Performance Based Learning and Assessment Task

Football Tackle Problem

I. **ASSESSSMENT TASK OVERVIEW & PURPOSE:**
Throughout the Football Tackle problem, students will be exploring how distances affect the ability of a tackle to be accurately made during football plays. Each group will modify current football plays for precision and accuracy. Students will use their knowledge of right triangles (Pythagorean Theorem, Special Right Triangles, Trigonometry, Angles of Elevation and Depression) and distance formula to determine the validity of the original plays and generate plays of their own. After creating their own situation, students will have the opportunity for other groups within the class to try out their plays. This project is meant to deepen and assess students' knowledge and understanding of triangles as used in the Geometry curriculum.

II. **UNIT AUTHOR:**
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III. **COURSE:**
Geometry and Geometry Honors

IV. **CONTENT STRAND:**
Geometry

V. **OBJECTIVES:**
The learner will be able to…
- Solve for missing lengths in geometric figures, using properties of 45-45-90 triangles.
- Solve for missing lengths in geometric figures, using properties of 30-60-90 triangles.
- Solve problems involving right triangles, using sine, cosine, and tangent ratios.
- Solve real world problems, using right triangle trigonometry and properties of right triangles.

VI. **REFERENCE/RESOURCE MATERIALS:**
- Project handout sheet (provided)
- Assessment and rubric sheets including Peer Evaluation Rubric (provided)
- Laptops or tablets
- Notes on triangles (Pythagorean Theorem, Special Right Triangles, Trigonometry, Angles of Elevation/Depression) and distance formula taken in previous classes
- Geometry Textbook
- Calculators
- Poster board or chart paper for display (1 per group)
- Poster decorating materials as provided or requested per group

VII. **PRIMARY ASSESSMENT STRATEGIES:**
Attached is the Assessment List and Rubric for the Football Tackle Project. The goal of the activity is to deepen and assess the students' understanding of triangles (G.8 VA SOL

specifically) by exploring a real life situation and creating a situation of their own. Using the attached documents, student assessment will focus on the completion of the task; how the work has been presented; if the student is able to explain their work, process and results through the products created; and the accuracy of their conclusions and diagrams. Each student will be asked to critique a different group's problem.

VIII.   EVALUATION CRITERIA:

Students will be evaluated on the accuracy of their counter moves for the original problem, their ability to present their findings in a meaningful and coherent manner, and their individual performance on the problem. Further description can be found in the attached Project Rubrics. All members of the group with evaluate each other using the Peer Evaluation Rubric.

IX.   INSTRUCTIONAL TIME:

2- 90 minute blocks

Football Tackle Problem

Strand
Geometry: Triangles

Mathematical Objective(s)
The learner will be able to…
- Solve for missing lengths in geometric figures, using properties of 45-45-90 triangles.
- Solve for missing lengths in geometric figures, using properties of 30-60-90 triangles.
- Solve problems involving right triangles, using sine, cosine, and tangent ratios.
- Solve real world problems, using right triangle trigonometry and properties of right triangles.

This activity is meant to be used as a culminating activity for Trigonometry, Special Right Triangles, and the Pythagorean Theorem unit in Geometry. It will introduce students to using mathematical reasoning in a professional environment, creating plays that work or do not work on a football field. It will also allow students to demonstrate their understanding of the use of triangles and distance in the "real world."

Related SOL
- **G.8** (The student will solve real world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.)

NCTM Standards
- Apply and adapt a variety of appropriate strategies to solve problems.
- Communicate mathematical thinking coherently and clearly to peers, teachers, and others.
- Use trigonometric relationships to determine lengths and angle measures.

Additional Objectives for Student Learning:
- **Health and PE SOL 9.4.f** (Apply problem-solving and critical-thinking skills in physical activity settings, both as an individual and in groups.)

Materials/Resources
- Project handout sheet (provided)
- Assessment and rubric sheets -including Peer Evaluation Rubric (provided)
- Laptops or tablets
- Notes on triangles (Pythagorean Theorem, Special Right Triangles, Trigonometry, Angles of Elevation/Depression) taken in previous classes
- Geometry Textbooks
- Scientific Calculators
- Poster board or chart paper for display (1 per group)
- Poster decorating materials as provided or requested per group.

