All answers must be read from the accompanying graphs. Calculations involving readings from the graph are allowed but not the Lorentz Transormation or Time Dilation or Length Contraction formulas. Use a ruler. The divisions are the same size on both sets of axes.
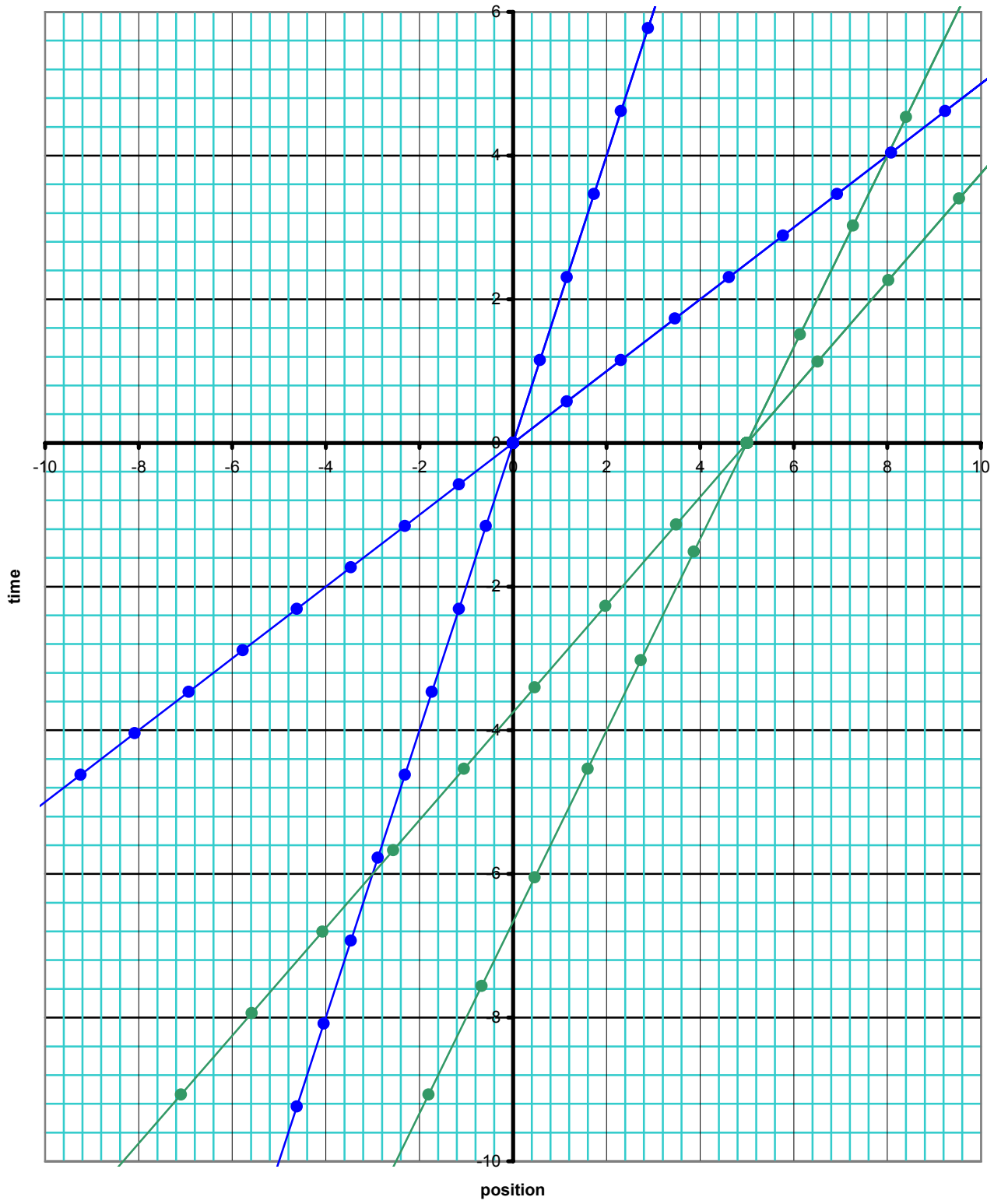
1.   STD #1 shows a spaceship travelling to a distant star. The graph units are years.
      (a) In the earth frame, how far away is the star?
      (b) In the spaceship frame, how far away was the star?
      (c) In the earth frame, how long does it take for the ship to reach the star?
      (d) In the spaceship frame, how long does it take for the ship to reach the star?
      (e) In the earth frame, how fast is the ship travelling?
      (f) In the spaceship frame, how fast is the star approaching?
      (g) Which frame, if either, measures a proper distance? Explain.
      (h) Which frame, if either, measures a proper time? Explain.

