A.2

Impulse

IB PHYSICS - MOTION

IB Physics Data Booklet

A.2

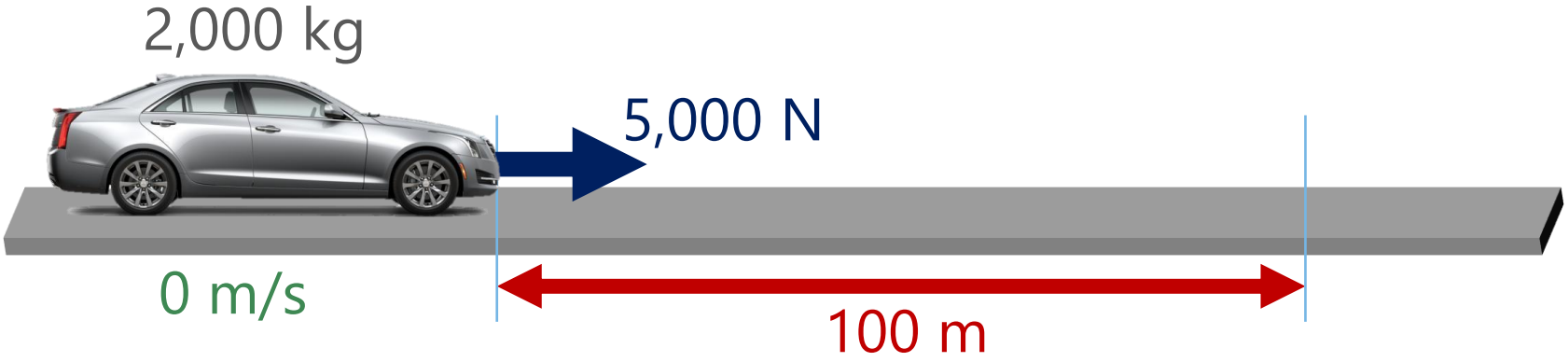
A.2 Forces and momentum	
	$F_f \leq \mu_s F_N$
	$F_f = \mu_d F_N$
	$F_H = -kx$
	$F_d = 6\pi\eta rv$
	$F_b = \rho Vg$
	$F_g = mg$
	$p = mv$
	$J = F\Delta t$
	$F = ma = \frac{\Delta p}{\Delta t}$
	$a = \frac{v^2}{r} = \omega^2 r = \frac{4\pi^2 r}{T^2}$
	$v = \frac{2\pi r}{T} = \omega r$

Introducing Impulse

A.2

Impulse = Force × _____

8.94 s



IB Physics Data Booklet

A.2

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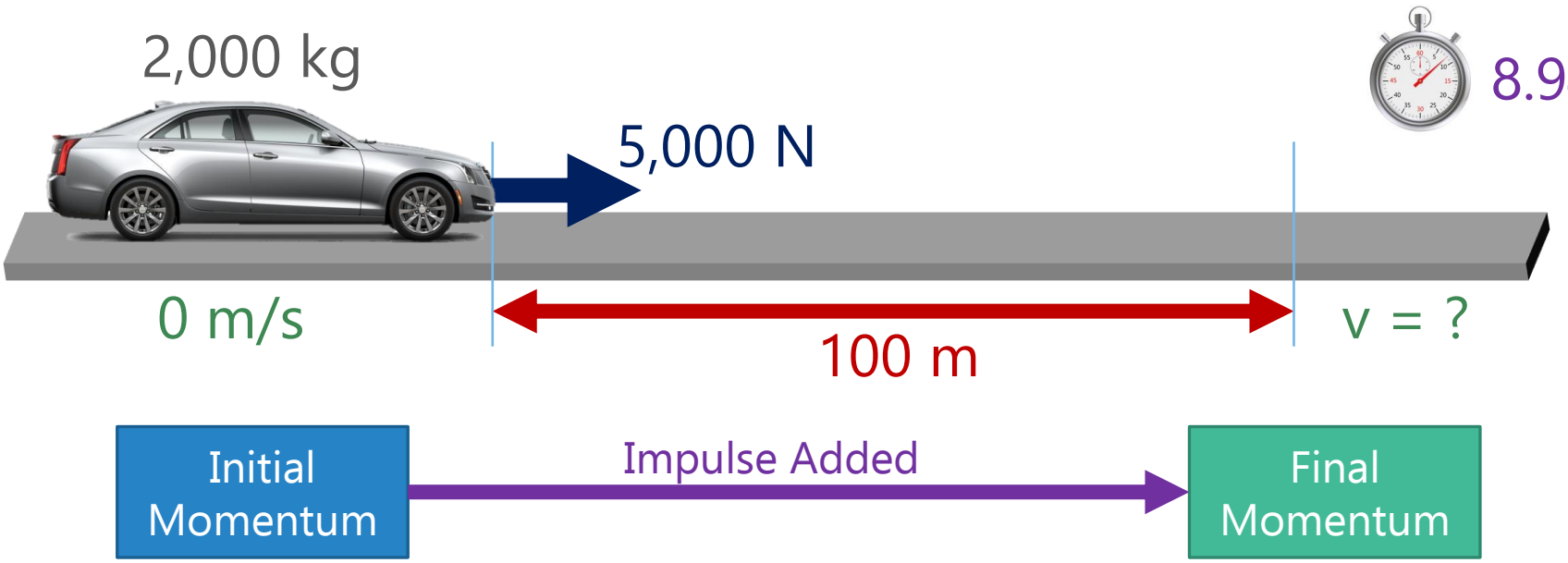
Impulse

