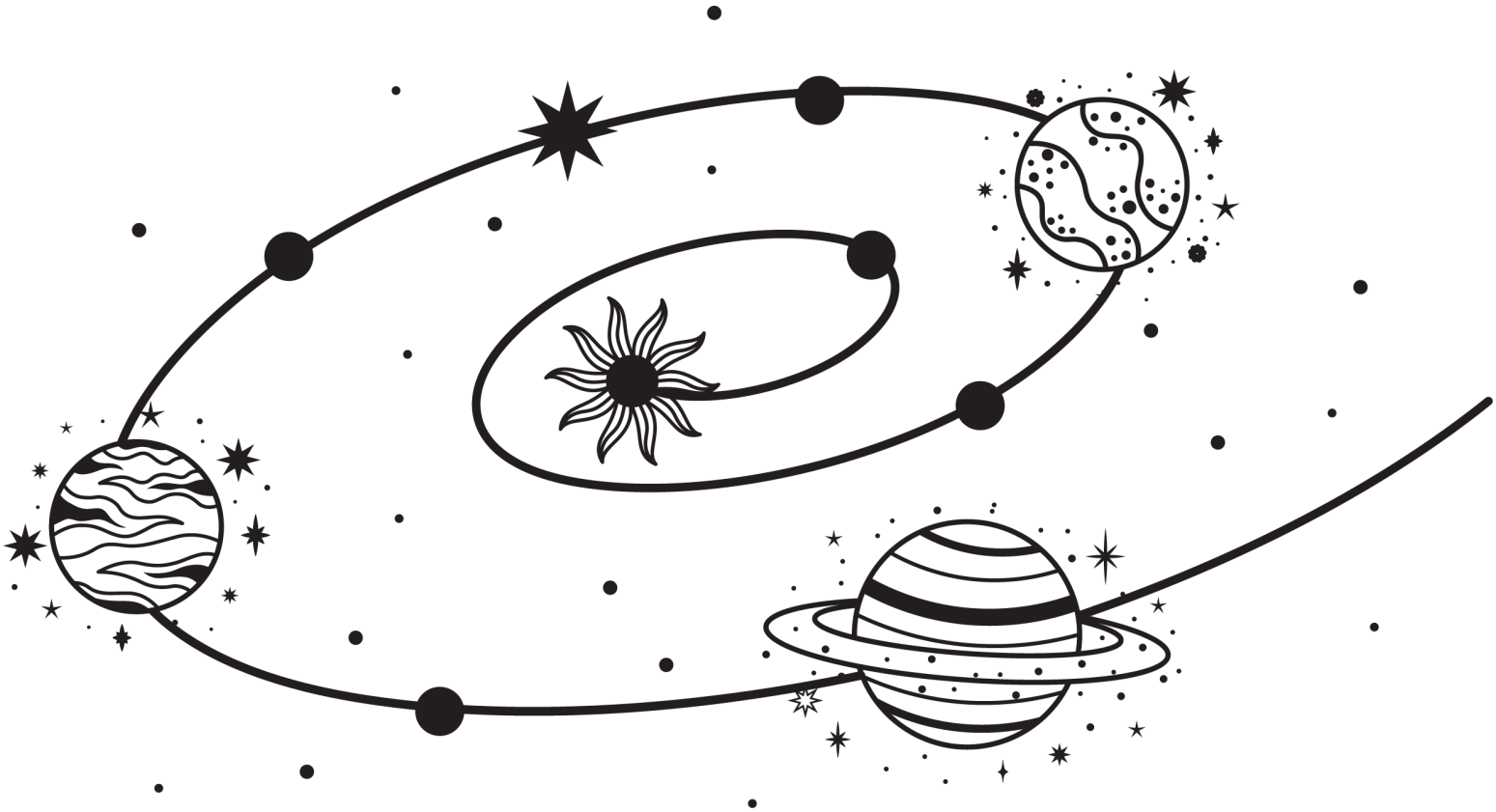
ARISTARCHUS

Learning sequences summary

Prepared by CYU



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Important note:

- Include relevant, must-know information (avoid theoretical or unnecessary information)
- Use the single second-person pronoun. Think that you are talking to the user (in this case, the teachers).

