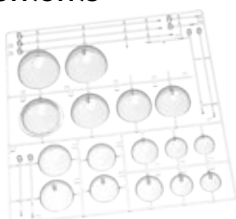


Orbiting Solar System

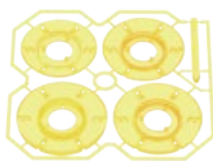
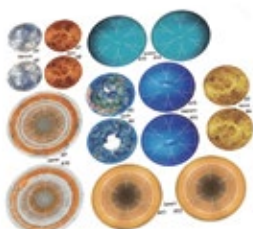


Kit Contents

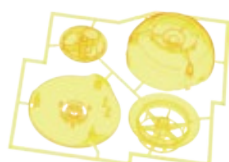


A1-A24

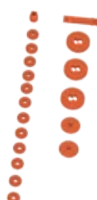
Planet graphics



B21-B24, B29



C25-C28



7069-W85-A
Windup motor box

D, F, and P Parts



3x



12x



2x



1x

D1 Sun gear

D2 Satellite gear

F1 Reduction gear

F2 Ratchet driven gear



1x



1x



1x



1x

F4 Escape wheel

F5 Escapement

F6 Sun axis

F7 Ratchet

Important!

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

Do you have any questions?

Our tech support team will be glad to help you!

USA: support@thamesandkosmos.com

or 1-800-587-2872

UK: support@thamesandkosmos.co.uk

or 01580 713000



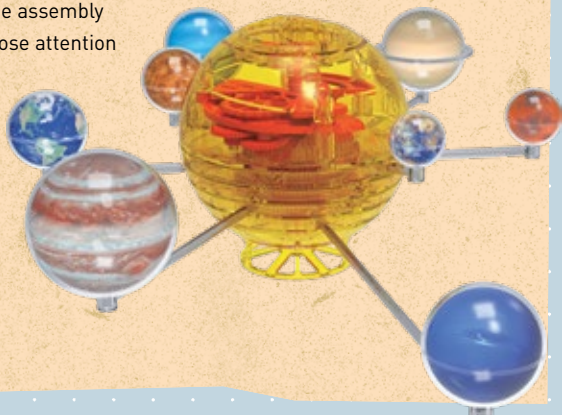
YOU WILL ALSO NEED:

Scissors or diagonal cutters

A WORD TO PARENTS AND ADULTS

With this science kit, your child can build a model of the solar system with a windup motor 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.



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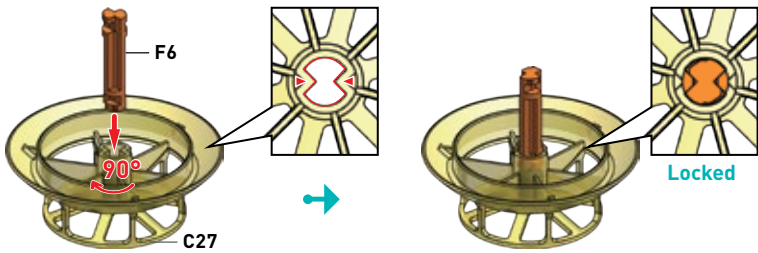
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ASSEMBLY INSTRUCTIONS: 1 OF 5

- 1** Push the sun axis (F6) in as far as it will go. Turn it clockwise 90 degrees.



- 2**
-
- Diagram 2 shows the assembly of gear D1 and gears D2 x3. The gear D1 is pushed onto the sun axis (F6). The gears D2 x3 are then pushed onto the sun axis (F6). The final state is labeled "3".

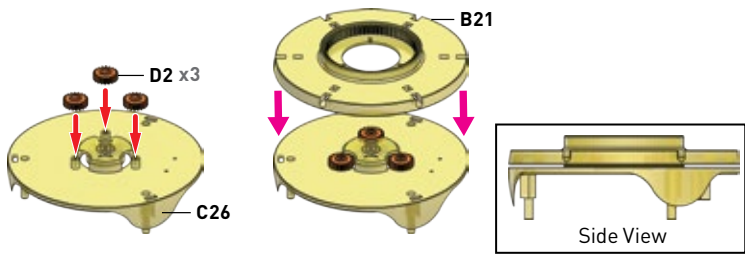
- 3**
-
- Diagram 3 shows the assembly of disk B23. The disk B23 is pushed onto the sun axis (F6). The final state is labeled "3".
- Make sure the holes in the disks are aligned.

- 4**
-
- Diagram 4 shows the assembly of disk B22. The disk B22 is pushed onto the sun axis (F6). The final state is labeled "3".
- Make sure the holes in the disks are aligned.



