Creating Science – Speed

*Some kids like to think they’re pretty fast, but just how fast are they? #CreatingScienceSpeed*

*A great way to use maths in science.*

# Suggested outcomes

(NOTE: This is by no means an exhaustive list of possible outcomes, neither is it intended that ONLY these outcomes can or should be met. Science is a deeply interrelated activity, and you may find cross curriculum links you can and should use.)

* Planning and conducting 7: Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed *AND* Measure and control variables, select equipment appropriate to the task and collect data with accuracy
* Physical sciences10: The motion of objects can be described and predicted using the laws of physics

*Also*

Physical sciences 7: Change to an object’s motion is caused by unbalanced forces acting on the object

# Warning

* Kids can get very silly when running around and testing for speed. Remind them to be careful, to not get over excited, and that the goal here is to **create knowledge** – not just be fast.

# Preparation

* You might enjoy some motivation from the following video clips
  + <https://youtu.be/HuZZpJJF71U> - USA importance of physics
  + <https://youtu.be/2vYI2NcVsXY> - English cartoon on physics
  + The Disney Pixar movie Cars, from around 40 seconds till 55.
* You’ll need some things that roll, such a toy cars, balls and cardboard tubes.
* Sloping ramps strong enough to hold your rollers – thin cardboard will not do.
* A stopwatch accurate to milliseconds.
* Something to record your results on.
* The online file ‘the relationship between distance and time’ from [www.drjoe.id.au](http://www.drjoe.id.au)
* Flat, hard ground, such as concrete or a table top. Carpet and grass slow things down too much.

## Being ready

Hi all! We’re really looking forward to a great class on Monday. Just a few things you might like to bring and do to prepare:

* **Hats** and **sunscreen**, we’ll be outside for some of today.
* A **stopwatch** if you can – we’ll be timing in milliseconds.
* **Running shoes** – though they’re not compulsory, those who wish can run for others.
* Download and set up on your device ‘the relationship between distance and time’ Excel file from the website (<http://creatingscience.weebly.com/activities.html>), you may need a free copy of an excel file to open and work on it.

And just for some extra preparation, can anyone tell me the equation for *SPEED!!?*

# Suggestions for other year levels

As always, more material is presented here than can be used by the average class during the average lesson time. However, since the students questions can and should guide student learning, more material is presented for you convenience. Remember, it is not uncommon for students to only remember those points which answered their personal questions.

## Younger:

This activity is not well suited to most early childhood audiences. You’ll need to do the maths for them. They may gain a sense of ‘faster’ or ‘slower’, but numerical values are a special challenge.

## Middle:

This activity is well suited to this age.

## Teen:

Having them perform their own calculations, including doing multiple trials and taking the average, might help engage this age group.

# Engage

* Make sure all students write down any questions they may have generated during this phase regarding the topic for today.

## Ask:

Some of you students think you are pretty fast. Just how fast do you think you can be?

* Maybe show a video clip on speed if you can.
* Ask students “What do you think speed is?”

Why do we need to know speed?

* We can predict how much damage an object will do if we know how much it weighs, and how fast it is moving when it hits. Scientists use this information to help solve crimes, for example, to help explain what happened in traffic accidents no one saw.
* You can find out if someone is going too fast to stop safely in a school zone if you know their speed.
* So we can plan for our journeys. If you know how long it will take to get to a certain place, you will be able to know if you have enough supplies to last the journey.

# Explore

* Encourage and validate student explanations of this phenomenon. You may like to ask students to write or draw their explanation personally to avoid embarrassment to students unfamiliar with this material. Remember, ‘I don’t know’ is a valid explanation in science – it is the beginning of learning new things!

To calculate the speed we just need a simple equation:

Speed = Distance

Time

Which means “Speed is equal to the distance you moved, divided by the time it took to move it.”

Of course, you can be more complex than that if you like[[1]](#footnote-1). But in simple terms, speed is the distance travelled, divided by the time it took to get there.[[2]](#footnote-2)

## Activity – the need for speed!

Help students to develop an inquiry question regarding speed, such as;

* How do we measure speed?
* Do you know how fast you are? How can we find out?
* Who is the fastest in the class?
* Is red really the fastest colour?