The teacher needs to be sure to procure the appropriate technological resources (Interactive Whiteboard, laptops or tablets, scientific calculators) in advance of giving this task in class.

Assumption of Prior Knowledge
Prior Knowledge
- Student should be able to "solve" a right triangle using the Pythagorean Theorem, Trigonometric ratios, and/or relationships within 30-60-90 or 45-45-90 triangles.
- Student should understand what a football play is, what it requires and how triangles can become involved (this may require classroom discussion)

- Students should have a grasp on how to present their findings in a professional setting (i.e. as if they were speaking during a job interview). Please incorporate this into class discussion if students need instruction on what this means.
- Students should be able to convert between different units of measure.

Background:
- Students should be familiar with problems at a higher level than the basic textbook problems. They should be successfully completing problems that require some sort of independent thought and completion. This task will push them to a new level of independent mathematical processing.

Possible Difficulties:
- Students may have difficulties coming up with a new situation that will actually fit the given information. Teachers should be prepared to help with some small prompts. Hopefully, this can be avoided by having students work in small groups.

Relevance:
- Students should consider how unfamiliarity with the concept of triangles could affect the outcome of planning plays in this professional sports setting.

Introduction: Setting Up the Mathematical Task

- Briefly discuss Pythagorean Theorem, Distance Formula, Parallel Line Theorems
- This task will cover two ninety minute blocks
- Show the following video to help students see the connections between their classroom knowledge and football: "Science Of NFL Football: The Pythagorean Theorem" http://science360.gov/obj/video/d37dd34c-b721-4230-9931-27c663c208df/science-nfl-football-pythagorean-theorem
- The teacher will hand out the Coach to Win! project handout, introduce the assignments, and have the students read through the handouts.
    - In this task, students will imagine they are preparing for a panel interview for a coaching job with a football team of their choice.
    - They will research a football play that resulted in their team suffering a loss. They will recreate the play and use their knowledge of the mathematical properties learned in class to describe key elements, such as distance between starting and ending points of particular players and angles of routes.
    - The students will then create a winning strategy, showing the mathematical calculations that verify the new strategy will be successful.
    - Students will create presentations to showcase their strategies and be ready to defend their ideas, in a job interview situation.
- Make students aware of the timeline:
    - Day 1 - Students will complete all mathematical calculations, plan their strategy, and create presentation for the class.
    - Day 2 - Students will give their presentations and defend their strategies.

Students should be made aware that they may need to do some work outside of class. They will need to make arrangements with the other students in their group.

- Take questions about the handout, presentations or timeline.
- Students may work in groups of two or three.

Student Exploration

Day 1 - Introduction and Research

- Assign laptops, tablets or arrange for computers.
- Have students work in their groups to research their chosen teams and to find a play they would like to present.
- Assist students create a visual to show the players and their routes.
- Students may also choose to use Geogebra, a coaching app, or other software to create their visual. They will also use graphing calculators for calculations.
- Monitor the groups and facilitate the discussions to ensure they are making progress.
- Students will practice their presentations with group members when they have completed the visual.

Day 2 - Interviews (Presentations)

- Student groups will be called to the front of room to introduce their ideas and give their presentation.
- The other students will ask questions and the student group will defend their strategy.
- Students will assess the presenters using the student rubric.

Monitoring Student Responses

Students are expected to communicate their ideas by creating a visual of the original situation as well as a visual for their winning strategy. They are expected to present their ideas orally and to be ready to defend these ideas by demonstrating the accuracy of their use of mathematics. Students are expected to share the work equally and to be ready to answer the questions posed by their fellow students.

Assessment List and Benchmarks

- The required assessment list, rubric and benchmarks are attached.
- The assessments for each task are described above in the daily plan. The way those assessments will be graded is included within the Football Tackle Project Handout.

Accommodations:

- Students in need of read-aloud services will be sent to resource to have their assessment read to them, if an inclusion teacher is not available.

