WINDMILL POWER

Performance Standard (6B/6D/8C/8D).I

Use an equation representing a situation of direct variation to solve problems and make a comparison accordingly:

- *Mathematical knowledge*: Set up and solve proportions for direct and inverse variation of simple quantities; solve problems by recognizing how an equation changes when parameters change.
- *Strategic knowledge*: To solve problems of direct variation situations.
- *Explanation*: Explain completely and clearly what was done and why it was done.

Procedures

1. ***In order to investigate, represent and solve problems using number facts, operations and their properties, algorithms, and relationships (6B), solve problems using comparison of quantities, ratios, proportions, and percents (6D), solve problems using systems of numbers and their properties (8C), and use algebraic concepts and procedures to represent and solve problems (8D),*** students with sufficient learning opportunities to develop the following:
   - Develop fluency in operations with real numbers using mental computation or paper-and-pencil calculations for simple cases and technology for more-complicated cases.
   - Judge the reasonableness of numerical computations and their results.
   - Set up and solve proportions for direct and inverse variation of simple quantities.
   - Solve problems by recognizing how an equation changes when parameters change.
   - Solve problems of direct variation situations using a variety of methods.
   - Interpret and use functions as a geometric representation of linear and non-linear relationships.
2. Provide each student a copy of the "Windmill Power" task sheet and the rubric. Have students review and discuss the task to be completed and how the rubric will be used to evaluate it.
3. Have students solve the following problem using a calculator.

   The power, P, generated in one hour by the windmill on the Brown's farm, is proportional to the cube of the wind speed, V, where the constant is 0.015, as shown by the formula, $P = 0.015\ V^3$ where P is measured in watts and V is measured in miles per hour.

   - Byron says that if the wind blew at 4 mph for one hour and then 12 mph for another hour, the amount of power generated by the windmill would be the same as the amount generated by an 8 mph wind in two hours. Leslie disagrees. Use mathematics to show who is correct.

   - If Leslie is correct, what would be the necessary wind speed for two hours that would generate the same amount of power as the original question?

   Decide who is correct and justify your answer mathematically, writing in full sentences what you did and why you did each step.

4. Evaluate each student's work using all dimensions of the rubric and its guide to determine the performance level. A 4 in mathematical knowledge would require the correct choice of "Leslie", a total of 26.88 instead of 15.36 for 2 hours at 8 mph, and a wind speed of 9.64 for question two. A 4 in strategy would require the qppropriate use of the given formula. A 4 in explanation would be a complete description of what was done and why each step was done.

Examples of Student Work follow

Resources

- Copies of the "Windmill Power" task sheet
- Calculator
- Mathematics Rubric

Time Requirements

- 30 minutes

Name _____ Date _____

WINDMILL POWER

The power, P, generated in one hour by the windmill on the Brown's farm is proportional to the cube of the wind speed, V, where the constant is 0.015, as shown by the formula

$$P = 0.015\ V^3$$

Where P is measured in watts and V is measured in miles per hour.

1. Byron says that if the wind blew at 4 mph for one hour and then 12 mph for another hour, the amount of power generated by the windmill would be the same as the amount generated by an 8 mph wind in two hours. Leslie disagrees. Use mathematics to show who is correct.

2. If Leslie is correct, what would be the necessary wind speed for two hours that would generate the same amount of power as the original question?

Decide who is correct and justify your answer mathematically, writing in full sentences what you did and why you did each step.

Adapted from the Massachusetts Comprehensive Assessment System, Released Spring 2000 item, Grade 10.

Name _____ Date 5/7/01

The power, P, generated in one hour by the windmill on the Brown's farm is proportional to the cube of the wind speed, V, where the constant is 0.015, as shown by the formula

$$P = 0.015\ V^3$$

Where P is measured in watts and V is measured in miles per hour.

1. Byron says that if the wind blew at 4 mph for one hour and then 12 mph for another hour the amount of power generated by the windmill would be the same as the amount generated by an 8 mph wind in two hours. Leslie disagrees. Use mathematics to show who is correct.

2. If Leslie is correct, what would be the necessary wind speed for two hours that would generate the same amount of power as the original question?

Decide who is correct and justify your answer mathematically, writing in full sentences what you did and why you did each step.

(1) First do 4 to the third power multiplied by .015 'cause that's going to be the formula you should get .96 then to the same for 12 to the third power you should get 25.92 then add them to get the power for a hour and it should equal 26.88 Then to get the power for 2 hours at 8 mph you do 8 to the 3rd multiplied by 0.15 and it should = 7.68 then double that number to get the wind speed for two hours and your answer should be 15.36 Leslie is correct!

$P = 0.015(4^3) = .96$

$P = 0.015(12^3) = 25.92$ } power for 2 hours

26.88

Adapted from the Massachussetts Comprehensive Assessment System, Released Spring 2000 item, Grade 10.

$P = 0.015(8^3) = 7.68$

15.36 } Power for 2 hours

(9.) 26.88 for two bolts
13.44 for one bolt

So use P=0.01543 and work backwards

$$0.015(V^3) = 13.44$$

$$V^3 = \frac{13.44}{.015}$$

$$V^3 = 896$$

$$V = 9.641$$

Leslie is correct and the wind speed would be 9.641

"Exceeds"

Name _____ Date April 30, 2001

The power, P, generated in one hour by the windmill on the Brown's farm is proportional to the cube of the wind speed, V, where the constant is 0.015, as shown by the formula

$$P = 0.015\ V^3$$

Where P is measured in watts and V is measured in miles per hour.

1. Byron says that if the wind blew at 4 mph for one hour and then 12 mph for another hour the amount of power generated by the windmill would be the same as the amount generated by an 8 mph wind in two hours. Leslie disagrees. Use mathematics to show who is correct.

Leslie correct

2. If Leslie is correct, what would be the necessary wind speed for two hours that would generate the same amount of power as the original question?

Decide who is correct and justify your answer mathematically, writing in full sentences what you did and why you did each step.

4 mph
$P = 0.015 r^3$
$P = 0.015 (4)^3$
$P = 0.015 (64)$
$= .96$

+ 12mph
$P = 0.015 (1728)$
$= 25.92$

$= 26.88$

Byron was wrong when he told leslie that if the wind blew at 4 mph for one hour then 12 mph for another hour it would be the same as the amount generated by an 8 mph wind in two hours. Leslie knew that if the wind blew at 4 mph on hour and 12 mph the next that the wind would blow at 26.88 mph she knew this because when you cube 3 it would be 64 and if you times it by 0.015 you would get .96 and if you add it to the answer 4 you get for 12 hours you would get 25.92 which adds up to 26.88. She also knew that 8 mph cubed was 512 times 0.015 = 7.68 which multiplied by 2 which would be hours is 15.36. She worked the problem out backwards She knew that 9.64 would be the time

8 mph
$P = 0.015 (512)$
$= 7.68$

× 2 hours
$= 15.36$

$\frac{13.44}{0.015} = \frac{.015 r^3}{0.015}$

$896 = r^3$

$= 9.64$

Adapted from the Massachussetts Comprehensive Assessment System, Released Spring 2000 item, Grade 10.

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