A.2

Impulse → Change in _____

Using Impulse

A.2



Initial Momentum = 0 kg m/s

Impulse = (5,000 N)(8.94 s) = 44,700 Ns

IB Physics Data Booklet

A.2

A.2 Forces and momentum

$$J = F\,\Delta t = \Delta p$$

$$F_f \le \mu_s F_N$$

$$F_f = \mu_d F_N$$

$$F_H = -kx$$

$$F_d = 6\pi\eta r v$$

$$F_b = \rho V g$$

$$F_g = mg$$

$$p = mv$$

$$J = F\Delta t$$

$$F = ma = \frac{\Delta p}{\Delta t}$$

Same idea

$$a = \frac{v^2}{r} = \omega^2 r = \frac{4\pi^2 r}{T^2}$$

$$v = \frac{2\pi r}{T} = \omega r$$

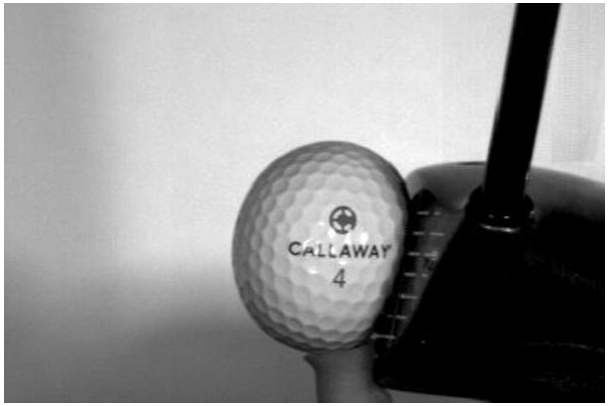
A.2

Impulse and Momentum

Impulse can act to increase or decrease an object's momentum

Final Velocity
$0\ m/s$

Initial Velocity
$0\ m/s$



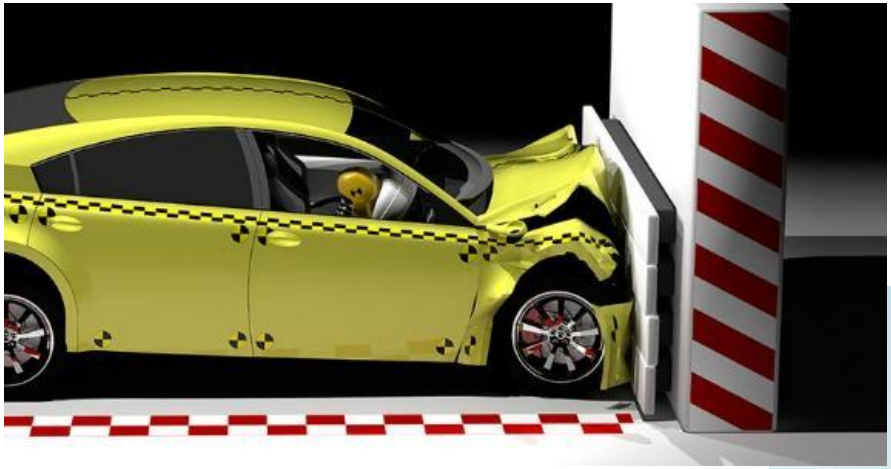
Initial Velocity
$0\ m/s$

How are these the same? different?