### How to measure student speed

Perform the following activity. Have students run a solo race of about 20 meters. Time it precisely.

Their speed is 20 divided by their time.

*Celebrate!*

A few suggestions;

* Some students who refuse to run might prefer to measure their ‘walking pace speed’, which is quite ok – it’s all in the science question you’re asking.
* As with the practice effects of dropping rulers, students need a running space to reach top speed *before* we begin to time them. So mark about 10 or so meters to reach top speed.
* Mark out another 10 meters. Another student can begin to time them when they hit the start of your 10 meters, and stop as soon as they reach the end.
* Don’t forget to remind them that they have to run past the finish line, not stop at it. Otherwise their speed slows down dramatically as they try to stop.
* If there is not enough time for you all to be confident in your measurement, you can do 100 meters in a circle and measure out start and stop times. This, of course, will exhaust them as it’s humanly impossible to keep up top speed over 100 meters.

# Explain

This helps to illustrate the difficulties in measuring in science. What can be done?

* Time is problem, how can we be more exact? Does anyone have a slow motion camera and starting gun?
* The longer the race, the more accurate the results, but people get tired!
* Do you need a start-up of about 10 meters, otherwise we might be including reaction time and not just max speed.
* Is one test enough? Shouldn’t we take several tests and average out the results?

Both these problems are faced by real scientists every day when trying to measure speed. They’re not simple problems with simple answers, and there will also be a tiny bit of uncertainty in any measurement of speed.

What are the student’s speeds? Who is the fastest?

Is this test fair? Does it measure human worth?

What can we do to get faster?

## Extra challenges

Help students develop their own experiments in order to create knowledge. For instance, can they find out;

* Who is faster on the day, boy or girls? (up till puberty there’s no significant difference)
* People wearing red or not? (again, no difference is expected, though with a small sample size it’s very easy to find a large difference. Perhaps it’s one of psychology – people who like speed also like red because it’s a typically ‘speedy’ colour in our culture? Apparently police pull over red cars twice as much as other colours for that very reason!)
* People who do running sports (such as football or athletics) v’s people who do not (such as badminton or swimming)?
* Add dexterity to the challenge – who is fastest when you have to run through an obstacle course, or push through certain barriers?

Again, our small sample size is never going to be very representative, so it’s wise to treat it with some caution.

\*\* **Remember the limits of all scientific knowledge claims**. For example, say all your boys beat all your girls in class, what can you conclude? Boys are faster than girls? Such a general statement is unhelpful and unfair. You can only say for certain that “On that day, and with those people, the boys average speed was greater than the girls.” But not, and never, something as all embracing, overly simplistic, and soul defining; as ‘A is faster than B,’ or in this case ‘boys are always faster than girls.’ \*\*

# Elaborate

## Extra challenges – high school

Set up the following activity. You need a ramp, a rolling thing (such as a ball, cylinder or toy car), a rule to measure 1 meter, and a stopwatch. Set it up over a hard surface such as a table top.

Mark out 1 meter from the base of the ramp. Hold the ramp at about 45 degrees.

Have students roll a tube or ball down a slope and guess how fast it was going as it exited the ramp.

Have a student time, as precisely as possible, the time it takes to travel that meter. It’s often less than one second.

### Explain

This helps to illustrate the difficulties in measuring in science. What can be done?

* Set up electronic signals that automatically start the clock when the roller hits the bottom of the ramp, and stop the clock when it passes the finish line. This is much more accurate, but very technically tricky. Olympic sports use exactly this same technique from the firing of the starter’s gun, and you can find out more if you wish.
* Measure out more than 1 meter. Of course, the roller slows down so again it’s not as accurate as a measure taken over a millisecond, for instance. Police radar guns, for instance, use this technique.

Both these problems are faced by real scientists every day when trying to measure speed. They’re not simple problems with simple answers, and there will also be a tiny bit of uncertainty in any measurement of speed.

