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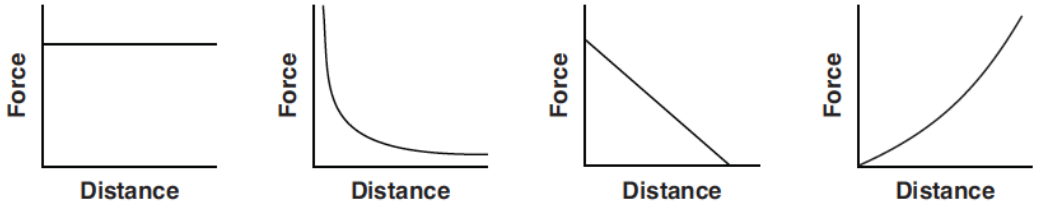
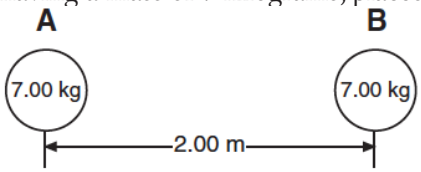
UCM-Gravity

1. A space probe is launched into space from Earth's surface. Which graph represents the relationship between the magnitude of the gravitational force exerted on Earth by the space probe and the distance between the space probe and the center of Earth?



(1) (2) (3) (4)

2. The diagram shows two bowling balls, A and B, each having a mass of 7 kilograms, placed 2 meters apart.



What is the magnitude of the gravitational force exerted by ball A on ball B?
1. 8.17×10^{-9} N
2. 1.63×10^{-9} N
3. 8.17×10^{-10} N
4. 1.17×10^{-10} N

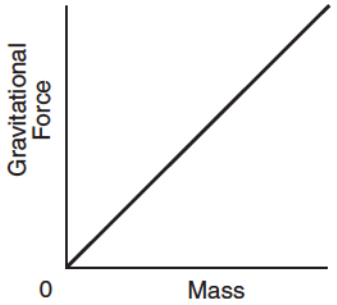
3. A 60-kg physics student would weigh 1560 N on the surface of planet X. What is the magnitude of the acceleration due to gravity on the surface of planet X?
1. 0.038 m/s^2
2. 6.1 m/s^2
3. 9.8 m/s^2
4. 26 m/s^2

4. Earth's mass is approximately 81 times the mass of the Moon. If Earth exerts a gravitational force of magnitude F on the Moon, the magnitude of the gravitational force of the Moon on Earth is
1. F
2. F/81
3. 9F
4. 81F

5. An object weighs 100 newtons on Earth's surface. When it is moved to a point one Earth radius above Earth's surface, it will weigh
1. 25 N
2. 50 N
3. 100 N
4. 400 N

6. A container of rocks with a mass of 65 kilograms is brought back from the Moon's surface where the acceleration due to gravity is 1.62 meters per second^2. What is the weight of the container of rocks on Earth's surface?
1. 638 N
2. 394 N
3. 105 N
4. 65 N

7. The graph below represents the relationship between gravitational force and mass for objects near the surface of Earth.



The slope of the graph represents the
1. acceleration due to gravity
2. universal gravitational constant
3. momentum of objects
4. weight of objects

8. A person weighing 785 newtons on the surface of Earth would weigh 298 newtons on the surface of Mars. What is the magnitude of the gravitational field strength on the surface of Mars?
1. 2.63 N/kg
2. 3.72 N/kg
3. 6.09 N/kg
4. 9.81 N/kg

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Base your answers to questions 9 through 11 on the passage and data table below.

The net force on a planet is due primarily to the other planets and the Sun. By taking into account all the forces acting on a planet, investigators calculated the orbit of each planet.

A small discrepancy between the calculated orbit and the observed orbit of the planet Uranus was noted. It appeared that the sum of the forces on Uranus did not equal its mass times its acceleration, unless there was another force on the planet that was not included in the calculation. Assuming that this force was exerted by an unobserved planet, two scientists working independently calculated where this unknown planet must be in order to account for the discrepancy. Astronomers pointed their telescopes in the predicted direction and found the planet we now call Neptune.