A.2

Impulse → Slowing Down

A.2



How can we decrease the force acting on an object?

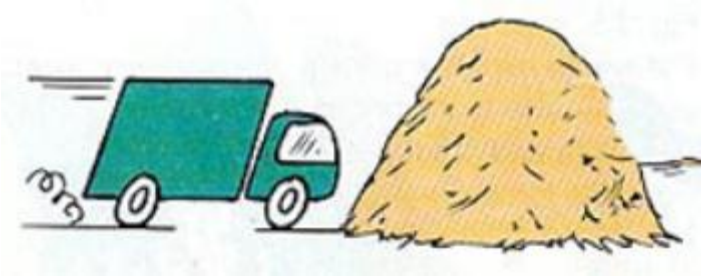
A.2

Impulse and Momentum

$$J = F\Delta t$$

$$F = \frac{\Delta p}{\Delta t}$$

$$\Delta p = F\Delta t$$



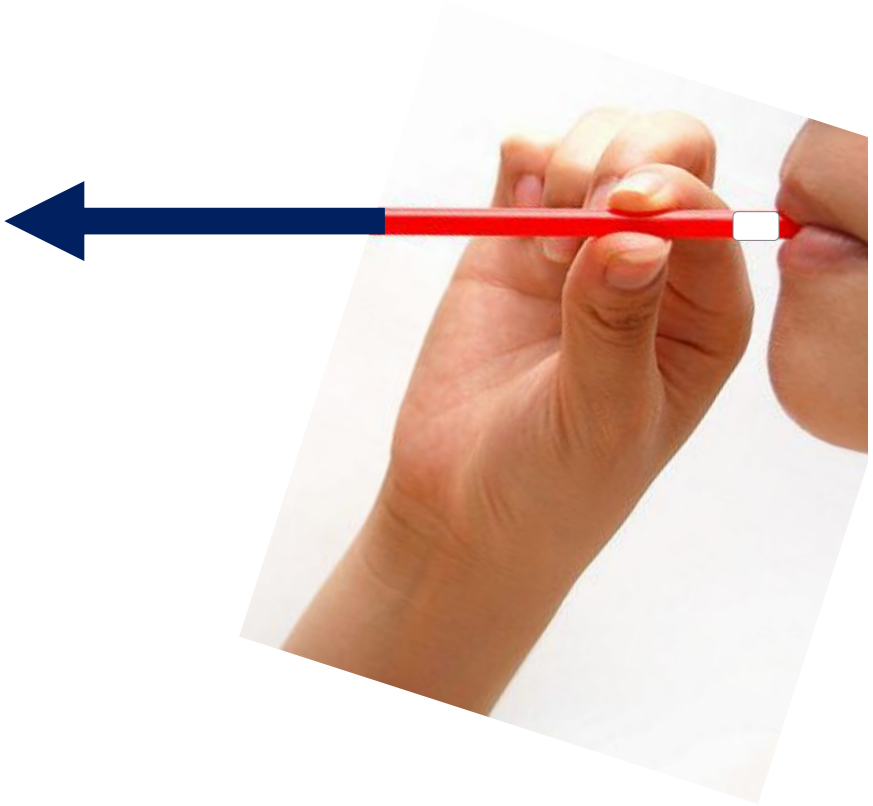
Impulse to Speed Up

A.2

Should a cannon have a long or short barrel to produce to largest final velocity? Why?