The answer students will receive is in meters per second. It is usually around 2 meters per second.

Have students generate their own questions and answers in regards to the ramp activity. For example;

* What precise angle produces the fastest exit speed? (Too high, and the object just bounces around)?
* Are heavy or light things faster?
* Are more or less wheels faster?
* Is it better to have a flat ramp, or a ramp that curves downwards at first?

# Evaluate

## Diagnostic:

Find out what students think ‘speed’ is. Have them draw pictures of things that have “speed” –

## Formative:

Have students carefully chart their results on a spreadsheet program. Help them demonstrate how to calculate speed at various times. Watch out for the following alternative conceptions:

* Ironically every single object is moving in relation to something else, so everything has a ‘speed’. This is not to be confused with what may be considered ‘fast’. That is, **even snails have a speed**.

## Summative:

Help students consider ways they can communicate their new understanding to others, just as scientists need to do. Have them write up an experiment;

* Question: What was their research question (i.e., what were they trying to find out)
* Theorise and Predict: What did they think would be the result might be (predict) and why did they think it would be that (theorise)?
* Plan and conduct: how they gathered their data and what problems they had to overcome (including getting accurate timing and controlling variables).
* Process and analyse data: How they analysed their data, including the equation for speed and using averages.
* Evaluate: Give the conclusion of their study, and then reflect on how accurate it might be, and what it tells us about speed, and what might be necessary to make a study more accurate.

# Creating science

1/ It is HARD to create a perfectly accurate measurement of speed. Indeed, we’re usually only estimating. But it’s an important piece of information and we’ve just go to try!

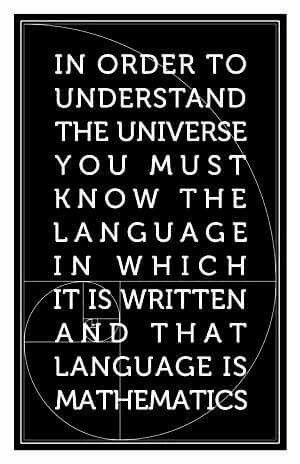
2/ Speed = distance travelled divided by the time it took.

