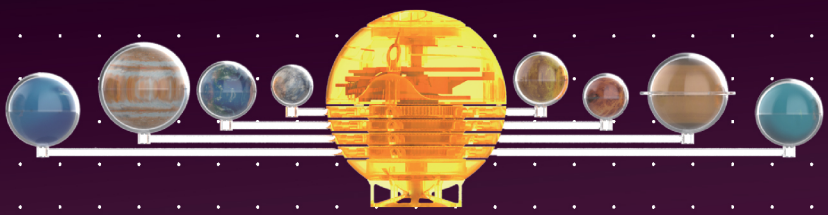
CREATIVE GIFT | # 7069R

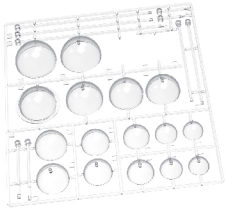
Experiment Manual

Orbiting Solar System

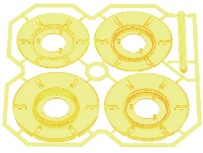


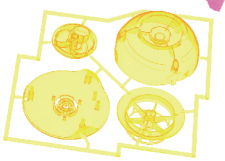
STEAM | 6+ AGES | 58 PIECES | 1 EXPERIMENT

Kit Contents



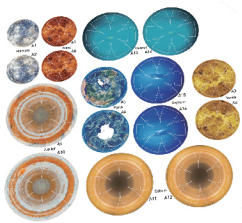
B21–B24, B29





C25–C28

A1–A24



P-PLANET GRAPHICS

7069-W85-A
H-WINDUP MOTOR BOX

D, F, and P Parts

3x **D1** H-SUN GEAR

12x **D2** H-SATELLITE GEAR

2x **F1** H-REDUCTION GEAR

1x **F2** H-RATCHET DRIVEN GEAR

1x **F4** H-ESCAPE WHEEL

1x **F5** H-ESCAPEMENT

1x **F6** H-SUN AXIS

1x **F7** H-RATCHET

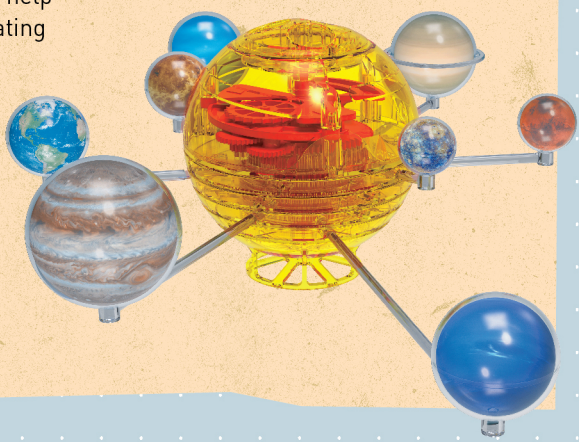
Important!
Do not remove the parts from the frames until they are needed so that you can locate the numbered parts during assembly.

YOU WILL ALSO NEED:
Scissors or diagonal cutters

R21#7069R

A WORD TO PARENTS AND ADULTS

With this science kit, your child can build a model of the solar system with a H-WINDUP MOTOR BOX inside.Please read the instructions and safety information with your child before starting. Stand by to assist your child should they need any help with assembling and operating the solar system model. Some of the assembly steps are challenging, so pay close attention to the instructions and illustrations. We hope you and your child have a lot of fun experimenting with the Orbiting Solar System!



SAFETY INFORMATION

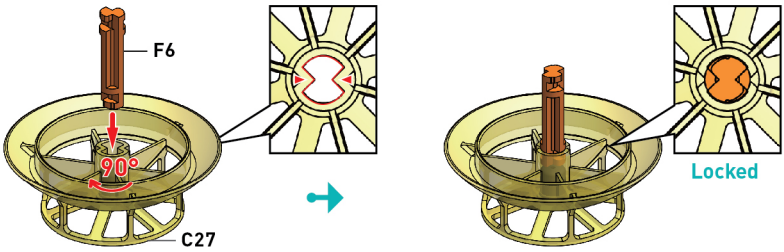
WARNING! Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled. Keep packaging and instructions as they contain important information.

