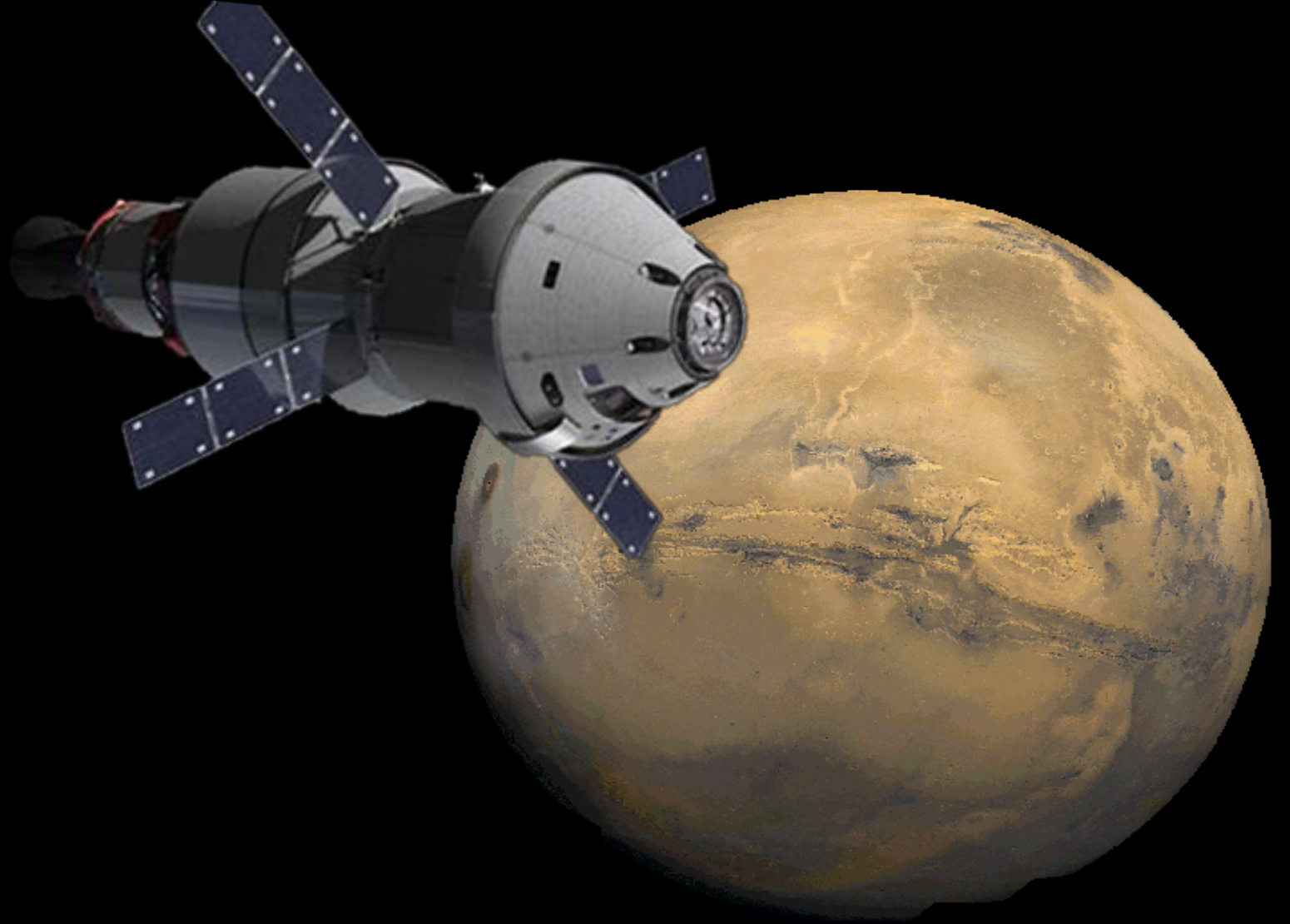


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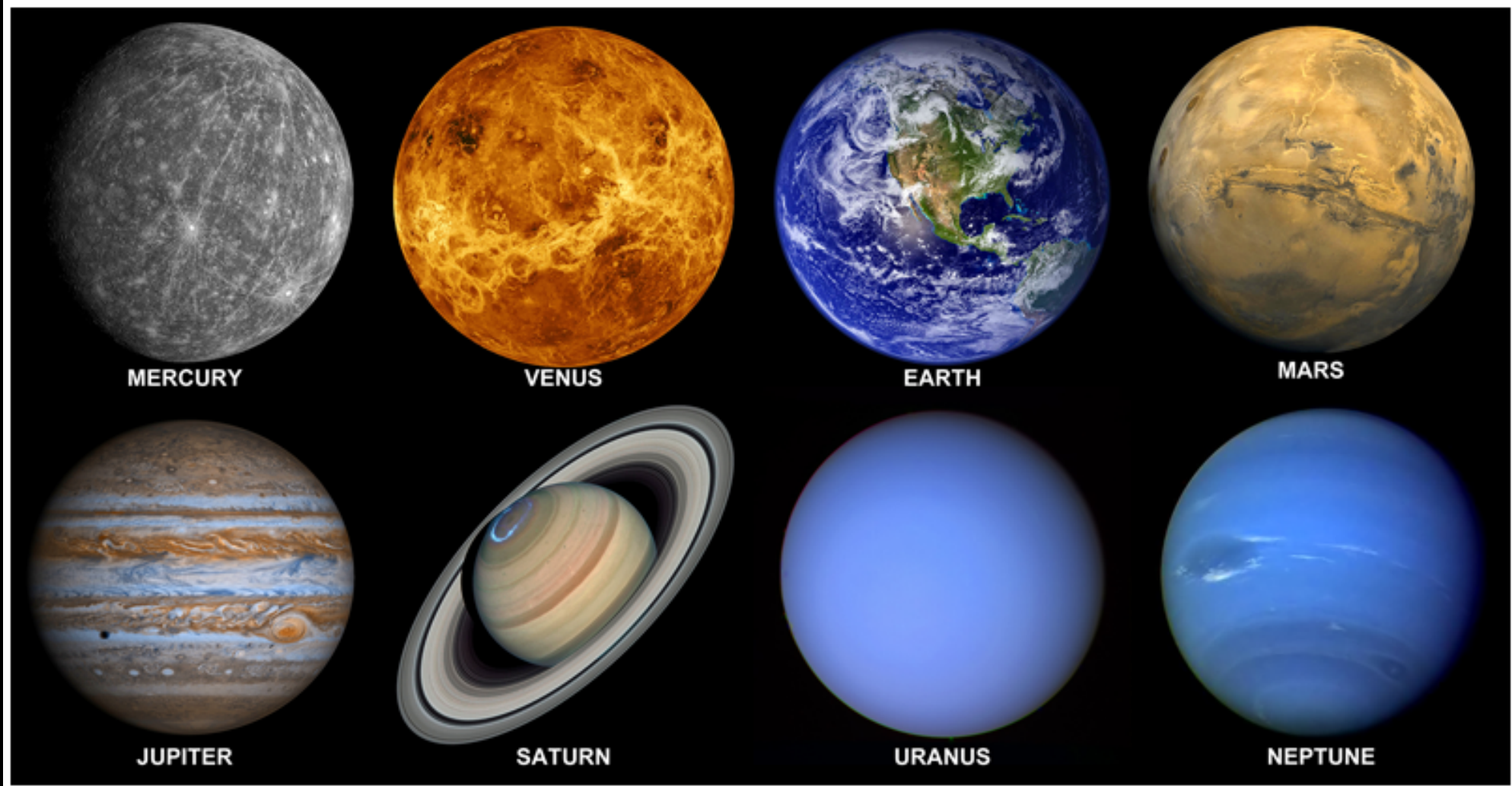


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Space Math - Fractions

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What is wrong with the picture?



Space Math— The Scale...

not all are the same size...

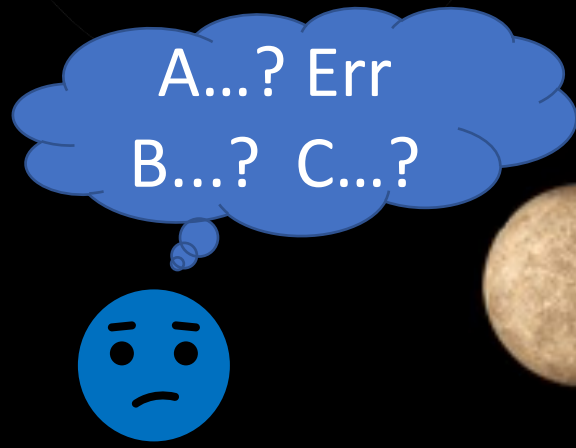


	<u>MERCURY</u>	<u>VENUS</u>	<u>EARTH</u>	<u>MARS</u>
<u>Mass (10²⁴kg)</u>	0.33	4.87	5.97	0.642
<u>Diameter (km)</u>	4879	12,104	12,756	6792

Space Math – Scientific Notation

What is 10^{24} kg?

- A. 1024 kg
- B. 1,000,000,000,000,000,000,000,000 kg
- C. 1,000,000,000,000,000,000,000,000 kg



	<u>MERCURY</u>	<u>VENUS</u>	<u>EARTH</u>	<u>MARS</u>
<u>Mass (10^{24}kg)</u>	0.33	4.87	5.97	0.642
<u>Diameter (km)</u>	4879	12,104	12,756	6792

So how many kilograms are the planets?

Earth	=	5,970,000,000,000,000,000,000,000 kg
Venus	=	4,870,000,000,000,000,000,000,000 kg
Mars	=	642,000,000,000,000,000,000,000 kg
Mercury	=	330,000,000,000,000,000,000,000 kg
Moon	=	73,000,000,000,000,000,000,000 kg
Ceres	=	938,350,000,000,000,000,000 kg
Comet	=	220,000,000,000,000 kg
USS Nimitz	=	91,800,000 kg
747-8	=	442,253 kg
Person	=	62 kg



Wow!