# Appendix – speeds of life

## List of orders of magnitude for speed adapted 11 feb 17 from https://en.wikipedia.org/wiki/Orders\_of\_magnitude\_(speed)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **List of orders of magnitude for**[**speed**](https://en.wikipedia.org/wiki/Speed) | | | | | |
| **Factor (**[**m/s**](https://en.wikipedia.org/wiki/Meters_per_second)**)** | **Value (m/s)** | **Value (km/h)** | **Item** |
| **10−13** | 1×10−13 | 3×10−13 | Rate of erosion of Bedrock.[[1]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-1) Which is another way of saying 1 meter divided by 10 13 times, or 0.0000000000003 kmph. |
| **10−11** | 9.8×10−11 | 3.5×10−10 | Rate of [global sea level rise](https://en.wikipedia.org/wiki/Current_sea_level_rise) in 1993–2003 (3.1 mm/yr).[[2]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-2) |
| **10−10** | 3×10−10 to 3×10−9 | 1×10−9 to 1×10−8 | Typical relative speed of [continental drift](https://en.wikipedia.org/wiki/Continental_drift). Or fingernail growth. |
| **10−9** | 1.3×10−9 | 4.68×10−9 | Average rate of the [Moon](https://en.wikipedia.org/wiki/Moon) receding from the [Earth](https://en.wikipedia.org/wiki/Earth) (approx. 38 mm/yr). |
| 4.8×10−9 | 1.7×10−8 | [Human hair growth](https://en.wikipedia.org/wiki/Human_hair_growth) (average rate—note that there is a great range of variation). |
| **10−6** | 1.52×10−6 | 5.4×10−6 | Speed of a [cellular](https://en.wikipedia.org/wiki/Cell_(biology)) [vesicle](https://en.wikipedia.org/wiki/Vesicle_(biology)) propelled by a motor protein.[[3]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-3) |
| **10−5** | 1×10−5 | 4×10−5 | Speed of the tip of an hour hand on a clock. |
| 1.4×10−5 | 5.0×10−5 | Growth rate of [bamboo](https://en.wikipedia.org/wiki/Bamboo), the fastest-growing woody plant, over 24 hours.[[4]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-4) |
| **10−4** | 4.0×10−4 | 1.4×10−3 | Speed of [Jakobshavn Isbræ](https://en.wikipedia.org/wiki/Jakobshavn_Isbr%C3%A6" \o "Jakobshavn Isbræ), one of the fastest [glaciers](https://en.wikipedia.org/wiki/Glacier), in 2003.[[5]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-5) |
| 6×10−4 | 0.002 | Typical speed of *[Thiovulum majus](https://en.wikipedia.org/wiki/Thiovulum_majus" \o "Thiovulum majus)*, the fastest-swimming [bacterium](https://en.wikipedia.org/wiki/Bacterium).[[6]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-6) |
| **10−3** | 0.00275 | 0.00990 | World record speed of the fastest [snail](https://en.wikipedia.org/wiki/Snail) in the Congham, UK.[[7]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-7) |
| **10−2** | 0.0476 | 0.171 | [Compact cassette](https://en.wikipedia.org/wiki/Compact_cassette) tape speed.[[8]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-8) |
| 0.080 | 0.29 | The top speed of a [sloth](https://en.wikipedia.org/wiki/Sloth). |
| **10−1** | 0.2778 | **1** | 1 [km](https://en.wikipedia.org/wiki/Kilometre)/hour. A slow walking pace. (4-6 kmph is average walking pace) |
| **100** | 1.2 | 4.32 | Typical scanning speed of an audio [compact disc](https://en.wikipedia.org/wiki/Compact_disc); the speed of signals ([action potentials](https://en.wikipedia.org/wiki/Action_potential)) traveling along [axons](https://en.wikipedia.org/wiki/Axon) in the human cortex. |
| 1–1.5 | 3.6–5.4 | Average [walking](https://en.wikipedia.org/wiki/Walking) speed—below a speed of about 2 m/s, it is more efficient to walk than to run, but above that speed, it is more efficient to run. |
| 2.39 | 8.53 | World record time 50m freestyle swim |
| 5.72 | 20.42 | World record time [marathon](https://en.wikipedia.org/wiki/Marathon) |