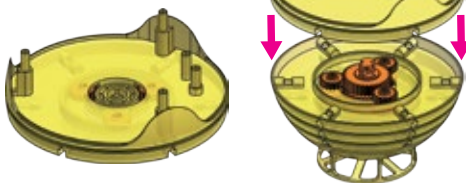
5

1 Pay attention to the orientation of the disk.



1 → **2**

Turn it upside down.



1 Make sure all the gears mesh and the holes align.

3 → **4**

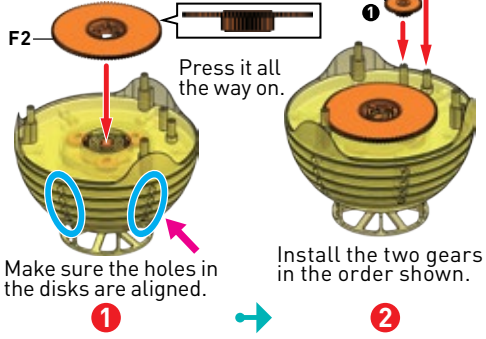
Rotate the upper disk 90 degrees clockwise to lock it in place.



5 → **After Locked**

6

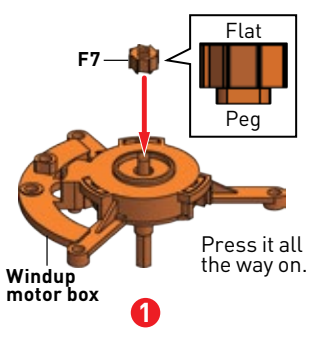
Pay attention to the orientation of the gear.



1 → **2**

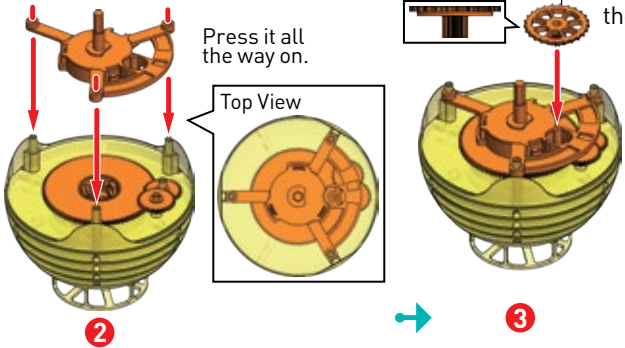
7

Pay attention to the orientation of the ratchet.



1

1 Pay attention to the orientation of the motor box.

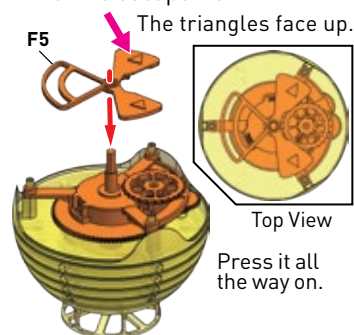


2 → **3**

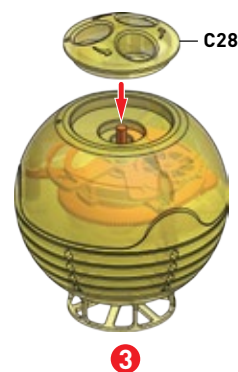
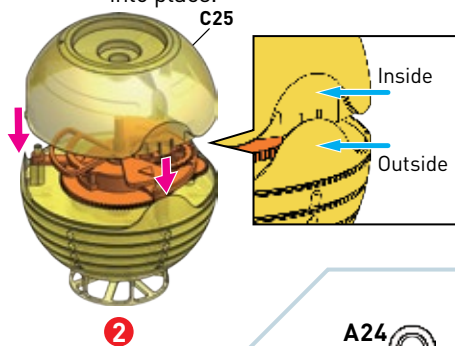
1 Pay attention to the orientation of the escape wheel.

ASSEMBLY INSTRUCTIONS: 3 OF 5

- 8** Pay attention to the orientation of the escapement.