IMPORTANT TIPS

- **You must carefully cut the plastic parts out of their frames with diagonal cutting pliers (diagonal cutters) or scissors.**
- Remove the parts from the frames only when they are needed.
- Remove excess material (burrs) from the parts before assembling them. Normal scissors do not cut as precisely as diagonal cutters, so you may have to file some of the rough edges down with a nail file or sandpaper.
- Everything must be assembled in order!
- During each assembly step involving gears, make sure the newly added gears are meshing with the gears already in place.

ASSEMBLY VIDEO!
Scan this QR code to view a step-by-step assembly video and tips on how to use the Orbiting Solar System.

1 Push the H-SUN AXIS (F6) in as far as it will go. Turn it clockwise 90 degrees.



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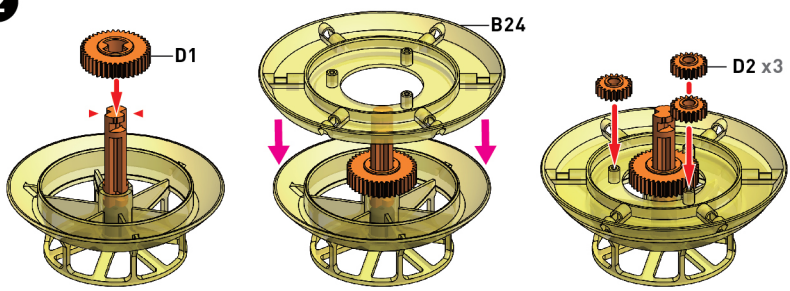

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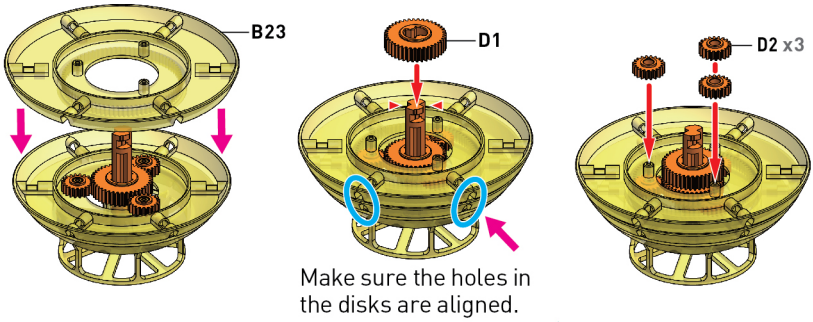