| 6–7 | 20–25 | Comfortable [bicycling](https://en.wikipedia.org/wiki/Bicycle) speed. |
| **101** | 10.438 | 37.578 | Average speed of [Jamaican](https://en.wikipedia.org/wiki/Jamaica) [athlete](https://en.wikipedia.org/wiki/Athletics_(sport)) [Usain Bolt](https://en.wikipedia.org/wiki/Usain_Bolt) while setting the [100m world record](https://en.wikipedia.org/wiki/Men%27s_100_metres_world_record_progression) in [Berlin](https://en.wikipedia.org/wiki/2009_World_Championships_in_Athletics_%E2%80%93_Men%27s_100_metres) on 16 August 2009. |
| 12.42 | 44.72 | Top speed reached by Bolt during the same race. |
| 8–14 | 30–50 | Typical residential [speed limit](https://en.wikipedia.org/wiki/Speed_limit); top speed of a running cat or dog. |
| 14 | 50 | Typical speed of road-race cyclist. |
| 17 | 60 | Typical speed of [thoroughbred](https://en.wikipedia.org/wiki/Thoroughbred) racehorse or racing [greyhound](https://en.wikipedia.org/wiki/Greyhound). |
| 5–25 | 18–90 | Speed of propagation for [unmyelinated](https://en.wikipedia.org/wiki/Action_potential) sensory [neurons](https://en.wikipedia.org/wiki/Neuron). |
| 30 | 110 | Typical speed of car (freeway); [cheetah](https://en.wikipedia.org/wiki/Cheetah)—fastest of all terrestrial animals; [sailfish](https://en.wikipedia.org/wiki/Sailfish)—fastest [fish](https://en.wikipedia.org/wiki/Fish); speed of [go-fast boat](https://en.wikipedia.org/wiki/Go-fast_boat). |
| 37.16 | 133.78 | Land speed record for a [human powered vehicle](https://en.wikipedia.org/wiki/Human_powered_vehicle).[[9]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-9) |
| 40 | 140 | Typical peak speed of a local service [train](https://en.wikipedia.org/wiki/Train) (or intercity on lower standard tracks). |
| 54 | 195 | Maximum speed a [human](https://en.wikipedia.org/wiki/Human) can attain during a face-down [free-fall](https://en.wikipedia.org/wiki/Free-fall). |
| 67 | 240 | The top speed of the world's fastest roller coaster, [Formula Rossa](https://en.wikipedia.org/wiki/Formula_Rossa). |
| 90 | 320 | Typical speed of a modern [high-speed train](https://en.wikipedia.org/wiki/High-speed_rail) (e.g. latest generation of production TGV); a diving [peregrine falcon](https://en.wikipedia.org/wiki/Peregrine_falcon)—fastest bird; 320 km/h or 200 mph is a parameter sometimes used in defining a [supercar](https://en.wikipedia.org/wiki/Supercar).[[10]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-10) |
| 91 | 328 | Fastest recorded ball (a [golf](https://en.wikipedia.org/wiki/Golf) ball) in sports.[[11]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-11) |
| **102** | 103 | 370 | Speed of super torpedo [VA-111 Shkval](https://en.wikipedia.org/wiki/VA-111_Shkval). |
| 103.5 | 372.6 | Maximum speed recorded by a [Formula One](https://en.wikipedia.org/wiki/Formula_One) [car](https://en.wikipedia.org/wiki/Formula_One_car). Set by [Juan Pablo Montoya](https://en.wikipedia.org/wiki/Juan_Pablo_Montoya) during the [2005 Italian Grand Prix](https://en.wikipedia.org/wiki/2005_Italian_Grand_Prix) at [Monza](https://en.wikipedia.org/wiki/Autodromo_Nazionale_Monza) in a [McLaren MP4-20](https://en.wikipedia.org/wiki/McLaren_MP4-20). |
| 105.5 | 379.8 | Maximum speed of a [Ferrari F50 GT1](https://en.wikipedia.org/wiki/Ferrari_F50_GT1). |
| 113 | 408 | Fastest non-tornadic wind gust recorded on Earth - at Barrow Island, Australia on 1996-04-10 during [Severe Tropical Cyclone Olivia](https://en.wikipedia.org/wiki/Cyclone_Olivia).[[12]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-12) |
