**ANSWER KEY**

**Mapping Alien Worlds**

Spacecraft can collect information about the surfaces of planets, moons, and asteroids using radar (radio detection and ranging) and lidar (laser imaging, detection, and ranging). Both methods send a signal from a spacecraft and measure how long it takes for the signal to bounce off the ground and return to the spacecraft. Signals traveling to lower surfaces take longer to get there and return, while signals traveling to higher surfaces return sooner since they’re not traveling as far. With this information, scientists can map the elevation of the path under the spacecraft, known as a swath, and therefore identify the surface features on planets, moons, and asteroids.

**Directions**

Choose a color for each number, then use the simulated elevation data in the swaths below to determine what surface feature (mountain, crater, sloping plain, valley, mountain range, canyon) is shown. Then use toy bricks, clay, 3D mapping software or other ways to make a model of the data.

**Materials List**

* Colored pencils, crayons or markers
* (Optional) plastic building bricks, soft kid clay, or 3D design software
* (Optional) graph paper

**Mapping key**

* 1 = 100 meters, color \_\_\_\_\_\_\_\_\_\_
* 2 = 200 meters, color \_\_\_\_\_\_\_\_\_\_
* 3 = 300 meters, color \_\_\_\_\_\_\_\_\_\_
* 4 = 400 meters, color \_\_\_\_\_\_\_\_\_\_
* 5 = 500 meters, color \_\_\_\_\_\_\_\_\_\_
* 6 = 600 meters, color \_\_\_\_\_\_\_\_\_\_

Mapped feature: **mountain range**

| 3 | 4 | 4 | 5 | 6 | 5 | 4 | 4 | 3 | 2 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3 | 3 | 4 | 5 | 6 | 5 | 4 | 4 | 3 | 2 |
| 3 | 3 | 4 | 5 | 6 | 5 | 5 | 4 | 3 | 2 |
| 3 | 3 | 4 | 5 | 6 | 6 | 5 | 4 | 3 | 2 |
| 3 | 3 | 4 | 5 | 6 | 6 | 5 | 4 | 2 | 2 |
| 3 | 3 | 4 | 5 | 6 | 6 | 5 | 4 | 2 | 2 |
| 4 | 4 | 4 | 5 | 5 | 6 | 5 | 4 | 2 | 2 |
| 4 | 4 | 4 | 4 | 5 | 6 | 5 | 4 | 3 | 2 |
| 4 | 4 | 4 | 5 | 6 | 6 | 5 | 4 | 3 | 3 |
| 3 | 4 | 4 | 5 | 6 | 6 | 5 | 4 | 3 | 3 |
| 3 | 4 | 4 | 5 | 6 | 5 | 4 | 3 | 3 | 3 |
| 3 | 3 | 4 | 5 | 6 | 5 | 5 | 4 | 3 | 3 |
| 3 | 3 | 4 | 5 | 6 | 6 | 5 | 4 | 3 | 2 |
| 3 | 3 | 4 | 5 | 6 | 6 | 5 | 4 | 3 | 2 |
| 3 | 3 | 4 | 5 | 5 | 6 | 5 | 4 | 3 | 2 |
| 4 | 3 | 4 | 5 | 5 | 6 | 5 | 4 | 3 | 2 |
| 4 | 3 | 4 | 4 | 5 | 6 | 4 | 4 | 3 | 2 |
| 4 | 4 | 3 | 4 | 5 | 6 | 4 | 4 | 3 | 2 |
| 4 | 4 | 3 | 4 | 5 | 6 | 5 | 4 | 3 | 2 |
| 4 | 4 | 3 | 4 | 5 | 6 | 5 | 4 | 3 | 2 |

|------ | = 1 km

Mapped feature: **canyon**

| 5 | 5 | 5 | 2 | 1 | 2 | 2 | 5 | 5 | 5 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 5 | 5 | 5 | 2 | 1 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 1 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 2 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 2 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 2 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 1 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 1 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 3 | 1 | 2 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 1 | 2 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 1 | 2 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 1 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 1 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 2 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 2 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 2 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 2 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 1 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 1 | 1 | 2 | 5 | 5 | 5 |
| 5 | 5 | 5 | 2 | 1 | 2 | 2 | 5 | 5 | 5 |

|------ | = 1 km

Mapped feature: **valley**

| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |
| 5 | 4 | 3 | 2 | 1 | 1 | 2 | 3 | 4 | 5 |

|------ | = 1 km

Mapped feature: **sloping plain**

| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

|------ | = 1 km

Mapped feature: **crater**

| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
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| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 2 |
| 3 | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 3 | 3 |
| 3 | 4 | 3 | 3 | 2 | 3 | 3 | 4 | 3 | 3 |
| 3 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 3 | 3 |
| 3 | 4 | 3 | 3 | 2 | 3 | 3 | 4 | 3 | 3 |
| 3 | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 3 | 2 |
| 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 2 |
| 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

|------ | = 1 km

Mapped feature: **mountain**

| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| 2 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 2 | 2 |
| 2 | 3 | 4 | 4 | 5 | 4 | 4 | 3 | 2 | 2 |
| 2 | 3 | 4 | 5 | 6 | 5 | 4 | 3 | 2 | 2 |
| 2 | 3 | 4 | 4 | 5 | 4 | 4 | 3 | 2 | 2 |
| 2 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 2 | 2 |
| 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

|------ | = 1 km

Mapped feature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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|------ | = 1 km