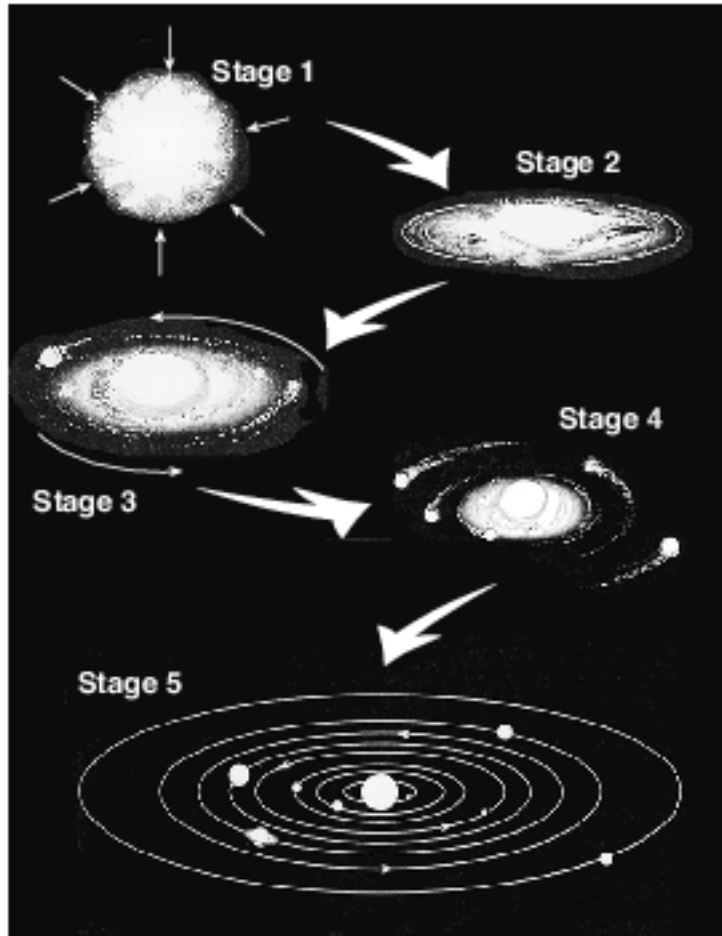


## Gravity

Base your answers to questions 1 on the diagram below. The diagram represents the inferred stages in the formation of our solar system. Stage 1 shows a contracting gas cloud. The remaining stages show the gas cloud flattening into a spinning disk as planets formed around our Sun.



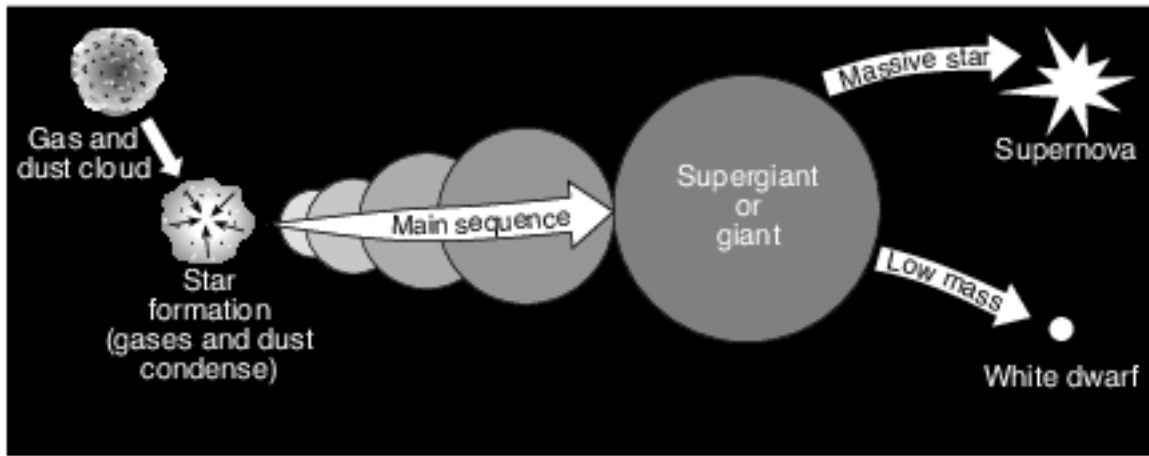
(Not drawn to scale)

