**Vectors and Projectiles**

**Question 1:**

aa. The difference between a vector and a scalar quantity is that a vector \_\_\_.

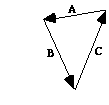
a. does not have any units

b. does not have a magnitude

c. is generally of the same magnitude or larger

d. has a magnitude AND a direction

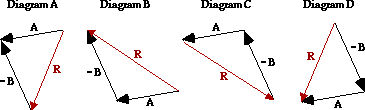
e. can be graphed; scalars can't

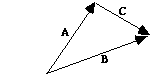


**Question 2:**

aa. Consider the vector diagram at the right. The magnitude and direction of vectors A and B are shown.

Which one of the diagrams below depicts R = A - B?

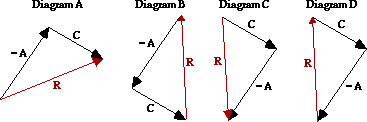




**Question 3:**

aa. Consider the vector diagram at the right. The magnitude and direction of vectors A and C are shown.

Which one of the diagrams below depicts R = C - A?



**Question 4:**

aa. When two or more vectors are added, the sum is called the \_\_\_\_\_.

a. hypotenuse b. vector c. diagonal d. resultant

**Question 5:**

aa. When adding vector B to vector A geometrically (or graphically) using the triangle method, the resultant is drawn from \_\_\_\_ to the \_\_\_\_.

a. head of A, tail of B b. tail of B, head of A

c. head of B, tail of A d. tail of A, head of B

**Question 6:**

aa. A student adds A + B + C and obtains the resultant. If another students adds the same three vectors in a different order (say C + B + A), the resultant would \_\_\_\_.

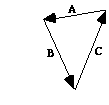
a. the same magnitude but a different direction

b. a different magnitude and a different direction

c. the same direction but a different magnitude

d. the same magnitude and the same direction

**Question 7:**

aa. Consider the diagram at the right. Which one of the following vector addition equations is shown in the diagram?

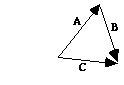
a. A + B = C b. B + A = C

c. A + C = B d. C + A = B

e. B + C = A ab. C + B = A

ac. None of these

**Question 8:**

aa. Consider the diagram at the right. Which one of the following vector addition equations is shown in the diagram?

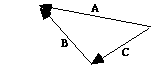
a. A + B = C b. B + A = C

c. A + C = B d. C + A = B

e. B + C = A ab. C + B = A

ac. None of these

**Question 9:**

aa. Consider the diagram at the right. Which one of the following vector addition equations is shown in the diagram?

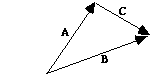
a. A + B = C b. B + A = C

c. A + C = B d. C + A = B

e. B + C = A ab. C + B = A

ac. None of these

**Question 10:**

aa. Consider the diagram at the right. Which one of the following vector addition equations is shown in the diagram?

a. A + B = C b. B + A = C

c. A + C = B d. C + A = B

e. B + C = A ab. C + B = A

ac. None of these

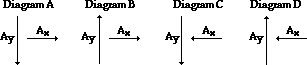
**Question 11:**

aa. The projection of a vector along the axis of a rectangular coordinate system is known as a(n) \_\_\_\_\_\_\_\_\_.

a. projector b. scalar c. resultant d. component

**Question 12:**

aa. Consider the diagram of vector **A** at the right. Which one of the following combinations would result in the projection of this vector onto the usual x- and y-axis?



a. Diagram A b. Diagram B c. Diagram C d. Diagram D

e. ... nonsense! None of these combinations represent a projection of vector **A**.

**Question 13:**

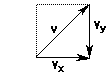
aa. Consider the diagram of vector **B** at the right. Which one of the following combinations would result in the projection of this vector onto the usual x- and y-axis?



a. Diagram A b. Diagram B c. Diagram C d. Diagram D

e. ... nonsense! None of these combinations represent a projection of vector **B**.

**Question 14:**

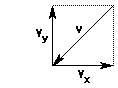
aa. Aaron Agin is resolving velocity vectors (**v**) into horizontal and vertical components (vx and vy respectively). Evaluate whether Aaron's diagrams are correct or incorrect. By his diagrams, he claims that **v** = **vx** + **vy**

a. Aaron's diagram is correct.

b. Aaron's diagram is incorrect.

If incorrect, explain the problem or make the correction.

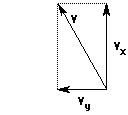
**Question 15:**

aa. Aaron Agin is resolving velocity vectors (**v**) into horizontal and vertical components (vx and vy respectively). Evaluate whether Aaron's diagrams are correct or incorrect. By his diagrams, he claims that **v** = **vx** + **vy**.

a. Aaron's diagram is correct.

b. Aaron's diagram is incorrect.

If incorrect, explain the problem or make the correction.



**Question 16:**

aa. Aaron Agin is resolving velocity vectors (**v**) into horizontal and vertical components (vx and vy respectively). Evaluate whether Aaron's diagrams are correct or incorrect. By his diagrams, he claims that **v** = **vx** + **vy**.

a. Aaron's diagram is correct.

b. Aaron's diagram is incorrect.

If incorrect, explain the problem or make the correction.

**Question 17:**

aa. A water balloon is launched with a speed of 40 m/s at an angle of 60° to the horizontal. The **vx** and **vy** components are \_\_\_\_ m/s and \_\_\_\_ m/s respectively.

a. -38.0, -12.2 b. 20.0, 34.6 c. 46.0, 38.6 d. none of these

**Question 18:**

aa. A motorcycle stunt person traveling 70 mi/hr jumps off a ramp at an angle of 35° to the horizontal. The **vx** and **vy** components are \_\_\_\_ mi/hr and \_\_\_\_ mi/hr respectively.

a. 12.0, 32.9 b. -63.3, -30.0 c. 57.3, 40.2 d. none of these

**Question 19:**

aa. A springboard diver jumps with a velocity of 12 m/s at an angle of 80° to the horizontal. The **vx** and **vy** components are \_\_\_\_ m/s and \_\_\_\_ m/s respectively.

a. 2.1, 11.8 b. 78.3, 16.6 c. -1.3, -11.9 d. none of these

**Question 20:**

aa. A football is kicked at an angle to the ground and is moving upwards and rightwards towards the peak of its trajectory. The acceleration of the football as it is approaching its peak is directed \_\_\_\_.