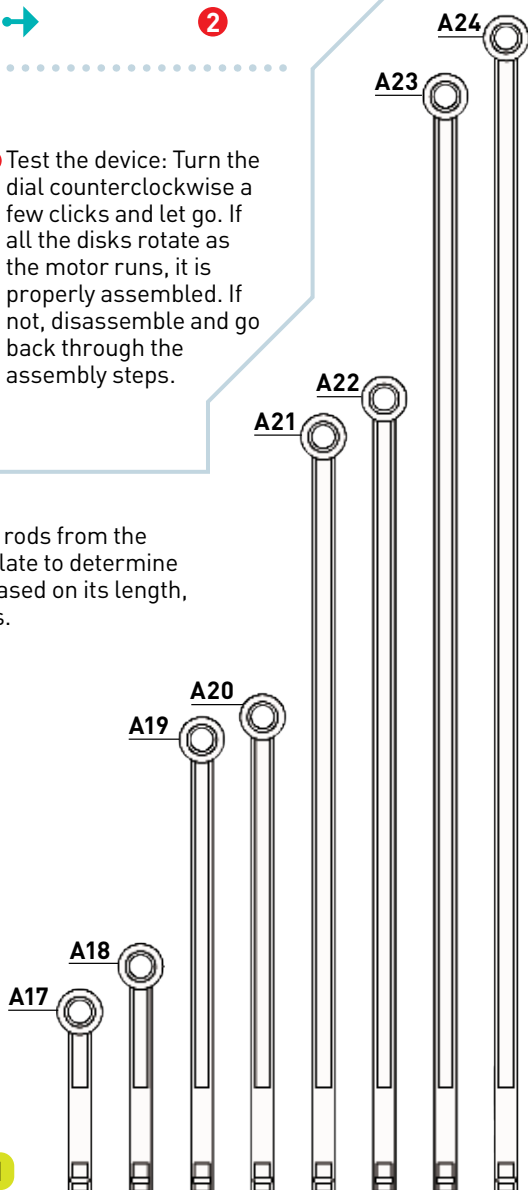


- !** Press the upper hemisphere down until all three tabs click into place.



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

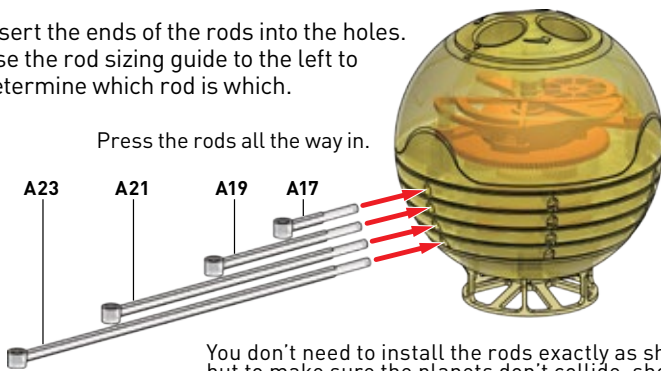
- 9** Carefully remove the rods from the frame. Use this template to determine which rod is which, based on its length, for the next two steps.



Rod Sizes **1:1**

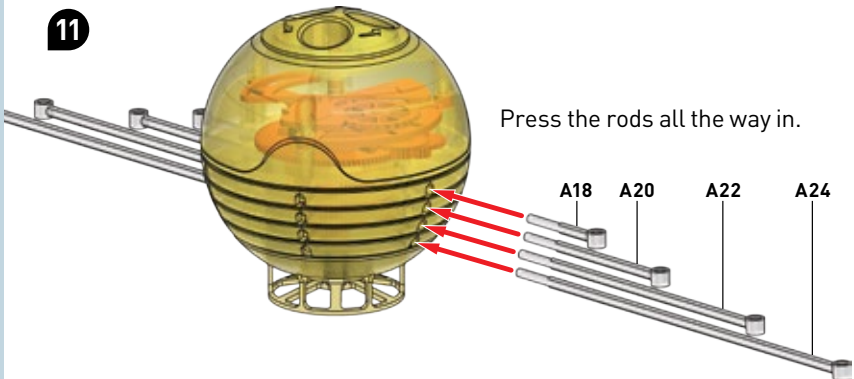
ASSEMBLY INSTRUCTIONS: 4 OF 5

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



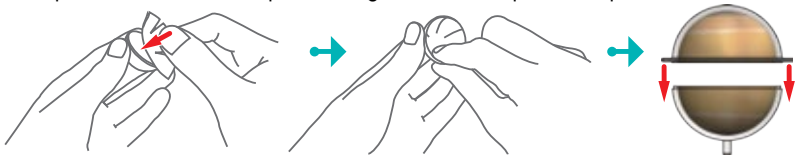
You don't need to install the rods exactly as shown, but to make sure the planets don't collide, shorter rods must always be installed above longer rods.