1 Which force was mostly responsible for the contraction of the gas cloud?

- (1) friction
- (2) gravity

- (3) magnetism
- (4) inertia

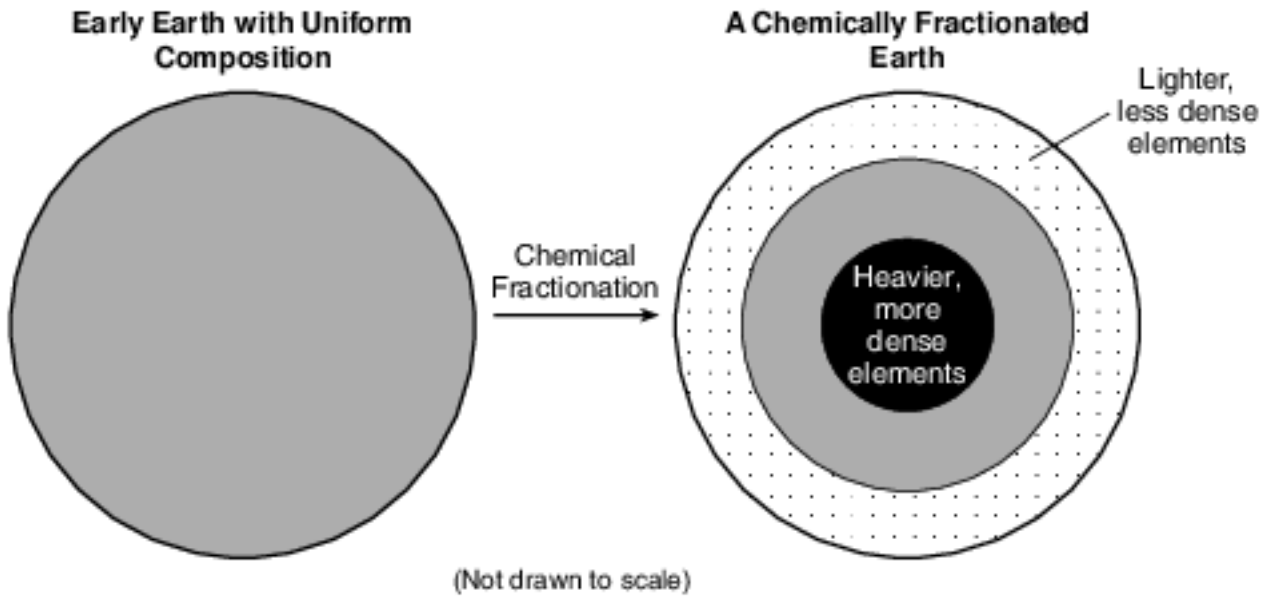
Base your answers to questions 2 on the diagram below and on your knowledge of Earth science. The diagram represents the inferred origin and evolution of most stars.



- 2 What causes the gas and dust cloud to condense and become a star?
- (1) density
  - (2) friction
  - (3) gravity
  - (4) outgassing
- 3 Which statement best explains why Earth and the other planets of our solar system became layered as they were being formed?
- (1) Gravity caused less-dense material to move toward the center of each planet.
  - (2) Gravity caused more-dense material to move toward the center of each planet.
  - (3) Materials that cooled quickly stayed at the surface of each planet.
  - (4) Materials that cooled slowly stayed at the surface of each planet.
- 4 Which two factors caused the interior layering of Earth and other planets in our solar system during their formation?
- (1) cosmic background radiation and density differences
  - (2) cosmic background radiation and specific heat
  - (3) gravity and density differences
  - (4) gravity and specific heat

Base your answers to questions 5 on the information and diagram below and on your knowledge of Earth science. The diagram represents a simplified model of the early formation of Earth's interior.

Early in its formation, Earth was a molten mass of evenly mixed composition. During the next few million years, the heavier and more dense elements sank to the center, while lighter and less dense elements rose toward the surface. This is called chemical fractionation.