Coach to Win!

Today, you will be using mathematics to land a coaching job with your favorite football team. The NFL is a multi-billion dollar industry in the United States. In fact, it was reported in 2014 that over 50% of Americans surveyed said they were NFL fans. While the salaries of the coaching staff pales in comparison to many of the athletes' contracts, head coaches' salaries are consistently higher than $1,000,000 per year.

You have been given the opportunity to interview for a coaching position with your favorite football team. The team has suffered some bad losses due to poorly thought out defensive plays. Your unique qualifications with distance and triangles could prove to be a deciding factor in whether or not you are hired. You are presented with a copy of their current play laid out on a coordinate grid for easier measuring. Your challenge is to prove that mathematics is important to your team by fixing their play.

You will defend your position by providing a mathematical analysis of a play that cost the team a game. Using your knowledge of geometry learned in this course, you will provide an alternative strategy that would have resulted in a victory for your team.

Here is the current play situation:
You are working for Team A.

With enough time for one last play, Team A (Virginia Cavaliers) is beating Team B (Norfolk State Spartans) 21-20. Team B has the ball on Team A's 20 yard line. If Team A can stop Team B from scoring, they will go to the bowl game. Team A's defensive coach set up a man-to-man defense against Team B and it did not work. You have the predicted routes for Team B's players. The goal line is at the line y=10. The offense (Team B) should line up at or behind y = -10. The defense (Team A) should line up before y = -10.

Team B's Predicted Movements:
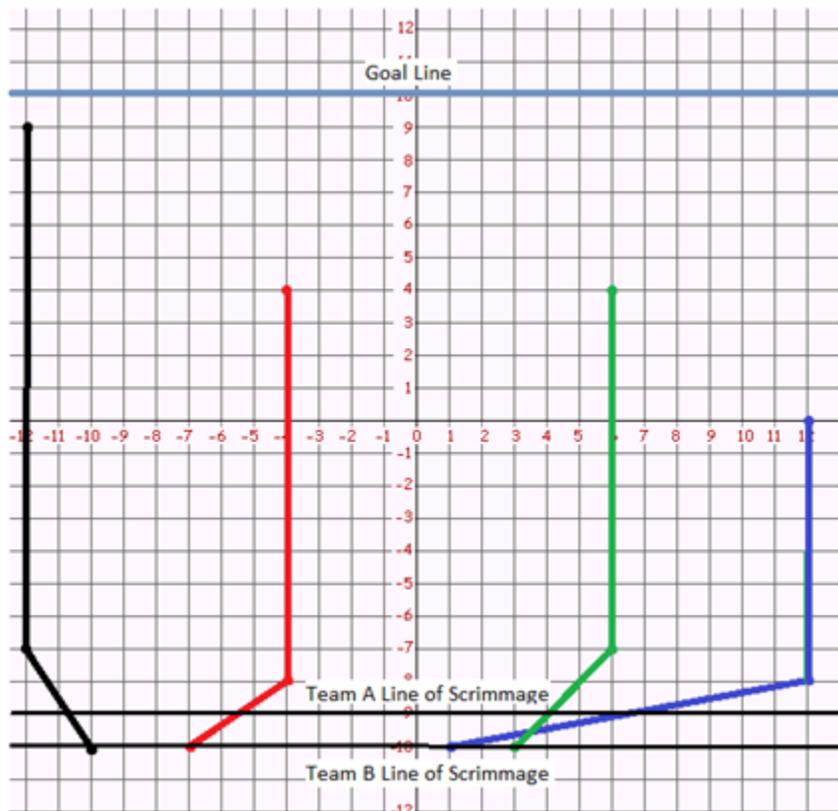
Player H: Start at (-10, -10). Run to (-12, -7), then cut up the field to (-12, 9) for the long pass.

Player I: Start at (-7, -10). Run to (-4, -8) then run to (-4, 4) for the pass.

Player J: Start at (1,-10). Run to (12, -8) then cut up the field to (12, 0) for the pass.
Player K: Start at (3, -10). Run to (6, -7) then run to (6, 4).