11



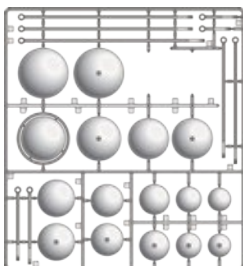
12

Assemble the eight planets. For each planet, match the clear planet hemispheres with the graphics for that planet. Carefully peel one graphic off 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.



 B29

A



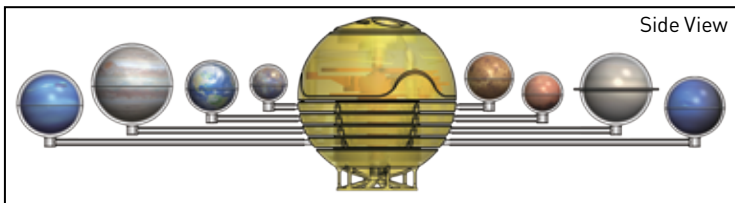
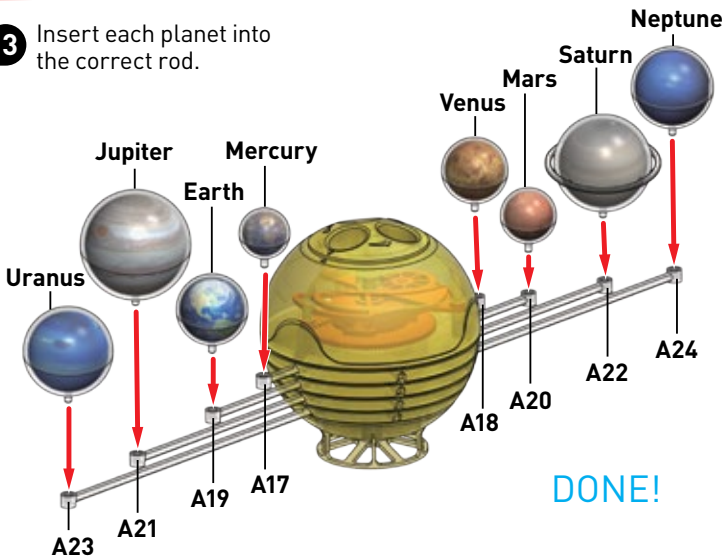
- A1 + A2 → Mercury ● Rod A17
- A3 + A4 → Venus ● Rod A18
- A5 + A6 → Earth ● Rod A19
- A7 + A8 → Mars ● Rod A20
- A9 + A10 → Jupiter ● Rod A21
- A11 + A12 → Saturn ● Rod A22
- A13 + A14 → Uranus ● Rod A23
- A15 + A16 → Neptune ● Rod A24



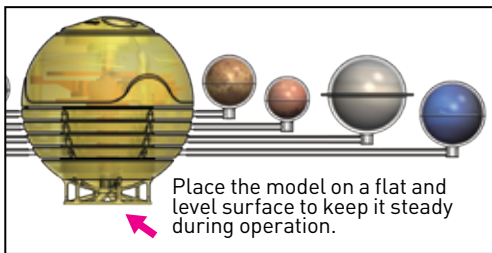
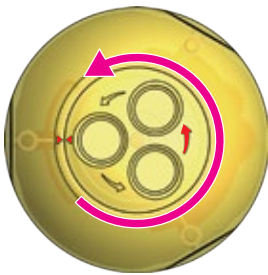
Tip! If you want to customize your planets, you can paint the insides of the spheres with model paint!

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 windup motor.



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!

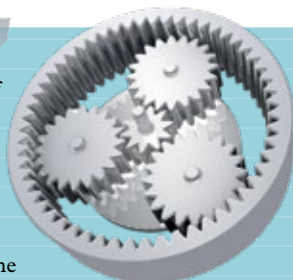


Illustration of a planetary gear

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.

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

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

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

SUN

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

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

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

EARTH

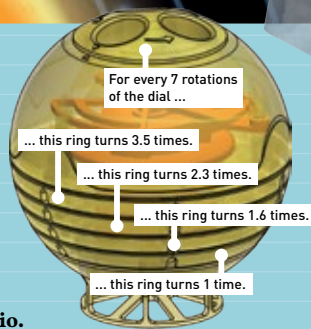
Distance from Sun: 150 million km
Diameter: 12,800 km
Mass: 5.97×10^{24} kg (= 1 Earth)
Orbital speed: 29.8 km/s
Orbital period: 365 Earth days
Number of moons: 1
Composition: Rocky with liquid water and thick atmosphere

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

ALL ABOARD THE GEAR TRAIN!

Your solar system model only has one motor. 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