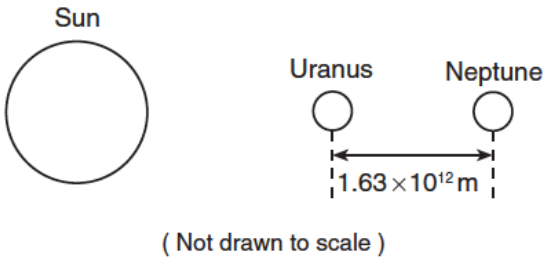
Data Table

Mass of the Sun	1.99×10^{30} kg
Mass of Uranus	8.73×10^{25} kg
Mass of Neptune	1.03×10^{26} kg
Mean distance of Uranus to the Sun	2.87×10^{12} m
Mean distance of Neptune to the Sun	4.50×10^{12} m

9. What fundamental force is the author referring to in this passage as a force between planets?

10. The diagram at right represents Neptune, Uranus, and the Sun in a straight line. Neptune is 1.63×10^{12} meters from Uranus.

    Calculate the magnitude of the interplanetary force of attraction between Uranus and Neptune at this point. [Show all work, including the equation and substitution with units.]



(Not drawn to scale)

11. The magnitude of the force the Sun exerts on Uranus is 1.41×10^{21} newtons. Explain how it is possible for the Sun to exert a greater force on Uranus than Neptune exerts on Uranus.

12. When Earth and the Moon are separated by a distance of 3.84×10^{8} meters, the magnitude of the gravitational force of attraction between them is 2.0×10^{20} newtons. What would be the magnitude of this gravitational force of attraction if Earth and the Moon were separated by a distance of 1.92×10^{8} meters?
    1. 5.0×10^{19} N
    2. 2.0×10^{20} N
    3. 4.0×10^{20} N
    4. 8.0×10^{20} N

13. An astronaut weighs 8.00×10^{2} newtons on the surface of Earth. What is the weight of the astronaut 6.37×10^{6} meters above the surface of Earth?
    1. 0.00 N
    2. 2.00×10^{2} N
    3. 1.60×10^{3} N
    4. 3.20×10^{3} N

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UCM-Gravity

Base your answers to questions 14 and 15 on the information and table below.

The weight of an object was determined at five different distances from the center of Earth. The results are shown in the table below. Position A represents results for the object at the surface of Earth.

Position	Distance from Earth's Center (m)	Weight (N)
A	6.37×10^6	1.0×10^3
B	1.27×10^7	2.5×10^2
C	1.91×10^7	1.1×10^2
D	2.55×10^7	6.3×10^1
E	3.19×10^7	4.0×10^1

14. The approximate mass of the object is
    1. 0.01 kg
    2. 10 kg
    3. 100 kg
    4. 1,000 kg

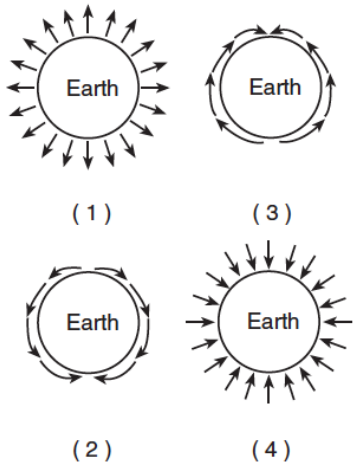
15. At what distance from the center of Earth is the weight of the object approximately 28 newtons?
    1. 3.5×10^7 m
    2. 3.8×10^7 m
    3. 4.1×10^7 m
    4. 4.5×10^7 m

16. Gravitational forces differ from electrostatic forces in that gravitational forces are
    1. attractive, only
    2. repulsive, only
    3. neither attractive nor repulsive
    4. both attractive and repulsive