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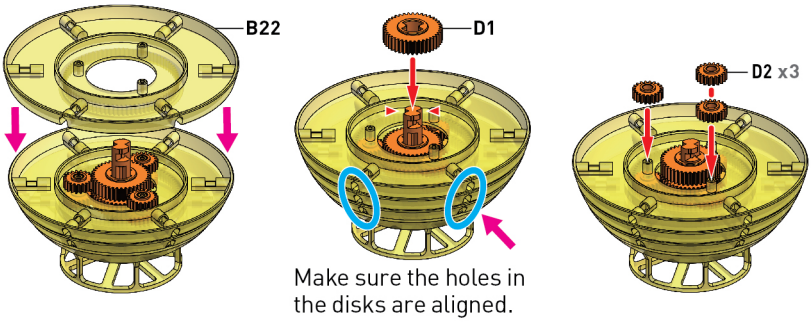
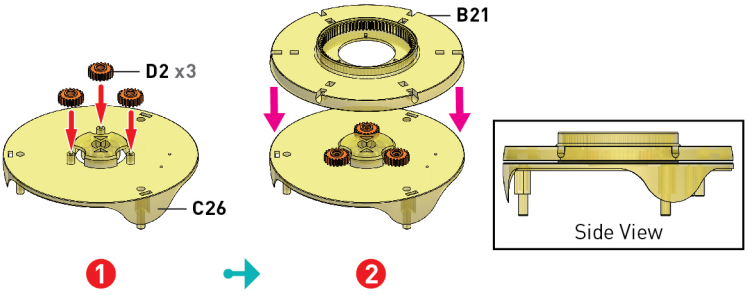
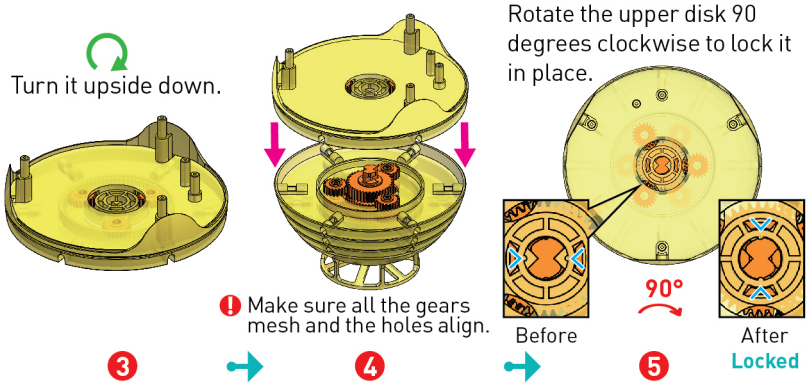


5

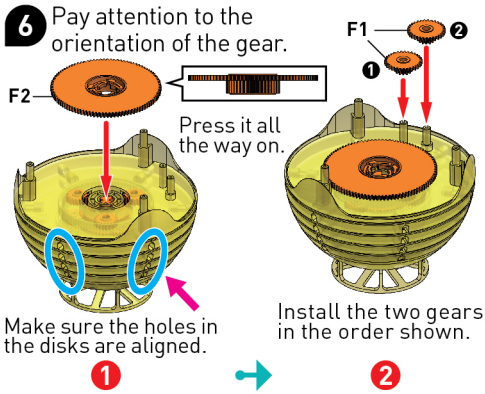
Pay attention to the orientation of the disk.





6

Pay attention to the orientation of the gear.



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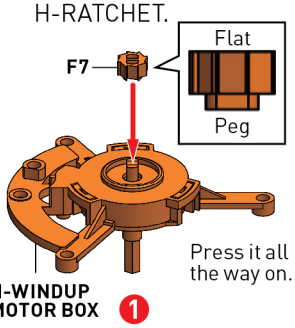
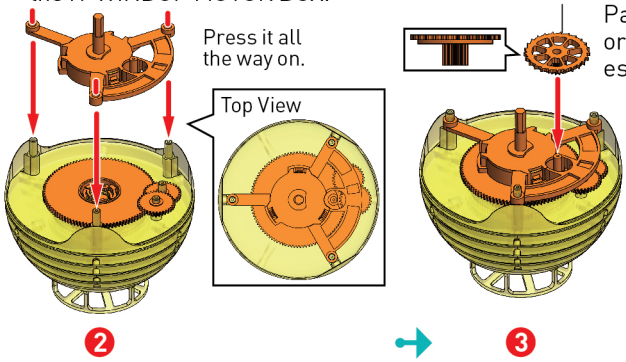
Pay attention to the orientation of the H-RATCHET.

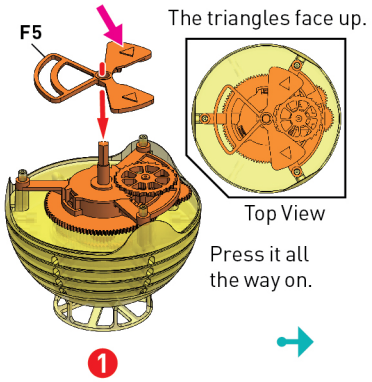


Pay attention to the orientation of the H-WINDUP MOTOR BOX.

