

Useful equivalences:

$$1 \text{ km} = 0.6214 \text{ miles (mi)}$$

$$1 \text{ mi} = 1.609 \text{ km}$$

Sprinter Usain Bolt once reached a top speed of 27.8 mi/hr. A wild cheetah can reach a top speed of 25.9 m/s.

Is a cheetah or Bolt faster? Show your dimensional analysis.

There are a number of ways you can arrive at the right answer. The first way is to convert the cheetah's speed from m/s to mi/hr and compare to Bolt's speed:

$$25.9 \frac{\text{m}}{\text{s}} \times \frac{1 \text{ km}}{1000 \text{ m}} \times \frac{0.6214 \text{ mi}}{1 \text{ km}} \times \frac{60 \text{ s}}{1 \text{ min}} \times \frac{60 \text{ min}}{1 \text{ hr}} = 57.9 \frac{\text{mi}}{\text{hr}} > 27.8 \frac{\text{mi}}{\text{hr}}$$

The second way is to convert Bolt's speed from mi/hr to m/s and compare to the cheetah's speed:

$$27.8 \frac{\text{mi}}{\text{hr}} \times \frac{1 \text{ km}}{0.6214 \text{ mi}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ s}} = 12.4 \frac{\text{m}}{\text{s}} < 25.9 \frac{\text{m}}{\text{s}}$$

You may see some slight variations of these two procedures that are all okay. For instance:

- *If you clump the conversion of seconds to hours using $\frac{3600 \text{ s}}{1 \text{ hr}}$ that's okay.*
- *If you clump the conversion of miles to km using $\frac{0.0006214 \text{ mi}}{1 \text{ km}}$ that's okay.*
- *If you use $\frac{1.609 \text{ km}}{1 \text{ mi}}$ instead of $\frac{1 \text{ km}}{0.6214 \text{ mi}}$ like I did above, that's okay.*

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Usain Bolt

$$\frac{27.8 \text{ mi}}{1 \text{ hr}} \times \frac{1.609 \text{ km}}{1 \text{ mi}} = 44.7302 \text{ km/hr} = 44.7 \text{ km/hr}$$

cheetah

$$\frac{25.9 \text{ m}}{1 \text{ sec}} \times \frac{60 \text{ sec}}{1 \text{ min}} \times \frac{60 \text{ min}}{1 \text{ hour}} \times \frac{1 \text{ km}}{1000 \text{ m}} = 93.24 \text{ km/hour} = 93.2 \text{ km/hour}$$

The cheetah travels at 93.2 km/hour, which is faster than Usain Bolt who only travels 44.7 km/hour.

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Bolt - 27.8 mi/hr vs. cheetah - 25.9 m/s

$$\frac{25.9 \cancel{\text{ m}} \cancel{\text{ s}} \left| \frac{60 \text{ s}}{1 \cancel{\text{ min}}} \right| \frac{60 \cancel{\text{ min}}}{1 \text{ hr}} \left| \frac{100 \cancel{\text{ cm}}}{1 \text{ m}} \right| \frac{1 \cancel{\text{ in}}}{2.54 \cancel{\text{ cm}}} \left| \frac{1 \cancel{\text{ ft}}}{12 \cancel{\text{ in}}} \right| \frac{1 \text{ (mi)}}{5280 \cancel{\text{ ft}}} = 57.9 \text{ mi/hr}$$

cheetah runs at 57.9 mi/hr (vs. Bolt's 27.8 mi/hr) so

the cheetah is faster

$$\frac{27.8 \cancel{\text{ mi}} \left| \frac{1 \cancel{\text{ hr}}}{3600 \text{ (s)}} \right| \frac{5280 \cancel{\text{ ft}}}{1 \cancel{\text{ mi}}} \left| \frac{1 \cancel{\text{ ft}}}{12 \cancel{\text{ in}}} \right| \frac{2.54 \cancel{\text{ cm}}}{1 \cancel{\text{ in}}} \left| \frac{1 \text{ (m)}}{100 \cancel{\text{ cm}}} \right| = 12.4 \text{ m/s}$$

∴ confirms Bolt is slower, cheetah is faster ✓

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$$\begin{array}{l} \text{Usain Bolt: } 27.8 \frac{\text{mi}}{\text{hr}} \times \frac{1.609 \text{ km}}{1 \text{ mi}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ s}} = 12.4 \frac{\text{m}}{\text{s}} \end{array}$$

Bolt's speed < cheetah's speed

$$12.4 \frac{\text{m}}{\text{s}} < 25.9 \frac{\text{m}}{\text{s}}$$

The cheetah is faster