Marshmallow Shooter

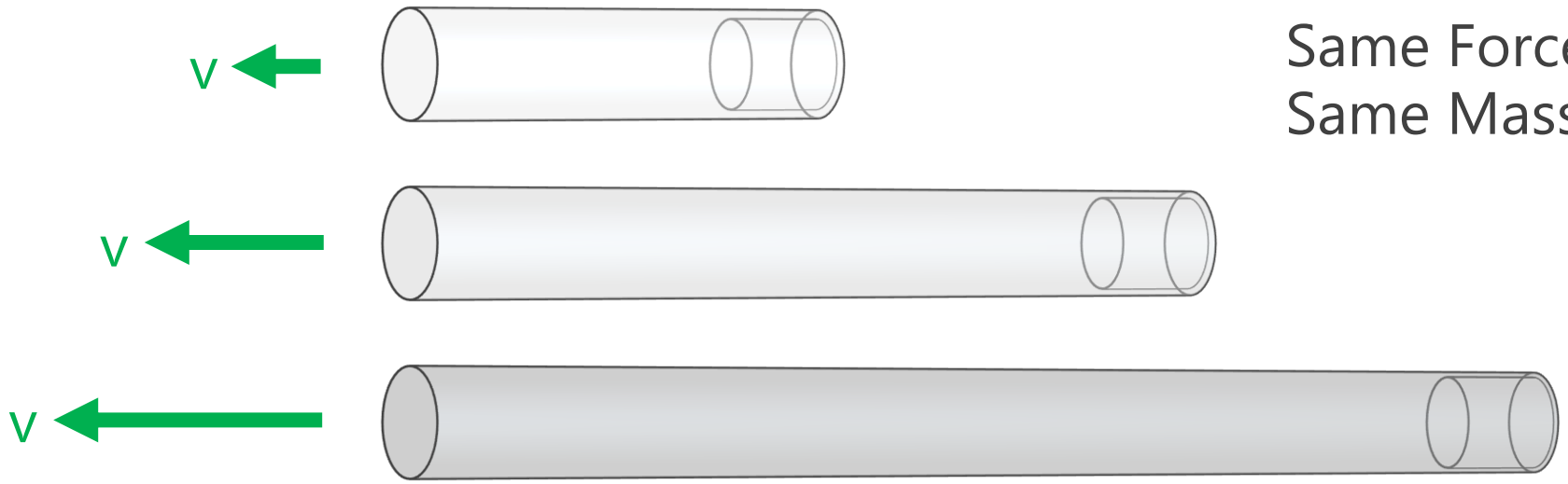
A.2



Marshmallow Shooter

A.2

$$J = F\Delta t = \Delta p = m\Delta v$$

