Name: ________________________________

Physics 117

Quiz 7 (4/25/2003)

Use as far as possible formula and try to explain your reasoning.

A) An aircraft carrier is moving to the north at a constant speed of 50 Km/h. A plane requires a speed of 250 Km/h relative to the water to take off. How fast must the plane be traveling relative to the deck to take off if the plane is headed

1) North?
2) South?

1) If the plane is headed north we shall have to take into account that its speed will add up with that of the ship. So the relative speed of the plane w.r.t. the air is

$v_{plane,relative-air} = v_{ship} + v_{plane,relative-ship}$

One has $v_{plane,relative-air} = 250 \text{ Km/h}$ if $v_{ship} + v_{plane,relative-ship} = 250 \text{ Km/h}$

$\Rightarrow v_{plane,relative-ship} = 250 \text{ Km/h} - v_{ship} = 250 - 50 \text{ Km/h} = 200 \text{ Km/h}$

2) If the plane is headed south we shall have to take into account that the speed of the ship will have to be subtracted to that of the plane to obtain the speed relative to the sourrounding air at rest. The relative speed of the plane w.r.t. the air is again

$v_{plane,relative-air} = v_{ship} - v_{plane,relative-ship}$

One has $v_{plane,relative-air} = 250 \text{ Km/h}$ if $v_{ship} - v_{plane,relative-ship} = 250 \text{ Km/h}$

$\Rightarrow v_{plane,relative-ship} = 250 \text{ Km/h} + v_{ship} = 250 + 50 \text{ Km/h} = 300 \text{ Km/h}$

Name: ________________________________

B) Assume that rocket taxis of the future move about the solar system at half the speed of light. For a one hour trip as measured by a clock on the taxi, a driver is paid 10 stellars. The taxi driver's union demands that pay be based on Earth time instead of taxi time.

1) If their demand is met, what will be the new pay for the same trip?

$$v_{taxi} = c/2$$

$$\Delta t_{trip,taxi(clock\ at\ rest)} = 1h$$

$$\Delta t_{trip,Earth(clock\ moving)} = \gamma \Delta t_{trip,taxi(clock\ at\ rest)}$$

$$\Delta t_{trip,Earth(clock\ moving)} = \frac{1}{\sqrt{1-\left(\frac{v_{taxi}}{c}\right)^2}} \cdot 1\ hour = \frac{1}{\sqrt{1-\frac{1}{4}}}\ hour \approx 1.155\ \ hours$$

$$New\ \ Cost = 1.155 \cdot 10\ \ stellars = 11.55\ \ stellars$$

The taxis after their duties are stored in garages on Earth.

2) If the moving rocket taxi (again at v=c/2) is measured from the Earth to be 2 m long, how long will the garage have to be?

$$v_{taxi} = c/2$$

$$L_{taxi(moving)} = \frac{L_{taxi(at\ rest)}}{\gamma}$$

$$\Delta t_{trip,Earth(clock\ moving)} = \gamma \Delta t_{trip,taxi(clock\ at\ rest)}$$

$$L_{taxi(at\ rest)} = \frac{1}{\sqrt{1-\left(\frac{v_{taxi}}{c}\right)^2}} \cdot L_{taxi(moving)} = \frac{1}{\sqrt{1-\frac{1}{4}}} \cdot 2\ \ m \approx 2.31\ \ m$$