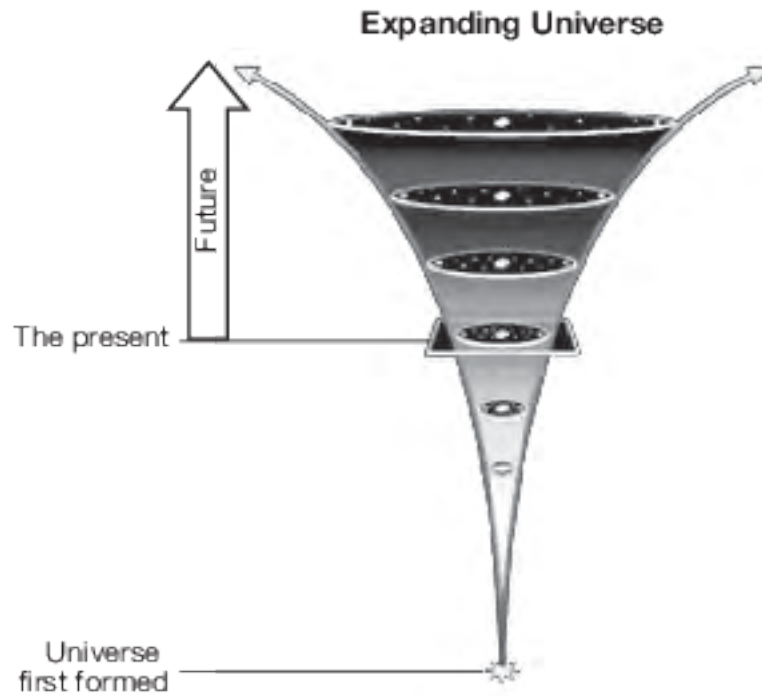
5 Chemical fractionation is most likely caused by

- (1) solidification
- (2) gravity
- (3) magnetic force
- (4) chemical weathering

Base your answers to questions 6 on the diagram in image provided, which represents eight positions of the Moon in its orbit around Earth.

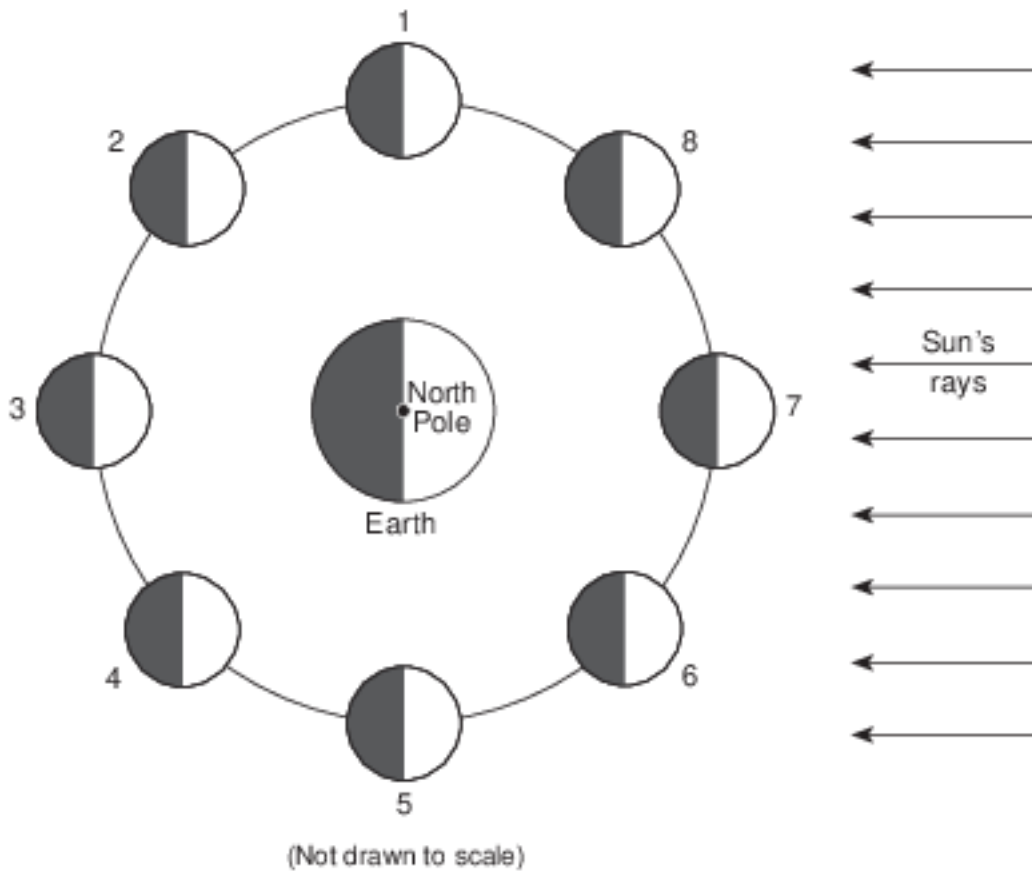
6 Explain why the Moon's gravity has a greater effect on Earth's ocean tides than the Sun's gravity. [1]

Base your answers to questions 7 on the diagram below and on your knowledge of Earth science. The diagram represents a model of the expanding universe.