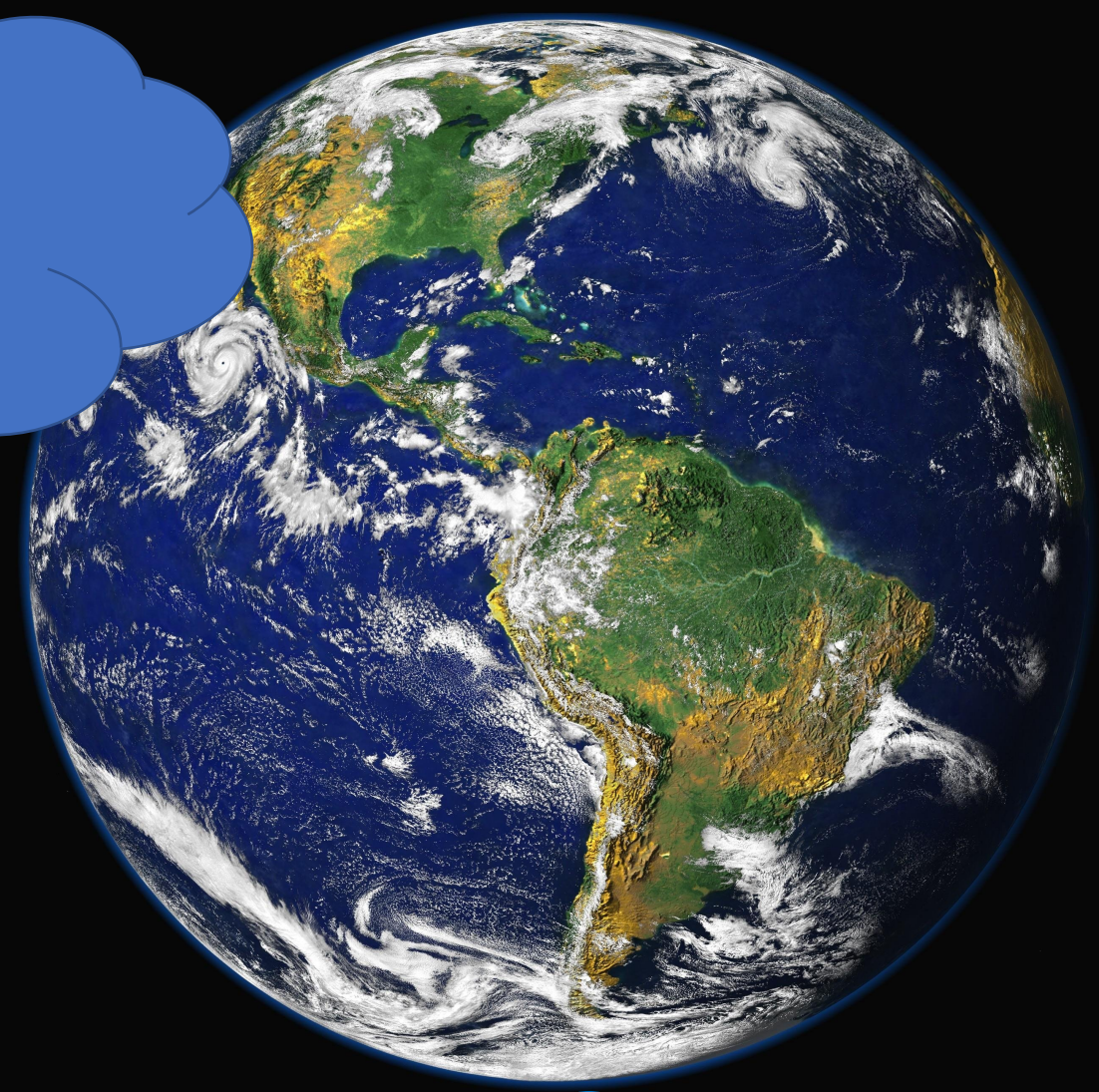
Space Math Names of Big numbers



Name	Number
Million	1×10^6
Billion	1×10^9
Trillion	1×10^{12}
Quadrillion	1×10^{15}
Quintillion	1×10^{18}
Sextillion	1×10^{21}
Septillion	1×10^{24}
Octillion	1×10^{27}
Nonillion	1×10^{30}
Decillion	1×10^{33}



I need a bigger scale...



So Earth is

5.97×10^{24} kg

or

5.97 Septillion kg

or

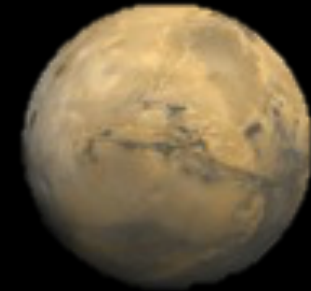
5,970,000,000,000,000,000,000,000 kg

Space Math –

Lets compare Earth and Mars

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6792 km / 12,756
km = .5324



	<u>MERCURY</u>	<u>VENUS</u>	<u>EARTH</u>	<u>MARS</u>
<u>Mass (10²⁴kg)</u>	0.33	4.87	5.97	0.642
<u>Diameter (km)</u>	4879	12,104	12,756	6792

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Count the
dots...



16



Simplification
Earth vs Mars

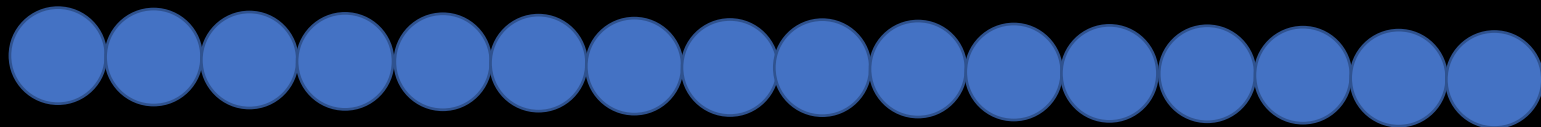
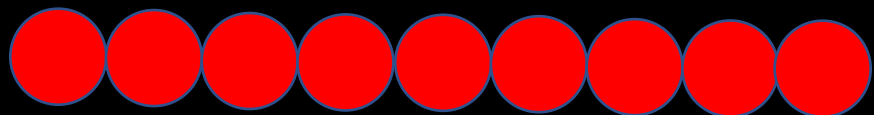
9



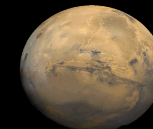
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Fraction of Earth **Mars**

Ohhh!!!



Earth

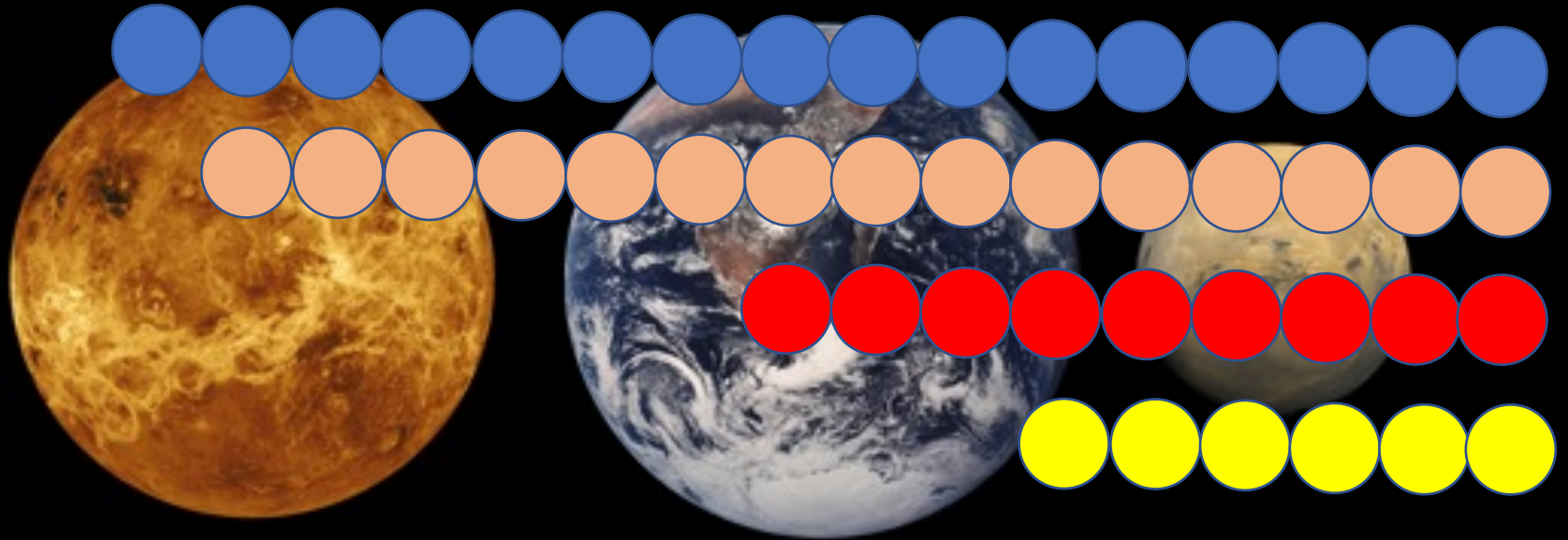


9

16

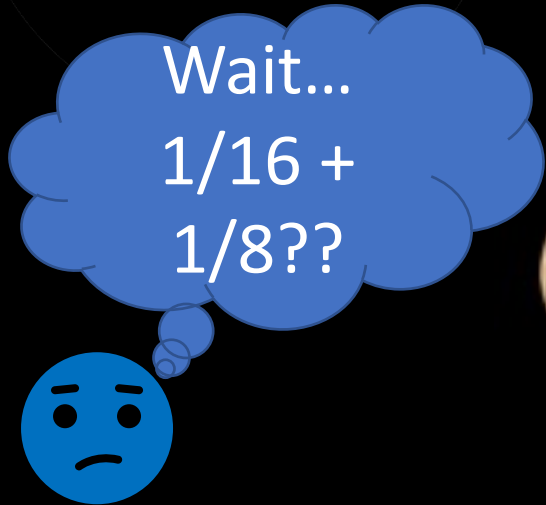


To make large numbers easier, we convert to Fractions -- Let's use Earth as the reference.



Fraction of Earth	<u>MERCURY</u>	<u>VENUS</u>	<u>EARTH</u>	<u>MARS</u>
<u>Mass</u>	1/16	13/16	1	1/8
<u>Diameter</u>	6/16	15/16	1	9/16

Lets add up the inner planets:
 Mercury + Venus + Earth + Mars = ?