Please include where you would start (somewhere along y = -9 or -8 would be ideal) and what your moves would be to intercept a particular player. Keep in mind, you are all moving the same speed, so if your player has gone a farther distance than Team B's player, you have missed them!

Coach to Win! Task Description

Names: _____

_____

_____

Part 1 – 40% of grade

Your task: Create your own play moving at least four players on Team A. You may choose their starting position along y = -9. Clearly show the routes your players will take, and provide the mathematics involved in your moves. This is to include how you know the movements you made will stop Team B from scoring. Create a visual that you will use in your presentation. Assume that all players are moving at the same speed.

Part 2 – 20% of grade

Your task: Research or develop a scenario where a team of your choosing loses a close game because of one defensive play. Create a diagram showing the movement of key players and use mathematics to describe their routes. Assume that all players are moving at the same speed.

Part 3 – 40% of grade

Your task: Create a presentation to showcase your ideas to a panel. You will be defending your answers to the panel.

For these tasks, you should use what you have learned about right triangles, including Pythagorean Theorem and the distance formula.

At the conclusion of the project, you will be completing an evaluation of your group mates and your project based on the provided rubrics.

Football Tackle Situation, Visual, and Presentation Rubric   Name: _____
Assessment List and Possible Points

Item Number	Description	Points Possible	Student Score of Him/Herself	Teacher Score of Student
1	Student was an equal participant in all aspects of the project: research, visual /quiz creation and presentation. (Result of Peer Evaluation Rubric).	5		
2	Math work was included to back up all stated calculations (could be turned in separately and not seen on the visual).	10		
3	Math work is neat and organized.	5		
4	Student completed a visual as requested on the project handout.	5		
5	Research is evident in presentation and work.	5		
6	Diagrams for any defensive suggestions for the original problem and created situation are included	5		
7	The student's presentation was neat, well-organized and engaging.	5		
8	The student could explain their process, thoughts and reasoning well.	5		
9	The student could answer the questions posed by classmates and teacher in a coherent, well-thought-out manner.	5		
Total Points Possible:		50		

Football Tackle Presentation/Research and Created-Situation Rubric

Item #	Description	0 points	2.5 points	5 points
1	Student was an equal participant in all aspects of the project: research, visual /quiz creation and presentation.	Scores for this portion will be based on the Peer Evaluation Rubric to be filled out by each group member. The resulting average will be out of 5 points (For example: an 85% on the Peer Evaluation would be 4.25 points).		
2	Math work was included to back up all stated calculations (Worth double points- 12 total).	No additional math work included.	Some of the work was included and is accurate or all of the work is included but some is accurate.	All of the math work was included and accurate.
3	Math work is neat and organized.	Work was not present or lacked organization/ neatness.	Work was partially organized.	Work was neat, legible, easy to follow and organized.
4	Student completed a visual as requested on the project handout.	No visual created.	Visual was partially complete.	Visual was complete with all needed information.
5	Research is evident in presentation and work.	No research included.	Research included was incomplete or not evident.	Research included was complete and evident.
6	Diagrams for any suggested defensive moves and the created situation are included.	No diagram included.	Diagram was partially accurate. Some parts are labeled.	Diagram was included, accurate, and fully labeled.
7	The student's presentation was neat, well-organized and engaging.	Presentation was not organized, lacked neatness, or was not engaging.	Presentation was difficult to follow, and only partially engaging. Lacked organization.	Presentation was easy to follow, neat and engaging.
8	The student could explain their process, thoughts and reasoning well.	Student provides no explanation.	Student provided an explanation, but was mostly inaccurate.	Student explanation was accurate and flowed well.
9	The student could answer the questions posed by classmates and teacher in a coherent, well-thought-out manner.	Did not answer questions.	Answered questions, but was not accurate or confident with responses.	Accurately answered questions.