a. upward and rightward b. downward and rightward

c. downward and leftward d. upward and leftward

e. downward only ab. upward only

**Question 21:**

aa. A projectile is launched at an angle of 25° above the horizontal with an initial velocity (vo) of 32.5 m/s. The magnitude of the vertical velocity (vy) upon returning to its original height (2.80 seconds after launch) is \_\_\_\_ m/s.

a. 5.02 b. 9.29 c. 9.8

d. 13.7 e. 32.5 ab. 60.0

**Question 22:**

aa. A projectile is set in motion in a horizontal direction with an initial horizontal velocity of 17.2 m/s from the edge of a 62.1-meter high cliff. The projectile lands upon the ground 3.56 seconds later. The horizontal distance at which it would land from the edge of the cliff (a vertical uprising) is \_\_\_\_ meters.

a. 17. b. 34. c. 61.2 d. 62.1 e. 123.3

**Question 23:**

aa. A football is kicked at an angle to the ground and has since reached its peak and is now moving downwards and rightwards. The acceleration of the football as it is falls from its peak is directed \_\_\_\_.

a. upward and rightward b. downward and rightward

c. downward and leftward d. upward and leftward

e. downward only ab. upward only

**Question 24:**

aa. A tennis ball is hit horizontally from a height of 1-meter above the ground. After being hit, it moves as a projectile. The magnitude of the horizontal velocity of the tennis ball while in flight will \_\_\_\_.

a. decrease

b. remain constant

c. increase at a constant rate

d. increase at first and then remain constant

e. increase at first, remain constant, then decrease as it approaches the ground

**Question 25:**

aa. A tennis ball is hit horizontally from a height of 1-meter above the ground. After being hit, it moves as a projectile. The magnitude of the vertical velocity of the ball while in flight will \_\_\_\_\_.

a. decrease

b. remain constant

c. increase at a constant rate

d. increase at first and then remain constant

e. increase at first, remain constant, then decrease as it approaches the ground

**Question 26:**

aa. The best word for describing the shape of a projectile's trajectory is \_\_\_\_\_.

a. an arc b. parabolic c. exponential d. a quarter-circle

**Question 27:**

aa. The acceleration of a projectile is directed downwards \_\_\_\_\_.

a. only

b. or upwards, depending on its direction of motion

c. and horizontally if it is moving in the horizontal direction

d. ... nonsense! A projectile has a constant velocity

**Question 28:**

aa. Which of the following statements are true of projectiles during their flight? Select all that apply.

a. Their vertical velocity remains constant.

b. Their horizontal velocity remains constant.

c. The vertical acceleration is directed downwards.

d. The horizontal acceleration is a constant, non-zero value.

e. The vertical velocity of the projectile is zero at the peak of its trajectory.

**Question 29:**

aa. The diagram at the right shows the initial velocity and direction of a projectile. The horizontal and vertical components of this velocity are \_\_\_\_ m/s, respectively.

a. -38.0, -12.2 b. 20.0, 34.6 c. 46.0, 38.6

d. none of these

**Question 30:**

aa. A projectile is launched at an angle of 25° above the horizontal with an initial velocity (vo) of 32.5 m/s. It reaches the peak of its trajectory in 1.40 seconds. Its horizontal velocity (vx) at the peak of its trajectory is \_\_\_\_ m/s.

a. 0.0 b. 3.0 c. 13.7 d. 29.5

e. 32.5 ab. 41.3

**Questions 31-35:**

The next several questions are based on the following scenario.

Two people are riding an escalator between the first and the second floor in a busy shopping mall. Person A is riding upward to the second floor; person B is riding downward to the first floor (in the exact opposite direction); the two people are approaching each other. You are at rest, observing from the first floor at the bottom of the escalator. The escalators move in either direction at a speed of 0.8 m/s with respect to the floor. The positive direction is defined as upwards along the direction of the escalator.

aa. The velocity of person A with respect to person B is \_\_\_\_\_ m/s.

a. 0.00 b. +0.8 c. -0.8 d. +1.6 e. -1.6

aa. The velocity of person A with respect to you is \_\_\_\_\_ m/s.

a. 0.00 b. +0.8 c. -0.8 d. +1.6 e. -1.6

aa. The velocity of person B with respect to you is \_\_\_\_\_ m/s.

a. 0.00 b. +0.8 c. -0.8 d. +1.6 e. -1.6

aa. If person A tosses a ball towards person B with a speed of 3.0 m/s (with respect to the escalator), then the velocity of the ball with respect to person B is \_\_\_\_ m/s.

a. +2.2 b. -2.2  c. +3.0 d. -3.0

e. +3.8 ab. -3.8 ac. +4.6 ad. -4.6

aa. If person A tosses a ball towards person B with a speed of 3.0 m/s (with respect to the escalator), then the velocity of the ball with respect to you is \_\_\_\_ m/s.

a. +2.2 b. -2.2  c. +3.0 d. -3.0

e. +3.8 ab. -3.8 ac. +4.6 ad. -4.6

**Questions 36-37:**

Consider the following river boat problem. The questions are based on the following scenario:

A motorboat heads due west across a river which flows south. The river water moves with respect to the shore with a velocity of 3.50 m/s, south. The boat moves with respect to the water with a velocity of 2.50 m/s, west.

aa. The velocity (magnitude) of the boat with respect to the shore is \_\_\_\_\_ m/s.

a. 1.00 b. 2.45 c. 4.30 d. 6.00

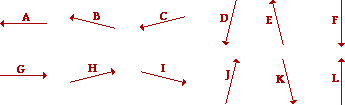
aa. The direction of the boat with respect to the shore is \_\_\_\_\_.

a. southwest b. 225 degrees

c. 54.5 degrees S of W d. 54.5 degrees W of S

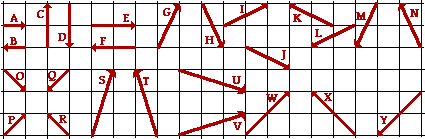
**Question 38:**

aa. A pilot wishes to fly from airport A to airport B. Airport B is located due south from airport A. The pilots aircraft averages a speed of 160 mi/hr. The pilot is flying in a wind which blows out of the west and towards the east at a speed of 40 mi/hr. Which vector best describes the direction in which the plane should head in order for the combined result of wind velocity and plane velocity to be directed south?



