Task: Grade of an Interstate	Geometry/Core Math II

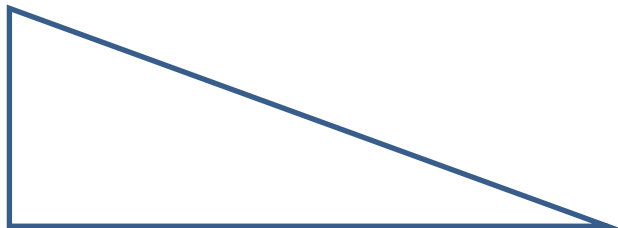You are travelling down an interstate and you see a sign that reads:

Use Caution

6% Grade Next 4 Miles

Trucks Use Lower Gear

You are curious to know exactly what this means. Your friend sitting in the passenger seat searches on his smartphone and determines that grade means vertical change in distance over horizontal change in distance.

a)   Use a pictorial representation to show what the 6% grade would look like in this situation.
b)   Find the change in elevation of your car on a 4 mile journey. Show any work that justifies your conclusion.
c)   If you turned around at the bottom of the hill and went right back up the same road, at what angle of elevation would you be driving? Appropriately label as much of the triangle below as possible to help justify your work.

Teacher Notes:

This is a different take on the typical sine, cosine, and tangent problem. This introduces the term grade, which is prevalent on interstates in Tennessee. A good discussion of angle of elevation/depression could also come out of this task.

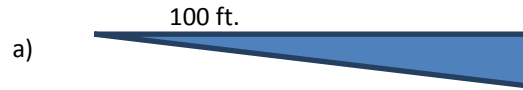| Common Core State Standards for Mathematical Content	Common Core State Standards for Mathematical Practice
G-SRT.C.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.▢	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.

Essential Understandings

- A diagram is a sophisticated mathematical device for thinking and communicating.
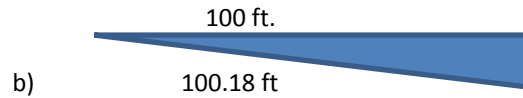
Explore Phase

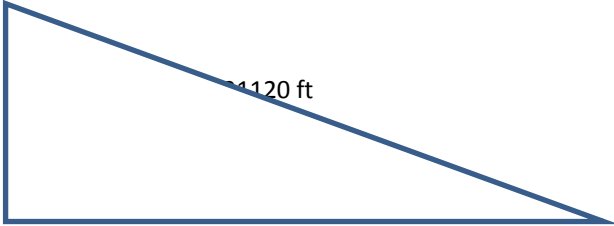| Possible Solution Paths	Assessing and Advancing Questions
a) 100 ft.	Assessing – Why did you choose 100 and 6? Advancing- Is there any other representation you could draw?
Find the hypotenuse by the Pythagorean Theorem 100 ft. b) 100.18 ft Use similar triangles 4 miles = 4 x 5280 feet = 21120 feet 21120 ft. $\dfrac{6}{x} = \dfrac{100.18}{21120}$ 100.18x = 126720 x = 1264.92 feet drop	Assessing – Why did you decide to use similar triangles? Advancing- Is there another method we could use to solve this problem?
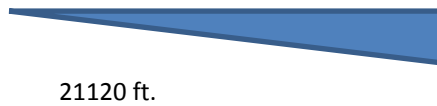
c) 1264.92 ft   21120 ft

$\sin X = \dfrac{1264.92}{21120}$

$X = \sin^{-1} \ 1264.92/21120$

Angle X = 3.43°

Assessing – Why did you decide to use sine in solving for the angle?

Advancing- How could you use cosine or tangent to solve for the angle of elevation?

Possible Student Misconceptions	Assessing and Advancing Questions
a) Students may struggle with the concept of 6% grade.	Assessing – What des 6 percent mean? Advancing – How can we use this to help us in this problem?
b) Students may put the 4 miles on the horizontal side of the triangle instead of the hypotenuse.	Assessing – Why did you put the 4 miles on this side? Advancing – Think about driving down the hill, where should we put the 4 miles?
c) Students may not know how to find the angle of elevation.	Assessing – What trig ratio can we identify in your triangle? Advancing – How can we use this to find the angle of elevation?
Entry/Extensions	**Assessing and Advancing Questions**
If students can't get started….	Assessing- Do you understand what the sign you see means? Advancing- Can we draw a diagram about what is happening and then label it for this situation?
If students finish early….	Assessing- At what angle did you descend down the slope? Advancing- Do you see any pattern in this with your answer to part c?
Whole Group Questions	

- Do we understand the concept of grade?   Have you seen this while riding on the Interstate?
- In part B did it matter where you put the 4 miles? Why?
- What did you notice about the angle of elevation and the angle of depression?   Do you think this would always be true?

Grade of an Interstate

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