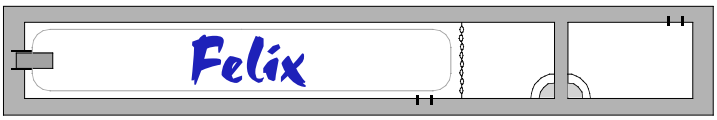
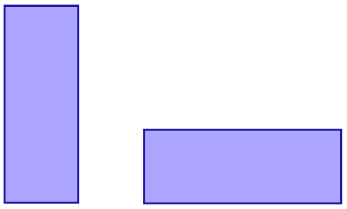
PhyzSpringboard: Intro to Momentum



AREA

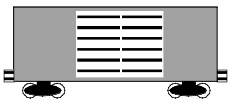
How can a rectangle with a small base have the same area as a rectangle with a large base? Answer and explain using words and diagrams.



Rectangle with small base has tall height.
Rectangle with large base has short height
Area is product of base and height.

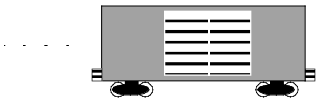
MOMENTUM

1. Consider the following findings regarding momentum.



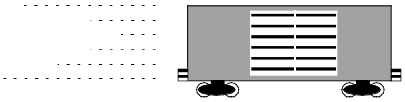
a. The railroad car at rest has _____none_____.

b. The railroad car moving slowly has _____some_____.



c. The railroad car moving quickly has _____more_____.

What might you conclude about momentum based on these findings?

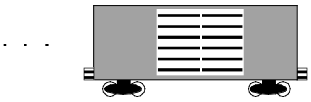


momentum ∝ speed

2. Consider the following findings regarding momentum.

a. The slow-moving fly has _____some_____.

b. The slow-moving railroad car has _____more_____.



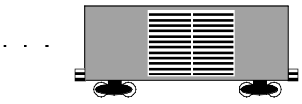
What might you conclude about momentum based on these findings?

momentum ∝ mass

3. Consider the following findings regarding momentum.

a. The high-speed bullet has _____some_____.

b. The slow-moving railroad car has _____same_____.



What might you conclude about momentum based on these findings?

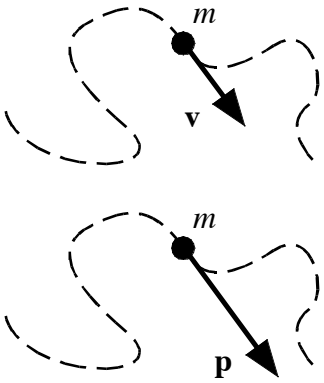
momentum ∝ mass · speed
$p = mv$

4. What are the units of measure for momentum?

$p = mv$

kg·m/s

5. Consider the following findings regarding momentum.
a. A snapshot is taken of a particle moving erratically. The path of the particle is illustrated with the dashed line. At the moment of the snapshot, the particle's instantaneous velocity vector is indicated by the arrow marked **v** in the diagram.



b. The particle's momentum at the instant the snapshot was taken is indicated by the vector labelled **p** in the diagram.

What might be concluded about momentum based on these findings?

The direction of momentum is the same as the direction of velocity

6. Sample calculations.
a. If m = 5 kg and v = 8 m/s, what is momentum p?

$p = mv = 5\ kg \cdot 8\ m/s = 40\ kg{\cdot}m/s$

b. If v = 4 m/s and m = 6 kg, what is momentum p?

$p = mv = 6\ kg \cdot 4\ m/s = 24\ kg{\cdot}m/s$

c. What is the momentum of a 0.02 kg bullet moving at 500 m/s?

$p = mv = 0.02\ kg \cdot 500\ m/s = 10\ kg{\cdot}m/s$

d. What is the momentum of a 10,000 kg railroad car moving at 0.001 m/s?

$p = mv = 10{,}000\ kg \cdot 0.001\ s = 10\ kg{\cdot}m/s$

e. What is the speed of a 0.05 kg baseball moving with 2 kg·m/s of momentum?

$p = mv$
$v = p/m = 2\ kg{\cdot}m/s\ /\ 0.05\ kg = 40\ m/s$

f. What is the mass of a car moving at 20 m/s if its momentum is 30,000 kg·m/s?

$p = mv$
$m = p/v = 30{,}000\ kg{\cdot}m/s\ /\ 20\ m/s = 1500\ kg$

6.b. 24 kg·m/s c. 10 kg·m/s d. 10 kg·m/s e. 40 m/s f. 1500 kg