2.   STD #2 shows a spaceship travelling to a distant star. The graph units are years.
      In the ship's frame, a radio signal is send to the star and bounced back.
      (a) In the earth frame, how far away is the ship when it sends the signal?
      (b) In the earth frame, when does the ship send the signal?
      (c) In the earth frame, how far away is the ship when it receives the reflected signal?
      (d) In the earth frame, when does the ship receive the reflected signal?
      (e) In the earth frame, how far has the ship travelled between sending and receiving the signal?
      (f) In the earth frame, how much time has passed between sending and receiving the signal?
      (g) In the earth frame, how far has the radio signal travelled between being sent and received by the spaceship?
      (h) In the spaceship frame, how much time has passed between sending and receiving the signal?
      (i) In the spaceship frame, how far has the radio signal travelled between being sent and received?
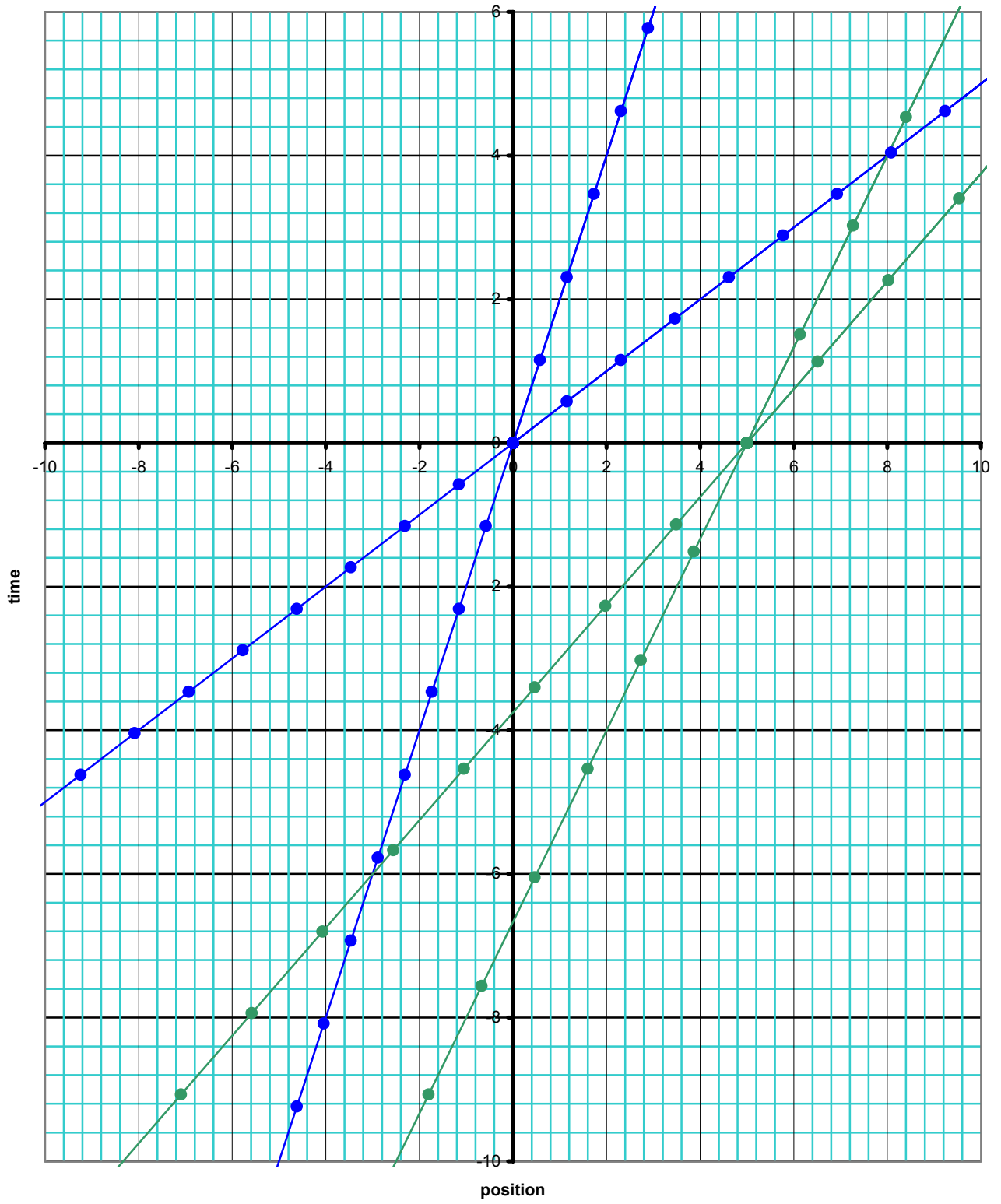
3.   STD #3 shows two spaceships. Spaceship A leaves earth and spaceship B leaves a distant star. Both leave at the same time in the earth frame. They are travelling towards one another and eventually meet. The graph units are years.
      (a) In the earth frame, how far away is ship A when it meets B?
      (b) In the earth frame, how far has B travelled when it meets ship A?
      (c) In the earth frame, how much time has passed until the meeting?
      (d) In spaceship A's frame, how far away is earth at the meeting point?
      (e) In spaceship A's frame, how much time has passed until the meeting?
      (f) In spaceship B's frame, how far away is earth at the meeting point?
      (g) In spaceship B's frame, how much time has passed until the meeting?

