${}_0A_r(5)$ = barrels of oil that flowed through the station between noon and 5 pm

   (b) ${}_2A_r(5)$ = barrels of oil that flowed through the station between 2pm and 5 pm

   (c) ${}_0A_r(x)$ = barrels of oil that flowed through the station during the first x hours after noon

   (d) $\dfrac{{}_0A_r(5)}{5}$ = average rate of oil flowing through the station between noon and 5 pm

   (e) ${}_2A_r(x) = 1000$:

   1000 barrels of oil flowed through the station in the first $(x-2)$ hours after 2pm