Name: _____

Peer Evaluation Rubric

Group Member Name	Total Score	Average %

Directions: Place your name and the group member's name you are evaluating in the space above. **Be honest in your evaluations; rewarding someone who did not fully participate is not fair to the group.** Add the points and fill in total next to names at the top. All group members' scores will be averaged from each evaluation sheet and recorded on your product grading sheet. (Example: If you receive an 18, 20, and 13 from your group members, your score would average out to 17 out of 20 possible, which is an 85 %.) Complete one of these evaluations for each of your partners.

5 points-strongly agree
4 points-very much agree
3 points-agree
2 points-somewhat agree
1 point-somewhat disagree
0 points-disagree

0	1	2	3	4	5	
						This person helped the group work hard to meet group objectives as listed on the project sheet.
						This person completed their assigned work without having to be re-directed by group members.
						This person did not spend time socializing with other groups.
						This person listened to the other group members ideas, and offered their own input.

Benchmark
Predicted Offensive movement

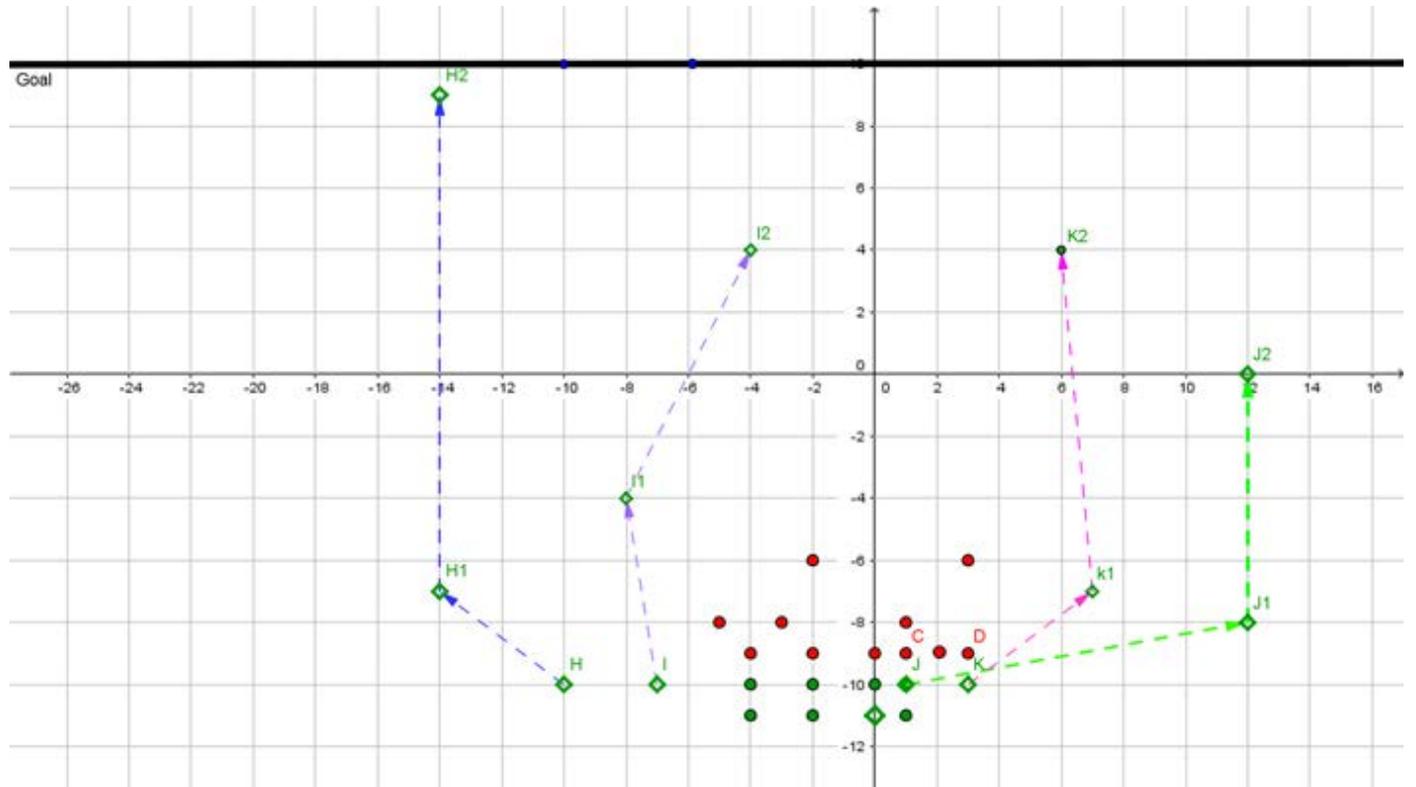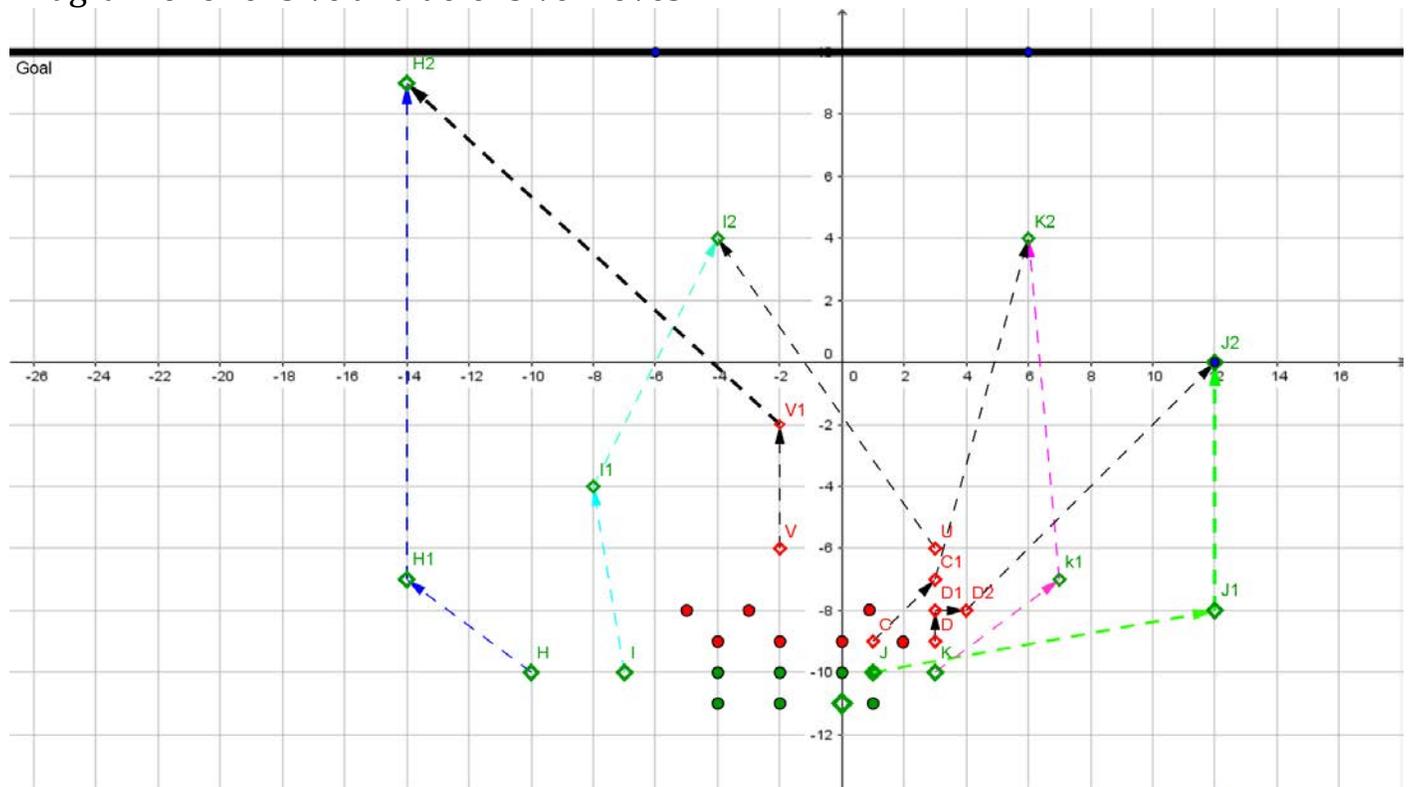Diagram of offensive and defensive moves.

