

Solutions to Period 4 Exercises

E.1 The gravitational force between two objects

- a) increases as the distance between them increases.
- b) decreases as the distance between them increases.
- c) acts to push objects apart.
- d) is felt more by the object with smaller mass.
- e) is felt more by the object with larger mass.

E.1 = b

E.2 Which exerts a larger force on the moon, the sun or the Earth?

Distance from moon to Earth = 3.84×10^8 m

Distance from moon to sun = 1.50×10^{11} m

Mass of the Earth = 5.98×10^{24} kg

Mass of the sun = 2.00×10^{30} kg

Mass of the moon = 7.36×10^{22} kg

$$F = \frac{G M_1 M_2}{D^2}$$

Force of the **Sun on the Moon** =

$$\frac{(6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2) \times 2.00 \times 10^{30} \text{ kg} \times 7.36 \times 10^{22} \text{ kg}}{(1.50 \times 10^{11} \text{ m})^2}$$

$$\frac{(6.67 \times 10^{-11} \text{ N } \cancel{\text{m}^2/\text{kg}^2}) \times (14.72 \times 10^{52} \cancel{\text{kg}^2})}{2.25 \times 10^{22} \cancel{\text{m}^2}}$$

$$\frac{98.18 \times 10^{41} \text{ N}}{2.25 \times 10^{22}} = 43.6 \times 10^{19} \text{ N} = \mathbf{4.36 \times 10^{20} \text{ N}}$$

Force of the **Earth on the Moon** =

$$\frac{(6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2) \times 5.98 \times 10^{24} \text{ kg} \times 7.36 \times 10^{22} \text{ kg}}{(3.84 \times 10^8 \text{ m})^2}$$

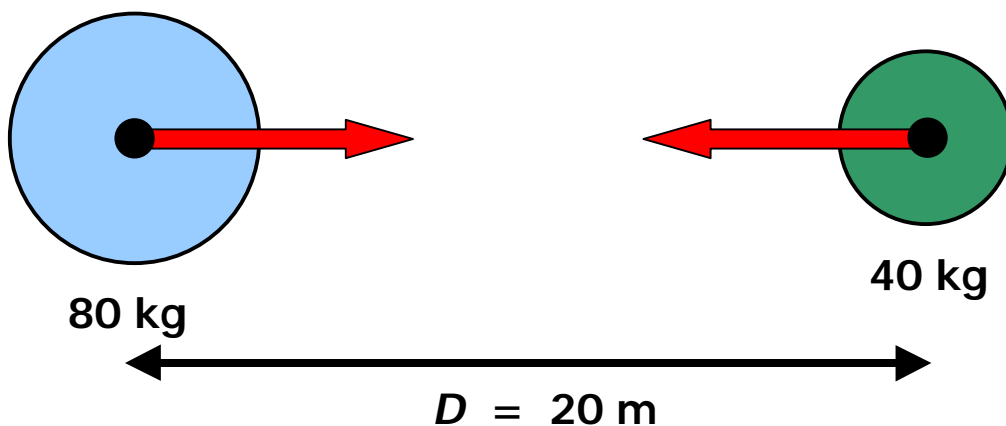
$$\frac{(6.67 \times 10^{-11} \text{ N } \cancel{\text{m}^2/\text{kg}^2}) \times 44.01 \times 10^{46} \cancel{\text{kg}^2}}{1.47 \times 10^{17} \cancel{\text{m}^2}}$$

$$\frac{2.93 \times 10^{37} \text{ N}}{1.47 \times 10^{17}} = \mathbf{1.99 \times 10^{20} \text{ N}}$$

E.2 = a

E.3 Two spherical balls exert a gravitational force on each other. Their centers are separated by a distance of 20 meters. One sphere has a mass of 40 kg and the other sphere has a mass of 80 kg. Which statement about the force each sphere exerts on the other sphere is CORRECT ?

- a) The force on the 80 kg mass is 4 times the force on the 40 kg mass.
- b) The force on the 80 kg mass is 2 times the force on the 40 kg mass.
- c) The force on the 80 kg mass is the same as the force on the 40 kg mass.
- d) The force on the 80 kg mass is one half the force on the 40 kg mass.
- e) The force on the 80 kg mass is one fourth the force on the 40 kg mass.



E.3 = c

E.4 If an astronaut weighs 588 newtons on the Earth, what would be her mass on the moon?