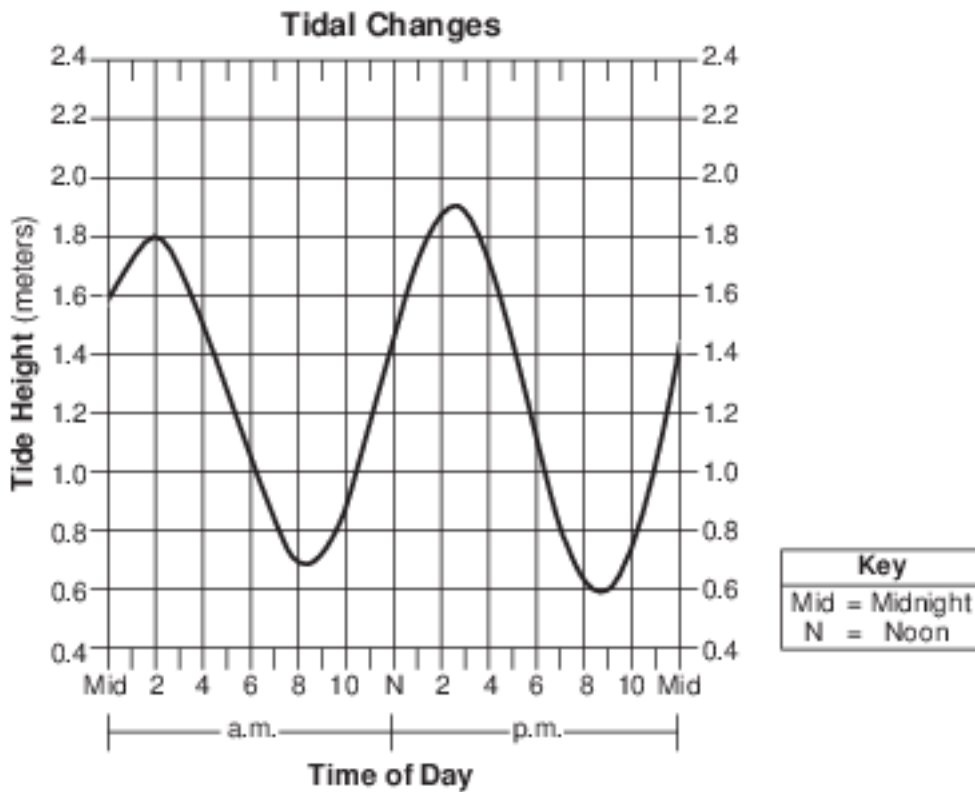
- 7 Identify the force that caused stars and planets in the universe to become layered according to density differences in their composition. [1]

Base your answers to questions 8 on the diagram below and on your knowledge of Earth science. The diagram represents the Moon at eight numbered positions in its orbit around Earth. The nighttime sides of the Moon and Earth are shaded.



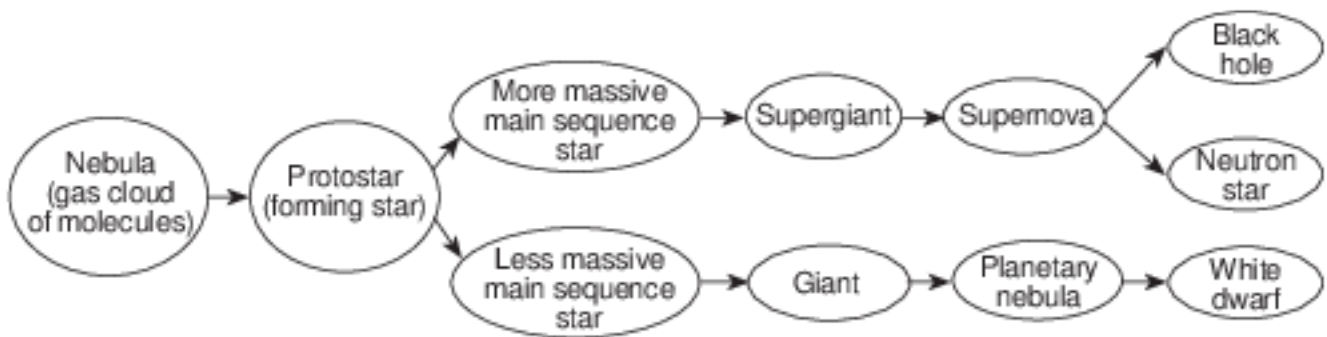
8 Explain why the Moon's orbital velocity is slowest when the Moon is farthest from Earth. [1]

Base your answers to questions 9 on the graph below and on your knowledge of Earth science. The graph shows the changes in ocean tide height at a New York State location during 1 day.