Player H –
Distance from (-10, -10) to (-14, -7) Distance from (-14, -7) to (-14, 9)

$$\sqrt{(-14+10)^2+(-7+10)^2}$$ = 5 $$\sqrt{(-14+14)^2+(9+7)^2}$$ = 16
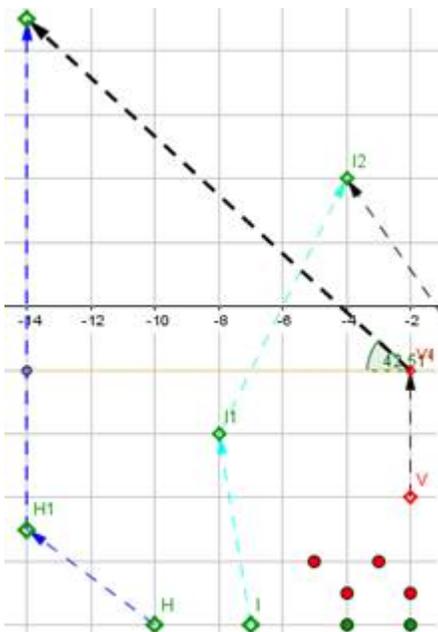
Total distance for player H = 21

Defensive Player V will run parallel to player H's route from starting point
(-2, -6) to (-2, -2), covering a distance of 4. This point creates a right triangle with legs of 11 on the vertical and 12 on the horizontal. Using trigonometry, we can find the angle player V needs to run to make his mark

$$\tan^{-1}\left(\frac{11}{12}\right) \approx 42.5°$$

He will run at a 42.5°angle to his mark at (-14, 9)
Distance from (-2, -2) to (-14, 9)

$$\sqrt{(-14+2)^2+(9+2)^2} \approx 16.28$$

The total distance traveled by the player V will be approximately 18.28. This is shorter than the distance traveled by the offensive player by approximately 2.72 leaving enough time for player V to be ready to intercept a pass.

Player I –

Distance from (-7, -10) to (-4, -8)

$$\sqrt{(-4+7)^2 + (-8+10)^2} \approx 3.61$$

Distance from (-4, -8) to (-4, 4)

$$\sqrt{(-4+4)^2 + (4+8)^2} = 12$$

Total distance for player I $\approx$ 15.61

Player U's route will be along the hypotenuse of a right triangle with a leg length of 10 on the vertical and 7 on the horizontal.
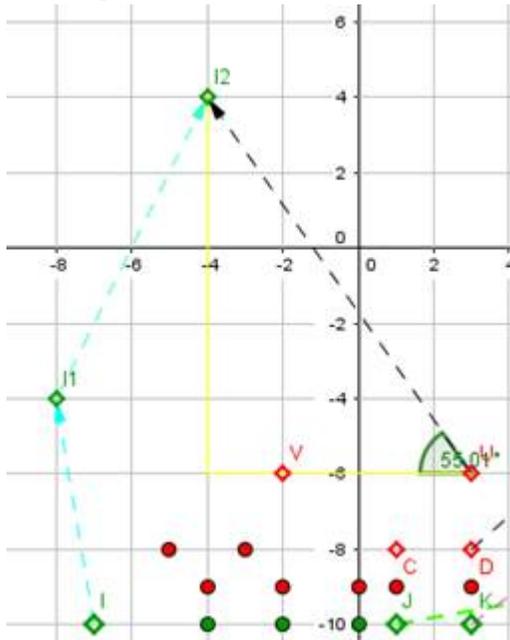
Using trigonometry, we can find the angle player U needs to run to make his mark

$$\tan^{-1}\left(\frac{10}{7}\right) \approx 55.1°$$

He will run at a 55°angle to his mark at (-4, 4)

Distance from his starting point at (3, -6) to (-4, 4)

$$\sqrt{(-4-3)^2 + (4+6)^2} \approx 12.21$$

The total distance traveled by the player U will be approximately 12.21. This is shorter than the distance traveled by the offensive player by approximately 3.4, leaving enough time for player U to be ready to intercept a pass.