**Question 39:**

aa. Consider the diagram below as you answer the following vector addition questions. For each question, enter the letter of the resultant into the blank.



a. A + C = \_\_\_\_\_\_\_\_\_\_\_

b. E + D + B = \_\_\_\_\_\_\_\_\_\_\_

c. I + K + R = \_\_\_\_\_\_\_\_\_\_\_

c. U + X + Y = \_\_\_\_\_\_\_\_\_\_\_

e. S + M + V + Q = \_\_\_\_\_\_\_\_\_\_\_

**Question 40:**

aa. The vector sum of two or more vectors is known as the \_\_\_\_.

a. component b. shadow c. resolution d. resultant e. scalar

**Question 41:**

aa. A vector diagram is often used to add two or more vectors. The method for adding such vectors is known as the tip-to-tail method. Using the tip-to-tail method, the resultant is drawn with a specific direction and orientation. The proper direction for drawing the resultant is \_\_\_.

a. from the tip of the first vector to the tail of the last vector

b. from the tip of the last vector to the tail of the first vector

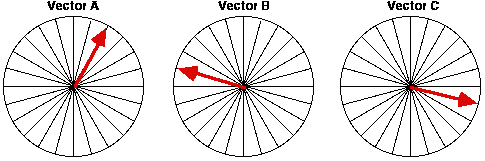
c. from the tail of the last vector to the tip of the first vector

d. from the tail of the first vector to the tip of the last vector

e. ... nonsense! The resultant can be drawn in any direction as long as it connects two vectors.

**Questions 42-44:**

Consider the diagram below as you answer the next three questions. You will have to indicate the direction of the three vectors using the usual map convention. Each direction is some multiple of 15 degrees.



aa. Vector **A** has a direction of \_\_\_\_\_. Choose two answers.

a. 30 degrees N of E b. 30 degrees S of W

c. 30 degrees W of S d. 60 degrees S of W

e. 30 degrees E of N f. 60 degrees E of N

g. 60 degrees N of E h. 60 degrees S of W

aa. Vector **B** has a direction of \_\_\_\_\_. Choose two answers.

a. 75 degrees S of E b. 75 degrees N of W

c. 15 degrees S of E d. 75 degrees W of N

e. 15 degrees N of W f. 15 degrees W of N

g. 75 degrees E of S h. 15 degrees E of S

aa. Vector **C** has a direction of \_\_\_\_\_. Choose two answers.

a. 15 degrees S of E b. 15 degrees N of W

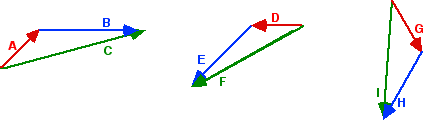
c.15 degrees E of S d. 75 degrees E of S

e. 75 degrees S of E ab. 75 degrees W of N

ac. 15 degrees W of N ad. 75 degrees N of W

**Questions 45-47:**

The diagrams below are tip-to-tail vector addition diagrams.



aa. Use a protractor to determine the direction of vector **C**.

a. 30 degrees N of E b. 30 degrees E of N

c. 15 degrees S of E d. 15 degrees E of S

e. 15 degrees N of E

aa. Use a protractor to determine the direction of vector **F**.

a. 30 degrees S of W b. 60 degrees E of N

c. 15 degrees N of E d. 30 degrees N of E

e. 30 degrees W of S ab. 15 degrees E of N

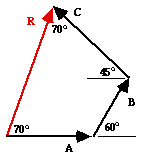
aa. Use a protractor to determine the direction of vector **H**.

a. 30 degrees S of E b. 60 degrees S of W

c. 60 degrees S of E d. 30 degrees E of N

e. 60 degrees N of E ab. 30 degrees S of W

**Question 48:**

aa. Physics student Chip Zindip has added vectors A, B and C using the tip-to-tail addition method. The resultant is vector **R**. See diagram at right. Use the angle measures on the diagram to determine the direction of the resultant.

a. 70 degrees E of N

b. 45 degrees N of W

c. 60 degrees N or E

d. 60 degrees E of N

e. 70 degrees N of E

**Question 49:**

aa. Consider the vectors below.



If vectors X and Y are added using the tip-to-tail method, then the resultant would be best represented by vector \_\_\_\_\_.

a. A b. B c. C d. D

**Question 50:**

aa. Consider the vectors below.



If vectors X and Y are added using the tip-to-tail method, then the resultant would be best represented by vector \_\_\_\_\_.

a. A b. B c. C d. D

**Question 51:**

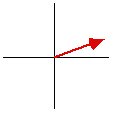
Consider the vectors below.



If vectors X and Y are added using the tip-to-tail method, then the resultant would be best represented by vector \_\_\_\_\_.

a. A b. B c. C d. D

**Question 52:**

aa. A vector is shown in the diagram at the right. This vector has two components. The \_\_\_\_ component would be greater than the \_\_\_\_ component. (Pick the best applicable answer.)

a. eastward, southward

b. westward, southward

c. southward, eastward

d. southward, westward

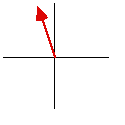
e. northward, westward

ab. westward, northward

ac. eastward, northward

ad. northward, eastward

**Question 53:**

aa. A vector is shown in the diagram at the right. This vector has two components. The \_\_\_\_ component would be greater than the \_\_\_\_ component. (Pick the best applicable answer.)

a. eastward, southward

b. westward, southward

c. southward, eastward

d. southward, westward

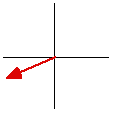
e. northward, westward

ab. westward, northward

ac. eastward, northward

ad. northward, eastward

**Question 54:**

aa. A vector is shown in the diagram at the right. This vector has two components. The \_\_\_\_ component would be greater than the \_\_\_\_ component. (Pick the best applicable answer.)

a. eastward, southward

b. westward, southward

c. southward, eastward

d. southward, westward

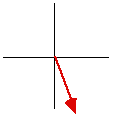
e. northward, westward

ab. westward, northward

ac. eastward, northward

ad. northward, eastward

**Question 55:**

aa. A vector is shown in the diagram at the right. This vector has two components. The \_\_\_\_ component would be greater than the \_\_\_\_ component. (Pick the best applicable answer.)

