Gravity Concept Inventory
Version 2

Please answer the following questions about Newtonian gravity to the best of your ability. This questionnaire is for research purposes only, so your performance will NOT affect your grade in any way, and your participation is optional. Your student ID number will be used for matching your responses to other data, but your information will be destroyed after the study is over.

SELECT THE SINGLE BEST CHOICE

1. Besides the force of gravity, which of the following factors hold(s) us to the Earth’s surface?
   a. Air pressure from the Earth’s atmosphere.
   b. Forces from the Earth’s spinning motion.
   c. Magnetism from the Earth’s magnetic field.
   d. More than one of the above factors.
   e. No other factors; gravity is the only one.

2. How would the gravitational force between the Earth and Moon change if the Moon were located twice as far from Earth as it is now?
   a. The force would become two times weaker.
   b. The force would not change.
   c. The force would become two times stronger.
   d. None of the above is correct.

3. Two astronauts are floating in space very far away from any planets or stars. What is the direction of the gravitational force that they experience, if any?
   a. Toward each other, because there is a gravitational force between them.
   b. Away from each other because they are pulled by distant planets and stars.
   c. They experience a gravitational force, but its direction cannot be determined.
   d. They do not experience a gravitational force because there is no large object nearby.

4. Astronauts appear weightless in their Earth-orbiting spacecraft because:
   a. They have escaped Earth’s gravity.
   b. There is no air in the spacecraft.
   c. They are moving at the same speed as their spacecraft.
   d. The spacecraft’s rocket engines counteract gravity.

5. The factors that most affect the gravitational force between two objects are:
   a. size and distance
   b. mass and size
   c. density and distance
   d. mass and distance
   e. density and size
6. Planets A, B and C are identical. A and C each have a moon of mass 2M orbiting them, while B has an artificial satellite of mass M orbiting it, as shown in the diagram. Which planet has the strongest gravitational interaction with its orbiting body?

a. Planet A  
b. Planet B  
c. Planet C  
d. All the same.  
e. Not enough information given to determine.

7. Satellites B is three times more massive than A, but orbiting the planet at three times the distance. Compare the force of gravity between each satellite and the planet. The diagram is not to scale.

a. A experiences a stronger force than B.  
b. B experiences a stronger force than A.  
c. A and B experience the same force.  
d. A and B experience no force at all.

8. Assuming the Earth is perfectly round and each person is the same mass, which person standing on Earth’s surface experiences a stronger force of gravity?

a. Both A and D  
b. B  
c. C  
d. D  
e. All the same

9. Why does the Earth exert a gravitational force on objects on its surface?

a. It has an atmosphere  
b. It is very dense.  
c. It has a magnetic field.  
d. It has mass.  
e. It rotates.

10. Suppose the Sun shrank in size but its mass remained the same so that it was compacted much more densely. How would the gravitational force experienced by the Earth change?

a. Earth would experience a weaker gravitational force.  
b. Earth would experience the same gravitational force.  
c. Earth would experience a stronger gravitational force.  
d. It cannot be determined with the given information.
11. What is the relationship between a planet’s gravity and its atmosphere?
   a. Atmosphere represents a boundary where objects can experience a gravitational force.
   b. Atmosphere causes objects on the surface to experience a stronger gravitational force.
   c. The gravitational force holds the particles in the atmosphere close to the planet.
   d. None of the above is correct.

12. Each planet below has the same mass M and an identical rocket orbiting at a distance D. The darker the planet, the denser the material. Which rocket experiences a stronger force of gravity?

   a. A
   b. B
   c. Both the same
   d. Not enough information given to determine.

13. The gravitational force between two objects is approximately zero:
   a. when another object lies in-between the two original objects.
   b. when the distance between them becomes extremely large.
   c. at a location halfway between the two objects.
   d. when they are balanced in a stable orbit around one another.
   e. when the two objects are not moving.

14. The following diagram shows two smaller planets of mass m and one larger planet of mass 4m, each separated by distance d.

   The gravitational force by Planet C on Planet A ______ that by Planet B on Planet A.
   a. is less than
   b. is equal to
   c. is greater than
   d. cannot be compared with the given information to.

