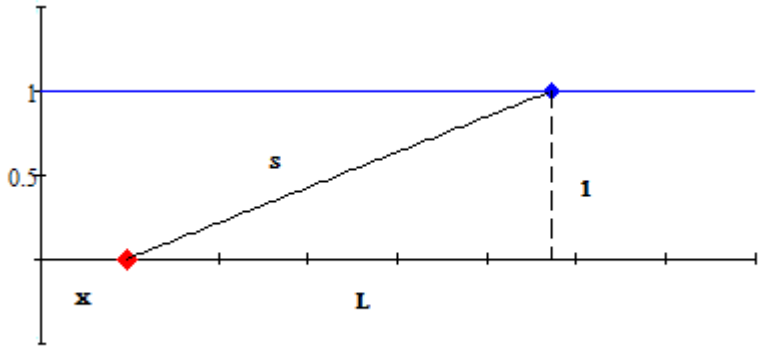
Suppose a submarine is 1 mile below the surface. A ship on the surface is traveling toward the submarine At 10 mph. The ship is 2.24 miles from the submarine when it first detects the sub and determines that the distance between the ship and the sub is decreasing at a rate of 13.4 mph.

See Animation 1.



a. What is the speed of the sub?

b. If a depth charge drops at a rate of 3 mph when should it be released so that it hits the sub?

c. Where is the ship when it releases the depth charge?

a. $L^2 + 1 = s^2$

$2 \cdot L \cdot \frac{dL}{dt} = 2 \cdot s \cdot \frac{ds}{dt}$ (Note $\frac{dL}{dt}$ is the speed of the ship minus the speed of the sub i.e. $\frac{dL}{dt} = -10 - \frac{dx}{dt}$)

$L \cdot \frac{dL}{dt} = s \cdot \frac{ds}{dt}$

$L \cdot \frac{dL}{dt} = 2.24 \cdot -10$

Using $L^2 + 1 = s^2$ we have

$L^2 + 1 = 2.24^2$

L = 2 miles

We have

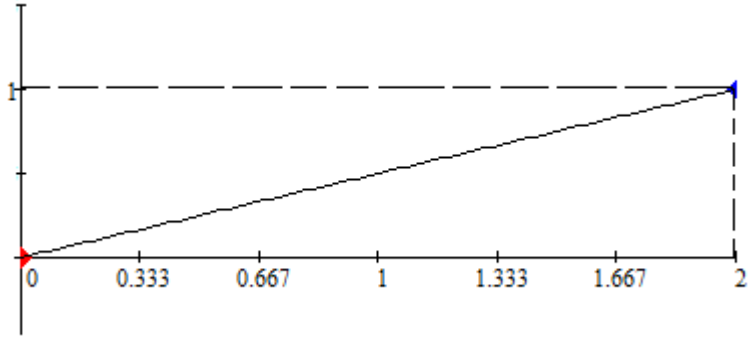
$$2 \cdot \frac{dL}{dt} = 2.24 \cdot -10$$

$$\frac{dL}{dt} = -15$$

But we want $\frac{dx}{dt}$ We have $\frac{dL}{dt} = -10 - \frac{dx}{dt} = -15$ and finally we have $\frac{dx}{dt} = 5\text{mph}$.

b and c. See Animation 2

the distance is 2.24 miles we have $L^2 + 1 = 2.24^2$ from which we have L = 2



The equations of the subs trajectory is x(t) = 5t and y(t) = 0

The equation of the ship is x(t) = 2 - 10 t and y(t) =1

Since the depth charge moves at 3mph it travels the 1 mile in 1/3 hrs or 20 min.

In 1/3 hr the sub travels 5/3 mile.

So the ship must release the depth charge at 5/3 or 1.667 miles.

The ship reaches this point when 2 - 10 t = 5/3 from which we obtain t = 1/30hr or 2minutes.

So if the ship releases the depth charge 2 mins after spotting the sub it will hit the sub.

Again See Animation 2.