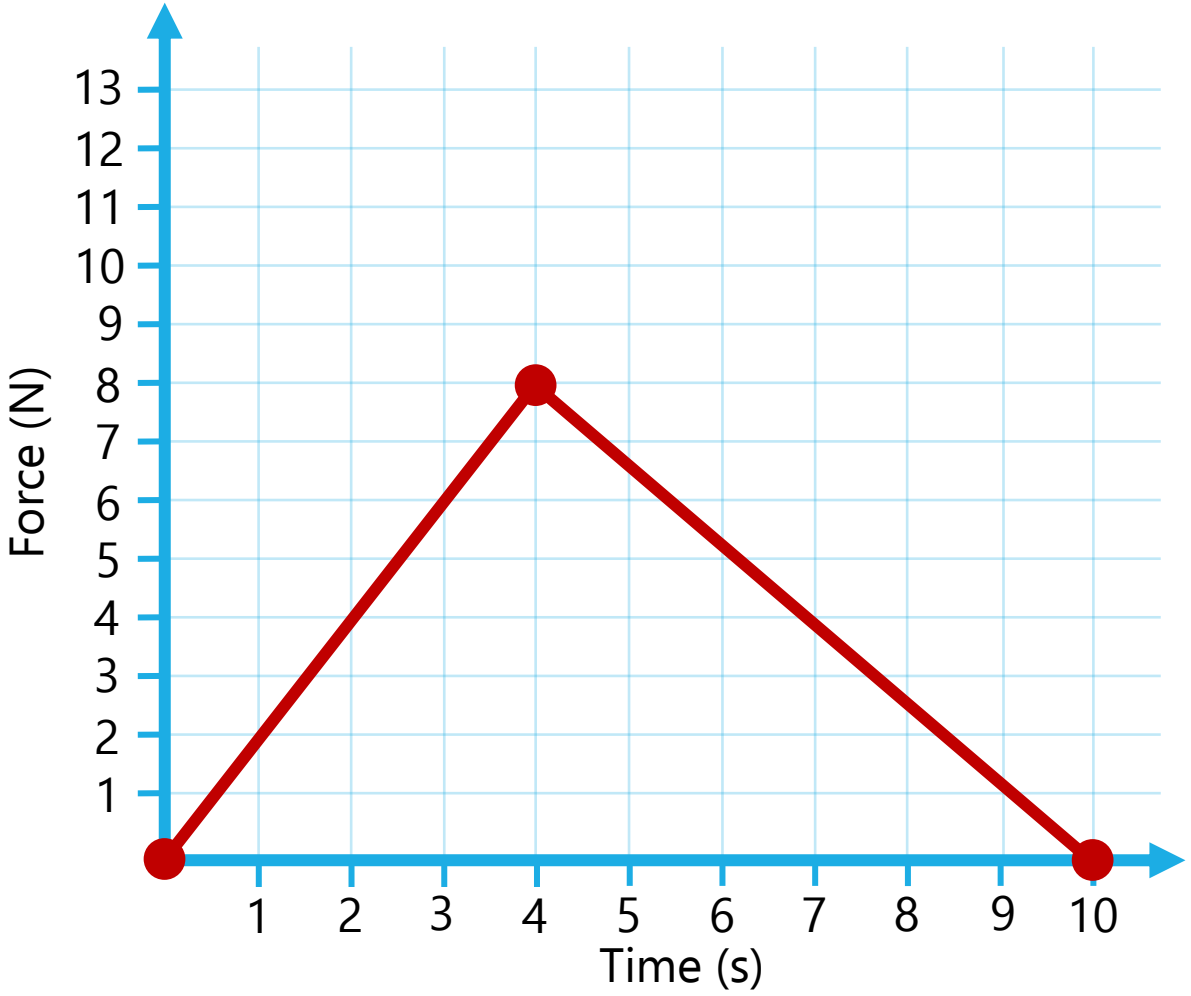


Same Force
Same Mass

More Time →

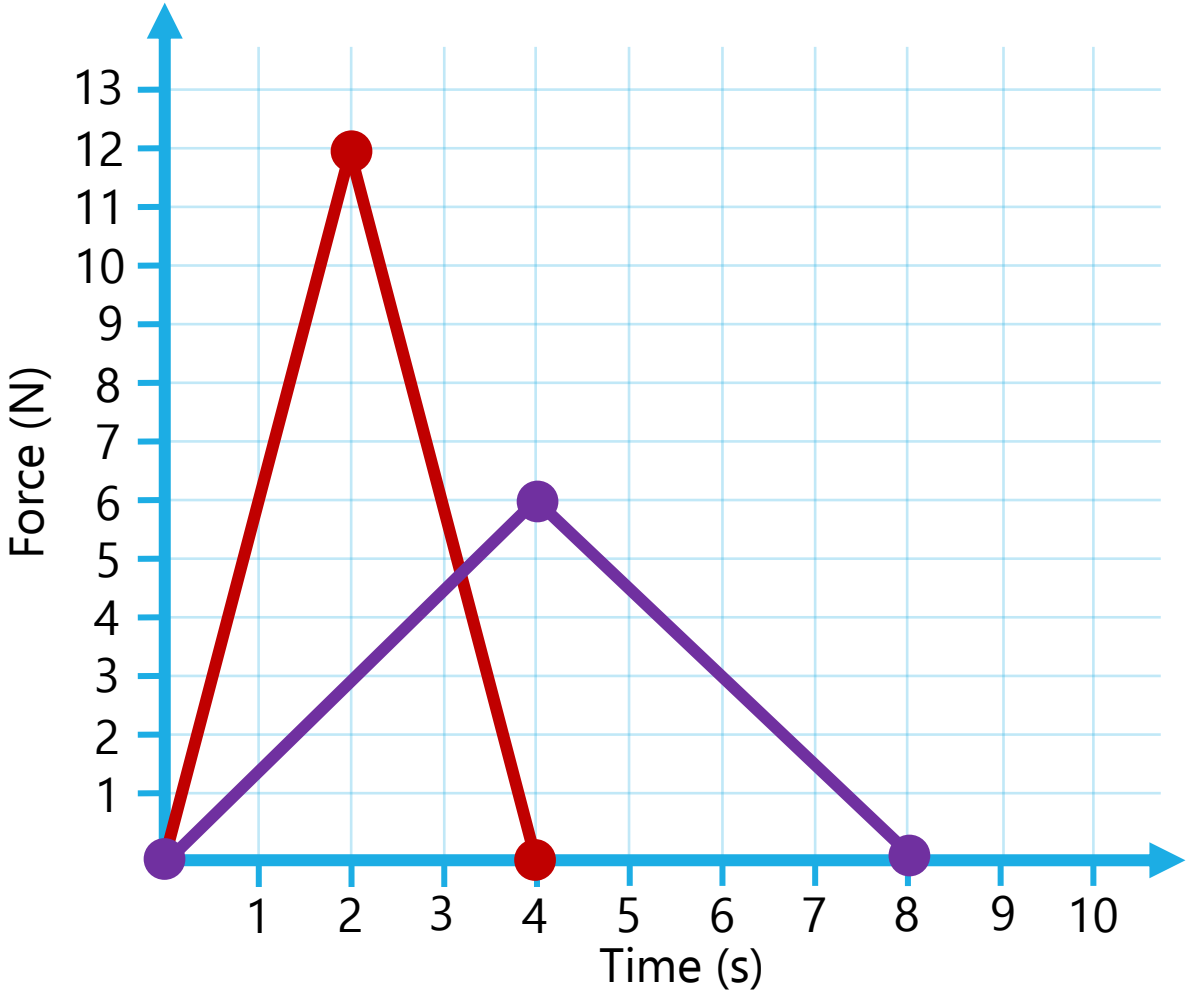
What if the force isn't constant?