4.   STD #4 shows two spaceships. Spaceship A leaves earth and spaceship B leaves a distant star. Both leave at the same time in the earth frame. They are travelling in the same direction. The graph units are years.

(a) In the earth frame, how far away is ship A from B?

(b) In spaceship A's frame, how far away is A from B when they leave?

(c) In spaceship B's frame, how far away is A from B when they leave?

(d) In spaceship A's frame, who left first A or B? How much time passed between the two ships leaving?

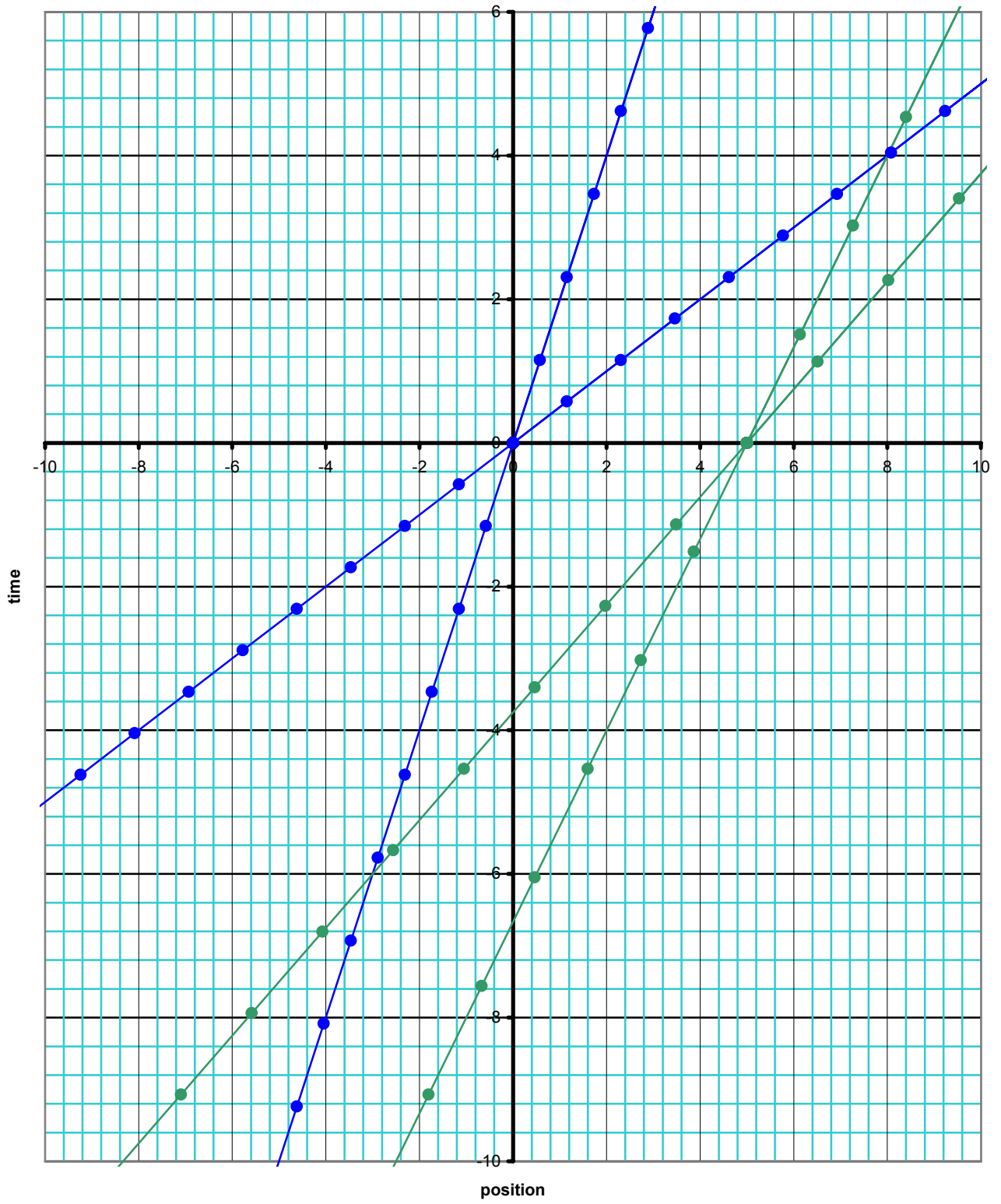(e) In spaceship A's frame, who left first A or B? How much time passed between the two ships leaving?

Q #4 STD

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