| 119.742 | 431.072 | Maximum speed of the [Bugatti Veyron Super Sport](https://en.wikipedia.org/wiki/Bugatti_Veyron#Bugatti_Veyron_16.4_Super_Sport.2C_World_Record_Edition_.282010.E2.80.93.29) (currently the [fastest production car](https://en.wikipedia.org/wiki/List_of_fastest_production_cars) in the world). |
| 120 | 432 | Speed of propagation for [mammalian](https://en.wikipedia.org/wiki/Mammal) motor [neurons](https://en.wikipedia.org/wiki/Neuron). |
| 130 | 468 | Wind speed of a powerful [tornado](https://en.wikipedia.org/wiki/Tornado). |
| 150.6 | 539 | Top speed of an internal-combustion-powered [NHRA](https://en.wikipedia.org/wiki/National_Hot_Rod_Association) [Top Fuel Dragster](https://en.wikipedia.org/wiki/Top_Fuel). |
| 157 | 575 | Top speed of experimental test [TGV](https://en.wikipedia.org/wiki/TGV) train in 2007. |
| 161 | 580 | Top speed of [JR-Maglev](https://en.wikipedia.org/wiki/JR-Maglev) in 2003. |
| 250 | 900 | Typical [cruising speed](https://en.wikipedia.org/wiki/Cruising_speed) of a modern [jet airliner](https://en.wikipedia.org/wiki/Jet_aircraft), e.g. an [Airbus A380](https://en.wikipedia.org/wiki/Airbus_A380). |
| 314 | 1,130 | Top speed of any World War II-era aircraft, the [Me 163B V18](https://en.wikipedia.org/wiki/Messerschmitt_Me_163#Later_versions) set on July 6, 1944. |
| 320 | 1,200 | The speed of a typical [.22 LR](https://en.wikipedia.org/wiki/.22_Long_Rifle) bullet. |
| 340.3 | 1,225 | [Speed of sound](https://en.wikipedia.org/wiki/Speed_of_sound) in [standard atmosphere](https://en.wikipedia.org/wiki/International_Standard_Atmosphere) (15 [°C](https://en.wikipedia.org/wiki/%C2%B0C) and 1 [atm](https://en.wikipedia.org/wiki/Atmosphere_(unit)" \o "Atmosphere (unit))). |
| 344.66 | 1,240.77 | Max speed reached by the jet-propelled car [ThrustSSC](https://en.wikipedia.org/wiki/ThrustSSC" \o "ThrustSSC) in 1997—Land speed record.[[13]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-13) |
| 373 | 1,342.8 | Highest speed recorded during a [free fall](https://en.wikipedia.org/wiki/Free_fall) set by [Felix Baumgartner](https://en.wikipedia.org/wiki/Felix_Baumgartner). |
| 428 | 1,540.8 | Max speed of [Bell X-1](https://en.wikipedia.org/wiki/Bell_X-1). |
| 464 | 1,670 | Speed of [Earth's](https://en.wikipedia.org/wiki/Earth) rotation at the [equator](https://en.wikipedia.org/wiki/Equator). |
| 603 | 2,170.8 | Speed of the [Concorde](https://en.wikipedia.org/wiki/Concorde) airliner. |
| 975 | 3,510 | [Muzzle velocity](https://en.wikipedia.org/wiki/Muzzle_velocity) of [M16](https://en.wikipedia.org/wiki/M16_(rifle)) rifle. |
| 981 | 3,532 | [SR-71 Blackbird](https://en.wikipedia.org/wiki/SR-71_Blackbird), the fastest [aircraft](https://en.wikipedia.org/wiki/Aircraft) driven by a mechanical [jet engine](https://en.wikipedia.org/wiki/Jet_engine). |
| **103** | 1,400 | 5,040 | Speed of the [Space Shuttle](https://en.wikipedia.org/wiki/Space_Shuttle) when the solid rocket boosters separate. |
| 1,500 | 5,400 | Speed of sound in [water](https://en.wikipedia.org/wiki/Water) or in [soft tissue](https://en.wikipedia.org/wiki/Soft_tissue).[[14]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-14) |
| 1,789 | 6,443 | Speed of [BrahMos II hypersonic cruise missile](https://en.wikipedia.org/wiki/BrahMos" \l "Hypersonic_Cruise_Missile" \o "BrahMos) |
| 2,000 | 7,200 | Estimated speed of a [thermal neutron](https://en.wikipedia.org/wiki/Thermal_neutron). |
| 2,019 | 7,268.4 | Speed of the [North American X-15](https://en.wikipedia.org/wiki/North_American_X-15) rocket plane. |
| 2,375 | 8,550 | [Escape velocity](https://en.wikipedia.org/wiki/Escape_velocity) from Moon. |
| 2,700 | 9,600 | Speed of wind on exoplanet [HD 189733 b](https://en.wikipedia.org/wiki/HD_189733_b).[[15]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-15) |
