PHYSICS 2204

Unit 1: Kinematics

Worksheet 12 : Relative Motion In One Dimension

STUDENT NAME:_____

Relative motion is just a way of saying that sometimes different people will say different things about the motion of the same object. This is not because one of them is wrong, but because they are using different frames of reference. A **frame of reference** can be thought of as any spot your doing your measurement from as long as it is not accelerating. This is called an **inertial frame of reference.**

Example 1

An ant travels 10 cm to the right on a plate relative to the plate as a disgusted picnicker pushes the plate a distance of 40 cm to the right relative to the earth. What is the displacement of the ant with respect to the earth?

The symbols:

adp: the displacement of the ant with respect to the plate
pde : the displacement of the plate with respect to the earth
ade: the displacement of the ant with respect to the earth.

Method I: The doing it in your head method

Method II: The vector diagram method

- We will use a scale for the vectors, 1 cm : 5 cm.
- Add the two vectors: make sure that the tail of the second falls on the tip of the first.
- Determine the Resultant vector: draw the RESULTANT vector (in this case ade) from the tail of the first to the tip of the second.

As with Method I, once again we have the displacement of the ant with respect to the earth to be 50 cm to the right.

Method III: Vector Algebra Method

Example 2:

You are watching a frog on a log drifting downstream. You see the log go 12.0 m downstream, but the frog only travels 10.5 m downstream. What must be the displacement of the frog with respect to the log? (Downstream positive.)

Example 3:

You walk in an up-stream direction at 1.4 m/s relative to a raft which is traveling downstream at 3.2 m/s. What is your velocity relative to your friend who is standing on the bank? (Downstream is positive.)

Example 4

You are driving Mr. Fifield's souped-up Beast at 195 km/hr north (relative to the earth) when your on-board radar tells you that your Friend in a south-bound snowmobile is traveling at 210 km/hr relative to your snowmobile. What is the reading on the speedometer of your friends machine? (North is positive)

did you know?

Frames of reference and relative motion is actually the reason that people get car sick. Your brain is getting two different sets of information about your body's motion that might not exactly agree with each other; information from your eyes, and information from your inner ear. Some people are more sensitive to these differences, which causes them to feel car sick as they watch the road "whiz" by. If you are prone to getting car sickness, try to look forward at a point far in the distance and stay focused on that.

PART A: MULTIPLE CHOICE

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

1. Balloon A is moving upwards at 4.8 m/s and balloon B is moving upwards at 1.2 m/s. What is the velocity of balloon A relative to balloon B?

	Magnitude	**Direction**
(A)	3.6 m/s	down
(B)	3.6 m/s	up
(C)	6.0 m/s	down
(D)	6.0 m/s	up

2. A moving sidewalk has a velocity of 1.5 m/s [E] relative to the ground. A child is running on the sidewalk at 4.5 m/s [W]. What is the velocity of the child relative to the ground?

(A) 3.0 m/s [E]
(B) 3.0 m/s [W]
(C) 6.0 m/s [E]
(D) 6.0 m/s [W]

3. A car travelling 90 km/h [W] is passed by a truck travelling 120 km/h [W]. What is the velocity of the truck relative to the car?

(A) 30 km/h [E]
(B) 30 km/h [W]
(C) 210 km/h [E]
(D) 210 km/h [W]

4. A bus moves 18 m [E] relative to the ground. A ball on the bus rolls 7 m [W] relative to the bus. What is the displacement of the ball relative to the ground?

(A) 11 m [E]
(B) 11 m [W]
(C) 25 m [E]
(D) 25 m [W]

5. Car A travels at 110 km/h [W] while Car B travels at 75 km/h [E]. What is the velocity of Car A relative to Car B?

(A) 35 km/h [E]
(B) 35 km/h [W]
(C) 185 km/h [E]
(D) 185 km/h [W]

6. A swimmer heads 1.8 m/s [W] in a river where the current is 1.1 m/s [W]. What is the magnitude of the swimmer's velocity relative to the shore?

(A) 0.7 m/s
(B) 2.1 m/s
(C) 2.9 m/s
(D) 4.5 m/s

7. A plane travelling at 250 m/s [N] encounters a 40 m/s [S] headwind. What is the velocity of the plane relative to the ground?

(A) 210 m/s [N]
(B) 210 m/s [S]
(C) 290 m/s [N]
(D) 290 m/s [S]

8. Snail A is travelling at 0.001 m/s [E] toward Snail B, travelling at 0.001 m/s [W]. What is the velocity of Snail A relative to Snail B?