a. eastward, southward

b. westward, southward

c. southward, eastward

d. southward, westward

e. northward, westward

ab. westward, northward

ac. eastward, northward

ad. northward, eastward

**Question 56:**

aa. A 60.0-N force is applied at 30 degrees north of east. This would be the same as applying two forces at \_\_\_.

a. 30.0 N east and 30.0 N north b. 18.0 N east and 42.0 N north

c. 42.0 N east and 18.0 N north d. 30.0 N east and 52.0 N north

e. 52.0 N east and 30.0 N north

**Question 57:**

aa. Vector A is resolved into two components - Ax and Ay. If the two components are added together in tip-to-tail fashion, then the resultant would \_\_\_\_.

a. be zero

b. be the original vector A

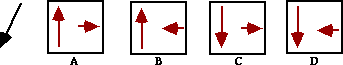
c. have a direction of 45 degrees

d. have no relationship to the original vector A

e. have the same magnitude as A but the opposite direction

**Question 58:**

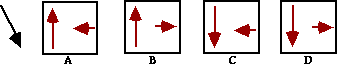
aa. Consider the vector below.



Its x- and y- components are best represented in diagram \_\_\_\_. (Enter a letter.)

**Question 59:**

aa. Consider the vector below.



Its x- and y- components are best represented by \_\_\_\_.(Enter a letter.)

**Question 60:**

aa. The process of determining the components of a vector is referred to as \_\_\_\_\_.

a. vector addition b. vector division

c. vector resolution d. vector subtraction

e. vector trigonometry ab. vector composition

**Question 61:**

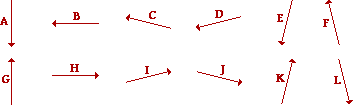
aa. Vector A has two components - Ax and Ay. If these two components are added together in tip-to-tail fashion, then the resultant would be \_\_\_\_.

a. zero b. vector A c. the opposite of vector A

d. a diagonal line at 45 degrees North of East

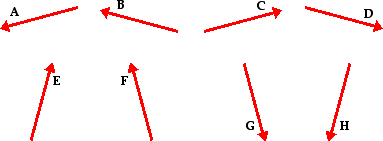
**Question 62:**

aa. A pilot wishes to fly from airport A to airport B. Airport B is located due south from airport A. The pilot's aircraft averages a speed of 160 mi/hr. If the pilot is flying in a wind that blows out of the west (i.e. towards the east) at a speed of 40 mi/hr, then the pilot should head his plane in the direction of vector \_\_\_\_.

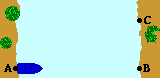


**Question 63:**

aa. A boater wishes to cross a river and land at a pier located directly across the river. The boater is on the south side of the river and must reach the opposite shore directly north of his starting point. The river flows west at a speed that is one-fourth of the boat's speed. In which direction should the boater head the boat in order to end up directly north of the starting point? Choose from the diagram below.



**Question 64:**

aa. A boat begins at point A and heads straight across a river. Because of the 2 m/s river current, the boat lands on the opposite shore at point C. If the river current was 3 m/s, then the boat would land on the opposite shore at \_\_\_. (Assume that the boat speed relative to the water does not change.)

a. a location north of C

b. the same location of C

c. a location south of C

d. Nonsense! Impossible to answer without knowledge of the time to cross the river.

**Question 65:**

aa. A boat begins at point A and heads straight across a 60-meter wide river with a speed of 4 m/s (relative to the water). The river water flows north at a speed of 3 m/s (relative to the shore). The boat reaches the opposite shore at point C. Which of the following would cause the boat to reach the opposite shore in LESS time? Select all that apply.

a. The river is 40 meters wide.

b. The river is 80 meters wide.

c. The river flows north at 4 m/s.

d. The boat heads across the river at 3 m/s.

e. The boat heads across the river at 5 m/s.

**Question 66:**

aa. A basketball is shot. After the ball leaves the player's hand, in which direction does the ball accelerate?

a. It always accelerates in a upward direction.

b. It always accelerates in a downward direction.

c. It always accelerates in the opposite direction that the object is moving.

d. It accelerates upward when the ball is rising and downward when it is falling.

**Question 67:**

aa. A boat begins at point A and heads straight across a 60-meter wide river with a speed of 4 m/s (relative to the water). The river water flows north at a speed of 3 m/s (relative to the shore). The boat reaches the opposite shore at point C. Which of the following would cause the boat to reach the opposite shore at a location NORTH of C? Select all that apply.

a. The river flows north at 4 m/s.

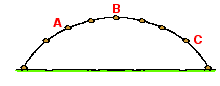
b. The river flows north at 2 m/s.

c. The boat heads across the river at 5 m/s.

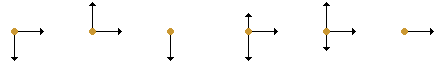
d. The boat heads across the river at 3 m/s.

e. Nonsense! None of these effect the location where the boat lands.

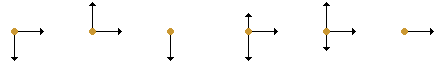
**Questions 68-70:**

A football is kicked off a tee. It is traveling through the air along a trajectory as shown at the right. There are three locations marked on the diagram. **Location A** is a location prior to the ball reaching the peak of the trajectory. **Location B** is the location when the ball is exactly at the peak of its trajectory. **Location C** is a location after the ball has reached the peak of its trajectory. Use the diagram to answer the following three questions. Consider air resistance to be negligible.

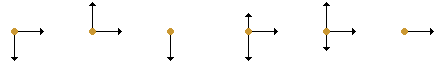
aa. Which of the diagrams below are proper representations of the forces that act upon the football at location A? Circle the proper diagram.



aa. Which of the diagrams below are proper representations of the forces that act upon the football at location B? Circle the proper diagram.



aa. Which of the diagrams below are proper representations of the forces that act upon the football at location C? Circle the proper diagram.



**Question 71:**

aa. Which of the following statements are true of the horizontal motion of an angle-launched projectile? Select all that apply.

a. The horizontal velocity at the peak is the same as just after it was launched.

b. The horizontal acceleration is 0 m/s/s.

c. The horizontal velocity increases as the projectile falls downward from the peak.

d. The horizontal velocity at the peak of the trajectory is 0 m/s.

e. The magnitude of the horizontal acceleration is 9.8 m/s/s.

