NS547 MIDTERM TEST, Part 1 of 2

January 2010 **Name: _____**

Useful Equations

c = 3 x 10^8 m/s.

$$(c\Delta t)^2 - (\Delta x)^2 = (c\Delta t')^2 - (\Delta x')^2 = (\text{interval})^2$$

Transformations involve a constant called gamma:

$$\gamma = \frac{1}{\sqrt{1-v^2}}, \quad \text{where } v \text{ is expressed as a fraction of } c.$$

Transformations from one frame of reference to another are given by:

$$x' = \gamma\left[x - v(ct)\right] \qquad x = \gamma\left[x' + v(ct')\right]$$
$$t' = \gamma\left(ct - vx\right) \qquad t = \gamma\left(ct' + vx'\right)$$

The relativistic relative velocity equation: $\vec{v}_{AC} = \dfrac{\vec{v}_{AB} - \vec{v}_{CB}}{1 - \dfrac{\vec{v}_{AB}\vec{v}_{CB}}{c^2}}$.

Scores

Problem 1: _____ / 10

Problem 2: _____ / 20

Problem 3: _____ / 15

TOTAL: _____ / 45

PROBLEM 1 – 10 points

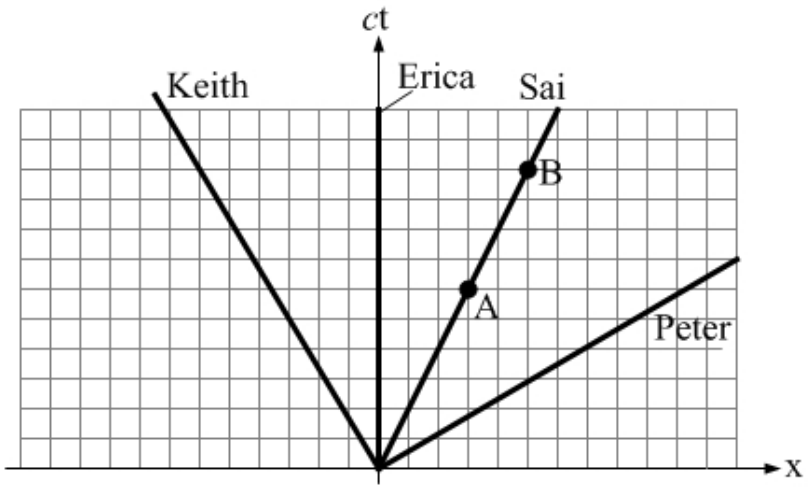
According to Jim, two events are separated by 30 m of time and 20 m of space.
According to Versa, these same two events are separated by 40 m of time.
According to Robby, these same two events occur at the same location.

[5 points] (a) In Versa's reference frame, what is the spatial separation between the two events?

[5 points] (b) In Robby's reference frame, how much time passes between the two events?

PROBLEM 2 – 20 points

Each box on this spacetime diagram measures 1 lightyear by 1 lightyear. The diagram is drawn from Erica's reference frame.



[2 points] (a) Is there anything wrong with the diagram? If so, describe what it is.

[4 points] (b) What is Sai's velocity with respect to Erica? What is Keith's velocity with respect to Erica?

[4 points] (c) What is Sai's velocity with respect to Keith?

[5 points] (d) What is the spatial distance between Event A and Event B, according to Erica? How much time passes between Event A and Event B, according to Erica?

[5 points] (e) What is the spatial distance between Event A and Event B, according to Sai? How much time passes between Event A and Event B, according to Sai?

PROBLEM 3 – 15 points

Consider the following table of clock readings for four different events. Each observer moves at their own constant velocity.

	Brandon's clock	Nancy's clock	Kate's clock	Steve's clock
Kate passes Brandon		2 hours	0 hours	0 hours
Steve turns on the TV	7 hours		3 hours	
Nancy ties her shoe		5 hours	9 hours	6 hours
Kate flips a coin	19 hours	6 hours		

[6 points] (a) Fill in the missing entries in the table.

[4 points] (b) These clock readings are according to one of the four observers listed in the table. Which one?

[ ] Brandon [ ] Nancy [ ] Kate [ ] Steve

Justify your answer:

[5 points] (c) How fast is Brandon moving with respect to Kate?