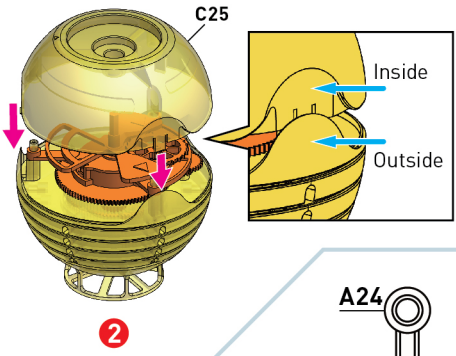


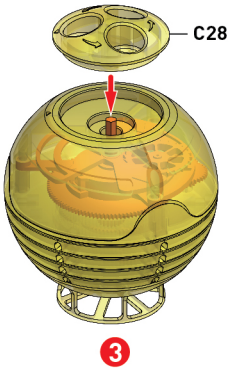
CONTINUED ON BACK

8 Pay attention to the orientation of the H-ESCAPEMENT.



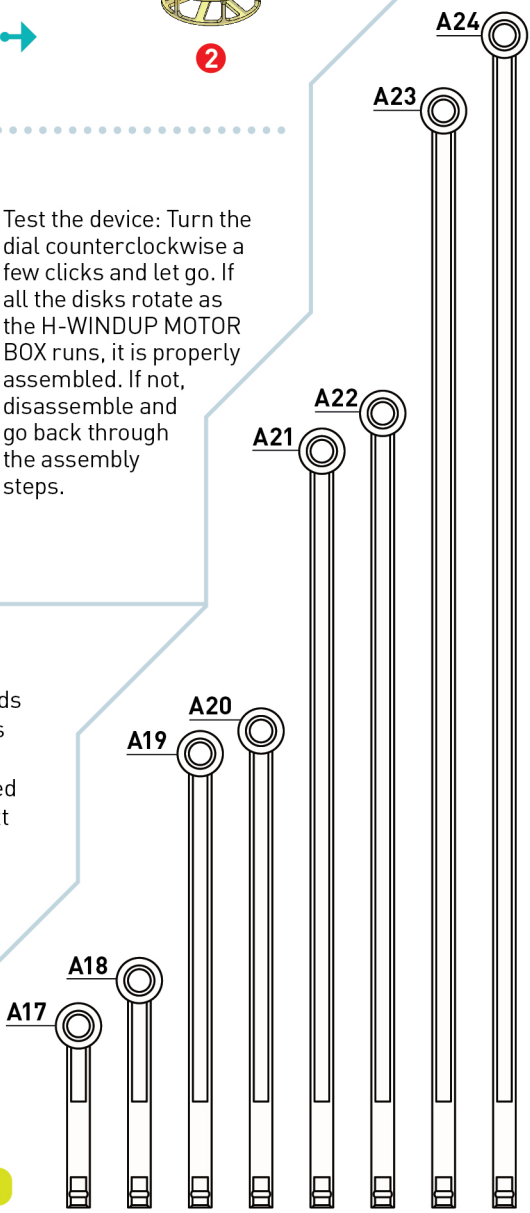
❗ Press the upper hemisphere down until all three tabs click into place.





❗ Test the device: Turn the dial counterclockwise a few clicks and let go. If all the disks rotate as the H-WINDUP MOTOR BOX runs, it is properly assembled. If not, disassemble and go back through the assembly steps.

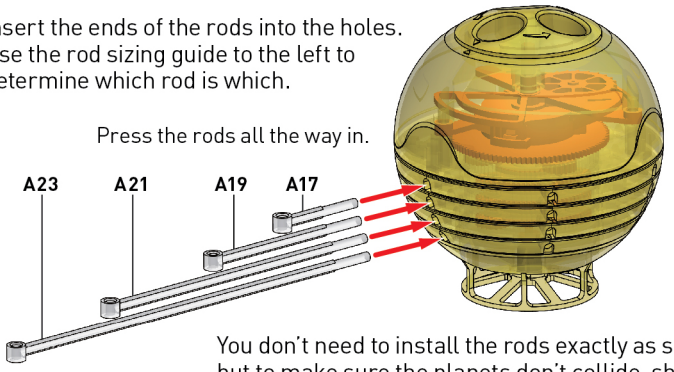
9 Carefully remove the rods from the frame. Use this template to determine which rod is which, based on its length, for the next two steps.