**Question 72:**

aa. Which of the following statements are true of the horizontal motion of a projectile? Select all that apply.

a. The horizontal velocity at the peak is the same as just after it was launched.

b. The horizontal acceleration is 0 m/s/s.

c. The horizontal velocity increases as the projectile falls downward from the peak.

d. The horizontal velocity at the peak of the trajectory is 0 m/s.

e. The magnitude of the horizontal acceleration is 9.8 m/s/s.

**Question 73:**

aa. Which of the following statements are true of the vertical motion of an angle-launched projectile? Select all that apply.

a. The vertical acceleration is 0 m/s/s.

b. The magnitude of the vertical velocity is 9.8 m/s

c. The vertical velocity at the peak of the trajectory is 0 m/s.

d. The vertical velocity decreases as the projectile rises upward toward the peak.

e. The vertical acceleration changes during the flight of the projectile.

**Question 74:**

aa. Which of the following statements are true of the vertical motion of a projectile? Select all that apply.

a. The vertical acceleration is 0 m/s/s.

b. The magnitude of the vertical velocity is 9.8 m/s

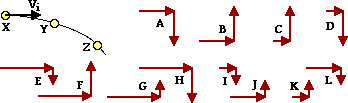
c. The vertical velocity at the peak of the trajectory is 0 m/s.

d. The vertical velocity decreases as the projectile rises upward toward the peak.

e. The vertical acceleration changes during the flight of the projectile.

**Question 75:**

aa. A projectile is launched with an initial horizontal velocity (and no vertical velocity). The initial velocity vector is shown on the right; it is labeled vi. Study the vector diagram and determine the relative size of the vector components for positions Y and Z. Enter the letters into the blanks.



a. Position Y components represented by diagram: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b. Position Z components represented by diagram: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question 76:**

aa. A ball is thrown across the room. While the ball is moving through the air upward and rightward along its trajectory, the forces that act upon it are \_\_\_\_\_\_\_. Select all that apply.

a. the force of the floor supporting its weight

b. the force of air resistance pushing the ball upward and forward

c. the force of friction between the floor and the ball

d. the force of the earth's gravity pulling it downward

e. the force of the thrower's hand pushing the ball upward and forward

**Question 77:**

aa. In which direction does the force of gravity on a projectile act?

a. It always acts in a downward direction.

b. It always acts in the opposite direction that the object is moving.

c. It always acts in the same direction that the object is moving.

d. It is impossible to make such a prediction. The direction of the force of gravity varies.

**Question 78:**

aa. The force of gravity **always** causes a projectile to \_\_\_\_\_\_.

a. speed up

b. slow down

c. accelerate downward

d. maintain a constant speed

e. accelerate in the same direction that it is moving

**Question 79:**

aa. Ball A is dropped from rest. Ball B is launched horizontally at high speeds from the same height at the same time. Which one of the following statements is true?

a. Ball A will hit the ground first.

b. Ball B will hit the ground second.

c. Both balls will hit the ground at the same time.

**Question 80:**

aa. **True** or **False**:

The horizontal motion of a projectile effects the vertical motion of a projectile. For instance, increasing the horizontal velocity of a projectile will affect the falling motion - the time it takes to fall, the vertical velocity at which it falls, and its vertical acceleration.

a. True b. False

**Question 81:**

aa. In which direction does the force of gravity on a projectile act?

a. It always acts in a downward direction.

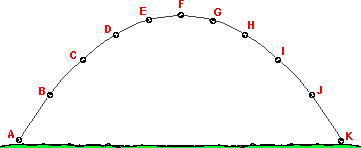
b. It always acts in the opposite direction that the object is moving.

c. It always acts in the same direction that the object is moving.

d. It is impossible to make such a prediction. The direction of the force of gravity varies.

**Questions 82-87:**

Suppose a baseball traveled through the air as a projectile with negligible air resistance. The trajectory of the baseball is shown below. The ball's position at 0.5-second intervals of time is shown.



aa. At which location is the vertical velocity (vy) 0 m/s?

aa. The vertical velocity (vy) at location **C** is 14.7 m/s. The magnitude of the vertical velocity at location **J** is \_\_\_\_\_.

a. exactly 14.7 m/s

b. less than 14.7 m/s

c. greater than 14.7 m/s

aa. At which location is the magnitude of the vertical velocity (vy) the same as location **B**. List the letter.

aa. Rank locations **C**, **D**, **G** and **J** in increasing order of their vertical velocity (vy) - magnitude only. List the location with the lowest magnitude of a vertical velocity first.

aa. The horizontal velocity (vx) at location **D** is 28 m/s. The magnitude of the horizontal velocity at location **I** is \_\_\_\_\_.

a. less than 28.0 m/s

b. exactly 28.0 m/s

c. greater than 28.0 m/s

aa. At which location or locations is the baseball moving with a smaller speed than at location **H**. List all that apply in alphabetical order.

**Question 88:**

aa. **True** or **False**:

The horizontal motion of a projectile effects the vertical motion of a projectile. For instance, increasing the horizontal velocity of a projectile will affect the falling motion - the time it takes to fall, the vertical velocity at which it falls, and its vertical acceleration.

a. True b. False

**Question 89:**

aa. A softball is thrown at an angle to the horizontal. As the softball moves upward toward the peak of its trajectory, it \_\_\_\_\_\_\_\_. As the softball falls downward from the peak of its trajectory, it \_\_\_\_\_\_\_\_\_.

a. keeps a constant speed, slows down

b. speeds up, speeds up

c. slows down, slows down

d. speeds up, slows down

e. keeps a constant speed, keeps a constant speed

ab. slows down, speeds up

ac. keeps a constant speed, speeds up

ad. speeds up, keeps a contant speed

ae. slows down, keeps a constant speed

**Question 90:**

aa. Which of the following statements are true of a projectile? Select all that apply.

a. A projectile is a free falling object.

b. A projectile is acted upon only by gravity.

c. A projectile has a constant vertical velocity of 9.8 m/s.

d. A projectile travels through the air with a constant horizontal velocity.