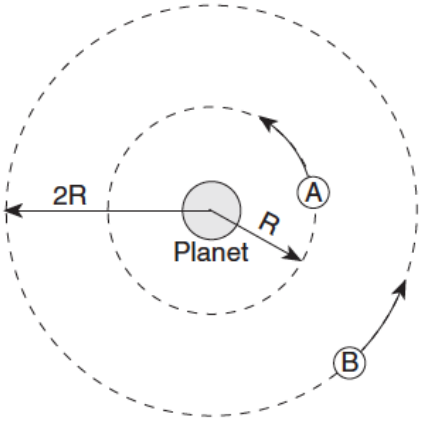
17. The gravitational force of attraction between Earth and the Sun is 3.52×10^{22} newtons. Calculate the mass of the Sun. [Show all work, including the equation and substitution with units.]

18. A 5.0-kilogram sphere, starting from rest, falls freely 22 meters in 3.0 seconds near the surface of a planet. Compared to the acceleration due to gravity near Earth's surface, the acceleration due to gravity near the surface of the planet is approximately
    1. the same
    2. twice as great
    3. one-half as great
    4. four times as great

19. Which diagram best represents the gravitational field lines surrounding Earth?



20. The diagram below represents two satellites of equal mass, A and B, in circular orbits around a planet.



Compared to the magnitude of the gravitational force of attraction between satellite A and the planet, the magnitude of the gravitational force of attraction between satellite B and the planet is
    1. half as great
    2. twice as great
    3. one-fourth as great
    4. four times as great

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Base your answers to questions 21 and 22 on the information below. [Show all work, including the equation and substitution with units.]

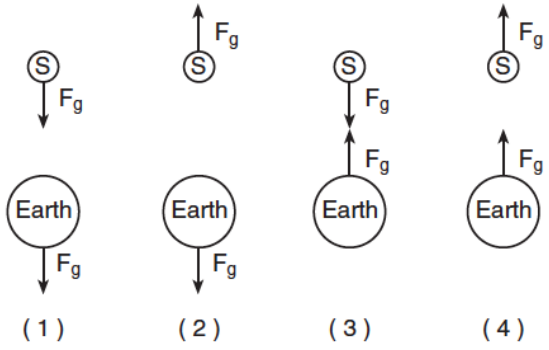
Io (pronounced "EYE oh") is one of Jupiter's moons discovered by Galileo. Io is slightly larger than Earth's Moon.

The mass of Io is 8.93×10^{22} kilograms and the mass of Jupiter is 1.90×10^{27} kilograms. The distance between the centers of Io and Jupiter is 4.22×10^{8} meters.

21. Calculate the magnitude of the gravitational force of attraction that Jupiter exerts on Io.

22. Calculate the magnitude of the acceleration of Io due to the gravitational force exerted by Jupiter.

23. Which diagram best represents the gravitational forces, F_g, between a satellite, S, and Earth?



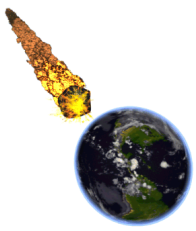
24. Two physics students have been selected by NASA to accompany astronauts on a future mission to the Moon. The students are to design and carry out a simple experiment to measure the acceleration due to gravity on the surface of the Moon.

Describe an experiment that the students could conduct to measure the acceleration due to gravity on the Moon. Your description must include:

- the equipment needed
- what quantities would be measured using the equipment
- what procedure the students should follow in conducting their experiment
- what equations and/or calculations the students would need to do to arrive at a value for the acceleration due to gravity on the Moon.

