

3. HOW THINGS MOVE: *Galileo Asks the Right Questions*

Answers to conceptual exercises

2. Dry wood has spaces in it that are filled with air, so that on balance the dry wood is lighter than water but heavier than air, so it floats. Water-logged wood is made of the elements water and earth, so that it is heavier than water but lighter than earth, so it sinks to the bottom of the water. The air-filled balloon contains more of the element air than a partly deflated balloon, so it stays up in the air more readily (longer). Smoke rises because it contains a lot of the element fire.
9. The lurch forward because of their own inertia--their bodies have a tendency to keep on moving.
16. The upper ball travels 0.8 cm in 0.2 s, so its speed is $0.8 \text{ cm} / 0.2 \text{ s} = 4 \text{ cm/s}$. The lower ball's speed is $1.2 \text{ cm} / 0.2 \text{ s} = 6 \text{ cm/s}$.
20. Although your foot is on the accelerator, you are not actually accelerating (in the physics sense of the word) when you drive along a level highway at constant speed; this is also true when you climb a straight (unchanging "slope") hill at constant speed. When you remove your foot from the accelerator, you slow down; this is an acceleration.
23. (a) Accelerated. (b) Not accelerated. (c) Accelerated, since it is moving in a circle. (d) Accelerated, since it is moving in a circle. (e) Not accelerated.
30. Car: $\text{accel} = \text{change in speed} / \text{time} = \frac{100 \text{ km/hr}}{10 \text{ s}}$
 $= 10 \text{ (km/hr)/s}$.
 Drag-racer: $\text{accel} = \frac{400 \text{ km/hr}}{5 \text{ s}} = 80 \text{ (km/hr)/s}$.
37. 1st second: About 10 m/s. 2nd second: About 20 m/s. 3rd second: About 30 m/s.

Answers to problems

3. The distance to the moon and back is $7.6 \times 10^8 \text{ m}$. The speed is $300,000 \text{ km/s} = 3 \times 10^5 \text{ km/s} = 3 \times 10^8 \text{ m/s}$. Solving $d = st$ for t , we get $t = d/s = (7.6 \times 10^8 \text{ m}) / (3 \times 10^8 \text{ m/s}) = 2.5 \text{ s}$.
8. $d = (1/2)at^2 = (1/2) (9.8 \text{ m/s}^2) (6 \text{ s})^2 = 176 \text{ m}$. The cliff is actually lower than 176 m.

4. WHY THINGS MOVE AS THEY DO

Answers to conceptual exercises

2. Because you have an acceleration (because the direction of your velocity is changing), there must be a force on you. Newton's law of motion says so.
10. The floor exerts a force on your feet, upward. You don't accelerate upward because the net force on you is zero.

Answers to problems

4. $a = F/m$, where F is the total thrust of all 4 engines. Solving for F ,
 $F = ma = 30,000 \text{ kg} \times 4 \text{ m/s}^2 = 120,000 \text{ N}$.
Each engine's thrust must be $1/4$ of this, or 30,000 N.