Rod Sizes **1:1**

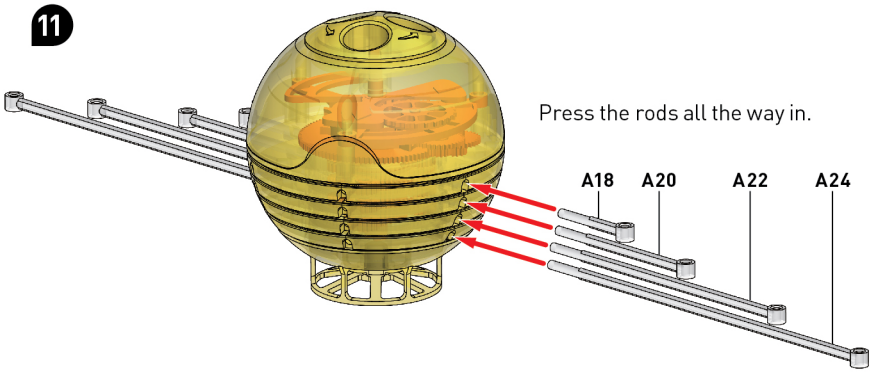
10 Insert the ends of the rods into the holes. Use the rod sizing guide to the left to determine which rod is which.

Press the rods all the way in.

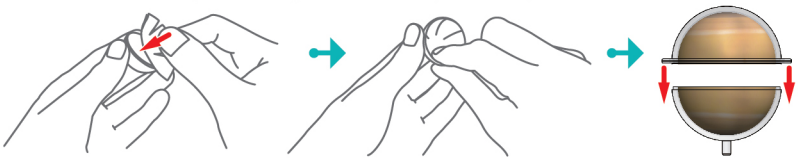


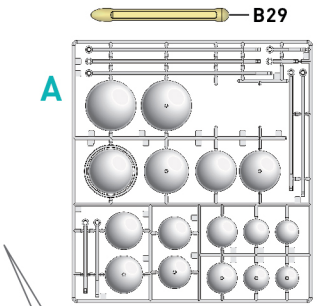
You don't need to install the rods exactly as shown, but to make sure the planets don't collide, shorter rods must always be installed above longer rods.

11



12 Assemble the eight planets. For each planet, match the clear planet hemispheres with the graphics for that planet. Carefully peel one graphic off of the sheet. Press it into one hemisphere with the printed side facing out. Use your fingers or the tool (B29) to press the graphic to the inside of the hemisphere and smooth out any bubbles. Reposition if necessary. It's okay if it's not perfectly adhered — it will still look good inside the clear planet sphere. Repeat for each hemisphere. Then press the two hemispheres together to complete the planet.



