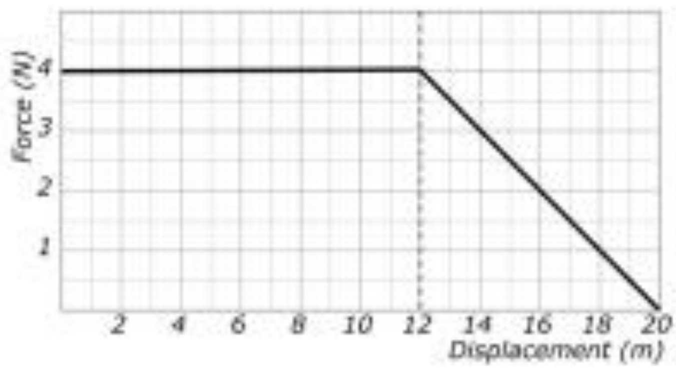
NAME ______________________ DATE ____________

## Scenario

*Starting from rest, a 1 kg cart moves to the right along a horizontal surface that exerts negligible friction, while being pushed by a horizontal force F as shown. The force exerted on the cart as a function of displacement is graphed below.*




## Data Analysis

PART A: **Claim:** The cart will have a change in mechanical energy of 48 *J* as its displacement is changed by 12 m.

Collect evidence about the physical meaning of the area under the line on the graph that can be used to support the claim above. Write an equation (including units) for the area between the force line and the $x$-axis between $x = 0$ m and $x = 12$ m.

**Evidence:** The area under the line of the force vs. displacement graph is equal to

4 (number) N (units) × 12 (number) m (units) = 48 (number) N·m (units). This area is also known as the

Work (physical quantity) done on the object.

**Reasoning:** Fill in the blanks of the following statement:

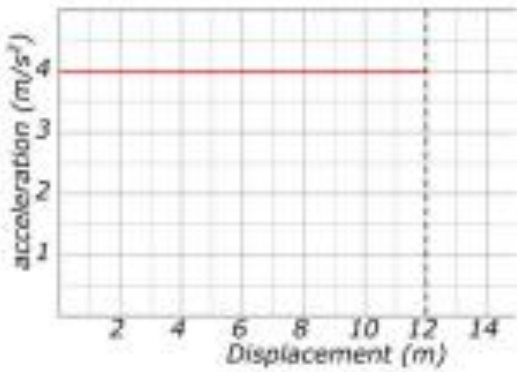
The claim makes sense because the Work done on the cart is also equal to the change in Mechanical Energy of the cart.

PART B: Explain how the graph above could be used to determine the final speed of the cart after 12 m.

Since the cart can be modeled as an object, the work done on the cart is also equal to the change in kinetic energy of the cart. The cart started from rest, so the initial kinetic energy is zero, and the change in kinetic energy will be equal to the final kinetic energy. So, the 48 J of work done on the cart increases the kinetic energy by 48 J. So, the final kinetic energy ($\frac{1}{2}mv^2$) is equal to 48 J. Since we know the mass of the cart, the final speed of the cart can be solved for.

## Using Representations

PART C: On the grid to the right, sketch a graph of the acceleration of the cart as a function of displacement from $x = 0$ m to $x = 12$ m.




PART D: After creating her graph of acceleration vs. displacement, Angela says, "Oh, the slope of a velocity graph represents the acceleration. So, since the acceleration is constant at 4 m/s$^2$, the graph of velocity as a function of displacement should be a line with a slope of 4 m/s$^2$.

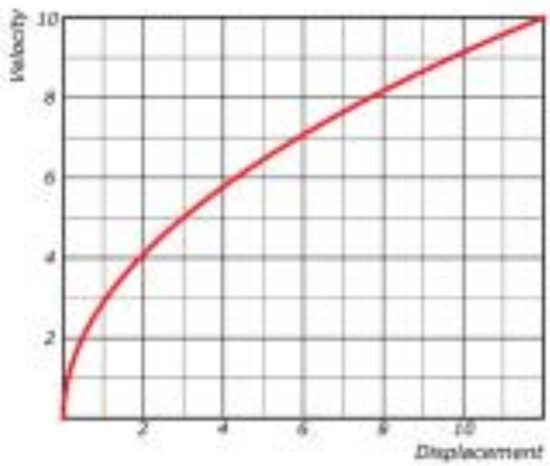
Do you agree with Angela?

_____ Yes __X__ No

Explain.

The slope of the velocity vs time graph represents the acceleration and would be linear, but since this car is accelerating and will be speeding up uniformly in time, it will not be speeding up uniformly vs displacement

PART E: Sketch a graph of the velocity of the cart as a function of displacement.




## Quantitative Analysis

PART F: The equation $v^2 = v_0^2 + 2a(\Delta x)$ can help describe the velocity of an object with a constant acceleration as a function of position. Is this equation consistent with the graph you sketched in Part E? Explain.

Yes, the equation above shows that the relationship between position and velocity for a constant acceleration is NOT linear, as Angela predicted, but a square-root relationship. If you rewrite the equation given above for the final velocity of the cart, knowing that the initial velocity was zero, the relationship in the equation matches the graph above.