**Question 91:**

aa. An angle-launched projectile travels upward and rightward towards the peak of its trajectory and then falls downward. Which of the following statements are true of the projectile at the moment it is at the peak of its trajectory? Select all that apply.

a. The net force on the projectile is 0 N.

b. The vertical velocity of the projectile is 0 m/s

c. The horizontal velocity of the projectile is 0 m/s.

d. The vertical acceleration of the projectile is 0 m/s/s.

e. The horizontal acceleration of the projectile is 0 m/s/s.

**Calculations and Long Answer**

**Question 92:**

aa. The Pythagorean Theorem can be used to add vectors which are oriented at right angles to each other. Use the Pythagorean Theorem to determine the sum of the following right-angle vectors.

35 m, North + 25 m, East

**Question 93:**

aa. The Pythagorean Theorem can be used to add vectors which are oriented at right angles to each other. Use the Pythagorean Theorem to determine the sum of the following right-angle vectors.

68 m, South + 43 m, East

**Question 94:**

aa. The Pythagorean Theorem can be used to add vectors which are oriented at right angles to each other. Use the Pythagorean Theorem to determine the sum of the following right-angle vectors.

72 m, West + 98 m, South

**Question 95:**

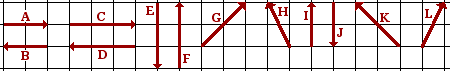
aa. The Pythagorean Theorem can be used to add vectors which are oriented at right angles to each other. Use the Pythagorean Theorem to determine the sum of the following right-angle vectors.

35 m, North + 49 m, East + 29 m, West + 72 m, South + 6 m, East

Hint: First simplify the 5 vectors into two single east-west and north-south vectors.

**Question 96:**

aa. The diagram below shows several displacement vectors displayed across a background grid. Each square of the grid is 10 m along its edge. Use the grid below and the method discussed in the reading to answer the following six questions. Enter your answers accurate to the first decimal place.



a. The vector sum of **A + E + K + J** would have a magnitude of \_\_\_\_\_\_\_\_\_\_ m.

b. The vector sum of **A + C + G** would have a magnitude of \_\_\_\_\_\_\_\_\_\_ m.

c. The vector sum of **D + F + H + K** would have a magnitude of \_\_\_\_\_\_\_\_\_\_ m.

d. The vector sum of **C + F + G + L** would have a magnitude of \_\_\_\_\_\_\_\_\_\_ m.

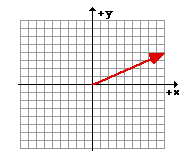
e. The vector sum of **A + E + K + J** would have a direction of \_\_\_\_\_\_\_\_\_\_ degrees.

f. The vector sum of **A + C + G** would have a direction of \_\_\_\_\_\_\_\_\_\_ degrees.

g. The vector sum of **D + F + H + K** would have a direction of \_\_\_\_\_\_\_\_\_\_ degrees

**Question 97:**

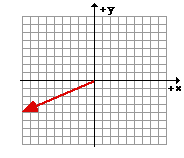
aa. Consider the vector below and the given coordinate system.



Vector A has an x-component of \_\_\_\_\_\_\_\_\_\_\_\_ units and a y-component of \_\_\_\_\_\_\_\_\_\_\_\_ units. (Enter the appropriate + and - values into the blanks.)

**Question 98:**

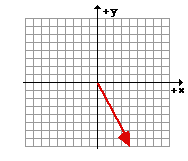
aa. Consider the vector below and the given coordinate system.



Vector A has an x-component of \_\_\_\_\_\_\_\_\_\_\_\_ units and a y-component of \_\_\_\_\_\_\_\_\_\_\_\_ units. (Enter the appropriate + and - values into the blanks.)

**Question 99:**

aa. Consider the vector below and the given coordinate system.



Vector A has an x-component of \_\_\_\_\_\_\_\_\_\_\_\_ units and a y-component of \_\_\_\_\_\_\_\_\_\_\_\_ units. (Enter the appropriate + and - values into the blanks.)

**Question 100:**

aa. Displacement vector A has a magnitude of 57.8 meters and a direction of 24.9 degrees north of west. Determine the x- and y-components of vector A.

**Question 101:**

aa. Displacement vector B has a magnitude of 71.0 meters and a direction of 61.8 degrees south of west. Determine the x- and y-components of vector B.

**Question 102:**

aa. Displacement vector C has a magnitude of 23.0 meters and a direction of 37.5 degrees east of south. Determine the x- and y-components of vector C.

**Question 103:**

aa. During the Vector Addition lab, Mac and Tosh start at the classroom door and walk:

12.8 m, west,

24.4 m north,

64.4 m west,

18.6 m south,

and 4.8 m, west.

Determine the magnitude of the resulting displacement (in meters) of Mac and Tosh.

**Question 104:**

aa. During the Vector Addition lab, Mac and Tosh start at the classroom door and walk:

13.7 m, west,

22.8 m north,

16.8 m west,

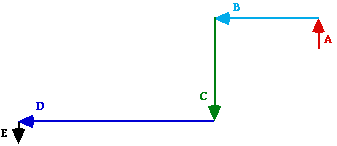
16.4 m south,

and 7.9 m, west.

Determine the magnitude of the resulting displacement (in meters) of Mac and Tosh.

**Question 105:**

aa. A student was doing a physics lab and made the following displacements through the hallways.



Each *leg* of the trip was carefully measured. The results of the measurements are as follows:

**A** = 3.2 m

**B** = 17.2 m

**C** = 19.2 m

**D** = 38.4 m

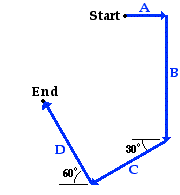
**E** = 3.7 m

Determine the resulting displacement of the physics student. Be sure to include both the magnitude and the direction.

**Question 106:**

aa. A waiter in a restaurant walks a distance of 67.8 feet west and then 39.1 feet south. What is the resultant displacement?

**Question 107:**

aa. A person going for a walk follows the path shown in the unscaled diagram at the right. The total trip consists of four straight-line paths. The magnitudes of the individual displacements are:

A = 977 m

B = 306 m

C = 162 m

D = 177 m

At the end of the walk, what is the person’s resultant displacement (in meters) measured from the starting point?