A.2



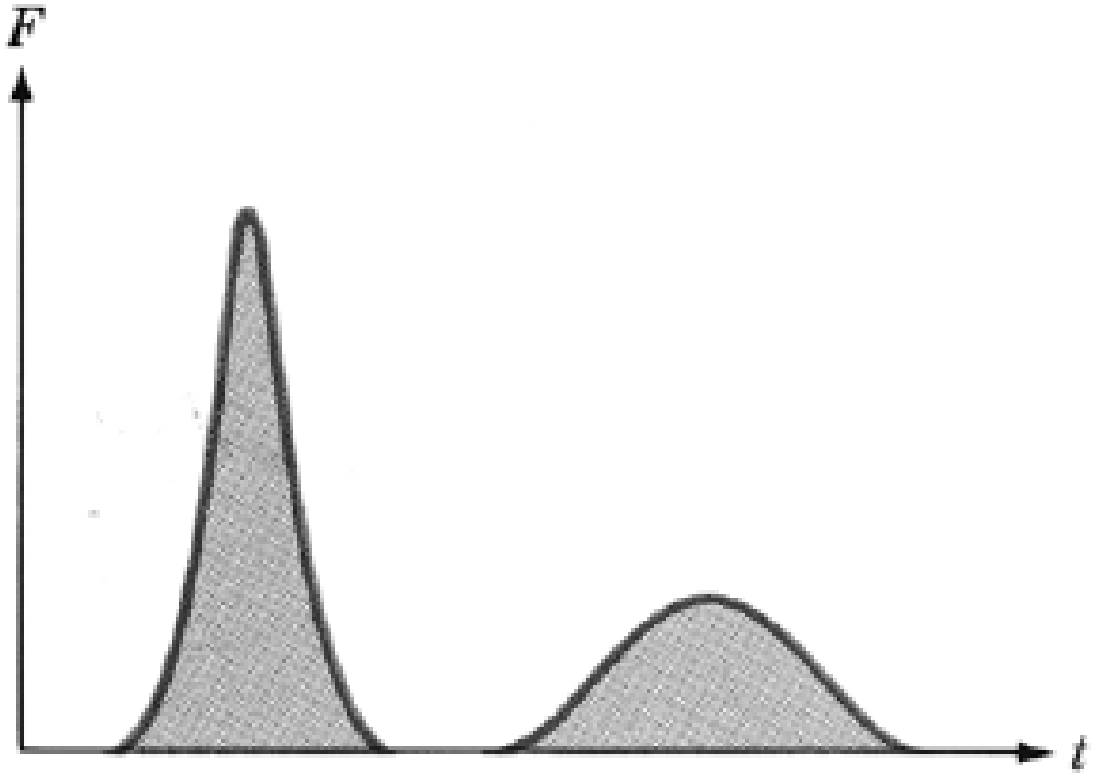
Which impulse is larger?