Introduction

The set of learning sequences enables you to create a progressive STEAM curriculum based on the Human Orrery. The first sequence represents your students' experience with the Human Orrery. Its goal is to state each sign on the Human Orrery explicitly and to plan the dance. The second series tries to help you create your own Human Orrery. The following five sequences allow you to examine STEAM topics such as space, duration, and scales. The final one is a sequence of short exercises ("warm-up") designed to improve body movements for choreography.

Learning objectives

- Comprehension: Summarise the characteristics of the Solar System (nomenclature, units of time and distance)
- Analysis: Compare and contrast the different orbits (shape, period and variation of speed)
- Synthesis: Argue about the cause of celestial phenomena such as day/night and seasons

Summary of learning sequences

1. What is a Human Orrery?
2. Our own Orrery
3. Birthday
4. The alternation of day and night
5. How do we move?
6. What are the shapes of the orbits?
7. Warm-up

Title of the learning sequence	What is the Human Orrery?
Education level	Primary or secondary education
Age group	6+
STEAM aspects (at least two fields should be combined- How each of the fields is integrated)	Mathematics provides the rules of artistic choreography through the use of numeration and helps to understand the modelisation in science (going from a map to the real world) through the scales Art (choreography) allows us to feel the movement of the planets (science)

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Link to the school curricula	Science: identify different types of solar system objects and their orbits. The notion of duration related to astronomy (years). Arts: reproduce choreographed movements Mathematics: scales (distance and duration), numeration
Prior knowledge	For teachers: name and order of the planet. The different objects of the Solar System (see the FAQ). The notion of orbital period. For students: walking in rhythm, knowing the numerical sequence up to 40, 3-fold multiplication table, an idea about scales
Materials/Equipment required	• a Human Orrery or an A4 printed sheet of the Orrery • a blank printed Orrery to be completed by each pupil • a metronome (not required) • a string (for the distance scale)
Summary	This learning sequence is made of 4 different phases. Students will walk on the Orrery during the first phase to become familiar with it as an object. The second phase is a discussion among students about what they saw and thought about the human Orrery (how they interpret what is drawn on it). They will learn about the Sun, planets, comets, satellites, orbits, distance and duration scale by comparing images, numerical sequences and colours. The next phase is a choreography for the planets; pupils play each planet. This phase allows the pupils to understand the different durations of one revolution (one turn around the Sun). The fourth and last phase is the choreography of the Encke comet. The pupils will perceive a movement with a varying velocity and a non-circular shape.

Title of the learning sequence	Warm-up
Education level	Primary or secondary education
Age group	all ages
STEAM aspects (at least two fields should be combined- How each of the fields is integrated)	Science: learn different types of kinematic Arts: improve the choreography

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Link to the school curricula	Arts: reproduce choreographed movements Science: description of movements (primary) - speed (secondary)
Prior knowledge	For teachers: None For students: None
Materials/Equipment required	• A rope
Summary	Warm-up is made up of short sequences (duration of 10' each) with one instruction each. You may alternate between one exercise and another. Most are presented in the form of coordination problems to be solved. One group tries to solve the problem, while others observe, comment, describe, and may propose other solutions. The goal is to help students master the guided walk on the Orrery and to relate this walk to gravity and inertia (for older learners).

Title of the learning sequence	Our own Orrery
Education level	Primary or secondary education
Age group	Options: 1 - with a stencil: 5+ 2 - drawing ellipses: 8+ 3 - expansion of the printed Orrery: 11+
STEAM aspects (at least two fields should be combined- How each of the fields is integrated)	Technology: search properties of the object (flat - astronomy, many points - math) Engineering: constraints of being made of a series of points for each planet (science) that form a geometrical figure (math), and (1 and 2) need to reproduce at a larger scale (math) Arts: how to reveal the different series, how to embellish the object (to ease its usage)
Link to the school curricula	Science: Different types of objects in the Solar System Technology: Construction of a complex object (the orrery) Arts: Production of artwork with stencils and chalk Mathematics: (1 and 2) geometrical figures (from circles to ellipse) and (2 and 3) alignment; (3) multiplicative problem and proportionality.

