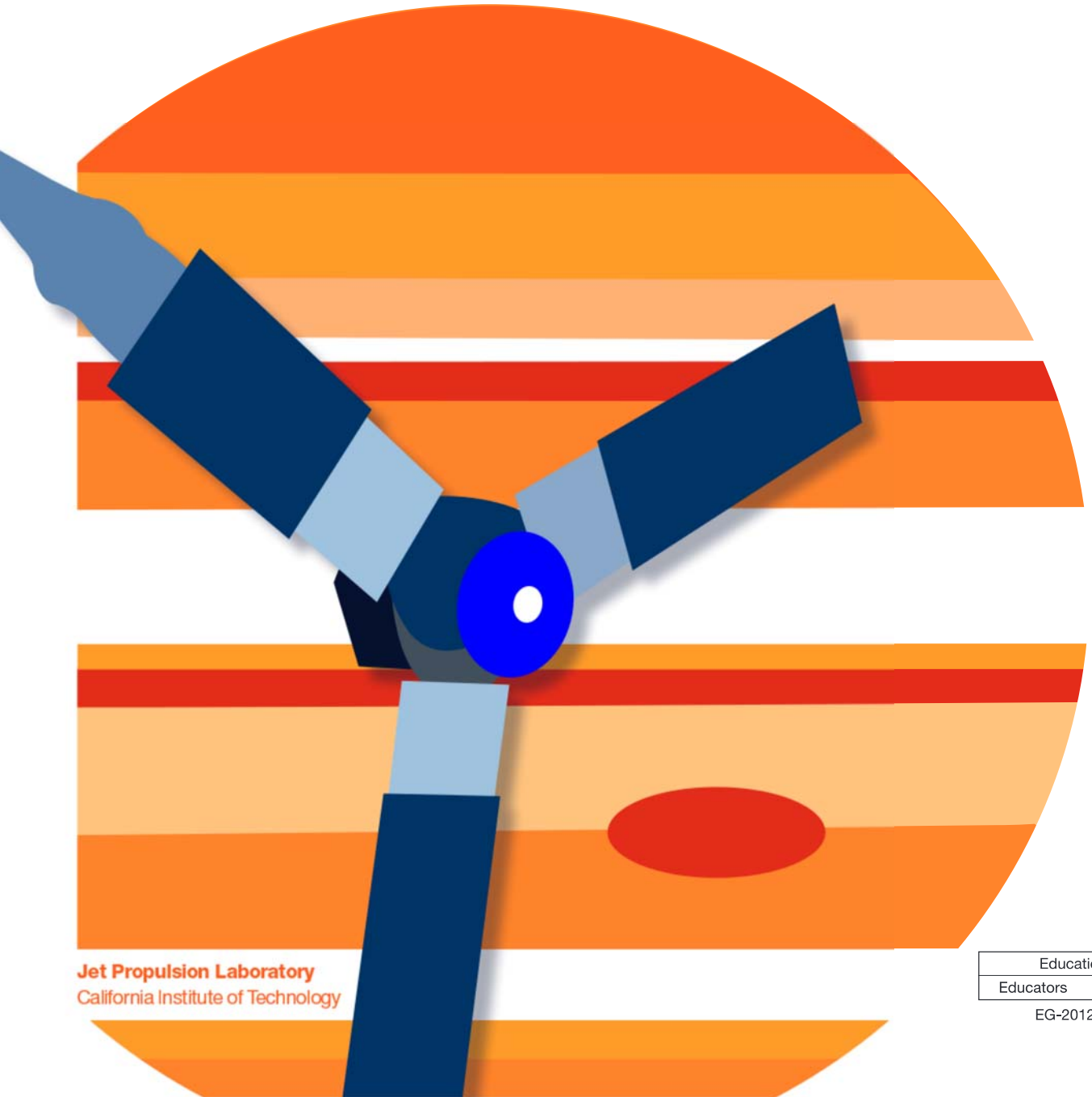
National Aeronautics and Space Administration

Explore! Jupiter's Family Secrets

Children Ages 8–13

Juno Informal Education Activity Guide



Jet Propulsion Laboratory
California Institute of Technology

Educational Product	
Educators	Children Ages 8–13

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Big Kid on the Block: Heavyweight Champion – Jupiter!

Adapted from Activities 1, 2, 3, and 4, How Much Would You Weigh on Distant Planets? NASA/MSU–Bozeman CERES Project.

Overview

This is a 30-minute activity in which children confront their perceptions of gravity in the solar system. The children weigh themselves on scales modified to represent their weights on other worlds to explore the concept of gravity and its relationship to weight. They consider how their weights would be the highest of all the planets while standing on Jupiter, but their mass remains the same no matter where in the solar system they are! They compare the features of different planets to determine which characteristics cause a planet to have more or less gravity.

