Name: Period: **Unit 3: Kepler's Laws Performance Tasks**

Task 1: I can draw an ellipse with proper scale to model the orbit of Earth and the orbit of Mars.

Materials:

- Big paper
- 2 Markers
- 2 Tacks
- Foam board
- 45.8 cm string loop
- 75 cm string loop
- Ruler

Directions:

1. Using the data below, identify which string should be used to model Earth's orbit and which string should be used to model the orbit of Mars. Explain your decision in the box on the right.
2. Using the data below, on your Big Paper mark where the foci for Earth and where the foci for Mars should be. Remember, they should share one common focus.
3. Use the tacks and the string to draw the ellipse for the orbits of Earth and Mars.
4. Label the orbits of Earth and Mars. Label the location of the Sun. Label which foci was used for Earth and which foci was used for Mars.

Student Explanation:

Which string was used for which orbit and why?

We used the _____ cm string for Earth's orbit because _____

_____

_____.

We used the _____ cm string for Mars's orbit because _____

_____

_____.

Data:

Distances in Earth and Mars Orbital Model to Scale

Planet	*Distance between Foci*
Earth	1.5 cm
Mars	12.8 cm

Student Checklist:

- ❑ I have drawn an ellipse for the orbit of Mars
- ❑ I have drawn an ellipse for the orbit of Earth
- ❑ I explained which string I chose and why
- ❑ I have labeled each foci
- ❑ I have labeled the Sun
- ❑ I have labeled the orbit of Mars
- ❑ I have labeled the orbit of Earth

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Task 2: I can use math to calculate the size of the eccentricity of the orbit of Earth and the orbit of Mars.

Materials:

- Calculator

Directions:

1. Using the data below, calculate the eccentricity of Earth's orbit
2. Using the data below, calculate the eccentricity of the orbit of Mars
3. Label the ellipse on the right to show d and L

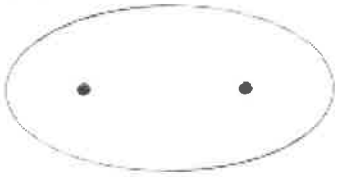
$$e = \frac{d}{L}$$

Student Explanation:

What is the eccentricity of Earth's orbit? Show your calculation below.

What is the eccentricity of Mars' orbit? Show your calculation below.

On the ellipse below, show the location of d and the location of L.



Data:

Distances in Earth and Mars Orbitals

Planet	*Distance between Foci (d)*	*Semimajor Axis Length (L)*
Earth	0.034 AU	2 AU
Mars	0.284 AU	1.524 AU

Student Checklist:

- ❑ I calculated the eccentricity of Earth's orbit and showed my work.
- ❑ I calculated the eccentricity of Mars's orbit and showed my work.
- ❑ I labeled the ellipse showing d and L.

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Task 3: I can model using proper scale the distance traveled by Earth and Mars during an amount of time.

Materials:

- Short string segment
- Medium String segment
- Markers

Directions:

1. Using the data below, identify which string should be used to model the distance traveled by Earth in orbit and which string should be used to model the distance traveled by Mars in orbit. Explain your decision in the box on the right.
2. Starting on the **right** side of the orbit path, place the string along the arch of the orbit path. Use a marker to place a dot at the start and end of the string. Move the string down orbit path, creating same distance segments.
3. Label the dots with letters. Start on the **right** and work left.
4. Repeat 2 and 3 with Mars's orbit.
5. Explain why one planet moves faster than the other.

Student Explanation:

Which string was used for which orbit and why?

We used the _____ string for Earth's orbit because

_____

_____

_____.

We used the _____ string for Mars's orbit because

_____

_____

_____

Which planet moves faster and why?

_____ *moves faster than* _____

because _____

_____

Data:

Orbital Velocity of Earth and Mars

Planet	Average Orbital Velocity
Earth	29.79 km/s
Mars	24.13 km/s

Student Checklist:

- ❑ I marked how far Earth travels in a given length of time throughout the orbit.
- ❑ I labeled the dots drawn with letters starting on the right for Earth's orbit.
- ❑ I marked how far Mars travels in a given length of time throughout the orbit.
- ❑ I labeled the dots drawn with letters starting on the right for Mar's orbit.
- ❑ I answered the two questions.

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Task 4: I can use a model to make a prediction about the proportion between the area a planet "sweeps out" during its orbit during the same amount of time.