Fraction of Earth	<u>MERCURY</u>	<u>VENUS</u>	<u>EARTH</u>	<u>MARS</u>
<u>Mass</u>	1/16	13/16	1	1/8
<u>Diameter</u>	6/16	15/16	1	9/16

Space Math – to do the math, Mars = $1/8 = 2/16$

common denominator



Fraction of Earth	<u>MERCURY</u>	<u>VENUS</u>	<u>EARTH</u>	<u>MARS</u>
<u>Mass</u>	1/16	13/16	1	1/8
<u>Diameter</u>	6/16	15/16	1	9/16

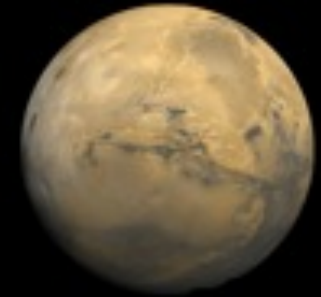


Lets add up the Mass of the inner planets:

Mercury + Venus + Earth + Mars = ?

$$1/16 + 13/16 + 1 + 2/16 = 2$$

Fractions
make this
easier!



Fraction of Earth	<u>MERCURY</u>	<u>VENUS</u>	<u>EARTH</u>	<u>MARS</u>
<u>Mass</u>	1/16	13/16	1	1/8
<u>Diameter</u>	6/16	15/16	1	9/16

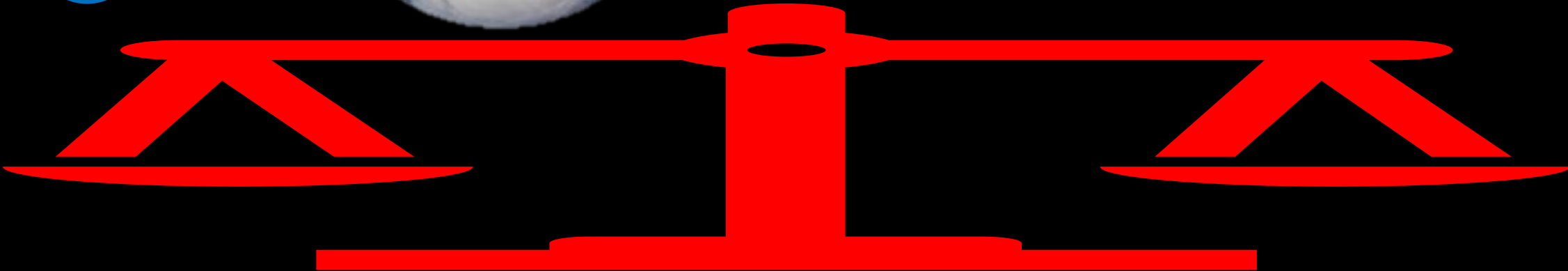
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Or...

Mercury + Venus + Mars = Earth

$$1/16 + 13/16 + 2/16 = 1$$

What
about
my
62kg?

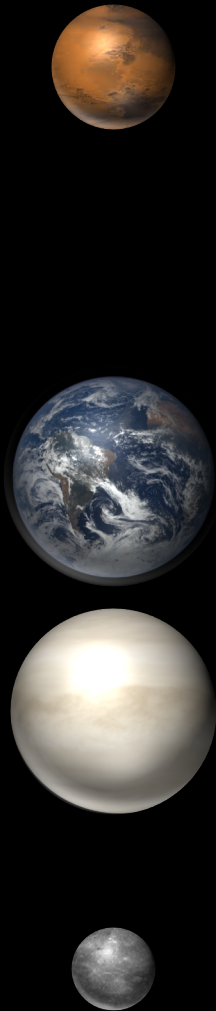


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Somebody
has a lot of
free time...



Planet Distance from Sun
and Relative size



1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0

Astronomical Unit "AU"

AU is distance from sun
Earth = 1

Why?

Because Earth is home

Earth is denominator

- Which way will a compass point on Mars?

- North
- South
- East
- West



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Packing list:

Food 🍕

Water 💧

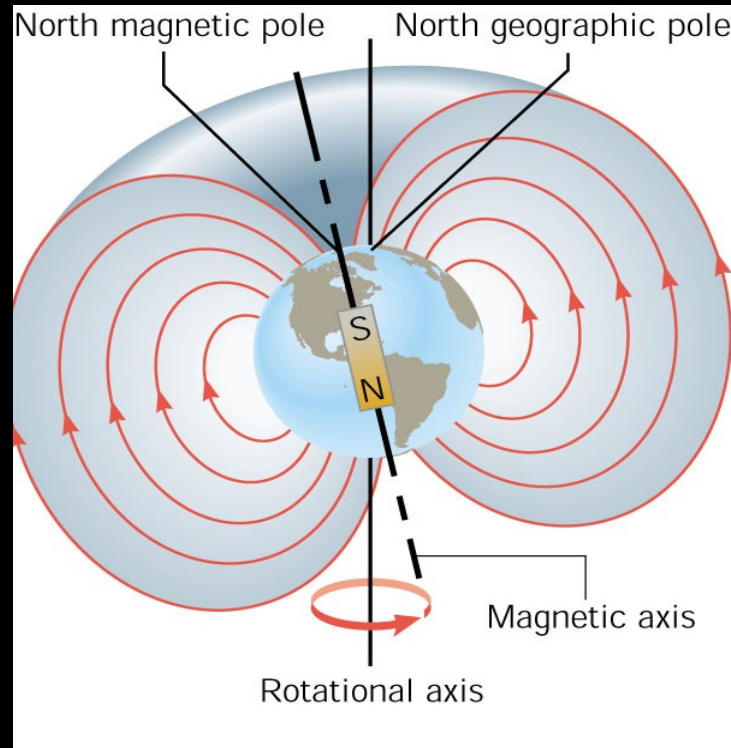
Flashlight 🔦

compass?



WEST EAST SPACE

The Earth is
a big
magnet..



- The earth's north geographic pole is the south pole of a big magnet.
- A compass needle is attracted to the earth's north geographic pole
- The earth's magnetism is due to currents flowing in its molten core (we think...)

The magnetic north pole is inclined about 14° from the geographic north pole, or by about 600 miles.

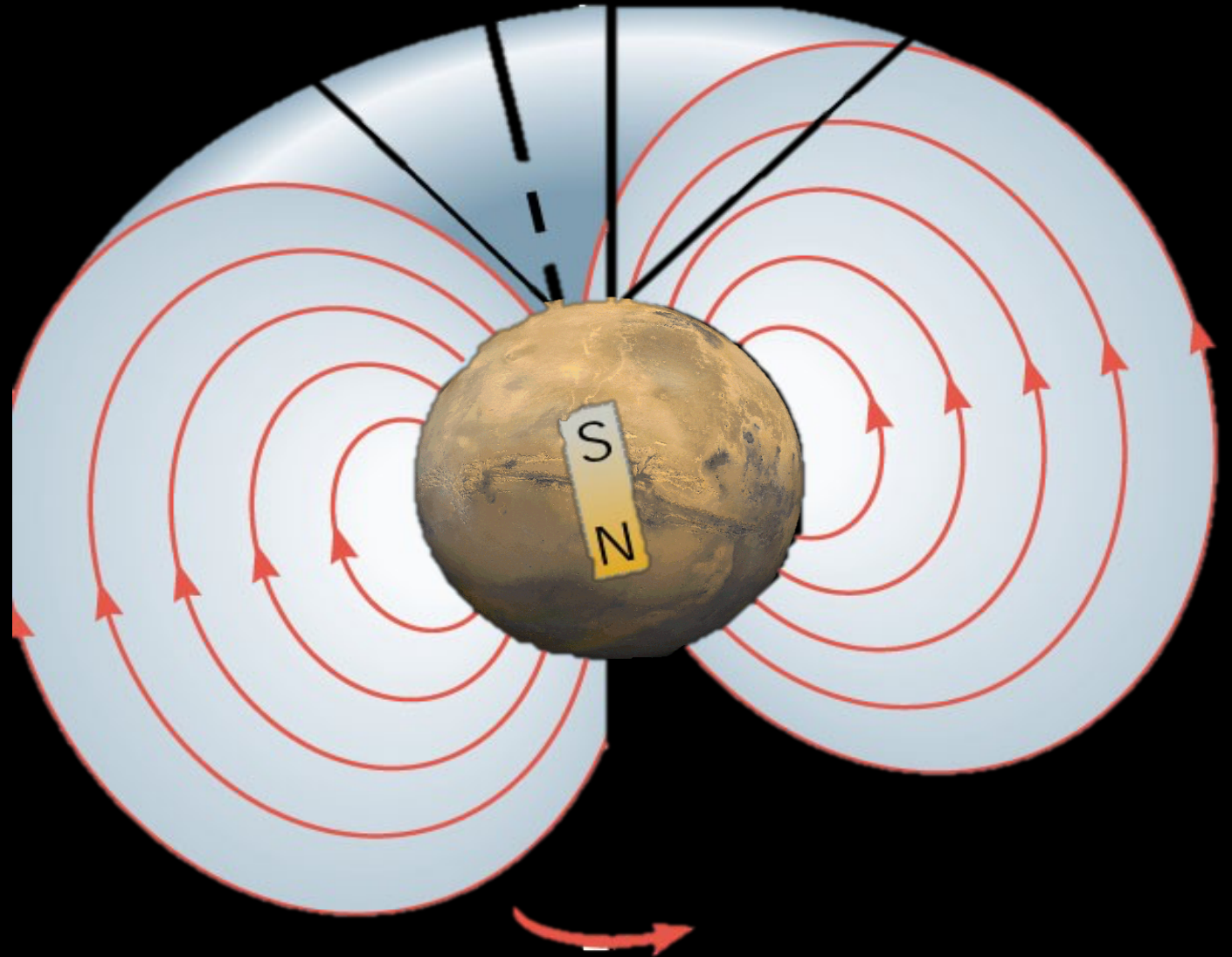


- Can we assume that Mars has the same? No.

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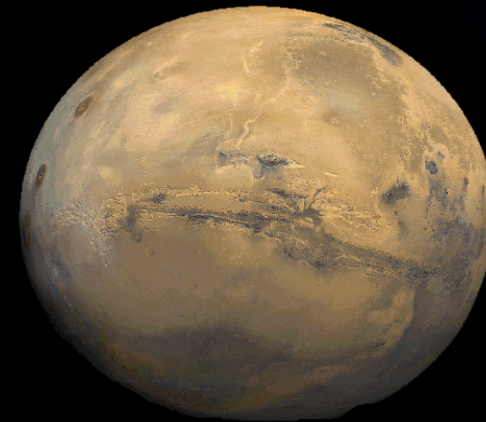
Wait does
that work???



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- In 1965 Mariner 4, passed within 8,000 kilometers (4,971 miles) of Mars' surface. At that distance, it failed to detect any magnetic field.