This activity should be conducted before *The Pull of the Planets* in order for the children to better understand gravity before they model it. These concepts involve more advanced science than previous activities in *Jupiter's Family Secrets*, and they explore more deeply the science of the Juno mission and the rich information it will return to us. Facilitators who choose to undertake this activity should have a firm grasp of the scientific basis so that misconceptions are not introduced to the children.

This series is appropriate for children ages 10 to 13.

What's the Point?

- Planets have measurable properties, such as size, mass, density, and composition. A planet's size and mass determines its gravitational pull.
- Gravity alone holds us to Earth's surface.
- A child's weight is determined by his or her mass and the gravitational pull of the planet.
- Jupiter is not only the largest planet in our solar system, it is the most massive. A child standing on Jupiter would weigh more than on any other planet.

Materials

For each group of 10 to 20 children:

- Computer and projector to show a brief movie of an astronaut walking on the Moon, such as Moon Walk — Apollo 11 HD Videos (requires high-speed Internet connection)
- 3–9 "solar system scales," prepared as described under "Preparation" using:
  —3–9 bathroom scales with dials (not digital)
  —Wite–Out®
  —Thin black marker
- *Solar System Scales Guide*
- 3–9 posters (one for each "solar system scale"), prepared as described under "Preparation" using:
  —Brightly colored poster board
  —Thick marker
- *Family Portrait...in Numbers*
- Optional: 1 set of Our Solar System lithographs (NASA educational product number LS-2001-08-002-HQ), preferably double-sided and in color
- Optional: books about each of the featured planets (see the Resources section for some suggestions)

For each child:

- His/her My Trip to Jupiter Journal or just the relevant "Heavyweight Champion: Jupiter!" pages
- 1 pencil or pen

For the facilitator:

- **Background information:**
  Secrets of the Solar System Family
  The Other Distant Giants Are Kindred Planets with Individual Quirks
  Inner, Rocky Neighbors Are Siblings to Earth
  Countless Small Objects Are Part of Our Solar System's Extended Family
- *Facilitator's Guide to Gravity*
- Shopping list

Preparation

- Review the complete background information and the *Facilitator's Guide to Gravity*.
- Select the number of scales to offer and which planets you'd like to feature. It is not necessary to provide a scale for every planet, but we recommend offering at least three, including Earth and Jupiter.

Caution: Offer a Saturn scale ONLY to advanced audiences who are prepared to tackle the high-level concepts broached by this "trick" planet.

- Prepare the scales: You will be altering each scale to represent the gravity of a different planet. First, remove the clear plastic covering to reach the dial with the numbers on it. Then cover each number with Wite–Out and replace it with the appropriate number for that planet using the *Solar System Scales Guide*. Leave one scale unaltered to provide the children's weight on Earth. Label each scale with the appropriate planet's name.
- Prepare posters about each planet for which you have a scale. If desired, decorate them with the appropriate Our Solar System lithograph. Use *Family Portrait...in Numbers* to include all of the following details:
  —Type of atmosphere
  —Planet temperature
  —Distance from the Sun
  —Planet diameter
  —Planet mass
- Post each planet's poster (perhaps in addition to the children's posters from *Jump Start: Jupiter!*) near the corresponding scale. If you are providing books about each planet, display them near the scale for the children to look through for more information.
- Set up the computer and projector.

Activity

1. Ask the children to consider what it would be like to explore other worlds in our solar system.

- Would they experience gravity on other planets and our Moon? How could we find out? *Accept all answers.*
- Do we experience gravity on Earth? How? *It holds us to Earth's surface.*

Optional: Invite the children to jump and test this principle for themselves.

- Astronauts have visited the Moon; did they experience gravity there? *Accept all answers.*

2. Play one or more movies of an astronaut walking on the Moon and assess the children's opinions.

- Now what do they think: Does the Moon have gravity? *Yes.*
- Does it have the same amount of gravity as Earth? *Less.*

- Which planet characteristics cause a planet to have more or less gravity? Consider the following variables: presence of an atmosphere, planet diameter, planet mass, planet temperature, and/or distance from the Sun. Which do they think is most important in determining a planet's gravitational strength? *Accept all answers.*

Invite the children to write their hypotheses in their journals.

Facilitator's Note
There are many different misconceptions about gravity; children may think that it is related to an object's motion, proximity to Earth or the Sun, temperature, magnetic field, atmosphere, or other unrelated concepts. Guide conversations cautiously and listen carefully to what the children say to avoid supporting their misconceptions.