| 2,885 | 10,385 | Top speed of the fastest [rocket sled](https://en.wikipedia.org/wiki/Rocket_sled).[[16]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-16) |
| 3,373 | 12,144 | Speed of the [X-43](https://en.wikipedia.org/wiki/NASA_X-43) rocket/scramjet plane. |
| 4,500 | 16,000 | A typical value for the [specific impulse](https://en.wikipedia.org/wiki/Specific_impulse) of current [rockets](https://en.wikipedia.org/wiki/Rocket). |
| 7,700 | 27,700 | Speed of [International Space Station](https://en.wikipedia.org/wiki/International_Space_Station) and typical speed of other [satellites](https://en.wikipedia.org/wiki/Satellite) such as the [Space Shuttle](https://en.wikipedia.org/wiki/Space_Shuttle) in [low Earth orbit](https://en.wikipedia.org/wiki/Low_Earth_orbit). |
| 7,777 | 28,000 | Speed of propagation of the explosion in a [detonating cord](https://en.wikipedia.org/wiki/Detonating_cord). |
| **104** | 11,107 | 39,985.2 | Speed of [Apollo 10](https://en.wikipedia.org/wiki/Apollo_10) – high speed record for human-crewed vehicle. |  |
| 11,200 | 40,320 | [Escape velocity](https://en.wikipedia.org/wiki/Escape_velocity) from Earth. |  |
| 16,100 | 57,900 | Fastest [projectile](https://en.wikipedia.org/wiki/Projectile) velocity (1994).[[17]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-17) |  |
| 16,210 | 58,356 | Escape speed from Earth by NASA [*New Horizons*](https://en.wikipedia.org/wiki/New_Horizons) spacecraft—Fastest escape velocity. |  |
| 17,000 | 61,000 | The approximate speed of the [Voyager 1](https://en.wikipedia.org/wiki/Voyager_1) probe relative to the sun, when it exited the Solar System.[[18]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-18) |  |
| 29,800 | 107,280 | Speed of the [Earth](https://en.wikipedia.org/wiki/Earth) in orbit around the [Sun](https://en.wikipedia.org/wiki/Sun). |  |
| 47,800 | 172,100 | Atmospheric entry speed of the [Galileo](https://en.wikipedia.org/wiki/Galileo_(spacecraft)) atmospheric probe—Fastest controlled atmospheric entry for a man-made object. |  |
| 70,220 | 252,800 | Speed of the [Helios 2](https://en.wikipedia.org/wiki/Helios_probes) solar probe. |  |
| 73,762 | 265,542 | Estimated top speed of the [Juno](https://en.wikipedia.org/wiki/Juno_(spacecraft)) spacecraft before insertion into Jupiter's orbit —Fastest man-made object.[[19]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-19) |  |
| **105** | 140,000 | 540,000 | Approaching [velocity](https://en.wikipedia.org/wiki/Hypervelocity) of [Messier 98](https://en.wikipedia.org/wiki/Messier_98) to our galaxy. |  |
| 200,000 | 700,000 | Orbital speed of the [solar system](https://en.wikipedia.org/wiki/Solar_system) in the [Milky Way](https://en.wikipedia.org/wiki/Milky_Way) galaxy. |  |
| 308,571 | 1,080,000 | Approaching [velocity](https://en.wikipedia.org/wiki/Hypervelocity) of [Andromeda Galaxy](https://en.wikipedia.org/wiki/Andromeda_Galaxy) to our galaxy. |  |
| 440,000 | 1,600,000 | Typical speed of the [stepped leader of lightning](https://en.wikipedia.org/wiki/Lightning#Downward_leader_formation_for_negative_CG_lightning) (*cf.* return stroke below).[[20]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-20) |  |
| 450,000 | 1,600,000 | Typical speed of a particle of the [solar wind](https://en.wikipedia.org/wiki/Solar_wind), relative to the [Sun](https://en.wikipedia.org/wiki/Sun). |  |
| 552,000 | 1,990,000 | Speed of the [Milky Way](https://en.wikipedia.org/wiki/Milky_Way), relative to the [cosmic microwave background](https://en.wikipedia.org/wiki/Cosmic_microwave_background). |  |
