Name _____ per_____ date_____ mail box _____

If absent, click on the link below. Follow along and then complete the assignment.
https://www.khanacademy.org/math/pre-algebra/pre-algebra-ratios-rates/pre-algebra-rates/v/usain-bolt-s-average-speed

Usain Bolt – He is fast! In fact the fastest, but just how fast is *fast*?

Version A: S=d/t

At the Beijing Olympics in 2008 he earned three medals as a sprinter. In track and field and in much of the world the victor of the 100 meter dash is often hailed the outright fastest alive. He first won the **100 meter** dash with a time of **9.69 seconds**. Later at Beijing, he also took gold in the **200 meter** dash with a time of **19.30 seconds**.

Four years later, he won gold again at the London 2012 Olympics. This time he won the **100 meter** dash with a time of **9.63 seconds** and the **200 meter** with a time of **19.32 seconds**.

Most recently, he sprinted to victory again in the Rio 2016 Olympics with a slower time of **9.85 seconds** in the **100 meter** dash yet still securing gold and a record setting best in the **200 meter** dash with a time of **19.19 seconds.**

Notes Calculating Speed: SI – meters per second (m/s)

Step 1

Step 2

Conversion factor: multiple by **2.24** for **(m/s) -> mph**

Directions: write out the formula and include all of the units. Round to the hundredths place 0.0**0**

Beijing - 2008	100m		200m
100^{ths}			
Convert to mph _____		Convert to mph _____	
London – 2012	100m		200m
Convert to mph _____		Convert to mph _____	
Rio – 2016	100m		200m
Convert to mph _____		Convert to mph _____	

The year following the Beijing Olympics, on 16 August 2009 at the World Championships in Berlin, Bolt attained a *speed record* of **44.72 km/h, (12.4 m/s)** or (**27.8 mph**), during the final 100-meter sprint. He attained this speed between the 60th and the 80th meter, which he covered in 1.61 seconds.

Why are the speeds calculated in class so much slower than the speed attained during the Berlin World Championships? Include what type of speed is considered above.

Explain:

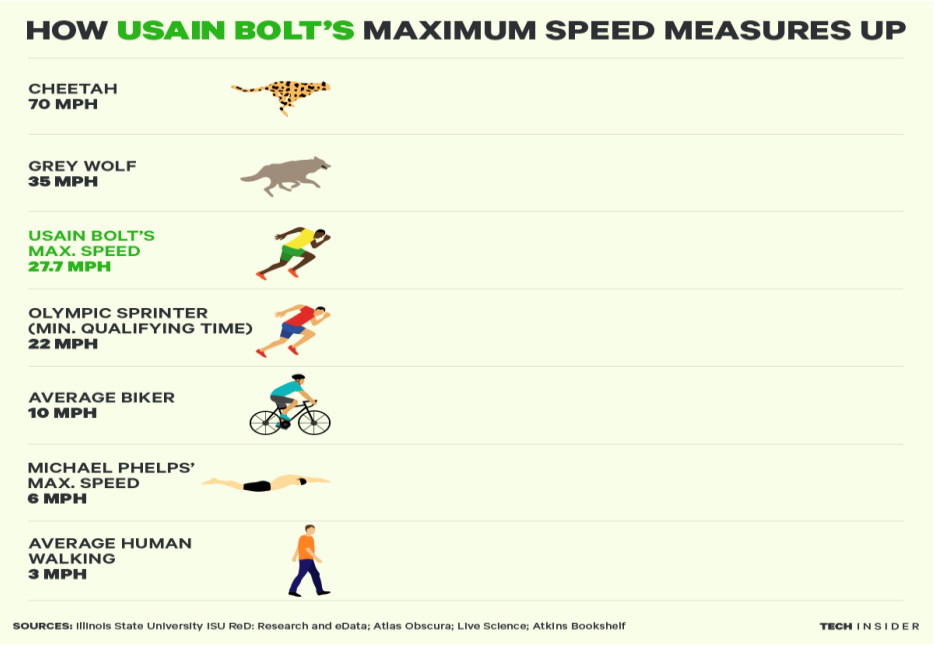
_____

_____

_____

_____

Hint: review prep reading on types of speed.