3. Discuss the concepts of weight and gravity.

- We can test for ourselves that gravity holds us to Earth's surface by jumping up and seeing that we came back to the ground. Would it be more or less difficult for say, a rhinoceros to jump as high as we did? Why? *It would be harder because they weigh more.*
- Would the same rhinoceros be able to jump higher or lower on the Moon? Higher. Why? *There is less gravity on the Moon so the rhinoceros would weigh less.*
- How about on Jupiter? *Accept all answers.*

4. Invite the children to test how much they would weigh on other planets. Ask them to weigh themselves on the scales you modified to see what effect each planet's gravity would have on their weights. In their journals, invite them to record their measurements for each scale. In addition, ask them to note the characteristics for each of those planets.

- On which planet did they weigh the most? *Jupiter.*
- What do the children think it would feel like to weigh that much? Have they ever carried a 100-lb. backpack? What would it be like to feel that kind of weight not only on your back, but your hands, legs, feet, and head?
- On which planet did they weigh the least?
- How high do they think they could jump on that planet?
- On which planet did the children have the most mass? The least? Trick question! Remind the children of their discussions during *Dunking the Planets*. While their weights varied, the children had the same mass on every planet.

Facilitator's Note
If you have a Saturn scale, children might notice that they weigh about the same on Saturn and Earth, because Saturn's gravitational pull is about the same as Earth's at its cloudtops (which are far above the planet's bulky — and gravitationally strong — center). Because the force of gravity depends on both mass and distance, planets that are less dense have less gravity at their cloudtops or surfaces, which are far above the bulk of the mass in their interiors. This is why planets like Saturn appear to have less gravity than Neptune, despite Saturn's greater mass. You may need to remind the children of what they learned in *Dunking the Planets* in order for them to understand these difficult concepts.

You may also find that different sources report a range of weights/gravity for both Jupiter and Saturn. The point of this activity is simply to gather the sense that the children would weigh different amounts on the different planets, which can be seen regardless of which source is used to define the weight on the planets.

5. Invite the children to consider the planet properties they discovered in *Jump Start: Jupiter* and recorded in their journals. Alternatively, ask them to research planet properties in books or consider a copy of *Family Portrait... in Numbers*. Allow them time to consider the hypotheses presented in their journals and form their own conclusions.

- Which properties cause a planet to have more or less gravity? Planets that are massive for their size have the most gravity. Which properties do not influence gravity? The presence of an atmosphere, temperature, and distance from the Sun do not affect a planet's gravity.

Conclusion

less gravity?

most gravity?

Invite the children to share their conclusions about the gravity in the solar system.

- Everyone weighed the most on Jupiter; in other words, Jupiter had the strongest gravitational pull of all the planets. What properties make Jupiter the heavyweight champion? *Jupiter has the greatest mass and size of all the planets.*
- What allowed Jupiter to beat out Saturn, a close contender in size? *Jupiter is more dense than Saturn; it has more mass for its size.*
- What planets are not even contenders? Why? *The inner planets are all much smaller and have much less mass than the giant planets.*
- Which planet would the children like to visit someday? Would they be able to jump higher or lower there?
- Would they want to visit Jupiter? What kind of gravity will the Juno spacecraft experience as it approaches and orbits Jupiter? *Juno will experience a strong gravitational pull.*

If possible, build on the children's knowledge by offering them a future Jupiter's Family Secrets activity. Invite the children to return for the next activity, *The Pull of the Planets*, where they will discover how gravity governs the motions of the solar system!

Grades 5–8

Science as Inquiry — Content Standard A

Abilities Necessary to Do Scientific Inquiry

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones. When such displacement occurs, science advances.

Earth and Space Science — Content Standard D

Earth in the Solar System

- Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the Moon, and eclipses.
- Gravity is the force that keeps planets in orbit around the Sun and governs the rest of the motion in the solar system. Gravity alone holds us to Earth's surface and explains the phenomena of the tides.

Solar System Scales Guide

The following 2-page chart lists the weights a child would experience on other planets (and Earth's Moon). Alter bathroom scales (with dials) from the numbers shown in the far-left column, under "Earth," to the corresponding numbers in other columns. First, remove the clear plastic covering to reach the dial with the numbers on it. Then cover each number with Wite-Out and replace it with the appropriate number for that planet. Label each scale with the appropriate planet's name. It is not necessary to provide a scale for every planet, but we recommend offering at least three, including Earth (using an unaltered scale) and Jupiter.