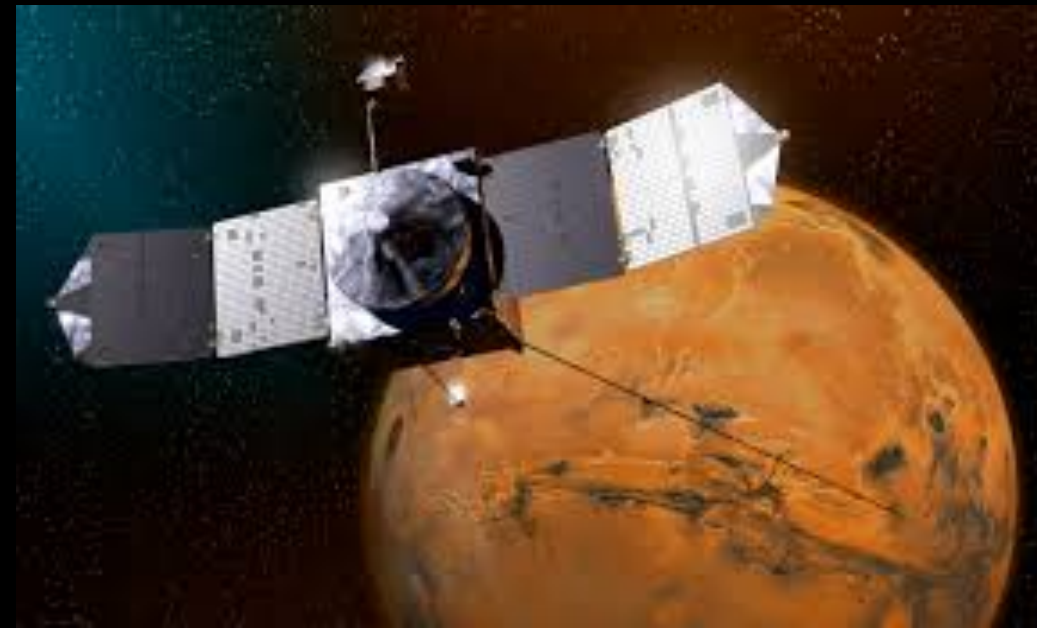
1965?
Mariner 4
wow that's
old...



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- NASA sent more probes...
- Mars Global Surveyor
- MAVEN
- They helped make a magnetic map

MAVEN
sounds like a
Disney
character...



- Which way will a compass point on Mars?

WEST EAST SPACE

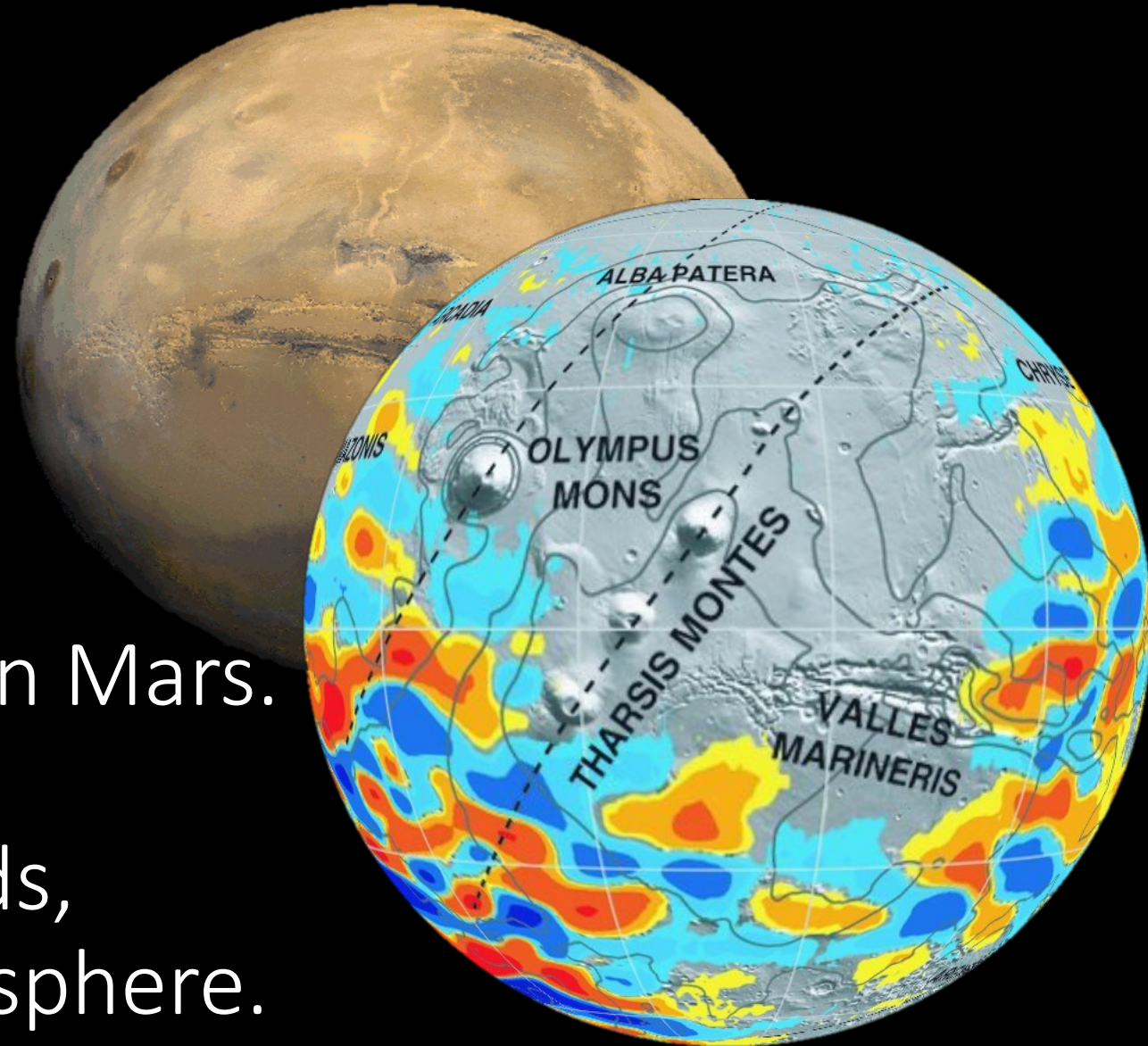
Food 🍕
Water 💧
Flashlight 🔦
Video Game 🎮



Answer:

Don't count on a compass on Mars.

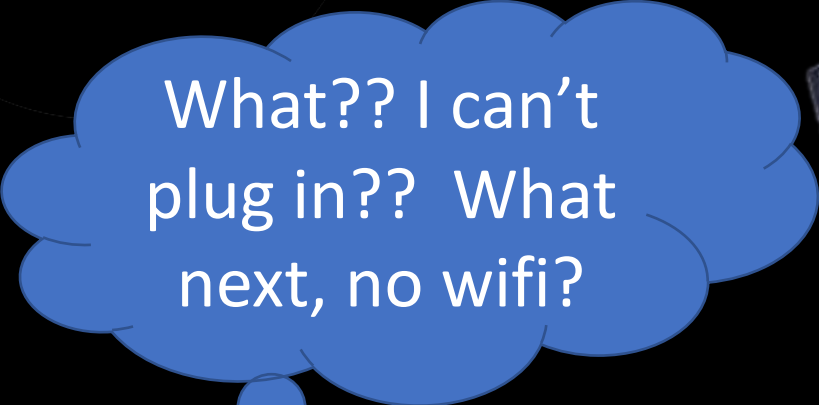
Mars has local magnetic fields, mostly in the southern hemisphere.



Credit: NASA



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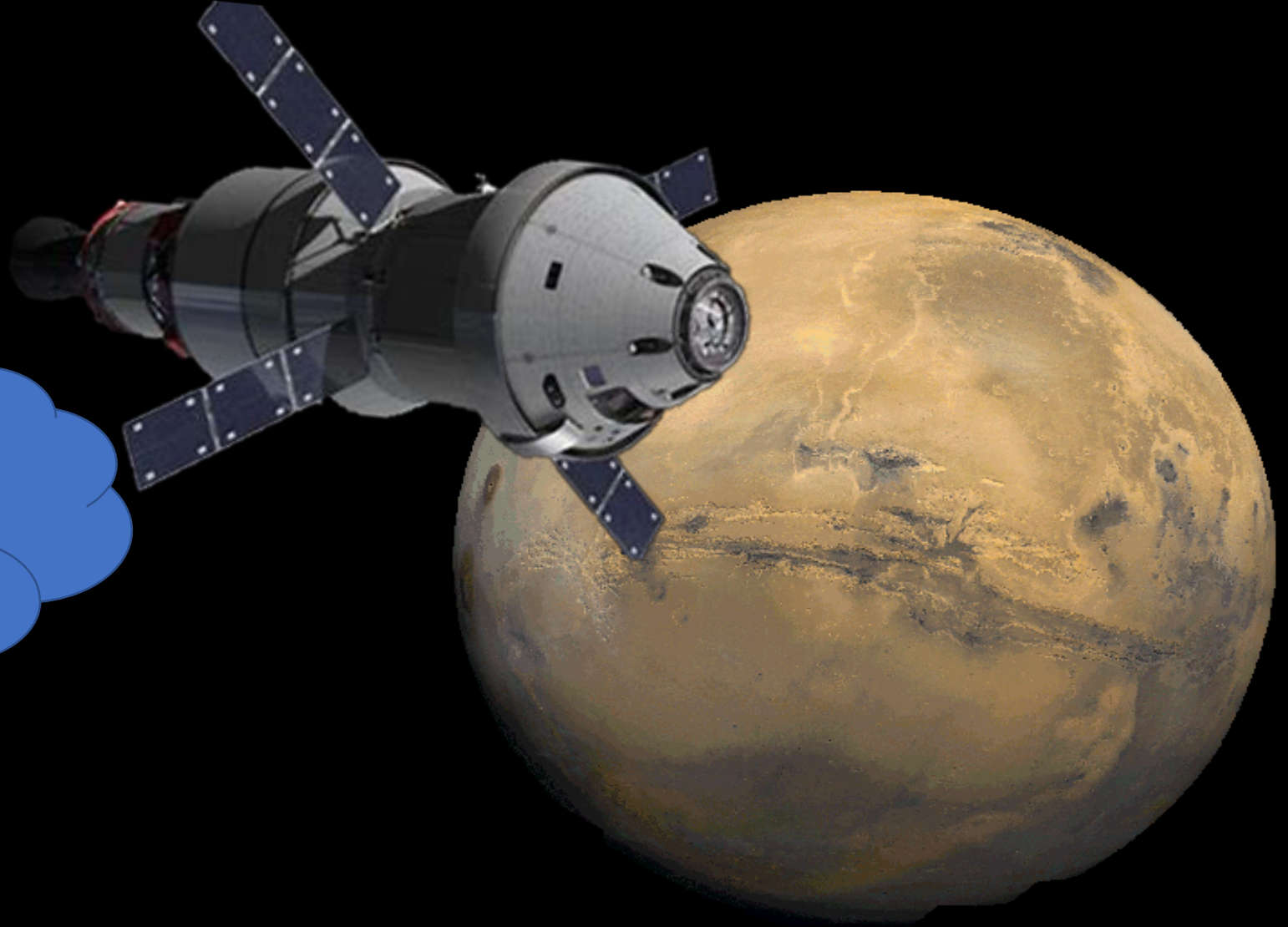
What?? I can't
plug in?? What
next, no wifi?