| 617,700 | 2,224,000 | Escape velocity from the surface of the [Sun](https://en.wikipedia.org/wiki/Sun). |  |
| **106** | 1,000,000 | 3,600,000 | Typical speed of a [Moreton wave](https://en.wikipedia.org/wiki/Moreton_wave) across the surface of the Sun. |  |
| 1,610,000 | 5,800,000 | Speed of [hypervelocity star](https://en.wikipedia.org/wiki/Hypervelocity_star) [PSR B2224+65](https://en.wikipedia.org/w/index.php?title=PSR_B2224%2B65&action=edit&redlink=1), which currently seems to be leaving the [Milky Way](https://en.wikipedia.org/wiki/Milky_Way). |  |
| 5,000,000 | 18,000,000 | Estimated minimum speed of star [S2](https://en.wikipedia.org/wiki/S2_(star)) at its closest approach to [Sagittarius A\*](https://en.wikipedia.org/wiki/Sagittarius_A*).[[21]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-21) |  |
| **107** | 14,000,000 | 50,000,000 | Typical speed of a [fast neutron](https://en.wikipedia.org/wiki/Fast_neutron). |  |
| 30,000,000 | 100,000,000 | Typical speed of an [electron](https://en.wikipedia.org/wiki/Electron) in a [cathode ray tube](https://en.wikipedia.org/wiki/Cathode_ray_tube). |  |
| **108** | 100,000,000 | 360,000,000 | The escape velocity of a [neutron star](https://en.wikipedia.org/wiki/Neutron_star). |  |
| 100,000,000 | 360,000,000 | Typical speed of the [return stroke of lightning](https://en.wikipedia.org/wiki/Lightning#Leader_formation_and_the_return_stroke) (*cf.* stepped leader above).[[22]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-22) |  |
| 124,000,000 | 447,000,000 | Speed of light in a [diamond](https://en.wikipedia.org/wiki/Diamond) ([Refractive index](https://en.wikipedia.org/wiki/Refractive_index) 2.417). |  |
| 200,000,000 | 720,000,000 | Speed of a [signal](https://en.wikipedia.org/wiki/Signalling_(telecommunications)) in an [optical fiber](https://en.wikipedia.org/wiki/Optical_fiber). |  |
| 299,792,456 | 1,079,252,840 | Speed of the 7 [TeV](https://en.wikipedia.org/wiki/TeV" \o "TeV) [protons](https://en.wikipedia.org/wiki/Proton) in the [Large Hadron Collider](https://en.wikipedia.org/wiki/Large_Hadron_Collider) at full power.[[23]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-23) |  |
| 299,792,457.996 | 1,079,252,848.786 | Maximal speed of an electron in [LEP](https://en.wikipedia.org/wiki/Large_Electron%E2%80%93Positron_Collider) (104.5 GeV). |  |
| 299,792,458 − 1.5×10−15 | 1,079,252,848.8 − 5.4×10−15 | Speed of the [*Oh-My-God particle*](https://en.wikipedia.org/wiki/Oh-My-God_particle) [ultra-high-energy cosmic ray](https://en.wikipedia.org/wiki/Ultra-high-energy_cosmic_ray).[[24]](https://en.wikipedia.org/wiki/Orders_of_magnitude_(speed)#cite_note-24) |  |
| **299,792,458** | **1,079,252,848.8** | [Speed of light](https://en.wikipedia.org/wiki/Speed_of_light) or other [electromagnetic radiation](https://en.wikipedia.org/wiki/Electromagnetic_radiation) in a [vacuum](https://en.wikipedia.org/wiki/Vacuum) or massless particles. |  |
| **10?** | >299,792,458 | >1,079,252,848.8 | Faster than the speed of light. |  |

# Appendix – Quote attributed to Galileo Galilei



1. **Speed** is a scalar quality – we only need to know how big or small it is (i.e., it’s ‘scale’). But science often uses a far more precise quality known as **velocity**, which not only take into account the ‘size’ of the speed, but also its direction. So velocity is vector quantity, able to be plotted out on a map for instance. It is calculated using the very similar equation velocity = displacement / time. [↑](#footnote-ref-1)
2. A nice, clean, fun kid’s video is up at <https://www.youtube.com/watch?v=_nAKwhZyXnw> to help you. [↑](#footnote-ref-2)