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Prior knowledge	For teachers: the gardener method (for method 2) For students: understand the meaning of the Orrery through the discovery session
Materials/Equipment required	(1) a stencil of the Human Orrery and chacks (2) and (3) ● Ropes, chacks ● templates of each orbit (A3 Orrery) through the online application (** add link) ● Position of the second focus and semi-major axis for each orbit (provided in the teaching sheet ** or a link?)
Summary	The construction of the Orrery may be a significant event in the school. You will then have a permanent representation of the Solar System in the courtyard or a hall of your school. Every student will be allowed to play on it as on a hopscotch. It is also a true learning moment that involves the notion of enlargement (or expansion) and, hence, the notion of distance scales. Once the Orrery is built (dots by dots), it may be enhanced by artistic drawings or information panels. Besides, the construction may be extended over many years. The first Orrery usually includes inner planets and one comet. Orbits further away may be drawn one after another until Uranus…

Title of the learning sequence	When is my Birthday?
Education level	Primary or secondary education
Age group	6-8 years old (cycle 2) and 8-14 (cycle 3-4) to go deeper
STEAM aspects (at least two fields should be combined- How each of the fields is integrated)	Link between duration and orbital revolution Use of the year as a unit of time Relation between speed and duration
Link to the school curricula	Science: locating the time frame / Astronomy: Planets of the Solar System, orbital revolution and planetary rotation. Mathematics: 1st level: measure of different duration, Higher level: definition and use of a time scale, multiplicative problem and proportionality.
Prior knowledge	For teachers: movement of the planets in the solar system, the difference between revolution and rotation, the choreography on the human Orrery. The closer the planet is to the Sun, the faster it rotates.

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	For students: The meaning of Birthday in terms of terrestrial year. Comparing numbers, notions of multiple and usual arithmetic operations In addition, for higher Levels: multiplicative problems and proportionality
Materials/Equipment required	• Nice drawing of birthday cakes and birthday gifts. • Tokens for printing orrery
Summary	For young learners, one year is related to one's birthday: Every year, I have my birthday, and I am one year older. The birthday is connected to gifts and cake. This sequence proposes to relate birthdays and revolutions around the Sun in two steps. First, the teacher puts a birthday cake on the disc that corresponds to a learner's birthday on the orbit of Earth. The learner encounters the cake at every turn, connecting birthdays and revolutions around the Sun. Through different episodes, the notion of the year will be disconnected from the cake, the birthday and then Earth. Second, the teacher asks the students to walk along the orbit of different planets regularly, stops the choreography and asks everyone how old each learner is.

Title of the learning sequence	The alternation of day and night
Education level	Primary or secondary education
Age group	9-11
STEAM aspects	Describe a movement grasp the notion of movement. Science: The alternation of day and night.
Link to the school curricula	Astronomy: Identify the rotation of Earth around its axis and its revolution around the Sun. Mathematics: The angle measurement between 0° and 180°. Art: Choreography on the Human Orrery
Prior knowledge	For teachers: The two movements of planet earth: rotation and revolution. The change of the frame of reference is important to understand the movement of Earth as a celestial object in the solar system. For students: The Human Orrery discovery Session #1