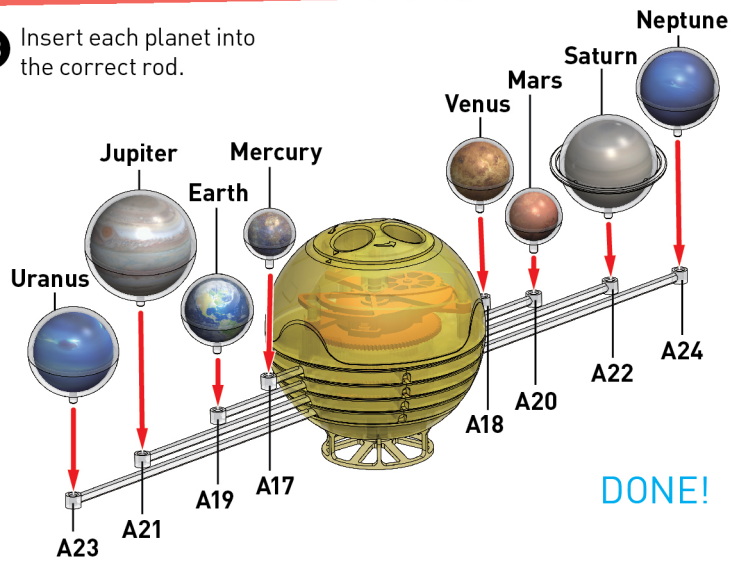


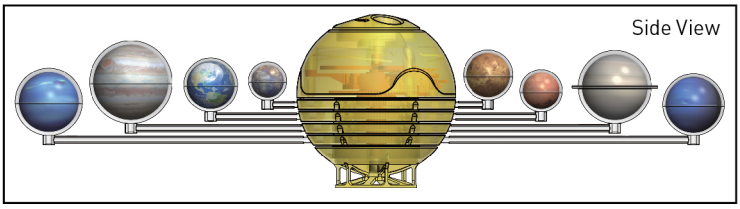
A1 + A2	Mercury	Rod A17
A3 + A4	Venus	Rod A18
A5 + A6	Earth	Rod A19
A7 + A8	Mars	Rod A20
A9 + A10	Jupiter	Rod A21
A11 + A12	Saturn	Rod A22
A13 + A14	Uranus	Rod A23
A15 + A16	Neptune	Rod A24

Tip! If you want to customize your planets, you can paint the insides of the spheres with model paint!

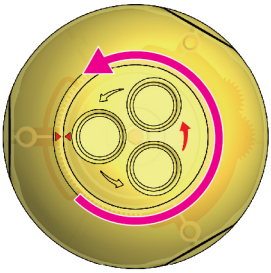
ASSEMBLY INSTRUCTIONS: 5 OF 5

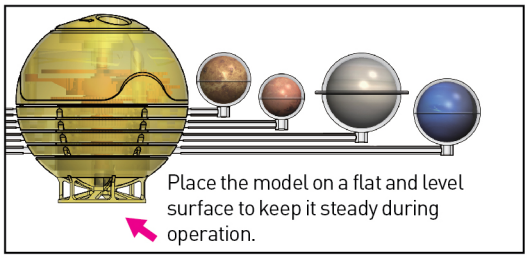
13 Insert each planet into the correct rod.





EXPERIMENT: WIND IT UP





1 To make the planets orbit the sun, put your fingers into the three circular holes on the dial and turn it counterclockwise up to seven times and let go. Don't wind it up more than seven times (56 audible clicks) or you might break the coil spring mechanism inside the H-WINDUP MOTOR BOX.

WHAT'S HAPPENING?

You built an orrery! An orrery is a mechanical model of the solar system (or of just the Sun, Earth, and Moon) that shows the relative position and motion of the planets around the Sun. This orrery uses a special type of gear called a planetary gear to move. This is simply a gear train in which one gear revolves around the other — much like how the planets revolve around (or orbit) the Sun. This makes it the perfect device with which to model the solar system. Of course, the real Sun doesn't have gears inside and rods holding up each planet. In the actual solar system, the motion of the planets is powered by the force of gravity!

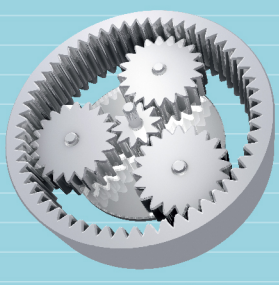
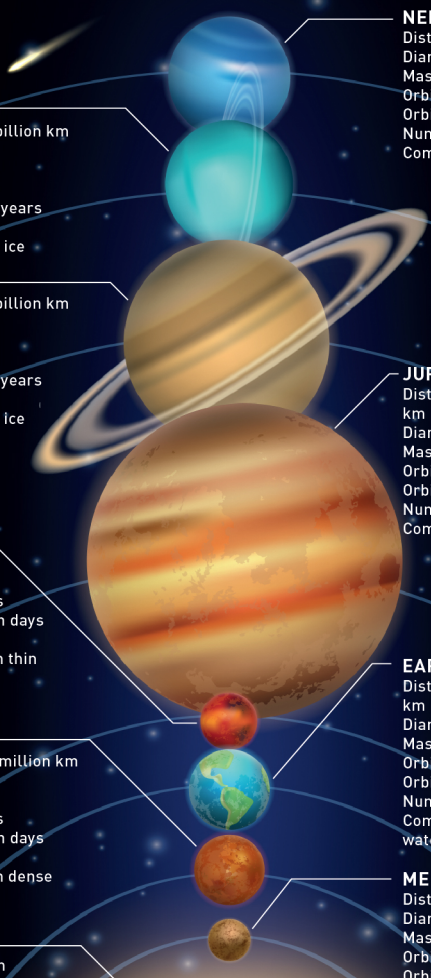