Going to Mars?

You need power to run your ship.

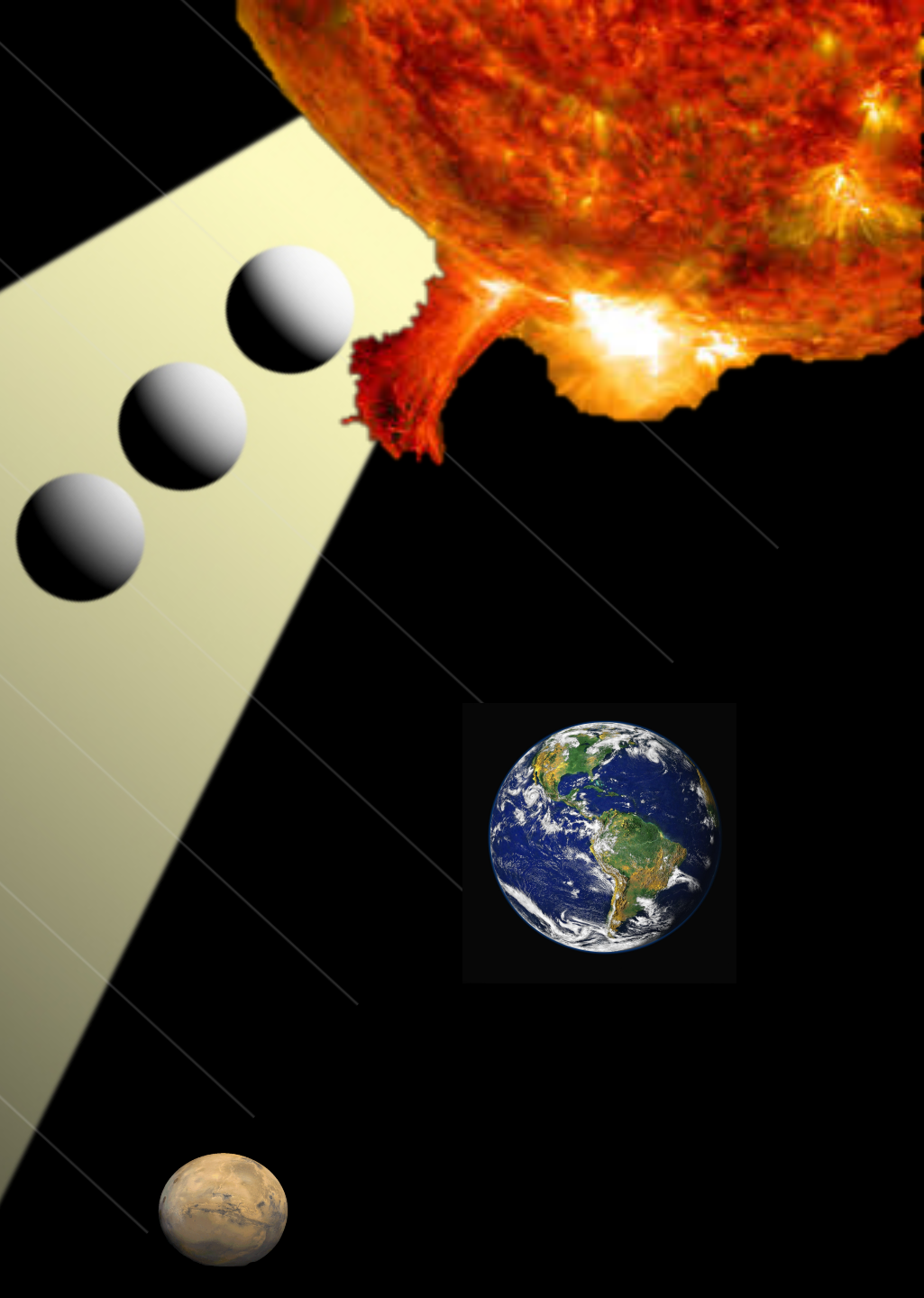
How much power can we get from Solar?



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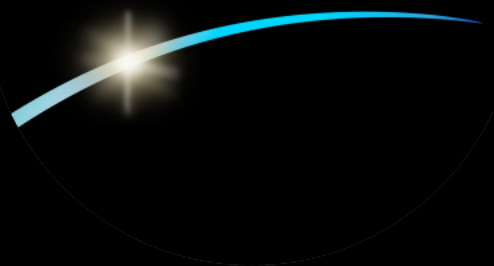
Fractions in Space... Inverse Square Law of Light

The Sun is light a
big flashlight 🔦 ...

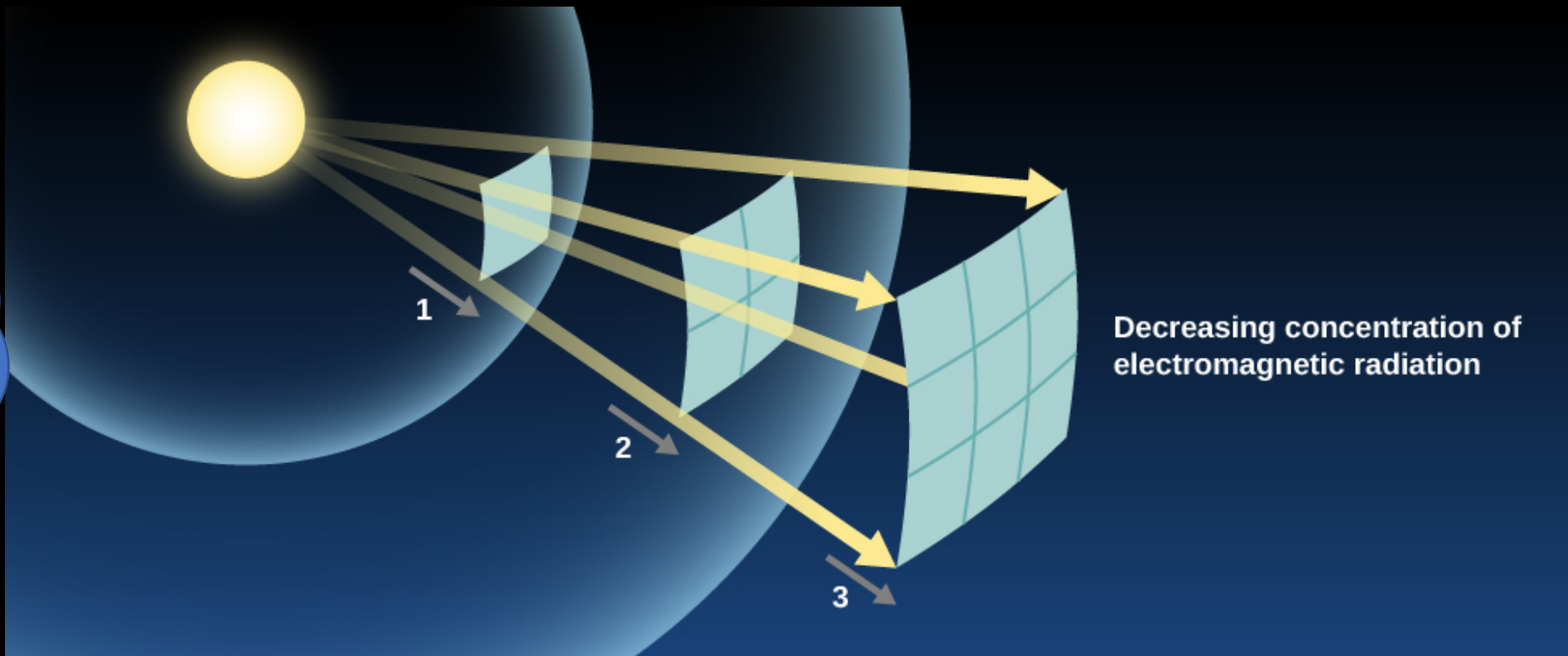


Fractions in Space... Inverse Square Law of Light

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Fractions
again...