Earth	Moon	Mercury	Venus	Mars	Jupiter	Saturn	Uranus	Neptune
5	1	2	5	2	12	5	4	6
10	2	4	9	4	24	11	9	11
15	3	6	14	6	35	16	13	17
20	3	8	18	8	47	21	18	22
25	4	10	23	10	59	27	22	28
30	5	11	27	11	71	32	27	34
35	6	13	32	13	83	37	31	39
40	7	15	36	15	94	42	36	45
45	8	17	41	17	106	48	40	50
50	9	19	46	19	118	53	45	56
55	9	21	50	21	130	58	49	62
60	10	23	55	23	142	64	53	67
65	11	25	59	25	153	69	58	73
70	12	27	64	27	165	74	62	78
75	13	29	68	29	177	80	67	84
80	14	30	73	30	189	85	71	90
85	14	32	77	32	201	90	76	95
90	15	34	82	34	212	95	80	101
95	16	36	86	36	224	101	85	106
100	17	38	91	38	236	106	89	112
105	18	40	96	40	248	111	93	118
110	19	42	100	42	260	117	98	123
115	20	44	105	44	271	122	102	129
120	20	46	109	46	283	127	107	134
125	21	48	114	48	295	133	111	140
130	22	49	118	49	307	138	116	146
135	23	51	123	51	319	143	120	151
140	24	53	127	53	330	148	125	157
145	25	55	132	55	342	154	129	162

Solar System Scales Guide

Earth	Moon	Mercury	Venus	Mars	Jupiter	Saturn	Uranus	Neptune
150	26	57	137	57	354	159	134	168
155	26	59	141	59	366	164	138	174
160	27	61	146	61	378	170	142	179
165	28	63	150	63	389	175	147	185
170	29	65	155	65	401	180	151	190
175	30	67	159	67	413	186	156	196
180	31	68	164	68	425	191	160	202
185	31	70	168	70	437	196	165	207
190	32	72	173	72	448	201	169	213
195	33	74	177	74	460	207	174	218
200	34	76	182	76	472	212	178	224
205	35	78	187	78	484	217	182	230
210	36	80	191	80	496	223	187	235
215	37	82	196	82	507	228	191	241
220	37	84	200	84	519	233	196	246
225	38	86	205	86	531	239	200	252
230	39	87	209	87	543	244	205	258
235	40	89	214	89	555	249	209	263
240	41	91	218	91	566	254	214	269
245	42	93	223	93	578	260	218	274
250	43	95	228	95	590	265	223	280
255	43	97	232	97	602	270	227	286
260	44	99	237	99	614	276	231	291
265	45	101	241	101	625	281	236	297
270	46	103	246	103	637	286	240	302
275	47	105	250	105	649	292	245	308
280	48	106	255	106	661	297	249	314
285	48	108	259	108	673	302	254	319
290	49	110	264	110	684	307	258	325
295	50	112	268	112	696	313	263	330
300	51	114	273	114	708	318	267	336

Family Portrait . . . in Numbers

Object	Atmosphere	Distance from Sun (miles)	Mass	Diameter	Mean Surface Temperature (degrees Fahrenheit)	Magnetic Field Present?
Sun	Thin	—	330,000 × Earth's	109 × Earth's	10,000 (27 million at the center)	Yes
Mercury	None	36 million	0.06 × Earth's	0.38 × Earth's	–300 to +800	Yes
Venus	Thick	67 million	0.82 × Earth's	0.95 × Earth's	850	No
Earth	Medium Thin	93 million	1.0 × Earth's	1.0 × Earth's (12,756 km)	–125 to +130	Yes
Mars	Thin	142 million	0.11 × Earth's	0.53 × Earth's	–116 to 32	No
Ceres*	None	257 million	0.0002 × Earth's	0.076 × Earth's	–160	No
Jupiter	Thick	484 million	318 × Earth's	11 × Earth's	–238	Yes
Saturn	Thick	886 million	95 × Earth's	9.4 × Earth's	–274	Yes
Uranus	Thick	1.8 billion	15 × Earth's	4.0 × Earth's	–328	Yes
Neptune	Thick	2.8 billion	17 × Earth's	3.9 × Earth's	–346	Yes
Pluto**	Thin	3.7 billion	0.002 × Earth's	0.18 × Earth's	–364	No

*Asteroid belt object/dwarf planet
**Dwarf planet

Heavyweight Champion: Jupiter

What makes a champion? **Put a check mark** next to the planet characteristics you think cause a planet to have more or less gravity. Put a star next to those that are most important in determining a planet's gravitational strength.

_____ presence of an atmosphere
_____ distance from the Sun
_____ planet mass
_____ planet diameter
_____ planet temperature

Weigh yourself on different planet scales. Note your weight and the characteristics of each planet.

Planet	My Weight There	Atmosphere (Thick or Thin)	Distance from Sun	Mass	Diameter	Temperature (Hot, Warm, or Cold)

I weighed the most on these planets:

They have a lot / not much gravity.

I weighed the least on these planets:

They have a lot / not much gravity.

Which properties **do not** influence a planet's gravity?

_____ presence of an atmosphere
_____ planet diameter
_____ planet mass
_____ planet temperature
_____ distance from the Sun

Which properties **do** cause a planet to have more or less gravity?

_____ presence of an atmosphere
_____ planet diameter
_____ planet mass
_____ planet temperature
_____ distance from the Sun