Chapter 4 HW Answers

Review Questions:

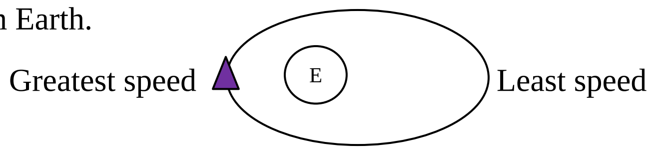
7. Force is decreased by a factor of 16.

$$F = \frac{GmM}{(4d)^2} = \frac{GmM}{16d^2} = \frac{1}{16}\frac{GmM}{d^2}$$

8. You weigh more at sea level because you are less distance from the center of mass of Earth than you would be atop a mountain.

24. Gravity does not act along the horizontal path the bowling ball follows. Gravity only acts along the vertical.

28. Greatest speed occurs when the satellite is closest to Earth, and least speed occurs when it is farthest from Earth.

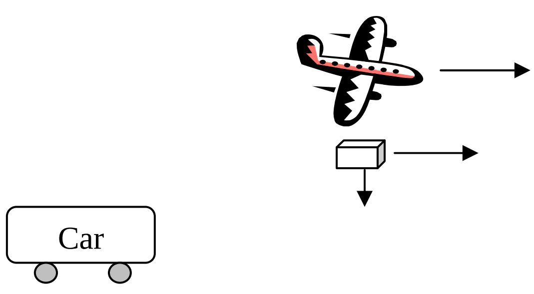


Exercises:

4. The force of gravity is the same on each piece of paper because they have the same mass. However, air resistance would be different.

17. The force of gravity is accelerating your pencil at the same rate that you and the elevator are accelerating. The pencil appears to hover as you and the pencil fall at the same rate.

23. The crate would land in front of the car. The crate would have and maintain the same horizontal velocity as the plane until it hits the ground, so the crate would travel along the horizontal with respect to the ground. It would **not** fall straight down and hit the car.



Problems:

2. The distance between the center of the Earth and the space shuttle is…

d = radius of Earth + 200 km = 6580 km = 6,580,000 m

The equation we need to start with is Newton's 2nd law: F = ma

The force of gravity that determines the acceleration due to gravity which is 9.81 m/s^2 for Earth.

$$\frac{GmM}{d^2} = mg \qquad \text{m = mass of space shuttle (which doesn't matter!)} \quad \text{M = mass of Earth}$$

$$g = \frac{GM}{d^2} = \frac{(6.67 \times 10^{-11}\ N\ m^2/kg^2)(6 \times 10^{24}\ kg)}{(6{,}580{,}000\ m)^2} = \mathbf{9.24\ m/s^2}$$

Now we need to compare the accelerations.

$$\frac{\text{Acceleration 200 km Up}}{\text{Acceleration at Surface}} = \frac{9.24\ m/s^2}{9.81\ m/s^2} \times 100\% = \mathbf{94\%}$$

5. s = 280 m/s
t = 30 sec

a) The altitude is found from $d = ½at^2$

$$d = ½at^2 = ½(9.81\ m/s^2)(30\ s)^2 = \mathbf{4{,}415\ m}$$

b) Horizontal distance is the range which is x = vt

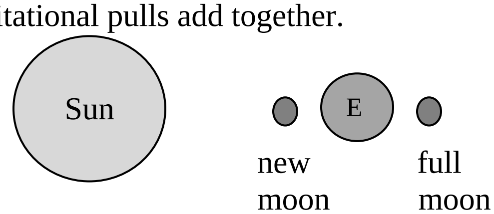
$$x = vt = (280\ m/s)(30\ s) = \mathbf{8{,}400\ m}$$

c) The engine will be directly below the plane at the moment it hits the ground because it will maintain its horizontal speed while falling.

<u>Additional:</u>

A. The gravitational force does not go to zero. No matter how large distance is, there is always some amount of gravitational force.

B. The alignment is such that the Moon and Sun are pulling along the same path so the gravitational pulls add together.



C. The path would be a straight line in the direction it was last traveling because of inertia.

D. Same! The force of gravitation is mutual. That means the pull of the Earth on the Moon is equal to the pull of the Moon on the Earth. The difference is the affect this amount of pull has on each mass.

E. $g = 10\ m/s^2$ $v_h = 30\ m/s$ $v_v = 30\ m/s$

a. Nothing! The horizontal velocity remains constant at 30 m/s.

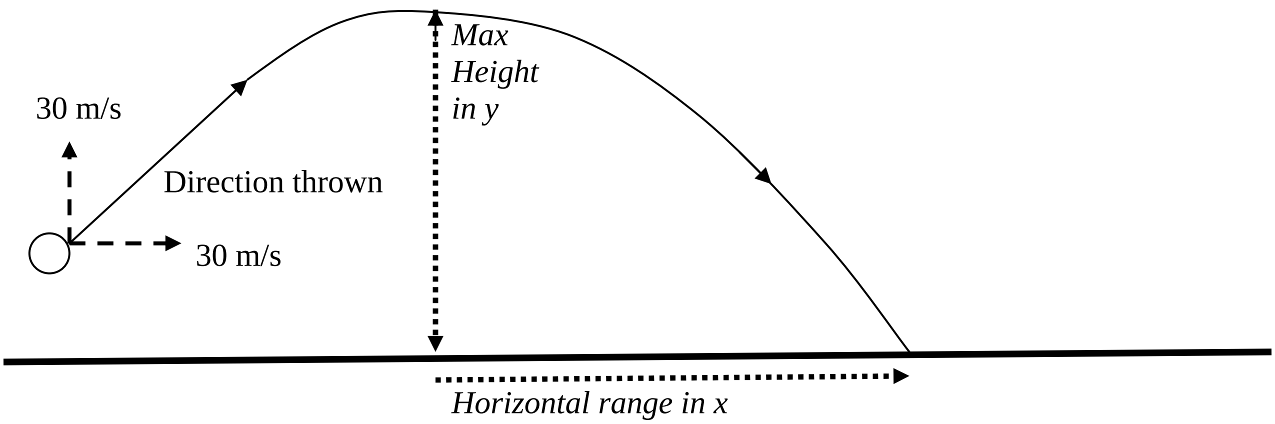
b. The vertical velocity decreases by 10 m/s every second it rises.

c. 20 m/s Up

d. 30 m/s Down

e. h = 5 meters

Need to use the height to determine how long it will take for the ball to drop to the ground. This is the time it will take to drop from the maximum height.



$y = 1/2gt^2$

$t^2 = \frac{2y}{g} = \frac{2(5\ m)}{10 m/s^2} = 1\ s^2$

t = 1 sec

Now we can use the range equation to determine how far it travels in the horizontal while it is dropping to the ground.

$x = vt$

$x = (30 m/s)(1\ s) =$ **30 meters**

F. The equation $P^2 = a^3$ can be used to determine the period of Mars and then you could calculate your age, or you could simply go to the web site that calculates your age for you. http://www.exploratorium.edu/ronh/age/

$P^2 = a^3 = (1.52)^3$ P = 3.51 Earth years You would only have a birthday every 3.5 years.

20 years old on Earth = 5.7 years old on Mars