Player J –

Distance from (1, -10) to (12, -8)

$$\sqrt{(12-1)^2+(-8+10)^2} \approx 11.18$$

Distance from (12, -8) to (12, 0)

$$\sqrt{(12-12)^2+(0+8)^2} = 8$$

Total distance for player J $\approx$ 19.18

Player D will move vertically one unit and horizontally one unit. This creates an isosceles right triangle with the route of player J, since the legs formed are both 8 units. We now know that player D should run at a 45° to get to his mark at (12, 0).

Using the rules of a 45-45-90 triangle, we know that the hypotenuse is equal to the leg $*\sqrt{2}$.

Player D will run $8\sqrt{2}$ or approximately 11.31 units .

We add the two units for his first moves which gives a total distance ≈ 13.31
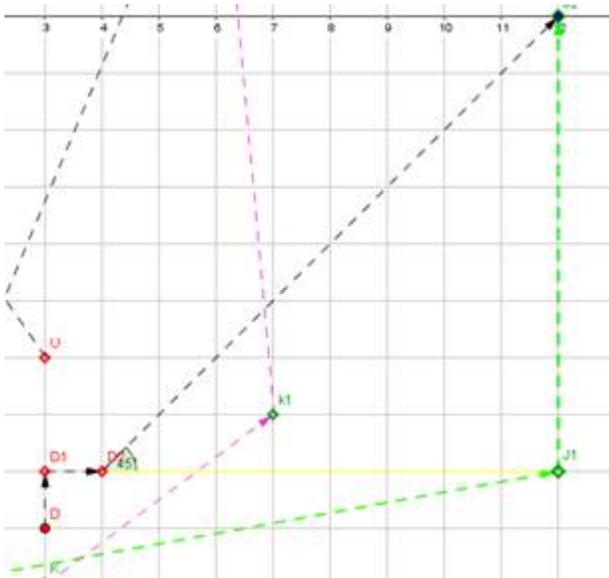
The total distance traveled by the player J will be approximately 13.31. This is shorter than the distance traveled by the offensive player by approximately 5.87, leaving enough time for player D to be ready to intercept a pass.

Player K –

Distance from (3, -10) to (6, -7)

$$\sqrt{(6-3)^2+(-7+10)^2} \approx 4.24$$

Distance from (6, -7) to (6, 4)

$$\sqrt{(6-6)^2+(4+7)^2} = 11$$

Total distance for player K $\approx$ 15.24

Player C will move at a 45° angle, going from (1, -9) to (3, -7).

This will be a distance of $2\sqrt{2} \approx 2.83$. This creates a right triangle with leg length 11 on vertical and 3 on the horizontal. Using trigonometry we find that he needs to run at a 74.37°angle towards his mark

$$\tan^{-1}(11/3) \approx 74.74°$$

Player C's distance across this hypotenuse will be:

Distance from (3, -7) to (6, 4)

$$\sqrt{(6-3)^2+(4+7)^2} \approx 11.40$$

We add the distances for his first move which gives a total distance ≈ 14.23
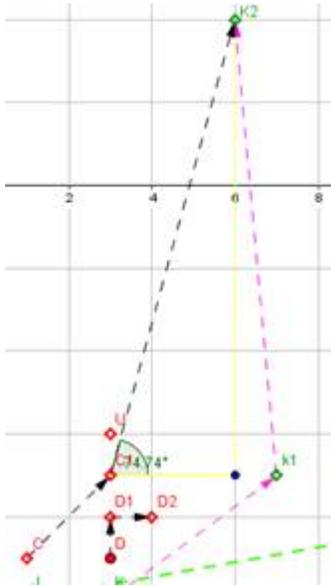
Player C's distance is shorter than the distance traveled by the offensive player by approximately 1.01. Player C will arrive at the mark first and be able to intercept a pass.