Teacher Notes

Unit 4 · Moons, Dwarf Planets & Small Bodies · Ages 9–14. Each page works on its own. Mix levels freely: ★ Explorer (ages 9–10), ★★ Navigator (11–12), ★★★ Commander (13–14). Figures are rounded; gravity is shown relative to Earth.

Page	Activity	Level	Time	Materials / notes
2	Field Guide	★	20 min	Read aloud; color the pictures.
3	Who Am I?	★	15 min	Pencil and ruler for the lines.
4	Sorting Hat	★★	25 min	Scissors, glue. ★★ item at the bottom.
5	Comet Lab	★/★★	30 min	Pencil; draw tails away from the Sun.
6	Word Search	★	15 min	Words go in six directions.
7	Math Lab 1	★★	30 min	Calculator.
8	Math Lab 2	★★★	35 min	Calculator; speed = distance ÷ time.
9	Asteroid Belt Maze	★★	25 min	Pencil.
10	Pluto	★★	30 min	Debate: allow students to disagree with evidence.
11	Cryovolcano	★★	40 min	Bottle, clay, baking soda, vinegar, food coloring, soap, tray. Adult supervision.
12	Bingo	★	25 min + play	Scissors, buttons or paper pieces.
13	Logic Lab	★★★	25 min	6×6 sudoku has one solution.
14	Create	★/★★	35 min	Colored pencils.
15	Unit Review	★–★★★	25 min	Quiz out of 20 points.
16	Mission Log	★	10 min	Self-assessment.

Figures are rounded. Gravity values: Moon 0.17, Io 0.18, Europa 0.13, Titan 0.14, Pluto 0.06, Ceres 0.03, Enceladus 0.01 (Earth = 1).

Pages 2–9

Page 3

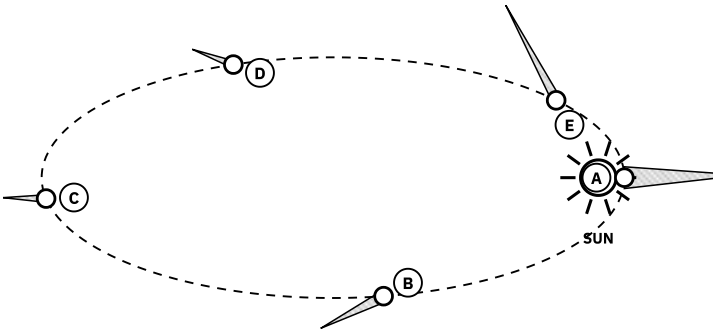
The Moon → **D** · Europa → **F** · Titan → **A** · Pluto → **B** · Ceres → **E** · Enceladus → **C**. ★ **"A world with an ocean" could fit Europa and Enceladus**.

Page 4

Earth **Planet** · Mars **Planet** · Pluto **Dwarf planet** · Ceres **Dwarf planet** · The Moon **Moon** · Titan **Moon** · Europa **Moon** · Enceladus **Moon** · Vesta **Asteroid** · Halley's Comet **Comet**. ★★ **It has not cleared its orbit: it shares the belt with many other objects**.

Page 5

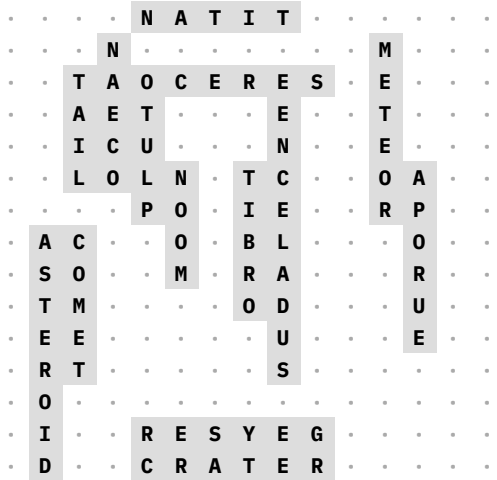
A **Nucleus**, B **Coma**, C **Dust tail**, D **Gas / ion tail**.



Tails always point away from the Sun; longest near the Sun.

1) **2061** (1986 + 75).

Page 6



Pages 7–15

Page 7 · Gravity

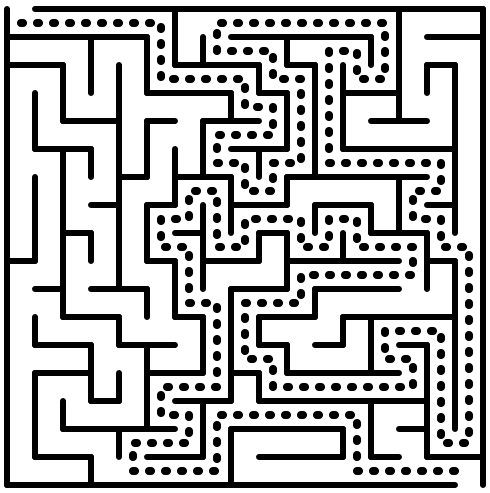
	The Moon	Io	Europa	Titan	Pluto	Ceres	Enceladus
Weight	**15.3**	**16.2**	**11.7**	**12.6**	**5.4**	**2.7**	**0.9**
Jump	**11.8**	**11.1**	**15.4**	**14.3**	**33.3**	**66.7**	**200.0**

1) **Enceladus**; **Io**. 2) **200.0 ft**; **you could leave the surface forever**. 3) 300 × 0.17 = **51 lb**.

Page 8 · New Horizons

1) **83,220** h. 2) 3,000,000,000 ÷ 83,220 = **36,049 mph**. 3) **65.5×**. 4) 3,000,000,000 ÷ 186,282 = **16,105 s** ≈ **4.5 h**. 5) **3,317 mph**. Pluto: 1930 + 248 = **2178** — **not yet: Pluto has not finished one orbit since its discovery**.

Page 9 · Maze



1) 3.2 − 2.2 = **1.0 AU** = **93,000,000 mi**.

Page 10 · Pluto

Earth: **yes · yes · yes → planet**; Pluto/Ceres: **yes · yes · no → dwarf planet**. 1) 751 ÷ 1,477 = **0.51** ≈ **one half**.

Pages 13–15

Page 13 · Sudoku

Pl	**Ti**	**Mo**	En	**Eu**	Ce
En	**Eu**	Ce	**Ti**	Mo	**Pl**
Ce	Pl	**En**	**Eu**	Ti	**Mo**
Ti	Mo	**Eu**	**Ce**	Pl	**En**
Mo	Ce	Ti	**Pl**	**En**	Eu
Eu	**En**	**Pl**	Mo	Ce	Ti

Titan / Titán · **Ceres** · **Europa**.

Page 15 · Review (20 points)

1. Dwarf planet: orbits the Sun, round, has not cleared its orbit. Comet: icy body with a tail near the Sun. (3). 2. Europa **C**, Titan **D**, Enceladus **A**, Pluto **B** (4). 3. **F** **F** **T** (3). 4. **13 lb** (2). 5. **2061** (2). 6–8. Open answers (2 points each).