Illustration of a planetary gear

CHECK IT OUT

Eight planets orbit the Sun. Each planet is moving on its own elliptical (nearly circular) path around the Sun. Each planet is a different distance from the Sun and orbits at a different speed — the closer to the Sun, the faster the planet orbits! The planets all have different sizes, masses, and compositions. The solar system you built in this kit is a model. This means it represents some characteristics of the real thing, but obviously not every characteristic. Here are some facts about each planet.



NEPTUNE
Distance from Sun: 4.5 billion km
Diameter: 49,000 km
Mass: 17 Earths
Orbital speed: 5.4 km/s
Orbital period: 165 Earth years
Number of moons: 14
Composition: Gases and ice

URANUS
Distance from Sun: 2.9 billion km
Diameter: 51,000 km
Mass: 15 Earths
Orbital speed: 6.8 km/s
Orbital period: 84 Earth years
Number of moons: 27
Composition: Gases and ice

SATURN
Distance from Sun: 1.4 billion km
Diameter: 121,000 km
Mass: 95 Earths
Orbital speed: 9.7 km/s
Orbital period: 29 Earth years
Number of moons: 82
Composition: Gases and ice

JUPITER
Distance from Sun: 780 million km
Diameter: 142,000 km
Mass: 318 Earths
Orbital speed: 13.1 km/s
Orbital period: 12 Earth years
Number of moons: 79
Composition: Mostly gases

MARS
Distance from Sun: 230 million km
Diameter: 6,800 km
Mass: 0.1 Earths
Orbital speed: 24.0 km/s
Orbital period: 687 Earth days
Number of moons: 2
Composition: Rocky with thin atmosphere

EARTH
Distance from Sun: 150 million km
Diameter: 12,800 km
Mass: 5.97 x 1024 kg (= 1 Earth)
Orbital speed: 29.8 km/s
Orbital period: 365 Earth days
Number of moons: 1
Composition: Rocky with liquid water and thick atmosphere

VENUS
Distance from Sun: 110 million km
Diameter: 12,100 km
Mass: 0.8 Earths
Orbital speed: 35.0 km/s
Orbital period: 225 Earth days
Number of moons: 0
Composition: Rocky with dense atmosphere

MERCURY
Distance from Sun: 60 million km
Diameter: 4,900 km
Mass: 0.06 Earths
Orbital speed: 47.4 km/s
Orbital period: 88 Earth days
Number of moons: 0
Composition: Rocky with dense metallic molten core

SUN
Diameter: 1.4 million km
Mass: 333,000 Earths
Composition: Hydrogen fusing into helium, producing heat and light

ALL ABOARD THE GEAR TRAIN!

Your solar system model only has one H-WINDUP MOTOR BOX. So how does it make the planet models revolve at four different speeds? The answer to this lies in the gear train (also known as a transmission) inside the model. It is made of many gears with different numbers of teeth. When one gear is turning another gear, the smaller gear with fewer teeth turns faster than the larger gear with more teeth. The ratio between the speeds of two gears in a transmission is called the gear ratio. When you put multiple layers of gears together, as in this model, you can make each layer progressively slower.

Relative rates of rotation of the disks in the Sun model