Name Key per____ date_____ mail box _____

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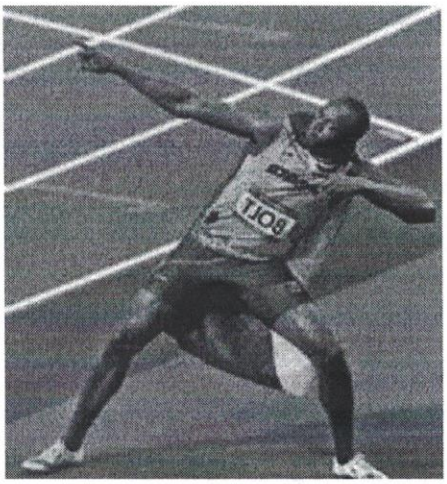

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Notes Calculating Speed: SI – meters per second (m/s)

Step 1 Write the formula

$\text{Speed} = \frac{\text{distance}}{\text{time}}$ $S = d/t$

Step 2 Include Units meters - m Seconds - s

m/s ⟶ mph

Conversion factor (2.24) multiple by

Step 3: 1 m/s = 2.24 mph

Directions: write out the formula and include all of the units. Round to the hundredths place 0.0**0**

Beijing - 2008 $S = d/t$ 100m

$S = \frac{100\text{m}}{9.69\text{s}}$ $S = 10.3199$ round $10.32\ \text{m/s}$

$10.32\ \text{m/s} \times 2.24 = 23.11\ \text{mph}$

$S = d/t$ 200m

$10.36\ \text{m/s} = \frac{200\text{m}}{19.30\text{sec}}$

$\frac{1\ \text{m/s}}{2.24\ \text{mph}} = \frac{10.36\ \text{m/s}}{x\ \text{mph}}$ $x = 23.21\ \text{mph}$ cross multiple

London – 2012 $S = d/t$ 100m

$10.38\ \text{m/s} = \frac{100\text{m}}{9.63\text{s}}$

$10.38\ \text{m/s} \times 2.24 = 23.25\ \text{mph}$

$S = d/t$ 200m

19.35m/s $= \frac{200\text{m}}{19.32\text{sec}}$

$10.36\ \text{m/s} \times 2.24 = 23.2\ \text{mph}$

Rio – 2016 $S = d/t$ 100m

$10.15\ \text{m/s} = \frac{100\text{m}}{9.85\text{s}}$

$10.15\ \text{m/s} \times 2.24 = 22.74\ \text{mph}$

$S = d/t$ 200m

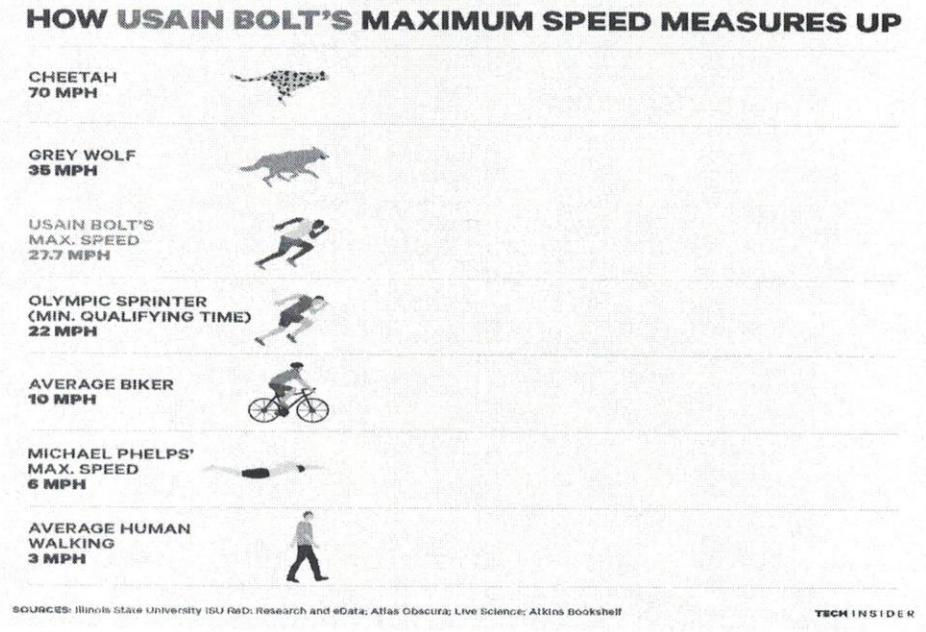
$10.42\ \text{m/s} = \frac{200\text{m}}{19.19\text{sec}}$

$10.42\ \text{m/s} \times 2.24 = 23.34\ \text{mph}$

The year following the Beijing Olympics, on 16 August 2009 at the World Championships in Berlin Bolt attained a record *speed* record of **44.72 km/h** (**12.4 m/s** or **27.8 mph**), during the final 100 meter sprint. He attained this speed between the 60th and the 80th meter, which he covered in 1.61 seconds.