- a) 6 kg
- b) 10 kg
- c) 60 kg
- d) 360 kg
- e) 588 kg

$F = M g$ where $F =$ force of gravity = weight

$$M = \frac{F}{g} = \frac{588 \text{ kg } \cancel{\text{m/s}^2}}{9.8 \cancel{\text{ m/s}^2}} = 60 \text{ kg}$$

The astronaut's weight would be less on the moon than on the Earth. However, her mass is the same anywhere in the Universe.

E.4 = c

E.5 Rock A weighs 1 lb and is dropped from a 3rd floor window. Rock B weighs 2 lbs and is dropped from a 2nd floor window. Rock C weighs 3 lbs and is dropped from a 1st floor window. Neglecting air resistance, which rock would be traveling with the highest velocity just before it hits the ground?

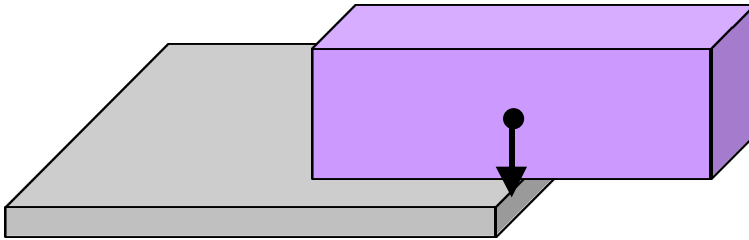
- a) rock A
- b) rock B
- c) rock C
- d) All three rocks hit the ground with the same speed.
- e) There is not enough information given to determine the answer.

Neglecting air resistance, the rock traveling the fastest is the one that has fallen for the longest time.

The rock falling for the longest time is the one dropped from the greatest height.

E.5 = a

E.6 If you push a uniform block of wood slowly over the edge of a table, the block will start to fall when

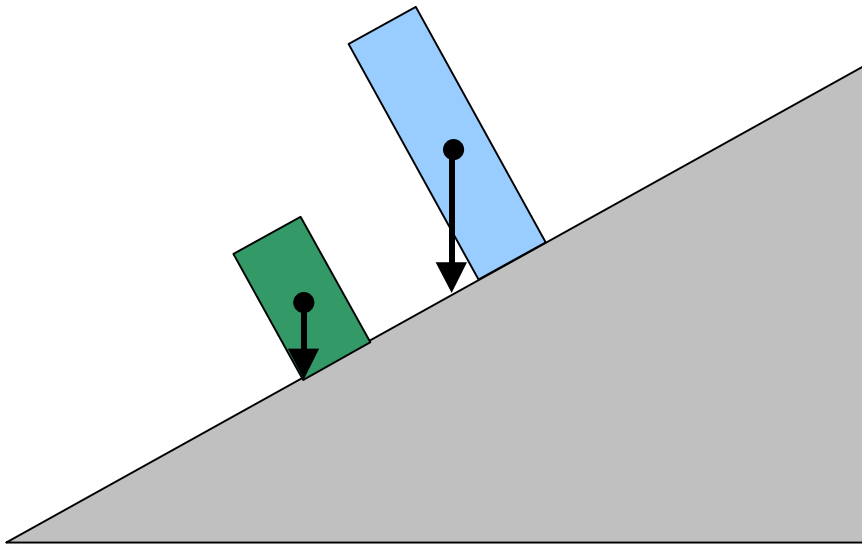


- a) the block's center of mass moves past the table's center of mass.
- b) the force of friction equals the force of gravity.
- c) the block's center of mass moves past the edge of the table.
- d) the force of friction is twice the force of gravity.
- e) one third of the block moves past the edge of the table.

Objects fall when their center of mass is not supported.

E.6 = c

E.7 A tall crate and a short crate of equal mass and uniform composition are placed side by side on an incline. The angle of the incline is slowly increased. Which crate will fall over first? (Hint: Draw a picture showing the center of mass of each crate and the force of gravity acting on it.)



- a) The tall crate will fall over first.
- b) The short crate will fall over first.
- c) They will fall over at the same time.

The crates fall over when their center of mass is no longer supported by the incline.

E.7 = a

Period 4 Exercise Solutions

$$\mathbf{E.1 = b}$$

$$\mathbf{E.2 = a}$$

$$\mathbf{E.3 = c}$$

$$\mathbf{E.4 = c}$$

$$\mathbf{E.5 = a}$$

$$\mathbf{E.6 = c}$$

$$\mathbf{E.7 = a}$$