9 Explain why the Moon has a greater influence on Earth tides than the Sun. [1]

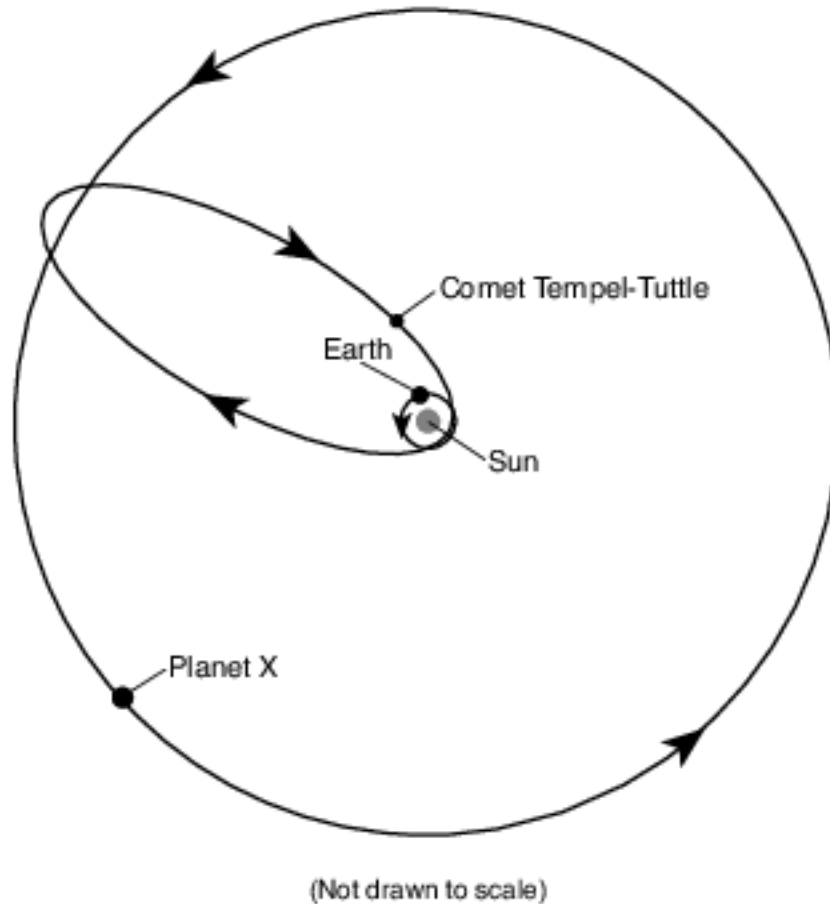
Base your answers to questions 10 on the flowchart below and on your knowledge of Earth science. The flowchart shows the evolution of stars.



10 Identify the force responsible for the contraction of a nebula (a gas cloud of molecules) to form a protostar. [1]

Base your answers to questions 11 on the diagram and passage below and on your knowledge of Earth science. The diagram represents the orbits of Earth, Comet Tempel-Tuttle, and planet X, another planet in our solar system. Arrows on each orbit represent the direction of movement.