Why are the speeds calculated in class so much slower the speed attained during the Berlin World Championships?
Explain: During class we in fact calculated average speed, not Bolt's true "top speed" or instantaneous speed. Sprinters start at a stand still & therefore must accelerate. Bolt doesn't attain top speed until nearly the 50th meter or so.

Hint: review prep reading on types of speed.



Prep Assign

Humans Could Run 40 mph, in Theory

Read

By Live Science Staff | January 22, 2010 08:57am ET

Running shoes may put more strain on your joints than running barefoot or even walking in high heels, a recent study suggests.

Humans could perhaps run as fast as 40 mph, a new study suggests. Such a feat would leave in the dust the world's fastest runner, Usain Bolt, who has clocked nearly 28 mph in the 100-meter sprint.

The new findings come after researchers took a new look at the factors that limit human speed. Their conclusions? The top speed humans could reach may come down to how quickly muscles in the body can move.

Previous studies have suggested the main hindrance to speed is that our limbs can only take a certain amount of force when they strike the ground. This may not be the whole story, however.

"If one considers that elite sprinters can apply peak forces of 800 to 1,000 pounds with a single limb during each sprinting step, it's easy to believe that runners are probably operating at or near the force limits of their muscles and limbs," said Peter Weyand of Southern Methodist University, one of the study's authors.

But Weyand and colleagues found in treadmill tests that our limbs can handle a lot more force than what is applied during top-speed running.

What really holds us back - Their results showed the critical biological limit is imposed by time — specifically, the very brief periods of time available to apply force to the ground while sprinting. In elite sprinters, foot-ground contact times are less than one-tenth of a second, and peak ground forces occur within less than one-twentieth of that second for the first instant of foot-ground contact.

To figure out what limits how fast we can run, the researchers used a high-speed treadmill equipped to precisely measure the forces applied to its surface with each footfall. Study participants then ran on the treadmill using different gaits, including hopping, and running forward and backwards as fast as they possibly could.

The ground forces applied while hopping on one leg at top speed exceeded those applied during top-speed forward running by 30 percent or more. That suggests our limbs can handle greater forces than those found for two-legged running at top speeds.

And although top backward speed was substantially slower than top forward speed, as expected, the minimum periods of foot-ground contact at top backward and forward speeds were essentially identical. The fact that these two drastically different running styles had such similar intervals for foot-ground contact suggest that there is a physical limit to how fast your muscle fibers can work to get your feet off the ground, the researchers say.

New speed limit - The new work shows that running speed limits are set by the contractile speed limits of the muscle fibers themselves, with fiber contractile speeds setting the limit on how quickly the runner's limb can apply force to the running surface.

"Our simple projections indicate that muscle contractile speeds that would allow for maximal or near-maximal forces would permit running speeds of 35 to 40 miles per hour and conceivably faster," Bundle said.

While 40 mph may not impress the cheetah, the world's fastest land animal reaching speeds of 70 mph (112 kph), it's enough to escape a grizzly bear and much quicker than T. rex, which may have reached 18 mph (29 kph) during a good jog. The results were published in the Jan. issue of the Journal of Applied Physiology.

1. How much force does an elite runner's leg exert approximately?

They can apply force of between 800-1000 pounds.

2. What was suggested by previous studies about the main hindrance to top speed running.

That our limbs can only exert and take a certain amount of force with each stride striking the ground.

3. How is this relevant to how fast we can run? Explain

Try as you might, you can only run as fast as the force your legs are capable of applying-

4. What are TWO factors that ultimately limit human's top running speeds according to this article?

Not, force but rather the physical limit with how fast your muscle fibers can work. Contractile speed limits the muscle fibers themselves. Also, the duration of time w/ which the feet have to apply force, rather than force - itself.

Burns 2017 Physical Science

Humans Could Run 40 mph, in Theory

By Live Science Staff | January 22, 2010 08:57am ET

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Previous studies have suggested the main hindrance to speed is that our limbs can only take a certain amount of force when they strike the ground. This may not be the whole story, however.

"If one considers that elite sprinters can apply peak forces of 800 to 1,000 pounds with a single limb during each sprinting step, it's easy to believe that runners are probably operating at or near the force limits of their muscles and limbs," said Peter Weyand of Southern Methodist University, one of the study's authors.

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