**Question 108:**

aa. An airplane begins its journey into Canada from a destination located 309 mi south of the border. The plane flies along a straight-line path at 197 mi/h in a direction of 23.2 degrees west of north. Determine the number of minutes before the plane crosses the border.

**Question 109:**

aa. Ima Late is riding in a bus moving slowly through heavy traffic at 3.4 m/s. Ima hurries to the front of the bus at 2.1 m/s relative to the bus. What is Ima’s speed relative to the street?

**Question 110:**

aa. A powerboat heads due west at 6.47 m/s relative to the water and across a river that flows due north at 3.36 m/s. What is the velocity (both magnitude and direction) of the motorboat relative to the shore?

**Question 111:**

aa. Kent is walking through a long corridor at an airport. He is walking *forward* on a walkway that moves with a speed of 1.14 m/s with respect to the surrounding corridor. Kent walks with a speed of 2.28 m/s with respect to the walkway. What is Kent's speed with respect to the surrounding corridor?

**Question 112:**

aa. During the Vector Addition lab, Mac and Tosh start at the classroom door and walk 32.6 m, north, 37.9 m west, 30.6 m south, 43.8 m west, and 29.5 m, north. Determine the magnitude of the resulting displacement (in meters) of Mac and Tosh.

**Question 113:**

aa. A person walk a distance of 29.7 m eastward followed by another eastward walk of 31.2 m.

a. What is the magnitude of the resultant displacement (in meters)?

b. What is the magnitude of the resultant displacement (in meters) in a situation in which the 31.2 m walk is in the direction opposite the 29.7 m walk?

**Question 114:**

aa. A river flows due east at 2.72 m/s. A boat crosses the river from the south shore to the north shore by maintaining a constant velocity of 7.73 m/s due north relative to water.

a. What is the magnitude of the velocity of the boat (in m/s) relative to the shore?

b. If the river is 133 m wide and the boat heads directly across it, then how much time (in seconds) does it take the boat to reach the opposite shore?

c. If the river is 133 m wide and the boat heads directly across it, then how far downstream (in meters) has the boat moved by the time it reaches the North shore?

**Question 115:**

aa. A boat heads due east directly across a 122-m wide river. The water flows due south with a speed of 2.33 m/s with respect to the shore. The boat speed with respect to the water is 2.75 m/s.

a. Determine the magnitude of the velocity (in m/s) with respect to the shore.

b. Determine the direction (in degrees) of the velocity with respect to the shore. Use the counter-clockwise from east convention.

c. Determine the distance (in m) that the boat will have traveled downstream when it has reached the opposite shore.

**Question 116:**

aa. The two displacement vectors - **A** and **B** - have a magnitude of 3.12 m. Vector **A** has a direction of 116 degrees. Vector **B** has a direction of 207 degrees.

a. Find the magnitude (in meters) of **A** + **B** using component analysis.

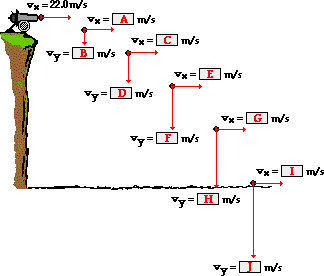
b. Use component analysis to determine the magnitude (in meters) of **A** - **B**.

**Question 117:**

aa. An airplane begins its journey into Canada from a destination located 290 mi south of the border. The plane flies along a straight-line path at 201 mi/h in a direction of 18.6 degrees west of north. Determine the number of minutes before the plane crosses the border.

**Questions 118-119:**

A cannonball is launched horizontally from the top of a tall cliff. The cannonball travels through the air for 5.0 seconds before reaching the ground. The position of the cannonball at 1.0-second intervals is shown in the diagram below. The horizontal and vertical components of velocity are constructed on the diagram; they are labeled as **vx** and **vy**.



aa. Determine the magnitude of the velocity components at each of the 1.0 second intervals of time:

**A:** \_\_\_\_\_\_\_\_\_\_\_\_ m/s **B:** \_\_\_\_\_\_\_\_\_\_\_\_ m/s

**C:** \_\_\_\_\_\_\_\_\_\_\_\_ m/s **D:** \_\_\_\_\_\_\_\_\_\_\_\_ m/s

**E:** \_\_\_\_\_\_\_\_\_\_\_\_ m/s **F:** \_\_\_\_\_\_\_\_\_\_\_\_ m/s

**G:** \_\_\_\_\_\_\_\_\_\_\_\_ m/s **H:** \_\_\_\_\_\_\_\_\_\_\_\_ m/s

**I:** \_\_\_\_\_\_\_\_\_\_\_\_ m/s **J:** \_\_\_\_\_\_\_\_\_\_\_\_ m/s

aa. What is the horizontal displacement of the projectile?

**Question 120:**

aa. A cannonball is launched off the top of a cliff with a horizontal velocity of 63.8 m/s. The cannonball lands a distance of 370 m from the base of the cliff.

a. How much time does it take the cannonball to travel this horizontal distance?

b. What is the height of the cliff from which the cannonball was launched? (Enter a positive value.)

**Questions 121-123:**

A Chicago Bear place kicker launches a kickoff at an angle of 39.1 degrees to the horizontal and a speed of 35.4 m/s. Use trigonometric functions to determine the x- and y-components of the initial velocity.

aa. Determine the time required for the projectile to rise to the peak and the total time the projectile is in the air.

aa. Determine the height to which the projectile rises when it is at its peak. (Use the tup value in your calculation.)

aa. Determine the horizontal displacement of the projectile. (Use the ttotal value in your calculation.)

**Question 124:**

aa. An angled-launched projectile takes 4.15 seconds to reach the peak of its trajectory.

a. What is the vertical component of the velocity (vy) the instant it is at the peak of its trajectory?

b. The projectile lands at the same height from which it was launched. What is the total time it is in the air?

**Question 125:**

aa. A golf ball is hit off a tee with an initial velocity of 38.0 m/s at an angle of 36.6 degrees above the horizontal. Assume the golf ball moves through the air as a projectile and use your projectile equations to answer the following questions.

a. What is the horizontal component of the initial velocity (vx)?

b. What is the vertical component of the initial velocity (vy)?