25. As a meteor moves from a distance of 16 Earth radii to a distance of 2 Earth radii from the center of Earth, the magnitude of the gravitational force between the meteor and Earth becomes

1. 1/8 as great
2. 8 times as great
3. 64 times as great
4. 4 times as great



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26. A 25-kilogram space probe fell freely with an acceleration of 2 meters per second^2 just before it landed on a distant planet. What is the weight of the space probe on that planet?
    1. 12.5 N
    2. 25 N
    3. 50 N
    4. 250 N

27. The acceleration due to gravity on the surface of planet X is 19.6 meters per second^2. If an object on the surface of this planet weighs 980 newtons, the mass of the object is
    1. 50 kg
    2. 100 kg
    3. 490 N
    4. 908 N

28. What is the acceleration due to gravity at a location where a 15-kilogram mass weighs 45 newtons?
    1. 675 m/s^2
    2. 9.81 m/s^2
    3. 3.00 m/s^2
    4. 0.333 m/s^2

29. As an astronaut travels from the surface of Earth to a position that is four times as far away from the center of Earth, the astronaut's
    1. mass decreases
    2. mass remains the same
    3. weight increases
    4. weight remains the same

30. A satellite weighs 200 newtons on the surface of Earth. What is its weight at a distance of one Earth radius above the surface of Earth?
    1. 50 N
    2. 100 N
    3. 400 N
    4. 800 N

31. A 2.00-kilogram object weighs 19.6 newtons on Earth. If the acceleration due to gravity on Mars is 3.71 meters per second^2, what is the object's mass on Mars?
    1. 2.64 kg
    2. 2.00 kg
    3. 19.6 N
    4. 7.42 N

32. A 1200-kilogram space vehicle travels at 4.8 meters per second along the level surface of Mars. If the magnitude of the gravitational field strength on the surface of Mars is 3.7 newtons per kilogram, the magnitude of the normal force acting on the vehicle is
    1. 320 N
    2. 930 N
    3. 4400 N
    4. 5800 N

33. What is the weight of a 2.00-kilogram object on the surface of Earth?
    1. 4.91 N
    2. 2.00 N
    3. 9.81 N
    4. 19.6 N

34. A 2.0-kilogram object is falling freely near Earth's surface. What is the magnitude of the gravitational force that Earth exerts on the object?
    1. 20 N
    2. 2.0 N
    3. 0.20 N
    4. 0.0 N

35. Calculate the magnitude of the centripetal force acting on Earth as it orbits the Sun, assuming a circular orbit and an orbital speed of 3.00×10^4 meters per second. [Show all work, including the equation and substitution with units.]

36. On a small planet, an astronaut uses a vertical force of 175 newtons to lift an 87.5-kilogram boulder at constant velocity to a height of 0.350 meter above the planet's surface. What is the magnitude of the gravitational field strength on the surface of the planet?
    1. 0.500 N/kg
    2. 2.00 N/kg
    3. 9.81 N/kg
    4. 61.3 N/kg

37. Calculate the magnitude of the average gravitational force between Earth and Moon. [Show all work, including the equation and substitution with units.]

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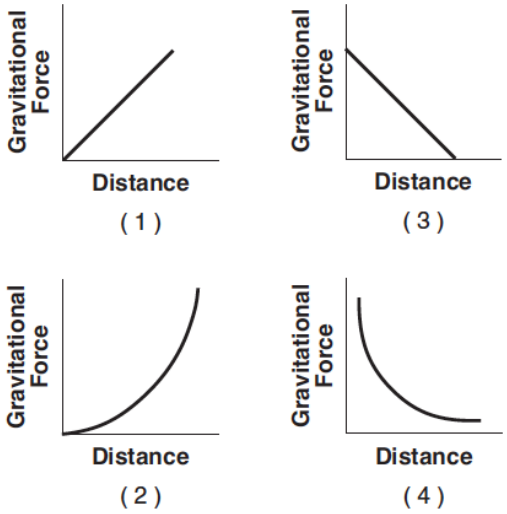
38. Which graph represents the relationship between the magnitude of the gravitational force exerted by Earth on a spacecraft and the distance between the center of the spacecraft and center of Earth? [Assume constant mass for the spacecraft.]



39. In which diagram do the field lines best represent the gravitational field around Earth?