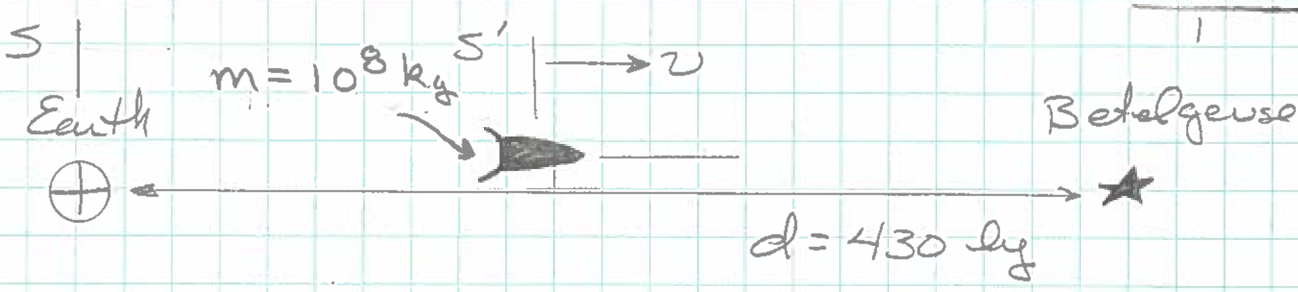


Want Ship time = Proper time, $\Delta t_p = 10y$.

a.) In S', $\Delta t_p = 10y$

In S, $v = \frac{d}{\Delta t} \Rightarrow \Delta t = \frac{d}{v}$

Now, time dilation : $\Delta t = \gamma \Delta t_p$

So $$\frac{d}{v} = \frac{\Delta t_p}{\sqrt{1 - v^2/c^2}}$$

and, $$\frac{d^2}{v^2} = \frac{\Delta t_p^2}{(1 - v^2/c^2)}$$

or

$$1 - \frac{v^2}{c^2} = \frac{\Delta t_p^2}{d^2} v^2$$

$$1 = \left(\frac{\Delta t_p^2}{d^2} + \frac{1}{c^2}\right) v^2$$

$$\therefore v = \left(\frac{\Delta t_p^2}{d^2} + \frac{1}{c^2}\right)^{-1/2}$$

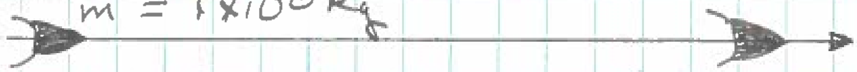
Now, use the units $d = ly$, $\Delta t_p = 10\,y$
So $c = 1\,ly/y$.

$\underline{v = 0.99973}$ ly/y

or, $\underline{v = 0.99973\,c}$

b.) Initial $\qquad\qquad$ Final

$m = 1\times10^{8}\,kg$



$K_i = 0,\ v_i = 0$ $\qquad\qquad$ $K_f\ \ v_f = v$

$= 0.99973c$

Energy needed $= \Delta K = K_f - K_i$

$= (\gamma - 1)mc^2$

and, $\gamma = \dfrac{1}{\sqrt{1 - v^2/c^2}} = 43.04$

$\therefore \quad \underline{\Delta K = 3.78\times10^{26}\ J}$

c.) P = price of energy $= 0.10\ \dfrac{\$}{kWh}$

Now:

$1.0\,kWh = 1000\,W\left(\dfrac{3600\,s}{1\,h}\right) = 3.6\times10^{6}\ J$

So:

Price of energy, $P = 0.10\ \dfrac{\$}{kWh}\left(\dfrac{1\,kWh}{3.6\times10^{6}\,J}\right)$

$= 2.78\times10^{-8}\ \$/J$

To accelerate the ship, we need

$\Delta K = 3.78\times10^{26}\ J$

So, our total cost is:

$\text{Cost} = \Delta K\,P \approx \underline{1\times10^{19}\ \text{dollars}}$

That's 10 Million Trillion dollars!

The US GDP in 2015 was only

\$18.1 Trillion.