**Orbit of Comet Tempel-Tuttle**

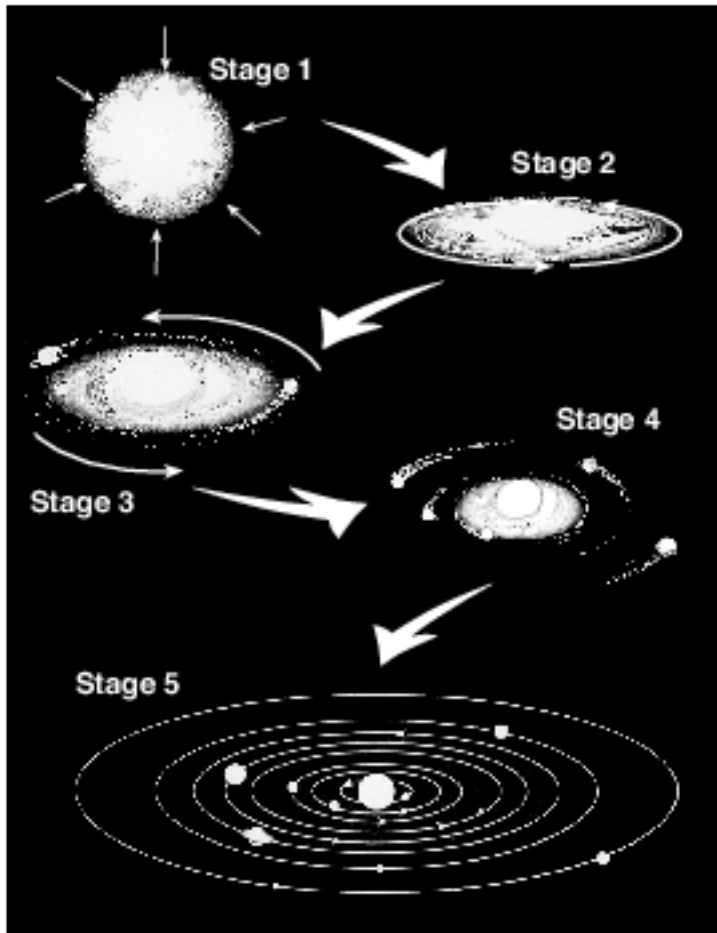


### Comet Tempel-Tuttle

Comet Tempel-Tuttle orbits our Sun and is responsible for the Leonid meteor shower event observed from Earth. This meteor shower occurs every year in November and is visible in the night sky as Earth passes through the debris left in space by this comet. The debris from the comet produces meteors that are smaller than a grain of sand, which enter Earth's atmosphere and burn up in the mesosphere temperature zone. Comet Tempel-Tuttle's orbital distance from the Sun ranges from about 145 million kilometers at its closest approach to 2900 million kilometers at its farthest distance. Its two most recent closest approaches to the Sun occurred in 1965 and one revolution later in 1998.

11 Identify the force that causes debris from the comet to fall through Earth's atmosphere. [1]

Base your answers to questions 12 on the diagram below and on your knowledge of Earth science. The diagram represents five inferred stages in the formation of our solar system. Stage 1 represents a contracting gas cloud. Stages 2 through 4 represent the gas cloud flattening into a spinning disk as planets formed around our Sun. Stage 5 represents the final stage in the formation of the solar system.



(Not drawn to scale)

12 Identify the force that was primarily responsible for contracting the gas cloud in stage 1. [1]



Base your answers to questions 13 on the table below and on your knowledge of Earth science. The table lists the average surface temperature, in kelvins, and the average orbital velocity, in kilometers per second, of each planet of our solar system.

**Data Table**

<b>Planet</b>	<b>Average Surface Temperature (K)</b>	<b>Average Orbital Velocity (km/s)</b>
Mercury	440	47.87
Venus	737	35.00
Earth	288	29.78
Mars	208	24.13
Jupiter	163	13.07
Saturn	133	9.69
Uranus	78	6.81
Neptune	73	5.43

- 13 The orbital velocity of Earth is sometimes faster and sometimes slower than its average orbital velocity. Explain why the orbital velocity of Earth varies in a cyclic pattern. [1]

## Answer Keys

1 2

2 3

3 2

4 3

5 2

6 Allow 1 credit. Acceptable responses include, but are not limited to:

- — The Moon is closer to Earth so gravity is greater.
- — The Sun is much farther away.

7 Allow 1 credit. Acceptable responses include, but are not limited to:

- — gravity
- — gravitational attraction/gravitational pull

8 Allow 1 credit. Acceptable responses include, but are not limited to:

- — The gravitational attraction between the Moon and Earth is least when they are farthest apart.
- — The force of gravity is less.
- — Gravitational attraction is greater when the Moon is closer to Earth.

9 Allow 1 credit. Acceptable responses include, but are not limited to:

- — The Moon is closer to Earth.
- — The Moon's gravitational pull is stronger because the Moon is closer to Earth than the Sun is.
- Note: Do not allow credit for "The Moon's gravity is stronger" alone because the Moon's distance from Earth is not described.

10 Allow 1 credit. Acceptable responses include, but are not limited to:

- — gravity
- — gravitational attraction

11 Allow 1 credit for gravity or gravitation or gravitational pull.

12 Allow 1 credit for gravity or gravitational force.

13 Allow 1 credit. Acceptable responses include, but are not limited to:

- — Earth's distance to the Sun changes in a cyclic pattern.
- — Gravity is greater when Earth is closer to the Sun.
- — Earth moves slower when it is farther from the Sun.
- — Earth has an elliptical/slightly eccentric orbit.