Materials:

- Meterstick
- Marker

Directions:

1. **On EARTH'S ORBIT** choose 2 letters next to each other (ex: A & B or D & E). From both points, draw a dotted line to the sun. (This should create like a triangle).
2. **STILL USING EARTH'S ORBIT** choose 2 different letters next to each other (ex: A & B or D & E). From both points, draw a dotted line to the sun. (This should create like a triangle).
3. Label one segment you created "Area 1" and the other "Area 2".
4. Explain how the two areas relate to each other (ie. bigger/ smaller/ same size) in the box on the right.

Student Explanation:

How do the two areas relate to each other? How do you know?

The area of Area 1 is _____ *as the area of Area 2. I know this because* _____

_____

_____

_____

_____

_____

Data:

Orbital Velocity of Earth and Mars

Planet	Average Orbital Velocity
Earth	29.79 km/s
Mars	24.13 km/s

Student Checklist:

- ❑ I drew dotted lines from 2 letters to the sun to create a "triangle"
- ❑ I drew dotted lines from 2 different letters to the sun to create a second "triangle"
- ❑ I labeled one "triangle" area 1 and one "triangle" area 2.
- ❑ I answered the question.

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Task 5: I can create a video model using proper scale showing the orbits of Earth and Mars from the perspective of the sun.

Materials:

- Play-doh
- Big Paper
- Chromebook/ Phone
- Stop Motion Animation Program

Directions:

1. Create a play-doh ball for the Earth, Mars and Sun. Use the data below to make sure Earth and Mars are about the right size relative to each other. Remember the sun is bigger than both Earth and Mars.
2. Place your Sun on the Foci labeled Sun
3. Place your **Earth** on the Earth's orbit path **starting at LETTER A.**
4. Place your **Mars** on Mars's orbit path **starting at LETTER B.**
5. Place your device at the bottom of the paper. Pretend your camera is "standing on the sun". Take the first picture
6. Move the planets one letter to the left. Take the next picture. Repeat this until you have taken 6 pictures (Earth should be on letter F and Mars should be on letter G)
7. Using the animation program, put the 6 pictures together to make a video clip.
8. Explain what is happening in the video clip.

Student Explanation:

What is this video model showing? Why is this happening?

In this video, we can see Earth's orbit is _____ *when compared to Mars's orbit. Because Earth travels* _____ *, the video shows Earth catch up and* _____ *Mars. This is because Earth is* _____ *to the sun than Mars. This relates to Kepler's Third law because* _____

_____

_____

Data:

Diameter of Earth and Mars

Planet	*Diameter (Size)*
Earth	12750 km
Mars	6790 km

Student Checklist:

- ❑ I created a Mars, Earth and Sun out of Play-doh
- ❑ I labeled the dots drawn with letters starting on the right for Mars's orbit.
- ❑ I created a video showing Earth's and Mars's orbit from the perspective of the sun.
- ❑ I explained what is happening in the video.

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Task 6: I can create a video model showing the pattern of the retrograde motion of Mars from the perspective of Earth

Materials:

- Play-doh
- Big Paper
- Chromebook/ Phone
- Stop Motion Animation Program

Directions:

1. Using the play-doh balls for the Earth, Mars and Sun from the last task, place your Sun on the Foci labeled Sun;
2. Place your **Earth** on the Earth's orbit path **starting at LETTER A.**
3. Place your **Mars** on Mars's orbit path **starting at LETTER B.**
4. Place a pin through the middle of your Earth and Mars.
5. Spin your Play-doh Earth and Mars so the pins are pointing at each other.
6. Pretend your camera is "standing on Earth and looking in the direction of the pin". Take the first picture
7. Move the planets one letter to the left. Line up the pins. Take the next picture. Repeat this until you have taken 6 pictures (Earth should be on letter F and Mars should be on letter G)
8. Using the animation program, put the 6 pictures together to make a video clip.
9. Explain what is happening in the video clip.

Diameter of Earth and Mars

Planet	*Diameter (Size)*
Earth	12750 km
Mars	6790 km

Student Explanation:

What is the retrograde motion of Mars? Why is this happening?

The retrograde motion of Mars is the illusion where

_____

_____

This happens because of two factors. First, Earth's orbit is has a _____ *eccentricity than Mars. This means the orbit is more like a* _____. *Second, Earth travels* _____ *compared to Mars. The video shows Earth catch up and* _____ *Mars. This is because Earth is* _____ *to the sun than Mars. What happens in retrograde motion is Earth catches up and* _____ *Mars. When this happens, Mars appears to travel* _____ *from the perspective of Earth as shown in the video.*

Student Checklist:

- ❑ I created a Mars, Earth and Sun out of Play-doh
- ❑ I created a video showing Earth's and Mars' orbit from the perspective of Earth.
- ❑ I explained the retrograde motion of Mars.