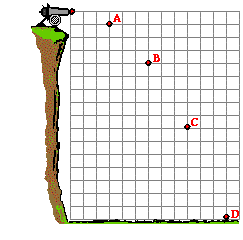
c. How much time does it take for the golf ball to reach the peak of its trajectory?

d. If the golf ball lands at the same height as the tee, then how much time is it in the air?

e. Determine the vertical height above the ground at the moment the projectile is at the peak of its trajectory.

f. Determine the horizontal displacement of the golf ball at the moment it hits the ground.

**Question 126:**

A cannonball is launched horizontally from the top of a tall cliff with a horizontal speed of 15.0 m/s. The trajectory of the ball is shown in the diagram at the right. The distance traveled horizontally by the projectile depends upon the horizontal speed and the time of travel:

**dx = vi x \* t**

For a horizontally-launched projectile, the distance fallen vertically by the projectile depends upon the time of travel and the acceleration of gravity:

**dy = 0.5 \* g \* t2**

aa. Determine the magnitude of the horizontal and vertical displacements of the cannonball after each of the 1.0-second intervals of time:

Location A (t = 1.0 s): dx = \_\_\_\_\_\_\_\_\_\_\_\_\_\_; dy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_;

Location B (t = 2.0 s): dx = \_\_\_\_\_\_\_\_\_\_\_\_\_\_; dy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_;

Location C (t = 3.0 s): dx = \_\_\_\_\_\_\_\_\_\_\_\_\_\_; dy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_;

Location D (t = 4.0 s): dx = \_\_\_\_\_\_\_\_\_\_\_\_\_\_; dy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_;

**Question 127:**

aa. A projectile is launched horizontally with an intial speed of 32.4 m/s. The projectile is in the air for 6.12 seconds.

a. What is the horizontal acceleration of the projectile?

b. What is the vertical acceleration of the projectile?

c. What is the horizontal component of velocity the instant prior to striking the ground?

d. What is the vertical component of velocity the instant prior to striking the ground?

e. What is the horizontal displacement of the projectile during this 6.12 seconds?

f. How far did the projectile fall vertically during this 6.12 seconds?

**Question 128:**

aa. In an equestrian event, a horse approaches a tall barrier and leaps over it. The horse leaves the ground with an initial speed of 7.65 m/s at an angle of 62.2 degrees to the horizontal. Determine the x- and y-components of the initial velocity.

vix = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s

viy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s

**Question 129:**

aa. A Chicago Bear place kicker launches a kickoff at an angle of 40.5 degrees to the horizontal and a speed of 33.7 m/s. Determine the x- and y-components of the initial velocity.

vix = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s

viy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s

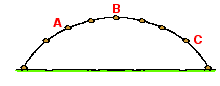
**Question 130:**

aa. Megan Progress, GBS golf standout, hits a nine-iron with a velocity of 25.2 m/s at an angle of 52.0 degrees to the horizontal. Determine the x- and y-components of the initial velocity.

vix = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s

viy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s

**Question 131:**

aa. Consider the trajectory diagram at the right for an angled-launch projectile. The initial velocity is 42.4 m/s at an angle of 25.6 degrees above the horizontal. What is the acceleration of the projectile at the three marked locations - **A**, **B** and **C**?

Acceleration at location **A**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s

Acceleration at location **B**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s

Acceleration at location **C**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s

**HINT:** It is a *projectile*.

**Question 132:**

aa. A ball rolls off a 110-cm high table and hits the ground a distance of 1.8 m from the base of the table.

a. Determine the speed (in m/s) of the ball the moment it leaves the table.

b. Determine the magnitude of the acceleration (in m/s/s) of the ball after it has fallen halfway to the ground.

c. Determine the speed (in m/s) of the ball the instant it hits the floor.

**Question 133:**

aa. A Hot Wheels car rolls off a table at a speed of 2.57 m/s and hits the floor a distance of 81.6 cm from the table's edge. Determine the height (in cm) of the table.

**Question 134:**

aa. A projectile is launched from the ground with a velocity of 50.4 m/s, directed at a angle of 30.8 degrees with the horizontal.

a. Determine the time (in seconds) that the projectile is in the air before landing.

b. Determine the horizontal displacement (in meters) of the projectile.

c. Determine the maximum vertical height (in meters) of the projectile - achieved when at the midpoint of its trajectory.

**Question 135:**

aa. A punter kicks a football at an angle of 27.9 degrees with the horizontal at an initial speed of 19.2 m/s.

a. What distance (in meters) away should a punt returner position himself to catch the ball just before it strikes the ground?

b. To what vertical height (in meters) does the football rise above the initial location?

**Question 136:**

aa. A tennis player stretches out to reach a ball that is just barely above the ground and successfully 'lobs' it over her opponent's head. The ball is hit with a speed of 19.4 m/s at an angle of 63.2 degrees.

a. Determine the time (in seconds) that the ball is in the air.

b. Determine the height (in meters) to which the ball rises above the court.

c. Determine how far away (in meters) the ball lands relative to its striking location.

**Question 137:**

aa. A good punt in football has a *hang time* (total time in the air) of 4.66 s. A punter kicks the ball at an angle of 46.4 degrees with the horizontal.

a. What must be the initial velocity (in m/s) of the ball to achieve this?

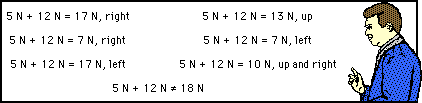
b. To what height (in meters) will such a punt rise above the ground?

**Question 138:**

aa. Billie Budten and Mia Neezhirt are having an intense argument at the lunch table. They are adding two force vectors together to determine the resultant force. The magnitude of the two forces are 3 Newton and 4 Newton. Billie is arguing that the sum of the two forces is 7 Newton; Mia argues that the two forces add together to equal 5 Newton. Who is right? Explain.

**Question 139:**

aa. Matt Erznott entered the classroom for his physics class. He is amazed by the remains of some of Mr. H's whiteboard scribblings. Evidently, Mr. H had taught his class on that day that:



Explain why the equalities are indeed equalities and the inequality must definitely be an inequality.

**Question 140:**

aa. Consider the following two projectiles. Projectile A is released from rest from an elevated position and fall vertically to the ground. Projectile B is projected horizontally with an initial speed from the same height above the ground and travels horizontally as it falls vertically.

a. Which projectile would hit the ground first? Circle answer.

A B They hit at the same time

b. Explain the reasoning behind your choice.