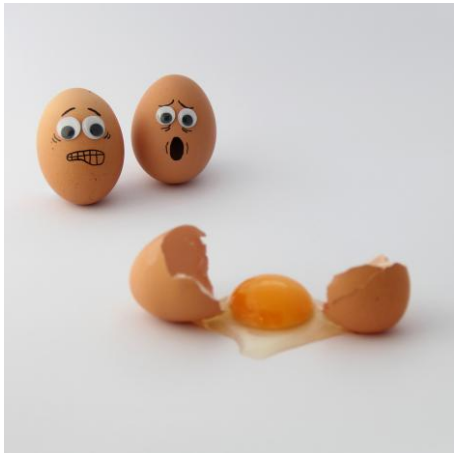
A.2



The force matters!

A.2





Slapshot!

A.2

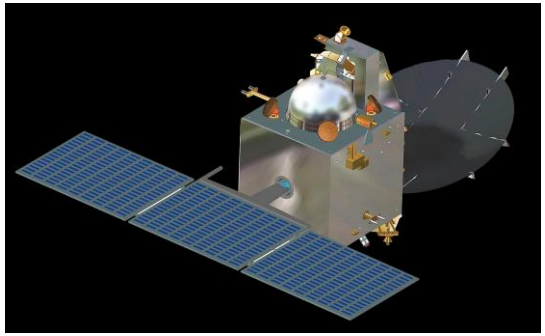
A hockey puck has a mass of 0.115 kg. A player takes a slap shot which exerts a force of 31.0 N for 0.15 sec. How fast will the puck be moving?

Impulse and Momentum

A.2

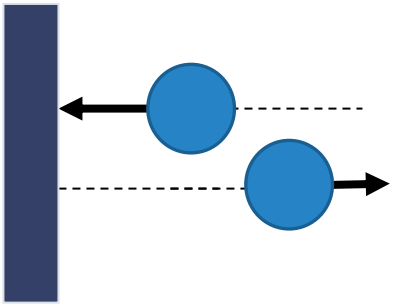
The 440 newton Liquid Apogee Motor (LAM) of India's Mars Orbiter Spacecraft, was successfully fired for a duration of 3.968 seconds on September 22, 2014. This operation of the spacecraft's main liquid engine was also used for the spacecraft's trajectory correction and changed its velocity by 2.18 m s^{-1}. What was the mass of the spacecraft at the time of this engine firing?

$$J = F\Delta t = \Delta p$$



Direction Matters

A.2



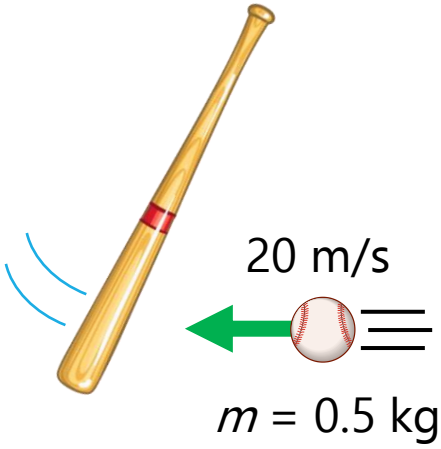
Initial speed = 30 m/s (left)
Final speed = 10 m/s (right)

What is the change in velocity?