(A) 0
(B) 0.001 m/s [E]
(C) 0.002 m/s [E]
(D) 0.002 m/s [W]

9. Mr. Philpott is running East at 4 m/s. Mr. Bishop is walking East at 1 m/s. What is Mr. Bishop's velocity relative to Mr. Philpott?

(A) 3 m/s [E]
(B) 3 m/s [W]
(C) 5 m/s [E]
(D) 5 m/s [W]

10. While travelling on a train, two boys play catch in the aisle. The train is moving north at 30.0 m/s. The ball is tossed front to back at 5.0 m/s relative to the boys. A bystander on the highway observes the ball being tossed toward the back. To the bystander, what is the relative speed of the ball?

(A) 5.0 m/s [N]
(B) 25 m/s [N]
(C) 35 m/s [N]
(D) 35 m/s [S]

11. An inertial reference frame is one that is:

(A) Not moving
(B) Moving at constant speed
(C) Moving at constant velocity
(D) Moving with constant acceleration

12. Car A is moving at 24 m/s [E] while Car B is moving 26 m/s [W]. What is the velocity of Car A with respect to Car B?

(A) 2 m/s [E]
(B) 2 m/s [W]
(C) 50 m/s [E]
(D) 50 m/s [W]

PART B: WRITTEN RESPONSE

1. A baseball pitcher is warming up as he travels to a game by plane. The plane is flying at 400 km/h [W] relative to the ground. The pitcher throws the ball at 150 km/h relative to the airplane. What is the ball's velocity relative to the ground, if the pitcher throws the ball towards:

A) the front of the plane? (550 km/h [W])
B) the back of the plane? (250 km/h [W])

2. A duck is flying due south at 30 km/hr with respect to the earth. A photographer is driving north at 50 km/hr with respect to the earth. Determine the velocity of the duck with respect to the photographer.

3. A wild life officer spots a moose 4.0 km due West and running 10 m/s with respect to the earth. The helicopter follows the moose at 42 m/s west with respect to the earth.

A) What is the velocity of the helicopter relative to the Moose.

B) What is the velocity of the Moose relative to the helicopter.

C) How long will it take for the helicopter to reach the moose's original location?

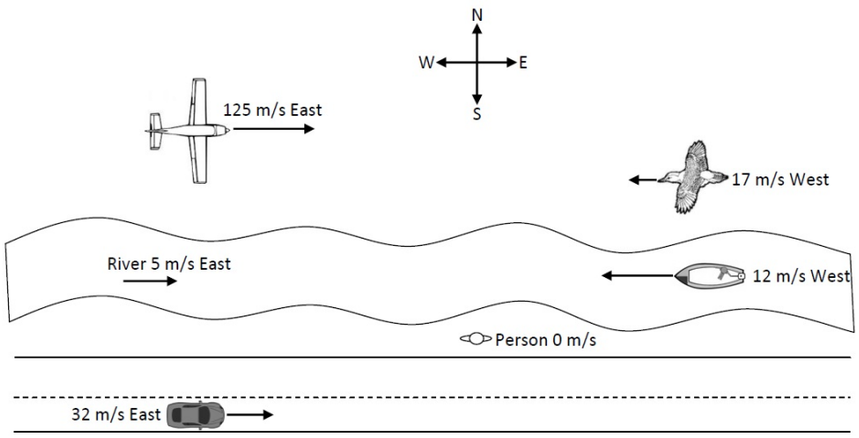
4. Two planes are approach each other head on. Each has a speed of 835 km/h, when they spot each other they are initially 10 km apart. How much time do the pilots have to take evasive action? s

5. A boat is capable of traveling 4.5 km/h on a river . The river's current is 1.5 km/h [E] with respect to the shore.

   A) When the boat is moving down stream with the current, find the time to travel 3 km relative to the shore.

   B) Find the time the boat takes to travel 3 km upstream to the starting position.

6. Put both a magnitude and a direction for the relative motion of the following objects:
   Note: All velocities are given relative to the surface of the Earth.



Object	Motion relative to the person standing on the ground	Motion relative to the river	Motion relative to the car	Motion relative to the powerboat	Motion relative to the plane	Motion relative to the bird
Person	**0**					
River		**0**				
Car			**0**			
Powerboat				**0**		
Plane					**0**	
Bird						**0**