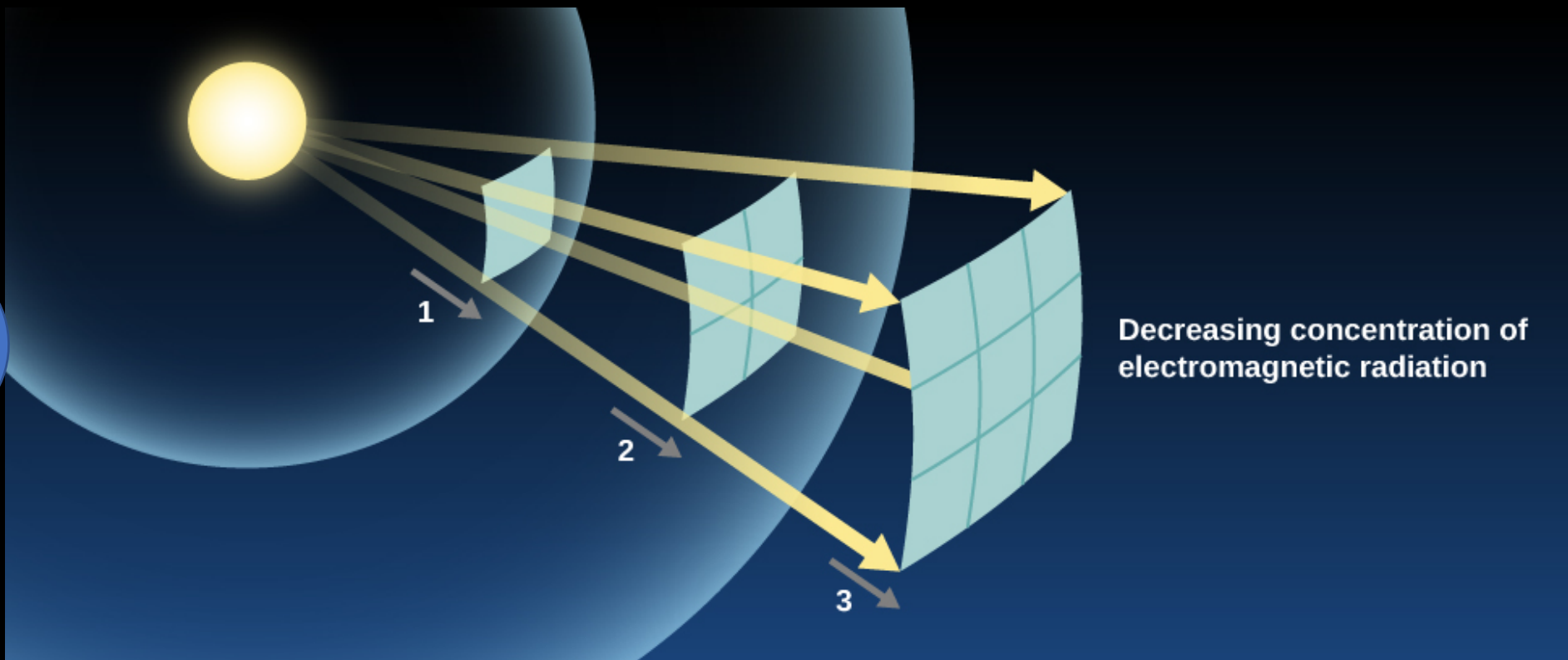
Distance AU	1	2	3	4	5	6	7	8	9	10
Strength	1	1/4	1/9	1/16	1/25	1/36	1/49	1/64	1/81	1/100

Fractions in Space... Inverse Square Law of Light

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Ohh..
Those are
the
planets!



AU

$2/5$

$5/7$

1

$1 \frac{1}{2}$

$5 \frac{1}{5}$

$9 \frac{4}{7}$

$19 \frac{1}{5}$

30

$39 \frac{1}{2}$

$5 \frac{1}{5}$

Strength

$6 \frac{11}{16}$

$1 \frac{15}{16}$

1

$53/123$

$1/16$

$1/64$

$1/369$

$1/900$

$6/10000$

$1/16$

Fractions in Space...

Inverse Square Law of Light

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Try at home with your flashlight
Same thing happens.

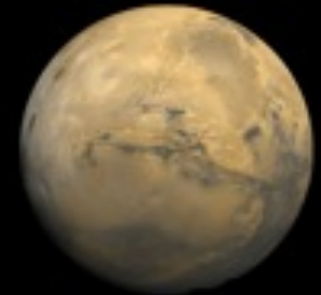
Mom... Can I
borrow your
iPhone to use the
light???



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Solar Power...What Fraction of Earth's solar Irradiance does Mars Receive?

Irradiance...
right light...
how much
light..

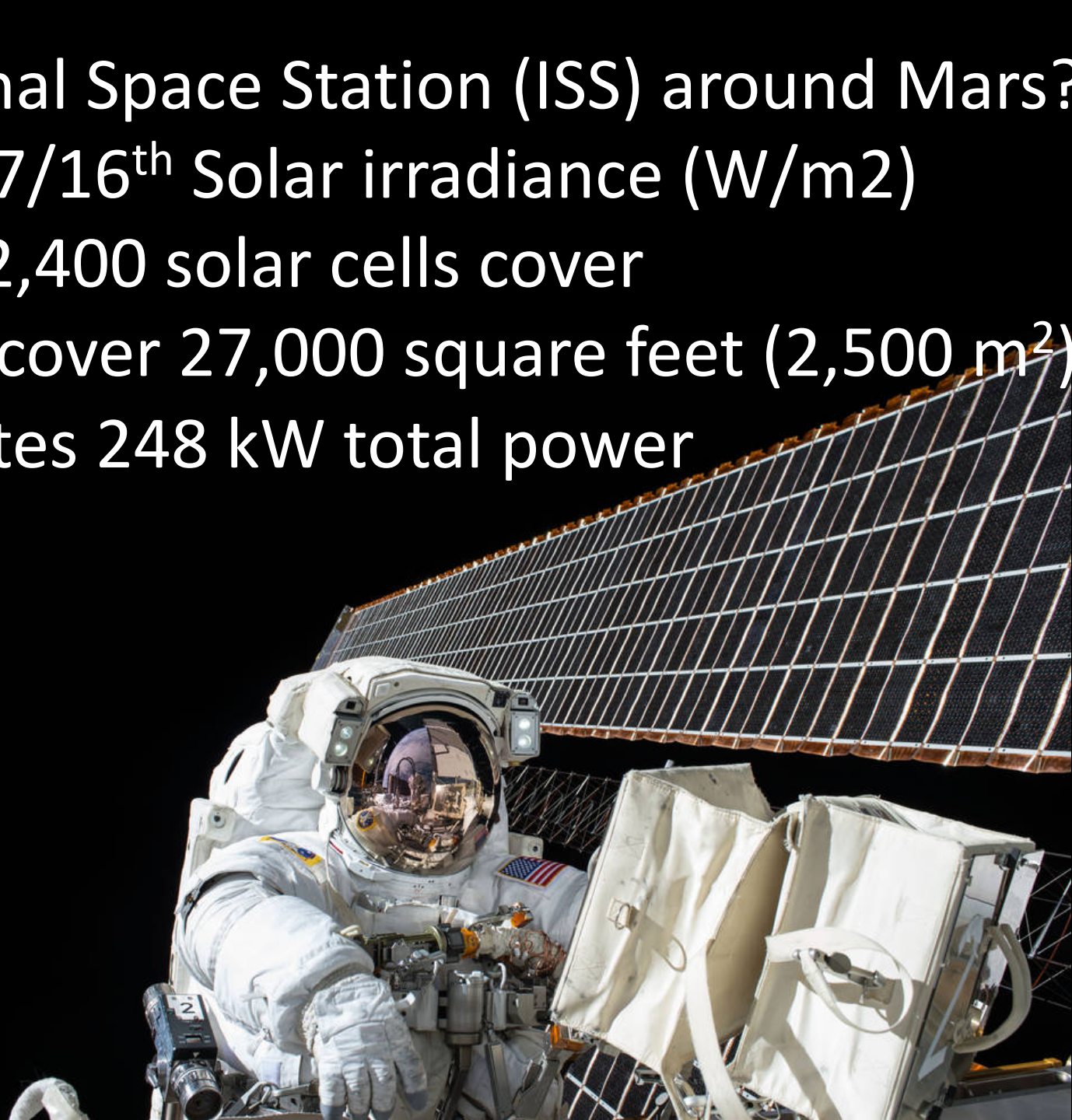


	<u>MERCURY</u>	<u>VENUS</u>	<u>EARTH</u>	<u>MARS</u>
Solar irradiance (W/m ²)	6 11/16	1 15/16	1	7/16
<u>Distance from Sun (AU)</u>	6/16	12/16	1	1 8/16

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- International Space Station (ISS) around Mars?
- Mars gets $7/16^{\text{th}}$ Solar irradiance (W/m^2)
- ISS has 262,400 solar cells cover
- Solar cells cover 27,000 square feet ($2,500 \text{ m}^2$)
- ISS generates 248 kW total power

Lets just move the
ISS 🛰️ to Mars!
Will that work?



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- Mars gets $7/16^{\text{th}}$ Solar irradiance (W/m^2)
- ISS generates 248 kW total power

Fraction upside down
 $7/16$ vs $16/7$



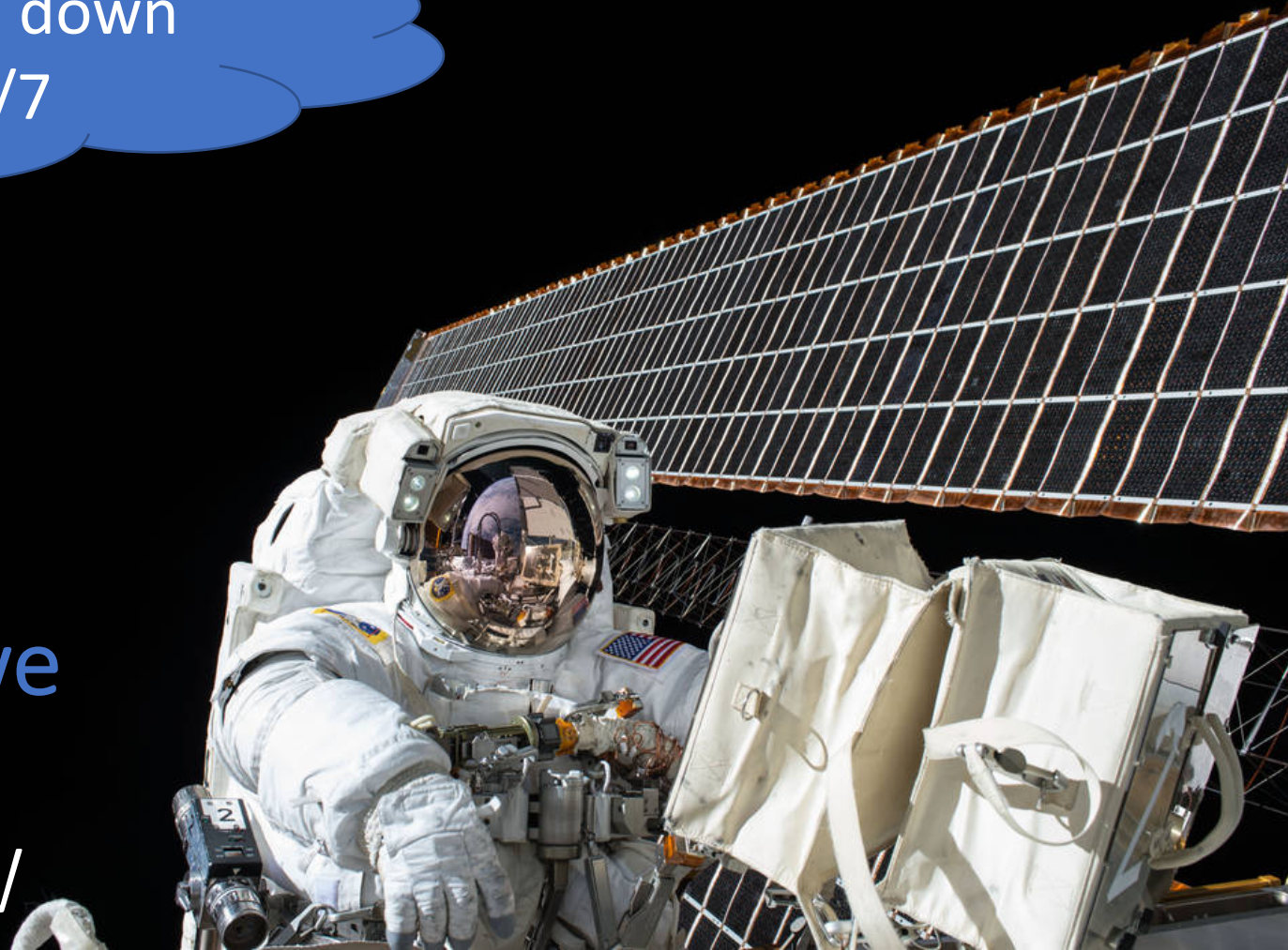
Answer:

$2,500 \text{ m}^2 = \text{Earth } 248 \text{ kW}$

$2,500 \text{ m}^2 = \text{Mars } 108 \text{ kW}$

(This is less than half so we need more 2X)

$2,500 \text{ m}^2 \times 16/7 = 248 \text{ kW}$

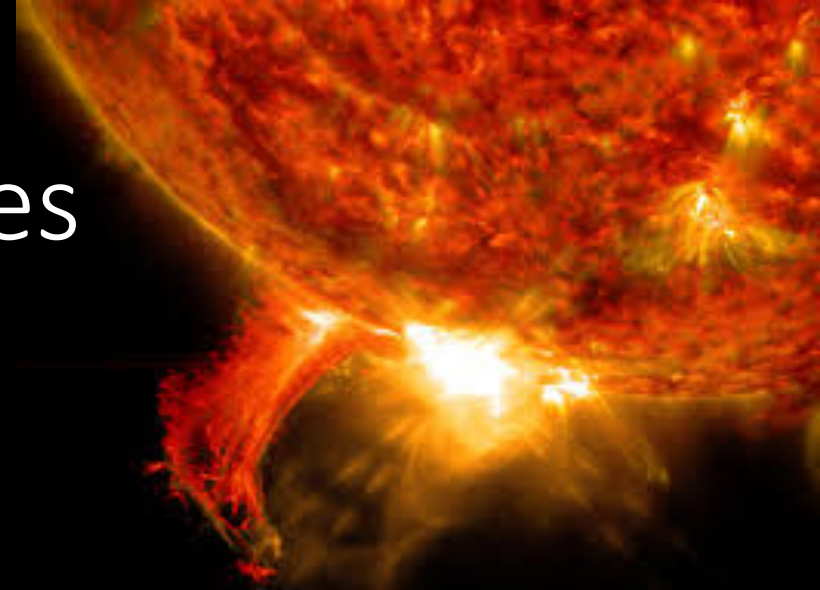


Fractions in Space...

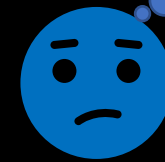
Sun Spots & Solar Flares

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- Sunspots are Big...
 - millionths of the solar hemisphere area
 - '1630' means 0.163% of the Sun's face.
 - Earth's area = 169 millionths by comparison!
 - $169/1,000,000$
- Flares are ranked by their brightness
 - 'C'
 - 'M' -- M-class flares being 10x more luminous than C-class flares
 - 'X' -- X-class flares being 10x brighter than M-class flares.



Note to self..
Add sunblock.



Fractions in Space...

Sun Spots

That's a lot of numbers...
what happened to
fractions?



- 75 day time period covered by this table
- (720-696=) 24 catalogued sunspots.
- The table shows only sunspots producing flares during this time.

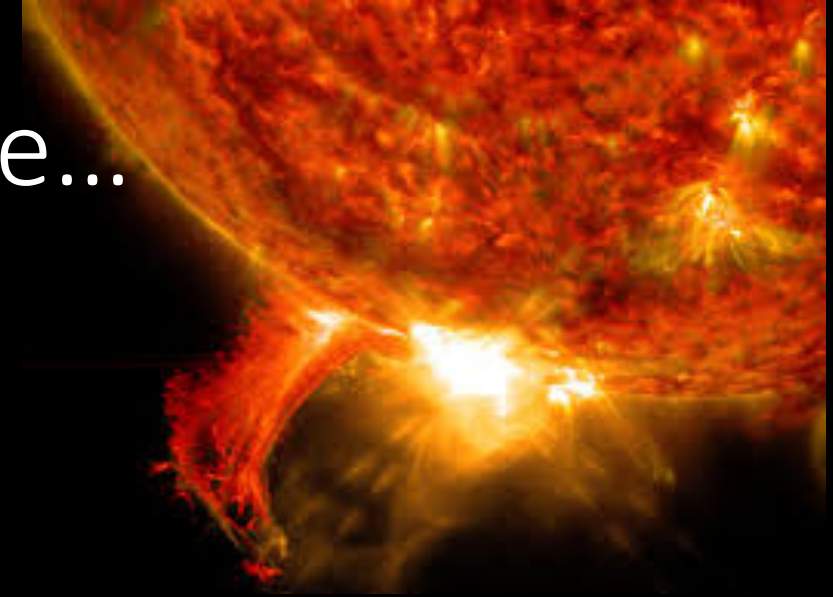
Date	Spot #	Area	Flare
6-Nov	#696	820	M
7-Nov	#696	910	M
8-Nov	#696	650	X
10-Nov	#696	730	M
11-Nov	#696	470	X
2-Dec	#708	130	M
3-Dec	#708	150	M
9-Dec	#709	20	C
29-Dec	#713	150	M
30-Dec	#715	260	M
31-Dec	#715	350	M
1-Jan	#715	220	M
2-Jan	#715	180	X
4-Jan	#715	130	C
10-Jan	#719	100	M
14-Jan	#718	160	C
15-Jan	#720	1540	M
16-Jan	#720	1620	X
17-Jan	#720	1630	M
18-Jan	#720	1460	X
19-Jan	#720	1400	M
Earth	N/A	169	N/A

Other Fractions in Space...

Sun Spots

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I had to ask...



Question 1: Construct a pie chart for the X, M and C-class flare data. During this 75-day period, what fraction of flares are X-class?

Question 2: What fraction of sunspots produce X-class flares?

Question 3: What fraction of sunspots did not produce any flares during this time?

Other Fractions in Space...

Sun Spots

Q 1: Construct a pie chart for the X, M and C-class flare data. During this 75-day period, what fraction of flares are X-class? $5/21$

Q 2: What fraction of sunspots produce X-class flares?
 $3/24$

There were 24 sunspots (698 -720) #696, #715, #720 were X class.

Q 3: What percentage of sunspots did not produce any flares during this time?

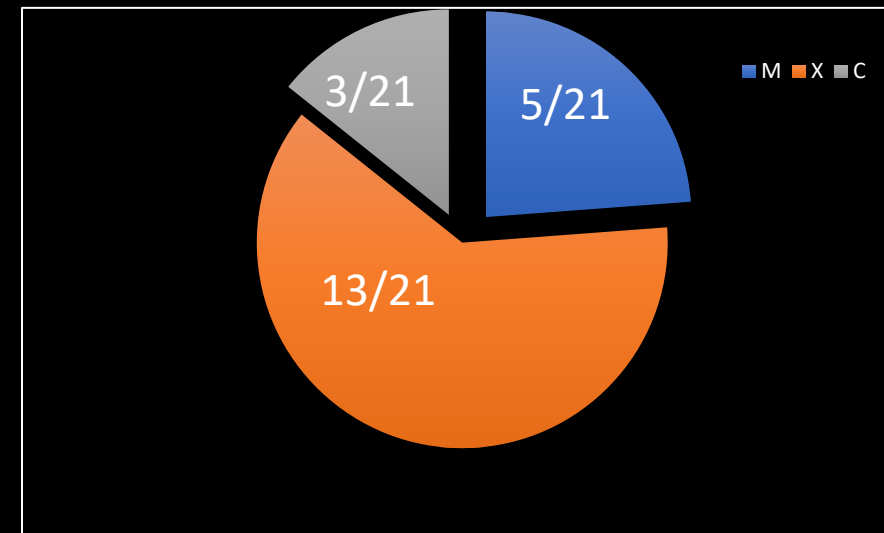
$8/24 \rightarrow .16/24$. did not...

Spot #696 #708 #709 #713 #715 #718 #719 #720

Not so bad...
Still need
sunblock..



Flare Type	Qty
X	5
M	13
C	3



Other Fractions in Space...

Sun Spots – try these on your own



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Wait... More?

I have Fortnite homework
to do



Question 4: What seems to be the minimum size for a sunspot that produces an X-class flare? An M-class flare? A C-class flare?

Question 5: If the area of Earth is '169' in the sunspot units used in the above tables, what are the maximum and minimum size of the sunspots compared to the area of Earth?

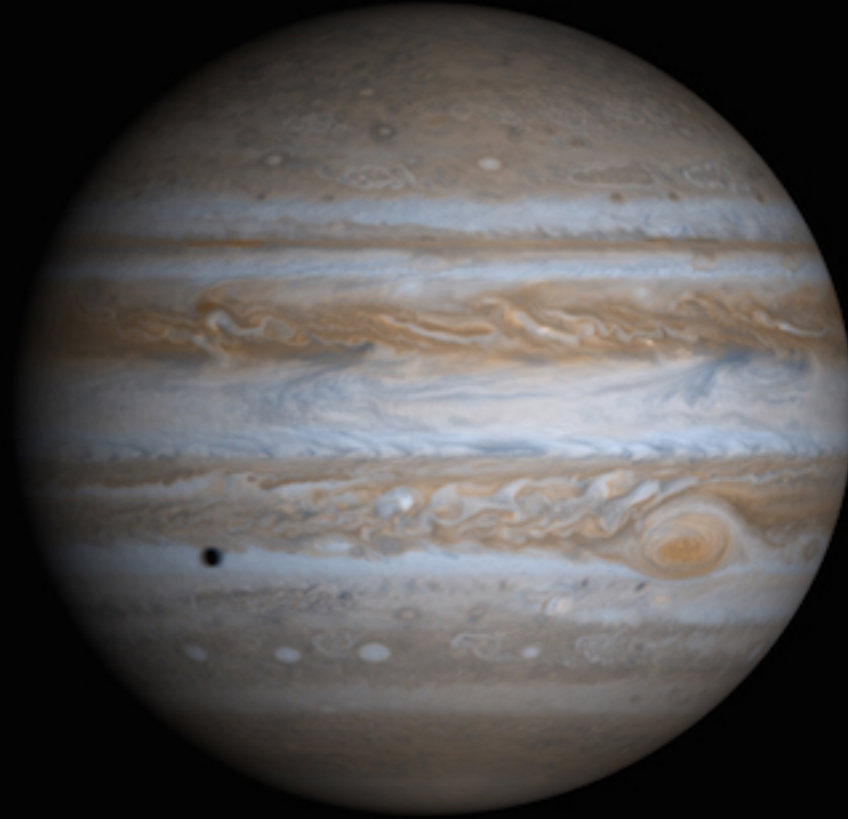
Other Fractions in Space...