Try This…

A.2

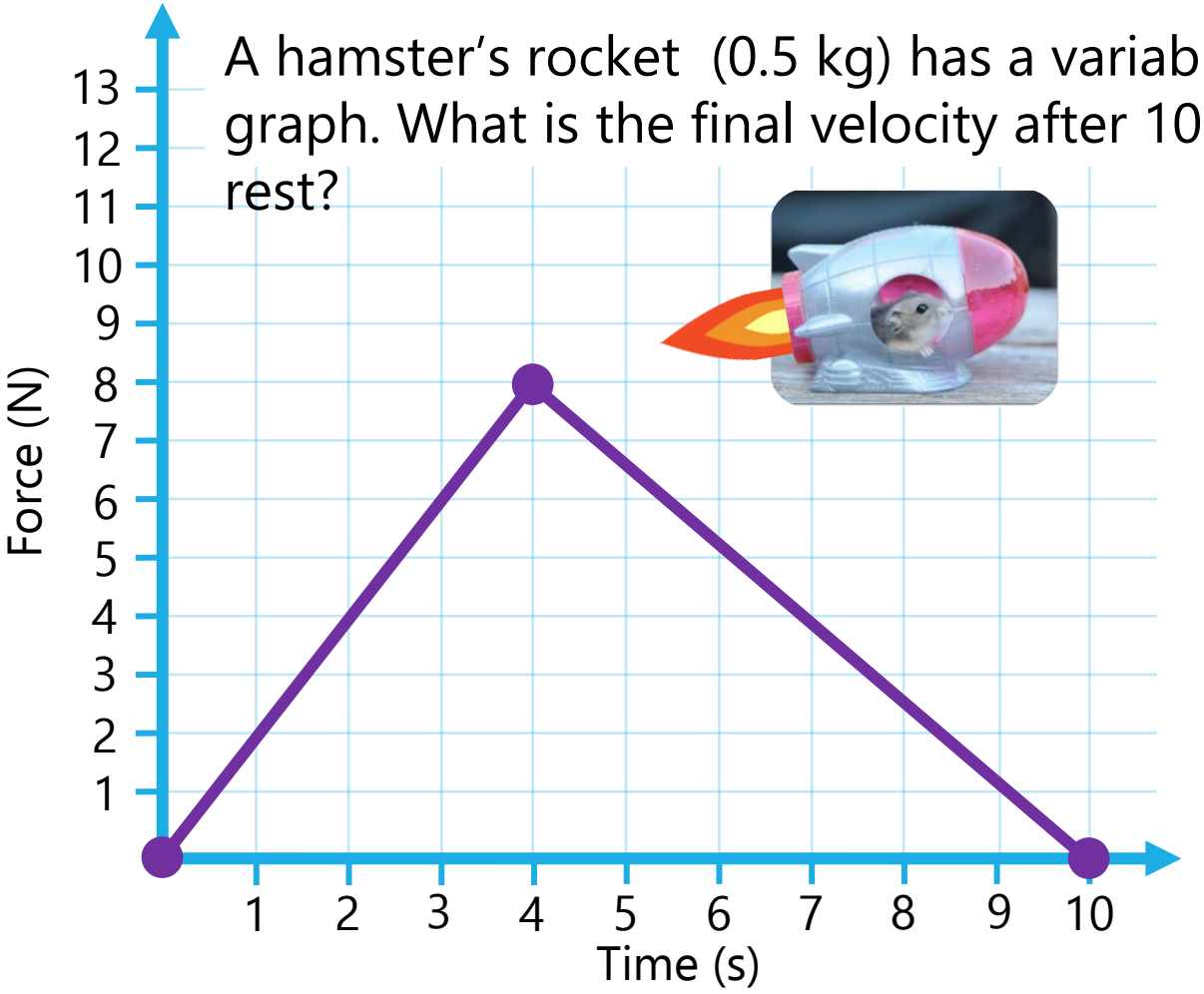
A **500 g** baseball moves to the left at **20 m/s** striking a bat. The bat is in contact with the ball for **0.002 s**, and it leaves in the opposite direction at **40 m/s**. What was average force on ball?



Impulse from a Graph

A.2

A hamster's rocket (0.5 kg) has a variable force as shown in the graph. What is the final velocity after 10 seconds if it starts from rest?



Try This...

A.2

Kara Less was applying her makeup when she drove into South's busy parking lot last Friday morning. Unaware that Lisa Ford was stopped in her lane, Kara rear-ended Lisa's rental car. Kara's 1300-kg car was moving at 5 m/s and stopped in 0.4 seconds. What was the force?

Lesson Takeaways

A.2

- ❑ I can describe the meaning of impulse and how it is related to momentum change
- ❑ I can use impulse and momentum to solve for an unknown in a collision problem
- ❑ I can conceptually describe how to decrease the force experienced in a collision
- ❑ I can determine the impulse of a collision from a force vs time graph