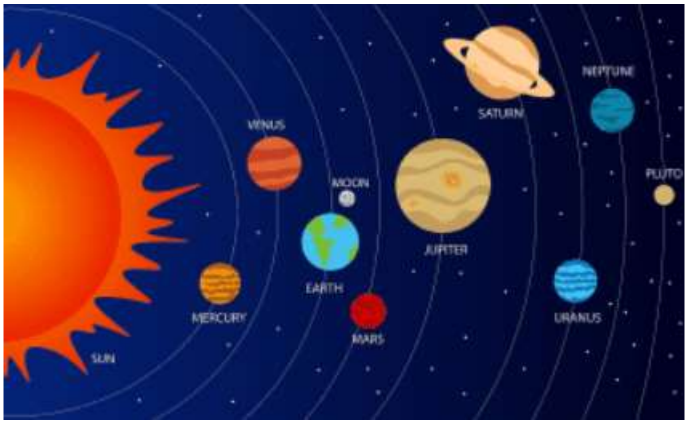
Walk Solar System

When people are asked to draw the solar system, they come up with something like this:



Not considering the incorrect scales for diameters and distances, this also does not convey the motions of different objects. Students can get a different view of the solar system by walking it. This activity simulates the relative motions of the Earth, Moon, and other planets, eclipses, transits, oppositions, comet motions, and how the sun bends light as Einstein predicted. While this takes work to set up, it gives a dynamic view of the solar system. Below is a long description; practice is recommended and omit any steps considered unnecessary.

Items needed:

- classroom from which the desks can be pushed back to make a 6 m diameter circle

- object for the Sun such as a basketball, member wearing a yellow T shirt or best yellow helium balloon tied to a block

- objects for Earth, Venus (same size) Mars (half) Moon (quarter Earth diameter).   Ideas: A green apple (with blue marks for oceans), a yellow apple of the same size, a tomato of half the diameter and another grape tomato of a quarter the Earth diameter. To show the rotation of the Earth push something like a pencil in the bottom.

- Printout of months giving constellation we are nearest. So in July we are closest to Sagittarius while Gemini is the opposite side of the Sun. https://rasc.ca/sites/default/files/MonthConstellations.pdf

- a model for a comet such as white pipe cleaners on a coat hanger.

- flashlight

The Sun object should be at about eye height. The students make a circle of radius of about 3-4 meters depending on the room size. Hand out signs in counterclockwise order for the Earth months.

The instructor stands about halfway out with the Earth model. It's useful to push a pencil into the bottom to simulate our 24 hour rotation.

Various aspects of the solar system can be shown.

1. Walk once around the Sun starting in January (Gemini). Ask when we are closest to the Sun? Most don't expect January. Show some orbits with exaggerated differences, moving slightly faster around January. Explain astronomical unit = average Earth-Sun distance.
2. Rotate Earth counterclockwise with you behind it so students on the outside can see it. You might push a toothpick with a tiny Canadian flag into the apple near the north. As you turn Earth, ask what time of day it is in Canada. The idea is night is when we are away from the Sun. Add times like noon, sunset and sun rise. Plan where to stand to give most students a good view and do this several times so all students around the circle can see it.
3. Then at sunset ask if in the evening do see the objects behind or ahead of us. (Behind).
4. Repeat for sunrise (ahead), Midnight (opposite sun).
5. Now get the moon object (ideally grey) and orbit it around the apple. When the moon is opposite the Sun ask if it would it be bright. (Yes, full moon.)

6. What about when between Earth and Sun? (Dark, new moon.) Repeat for people on all sides. Keep walking.
7. Now move it a little counterclockwise after new and ask would the moon be ahead or behind us? (Behind.) Would be visible in the morning or evening? (Waxing crescent visible in evening.)
8. Now hold moon exactly between the Sun and Moon. What happens? Solar eclipse. Next one in April 2024.
9. Why is there not an eclipse every new moon? Tilted orbit usually goes above or below.
10. Now put the moon down, remove the flag and get the Venus object, ideally yellow. Let a student walk ¾ radius inside moving faster to finish an orbit in 2/3 of an Earth year.
11. Stop when Venus is the other side of the Sun. Ask if we could see it. (No).
12. Then orbit some more and stop when Venus is between us and the Sun. Can we see it? (No.)
13. Then both move a bit counterclockwise and ask if faster Venus is behind or ahead. When could we see it? (Ahead. morning).
14. Keep moving until Venus is about 30 degrees behind us. Behind or ahead, when see? (Behind, evening)
15. Would Venus be brightest or faintest? After discussion say its very bright because its close and big.
16. Use terms superior and inferior conjunctions if appropriate.
17. You could ask if Venus would always cross the Sun. Mention the orbit is tilted so a Transit of Venus is rare.
18. But the planet orbits are mostly in a plane.
19. Put down Venus get the Mars object. Maybe get someone else to walk the Earth.
20. Walk about 1 ½ times the distance from the Sun slowly so a Mars orbit is about 2 and a bit Earth years.