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	The alternation of day and night is related to the movement of Earth
Materials/Equipment required	• The Human orrery • Worksheets previously prepared
Summary	The alternation of day and night is caused by the rotation of the Earth on its axis. Earth rotates once in about 24 hours concerning the Sun. An observer on Earth sees that the sun moves in the sky. To understand the movement of Earth as a celestial object in the solar system, we have to change our frame of reference, and the Human Orrery could help us do so. This sequence is composed of two steps. First, the teacher asks several students to stand on dots on the Earth's orbit and then asks them how to position themselves to see the Sun (day) and how to position themselves to no longer see the Sun (night). Does this observation remain the same for any position in the Earth's orbit? Second, the teacher asks students to perform a simulation: Using both arms to simulate the angle with which one looks at the sun from the moment when one is in profile concerning the sun (angle at 0°) passing by the moment when one is facing the sun (90°) until the moment when one is again in profile concerning the sun (180°) and to note these observations on the worksheet. The teacher engages the students in a reflection about how to relate these observations to what we observe about the movement of the sun in the sky during the daytime (from sunrise to sunset).

Title of the learning sequence	How do we move?
Education level	Primary or secondary education
Age group	12+
STEAM aspects (at least two fields should be combined- How each of the fields is integrated)	Combine an understanding of velocity through the body (perception) and measure (science) or formulae (math). Protocol of measurement is a standard place to combine math and science.
Link to the school curricula	Science: Speed, defined as the ratio of distance versus duration for any path between two points. Arts: perception of speeds (visual or kinesthetic). Mathematics: speed is the proportionality ratio between duration and distance.

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Prior knowledge	For teachers: none. For students: the measure of distance, the definition of speed as the ratio of distance versus duration
Materials/Equipment required	• a printed or Human Orrery • a ruler
Summary	Students first experience the choreography and discuss their perception. The teacher can ask pupils: “Is the speed of mercury [or another celestial body] constant or not?” and “Which planet is the fastest?”, “Which planet is the slowest?” Then, groups of students measure the distance and duration of different trips. They report their measures in a table or a graph. The main observation must be that the ratio duration over distance is constant for all planets, while it is not constant for the comet. Compared with perceptions from the body, students may then conclude that the constant speed is related to a constant ratio of distance over duration (a relation of proportionality).

Title of the learning sequence	What are the shapes of orbits?
Education level	Primary or secondary education
Age group	9-12 years
STEAM aspects (at least two fields should be combined- How each of the fields is integrated)	Link between the shape of orbits and circular forms (ellipse, circle). Measurement and using an instrument to measure length Arts: Working on the properties of a circle to draw a rose with a compass or to use the exercise form to imagine other “Solar Systems”
Link to the school curricula	Astronomy: Planets of the Solar System, orbital revolution and orbital period. Identify the shape of the orbit of planets Mathematics: acknowledgement of characteristics of a circle.
Prior knowledge	For teachers: knowing what a circle is and what are its mathematical characteristics. Same for the ellipse. For students: how to walk on the Human Orrery (HO); what defines a circle is; There are several planets in the solar system turning around the Sun; the Sun is the center of the Solar System.

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Materials/Equipment required	• Pieces of chalk • Orbits exercises form (given with the guide) • Printed Orrery • Length measurement instruments: compass (small one, used for geometry), ruler, string, rope of three-metre, folding metre (“mètre de menuisier »), decametre.
Summary	Students have to estimate the shapes of the orbits and make a conjecture of the geometrical figure of these shapes. Using strategies linked to characteristics of a circle by measuring the human orrery and trying to validate if orbits are circular or not. The teacher makes a quick reminder of the objects in the Orrery and of the choreography (He doesn’t refer to the Sun as the centre of the Solar System). The sequence is composed of 3 steps: First, he asks the students to formulate hypotheses on the geometrical shape of the orbits. Second, they have to suggest a method to validate if a form is circular or not and to test it with measuring tools on the exercise form and afterwards with the PO. Third, they use a similar method to test hypotheses about orbit shapes on the HO and conclude. Finally, they discuss their results and the validity of their methods to obtain them.

Title of the learning sequence	Warm-up
Education level	Primary or secondary education
Age group	all age
STEAM aspects (at least two fields should be combined- How each of the fields is integrated)	Science: learn different types of kinematic Arts: improve the choreography
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Materials/Equipment required	A rope

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