15. Assume that planets X and Y have the same mass, but planet X is made of a denser material. At which point would a rocket experience a gravitational force from planet X that is equal to that from planet Y? The black dot shows the midpoint between the planets.

   a. At point A, because planet Y is bigger.
   b. At point B, because planets X and Y have the same mass.
   c. At point C, because planet X is more dense.
   d. The rocket does not experience a gravitational force with X or Y, because it is in space.
   e. None of the above is correct.
16. Consider an irregular-shaped asteroid of constant density shown below. Which arrow best represents the direction of the gravitational force on the ball?

   a. A, because it points to the center of mass of the asteroid.
   b. B, because it points to the geometric center of the asteroid.
   c. C, because it points straight down to directly below the ball.
   d. D, because it points to the edge nearest the ball.

17. An astronaut standing on the Moon’s surface has a pen in his hand and releases it. What happens to the pen?

   a. It falls to the surface at a slower rate than it would on Earth.
   b. It falls to the surface at the same rate as it would on Earth.
   c. It doesn’t fall and floats where it is.
   d. It doesn’t fall and slowly drifts away.

18. Does an Earth-orbiting satellite or the Moon experience a greater force of gravity from the Earth?

   a. The satellite, because it is much closer to Earth.
   b. The moon, because it is much more massive.
   c. They experience the same force, because they both orbit.
   d. Neither experiences a force, because they are in space.
   e. Not enough information given to determine.

19. Theoretically, how far away from the Earth do you have to go to feel zero gravitational force from the Earth?

   a. Outside the atmosphere
   b. The orbit of the Moon
   c. The orbit of Mars
   d. Outside the solar system
   e. An infinite distance

20. Satellite B is three times more massive than Satellite A. Which satellite experiences a stronger gravitational attraction with the Earth?

   a. Neither, since they are in space.
   b. Neither, they are at the same distance.
   c. A, since it is easier to move.
   d. B, since it has more mass.
   e. None of the above is correct.

21. Which of the following would make you weigh half as much as you do right now?

   a. Take away half of the Earth’s atmosphere.
   b. Take away half of the Earth’s mass.
   c. Take away half of the Earth’s magnetic field.
   d. Make the Earth spin half as fast.
   e. Move Earth twice as far from the Sun.
22. The reason why your weight at the cloudy surface of Saturn is similar to that on Earth is that:
   a. Saturn has the same mass as Earth, and your weight depends only on the planet’s mass.
   b. Saturn’s large size would cause you to weigh more, but the rings counter the effect.
   c. Saturn is much more massive, but on its surface you are further from its center.
   d. Saturn is much more massive, but it is also much farther from the Sun.
   e. None of the above is correct.

23. Which graph best represents the gravitational force \( F \) that a rocket experiences as it travels a distance \( D \) away from the surface of the Earth? Note that \( R_{\text{atm}} \) represents the edge of the atmosphere.

   ![Graphs A, B, C, and D]

24. Which one of the following statements about gravity and magnetism is true?
   a. Gravity cannot exist without magnetism.
   b. Gravity is not affected by magnetism.
   c. Magnetism increases a planet’s gravity.
   d. Magnetism cancels out a planet’s gravity.

25. A person is living on a planet where a huge hole has been carved out. Which arrow best represents the direction of the gravitational force he experiences?

   ![Diagram of Sun, Moon, Person, and Mars]
   a. A, because it points along the surface with the most mass.
   b. B, because it points directly to the center of mass.
   c. C, because it points straight down to the center.
   d. D, because it points to the hole and he would fall in.

26. Of the objects listed at right, which experiences a gravitational force from the Earth?
   a. None of them
   b. Person only
   c. Moon and Person
   d. Moon, Person, and Sun
   e. All of them
27. In the diagram below, at which point would a spacecraft traveling from the Earth to the Moon experience a gravitational force from the Earth that is equal to the force it would feel from the Moon? Note that B is at the midpoint between the Earth and the Moon.

a. A, the spacecraft is closer to Earth and Earth is more massive.
b. B, the spacecraft is exactly halfway between Earth and the Moon.
c. C, the spacecraft is further from Earth and Earth is more massive.
d. All points are the same, since the spacecraft is in space.

Demographic questions

28. How many astronomy and/or physics courses have you taken before this one?
   a. 0
   b. 1
   c. 2
   d. more than 2

29. What is your gender?
   a. Male
   b. Female

---

i Adapted from E.E. Prather’s assessment.
ii Adapted from a question by Philip Blanco.
iii Adapted from J. Dostal’s Master Thesis.
iv Adapted from the TOAST.