Two boats start together and race across a 60-km-wide lake and back. Boat A goes across at 60 km/h and returns at 60 km/h. Boat B goes across at 30 km/h, and its crew, realizing how far behind it is getting, returns at 90 km/h. Turnaround times are negligible, and the boat that completes the round trip first wins.

(a) Which boat wins and by how much? (Or is it a tie?)

(b) What is the average velocity of the winning boat?

a) For boat A the round trip takes time:

$$t_1 = \frac{2l}{v_1} = 2 * \frac{60}{60} = 2\ h$$

where $l = 60\ km$ wide of the lake, v_1- speed of boat A

For boat B it takes time:

$$t_2 = \frac{l}{v_{21}} + \frac{l}{v_{22}} = \left(\frac{60}{30} + \frac{60}{90}\right) h = 2{,}66\ h$$

where $v_{21} = 30\frac{km}{h}$ and $v_{22} = 90\frac{km}{h}$ speeds of boat B

So, the boat A completes the round trip first. The difference of times equals:

$$\Delta t = t_2 - t_1 = 2{,}66\ h - 2h = 0.66\ h = 40\ min$$

Answer: boat A, $\Delta t = 40\ min$

b) Average speed for boat A equals:

$$v_a = \frac{2l}{t_1} = \frac{120}{2}\frac{km}{h} = 60\frac{km}{h}$$

(and because boat A has constant speed during all trip)

Answer: $60\frac{km}{h}$