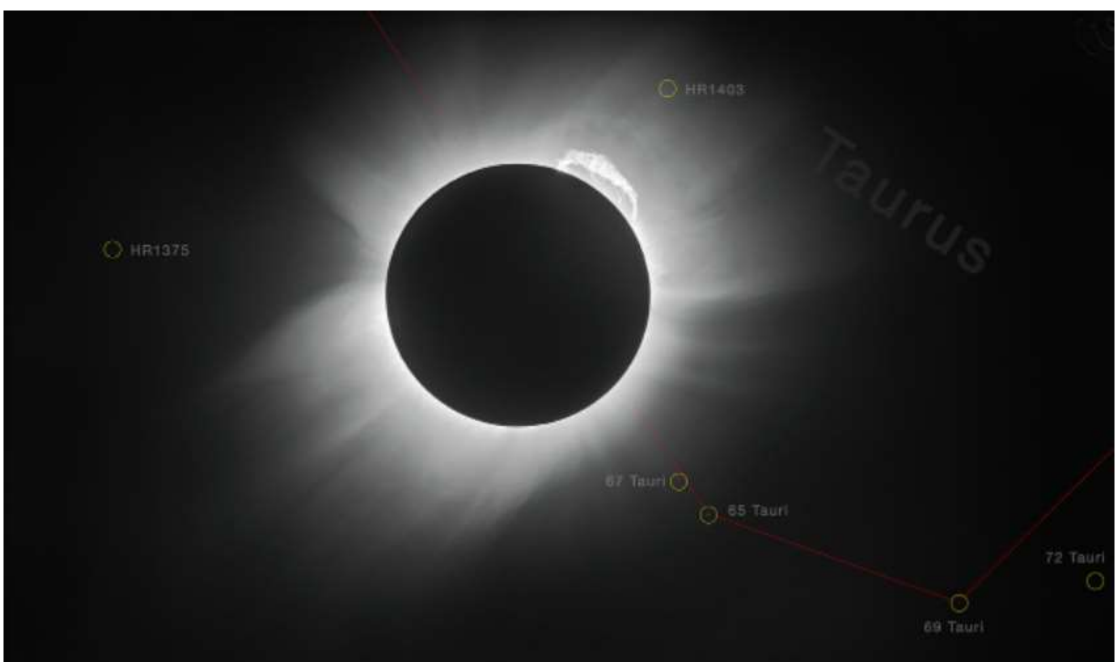
21. Ask the group to watch the distance from Earth to Mars and shout stop when its smallest. Then the Sun, Earth and Mars are in a line. That's called opposition.
22. Ask what would be special then? (Mars brightest, biggest, best view of features on Mars). Talk about false observations of canals if desired.
23. Then walk Mars so it's closer during the Earth August and further away at Earth February. Say the orbit is elliptical. Do a few more orbits and ask if it is a close or distant opposition. Close ones are always around August September. 2035 next close opposition.
24. As two of you walk the orbits, ask when NASA would have problems communicating with a rover on Mars. (when opposite Sun)
25. Advanced is the Hohman transfer orbit. Launch when Mars is about 45 degrees ahead. The spacecraft meets Mars opposite where it was launched from after an opposition. This path requires the least rocket fuel. Also all spacecraft to the red planet are launched close to each other.
26. Give another student a basketball to represent Jupiter. (Beachball better, Jupiter is 10 times bigger). Ask her to count steps from the Sun to Earth, then go 4 times more steps in the direction of a door. That's the distance to Jupiter. The outer planets are a long way away. Saturn twice Jupiter's; Neptune three times Saturn's.
27. Now walk a very elliptical orbit going slowly when far and quickly when close.
28. Mention the tail is pushed away by emissions from the Sun. Ask what way would the tail point while coming in. (Behind comet's motion)
29. Then ask about moving away. (In direction of comet's motion.)

30. Ask the general shape of the planet orbits. (mostly flat).

31. Now make a comet orbit which goes below the sun when close and way above the floor when further away. Say many comets are tilted.

32. Ask what might happen if the tilting is more than 90 degrees. Show a comet coming in from above going clockwise – opposite to most other objects. Say this is Halley's comet. Three comets were seen in 1531, 1607 and 1682. Edmund Halley suggested they were the same comet and predicted a return which happened in 1758 after his death.

33. Now get a flashlight and get someone to shine it from the far side of the room. Get the Earth and Moon objects and move the far side of the Sun from the flashlight nd put the moon in solar eclipse position. Say Einstein predicted that the mass of the Sun would slightly deflect light rays. Then during an eclipse, stars are visible. Photos of a 1919 eclipse showed some stars were deflected. Einstein became world famous.



Actual 1919 photo ESA

34. Perhaps end by getting students to move all four planets, plus the moon and a comet all at the same time. Some call that the Dance of the Planets which is very different from the normal solar system diagram.
35. Put the chairs back after many concepts in astronomy have been shown.

If you do this, please send reactions to schoolclubs@rasc.ca.