Jupiter

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Now we are
talking!

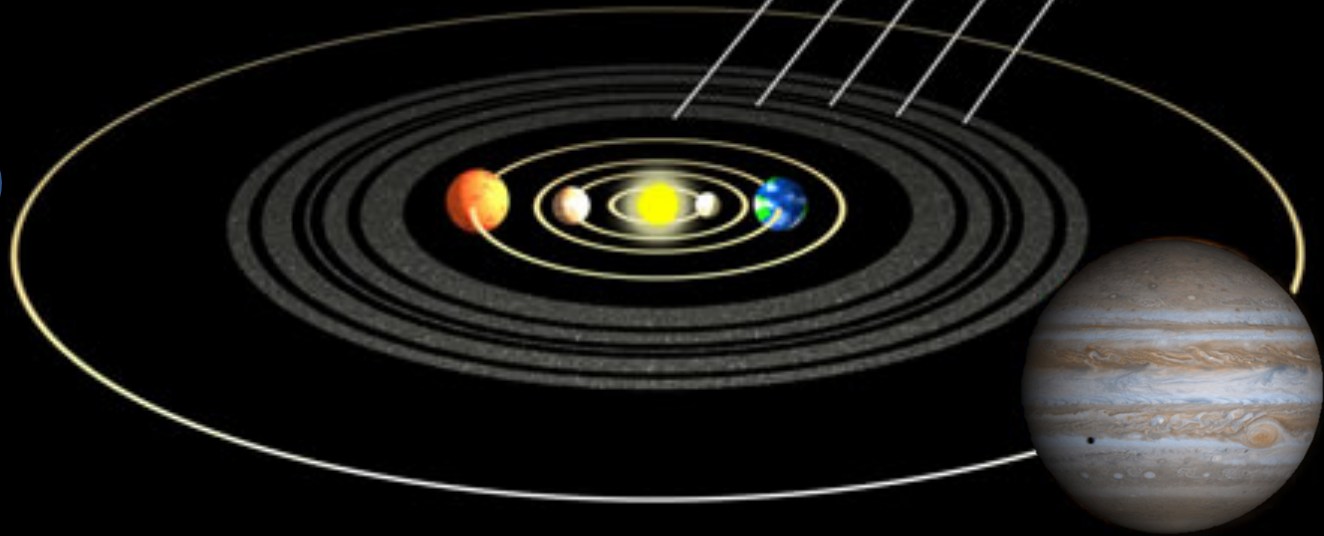


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Other Fractions in Space... Jupiter

Kirkwood Gaps in the Asteroid Belt

- ν_6 resonance
- 3:1 resonance
- 5:2 resonance
- 7:3 resonance
- 2:1 resonance

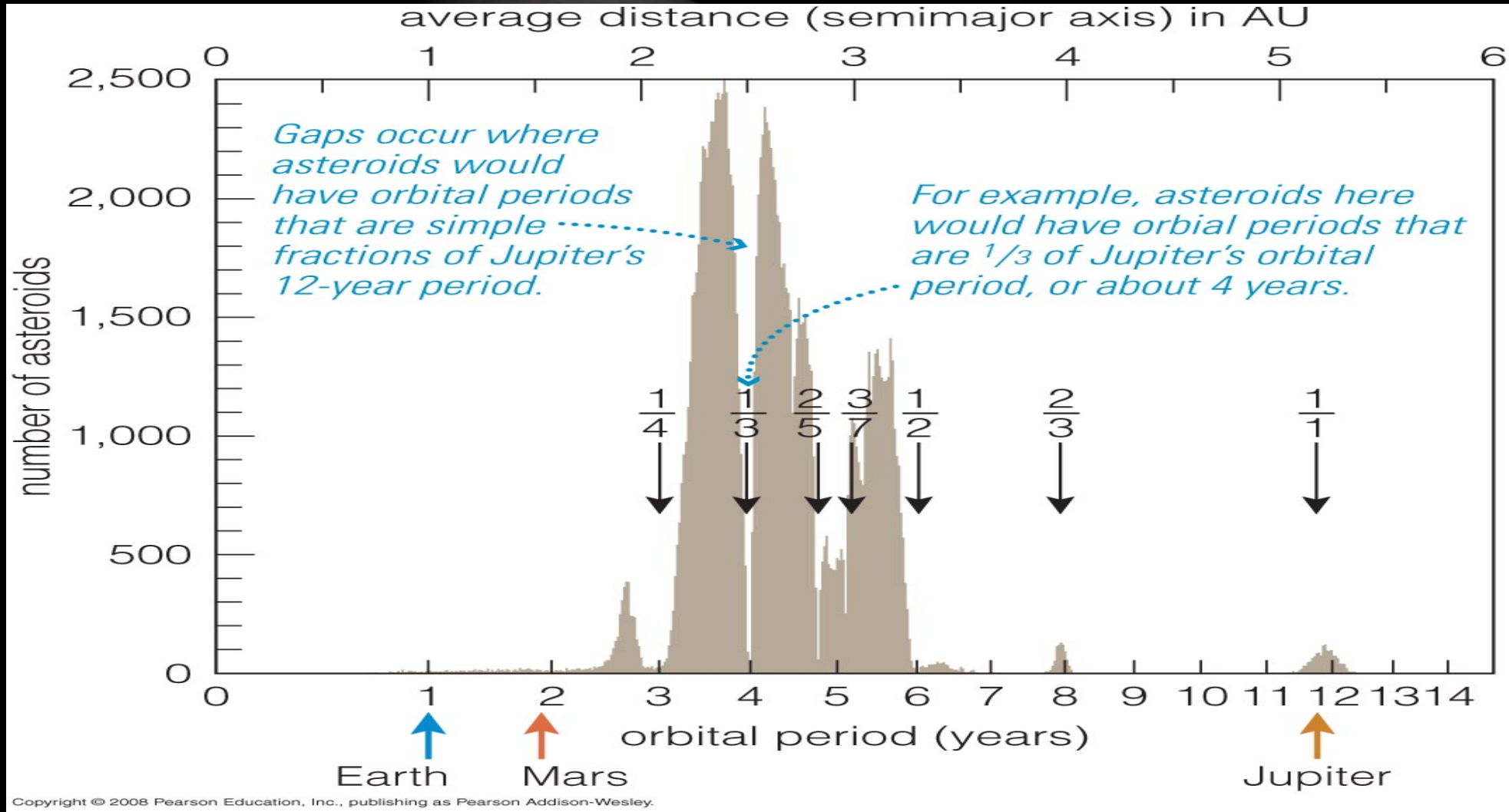


What does
Jupiter have to
do with ripples?



Other Fractions in Space... Jupiter

I had to ask.

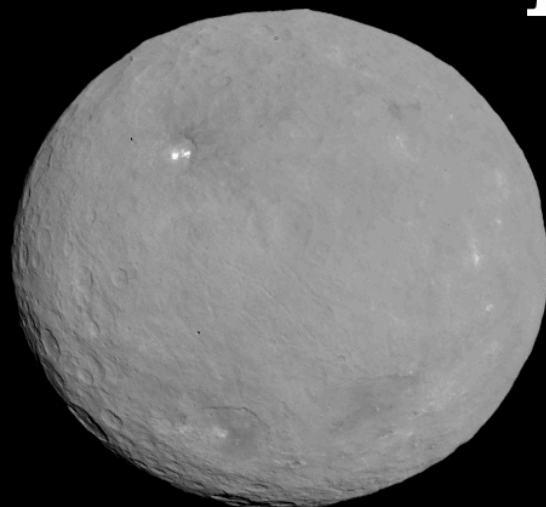


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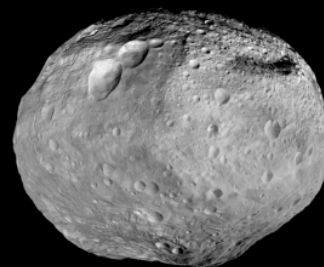
Wait... can we add all of the asteroids to make a new planet?

Get the
glue
ready!

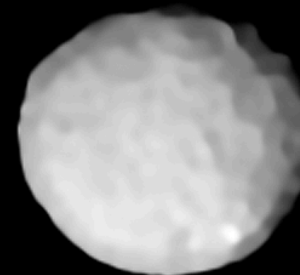
The four largest asteroids



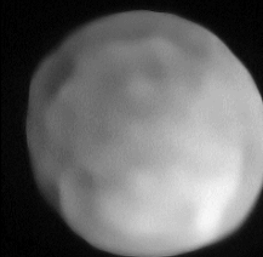
Ceres
939 km



Vesta
525 km



Pallas
512 km



Hygiea
434 km

Wait... can we add all of the asteroids to make a new planet?

About half the mass of the belt is contained in the four largest asteroids.

I had to ask.

	Kg	Ratio to Mars
Mars	6.42E+23	1
Ceres	9.3835E+20	15/10000
Vesta	2.59076E+20	4/10000
Pallas	2.01E+20	3/10000
Hygiea	8.32E+19	1/10000

The logo for WEST EAST SPACE is located in the top left corner. It consists of the text "WEST EAST SPACE" in a white, sans-serif font, positioned above a stylized graphic. The graphic features a bright, glowing blue arc that curves upwards from left to right, with a small, bright white starburst or light source at its left end.

WEST EAST SPACE

Thank you to NASA for making so much great material available so that this presentation was possible.

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"I could have gone on flying through space forever."

Yuri Gagarin

Sign me up
westeastspace.com



Visit us at www.westeastspace.com for more space.

Credit: "Dawn of the Space Age". Book by Robin Kerrod, 2004.

Credit: https://www.azquotes.com/author/5270-Yuri_Gagarin