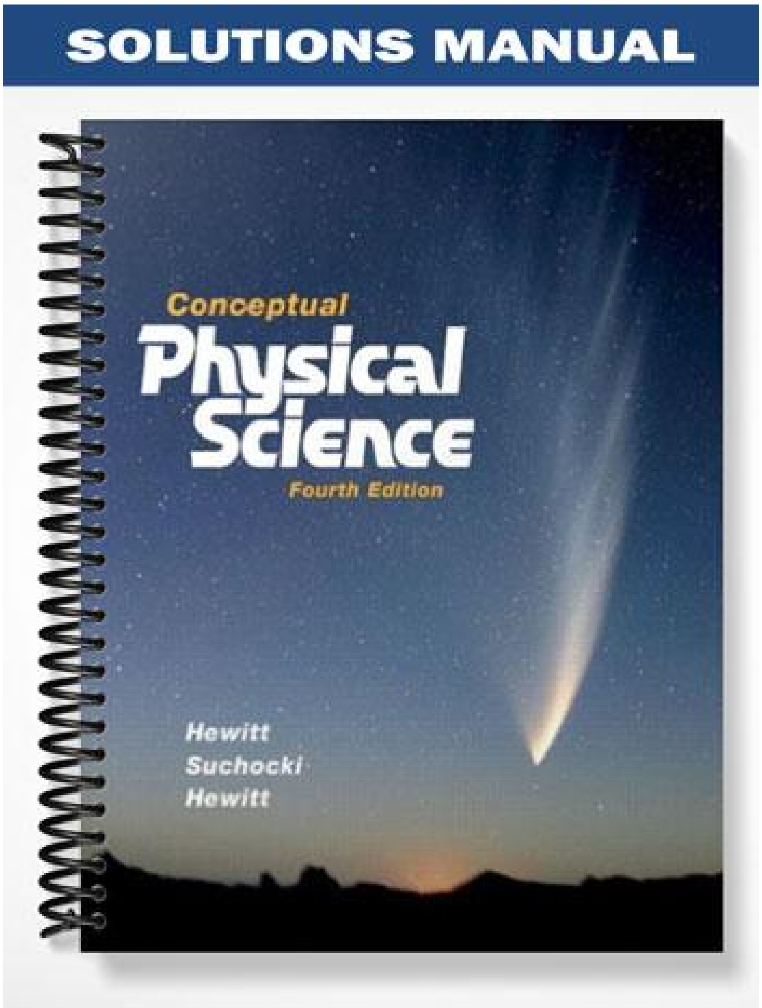
SOLUTIONS MANUAL
Conceptual
Physical
Science
Fourth Edition
Hewitt
Suchocki
Hewitt

Solutions: **Chapter 1 Exercises**

1. No force pushes it; it moves of its own inertia.

2. No force pushes it; it moves of its own inertia.

3. Aristotle would likely say the ball slows to reach its natural state. Galileo would say the ball is encountering friction, an unbalanced force that slows it.

4. The Leaning Tower experiment discredited the idea that heavy things fall proportionally faster. The incline plane experiments discredited the idea that a force was needed for motion.

5. When the ball rolls down it is going with gravity. Going up, against. (There are force components in the direction of motion, as we shall see later.) When moving horizontally, gravity is perpendicular, neither speeding nor slowing the ball.

6. Mass.

7. The piece of iron has more mass, but less volume. The answers are different because they address completely different concepts.

8. Mass. To lose weight, the person could go to the top of a mountain where gravity is less. But the amount of matter would be the same.

9. Like the massive ball that resists motion when pulled by the string, the massive anvil resists moving against Paul when hit with the hammer. Inertia in action.

10. Divide your weight in pounds by 2.2 and you'll have your mass in kilograms. Multiply this by 9.8 and you'll have your weight in newtons.

11. The weight of a 10-kg object on the Earth is 98 N, and on the Moon $^1/_6$ of this, or 16.3 N. The mass would be 10 kg in any location.

12. From $\Sigma F = 0$, the upward forces are 400 N, and the downward forces are 250 N + weight of the staging. So the staging must weigh 150 N.

13. From $\Sigma F = 0$, the upward forces are 400 N + tension in right scale. This sum must equal the downward forces of 250 N + 300 N + 300 N. Arithmetic shows the reading on the right scale is 450 N.

14. Each scale shows half her weight.

15. In the left figure, Harry is supported by two strands of rope that share his weight (like the little girl in the previous exercise). So each strand supports only 250 N, below the breaking point. Total force up supplied by ropes equals weight acting downward, giving a net force of zero and no acceleration.

In the right figure, Harry is now supported by one strand, which for Harry's well-being requires that the tension be 500 N. Since this is above the breaking point of the rope, it breaks. The net force on Harry is then only his weight, giving him a downward acceleration of *g*. The sudden return to zero velocity changes his vacation plans.

16. Yes, for it doesn't change its state of motion (accelerate). Strictly speaking, some friction does act so it is close to being in equilibrium.
17. If the crate speeds up, then your force is greater than the force of friction. Friction is less than your push. In this case there is a net force on the crate and it is not in equilibrium.

18. The upward force, the support force, isn't the only force acting. Weight does also, producing a net force of zero.

19. The support force is W. When a weight of water w is added, the support force is $W + w$.
20. Constant speed implies the net force on the cabinet is zero. So friction is 600 N in the opposite direction.

21. As the crate is lifted, it presses with less force on the table. So the support force is less.
22. Constant velocity means constant direction, so your friend should say "…at a constant *speed* of 100 km/h."

23. Relative speed is 2 km/h.

24. Its speed relative to you is twice the speed limit.

25. Not very, for his speed will be zero relative to the land.

26. 10 m/s.

27. The equation $d = \frac{1}{2}gt^2$ is most appropriate. Distance increases as the square of the time, so each successive distance covered is greater than the preceding distance covered.

28. The ball slows by 10 m/s each second, and gains 10 m/s when descending. The time up equals the time down if air resistance is nil.

29. Both hit the ground with the same speed (but not in the same time).

30. Zero, for no change in velocity occurred. Misreading the question might mean missing the word steady (no change).

31. Katelyn is correct. Jacob is describing speed. The rate at which speed changes is acceleration, what Katelyn is stating.

32. Acceleration is 10 m/s^2, constant, all the way down. (Velocity, however, is 50 m/s at 5 seconds, and 100 m/s at 10 seconds.)

33. The ball on B finishes first, for its average speed along the lower part as well as the down and up slopes is greater than the average speed of the ball along track A.

34. (a) Average speed is greater for the ball on track B.

(b) The instantaneous speed at the ends of the tracks is the same because the speed gained on the down-ramp for B is equal to the speed lost on the up-ramp side. (Many people get the wrong answer here because they assume that because the balls end up with the same speed that they roll for the same time. Not so.)

Solutions: **Chapter 1 Problems**

1. (a) 30 N + 20 N = 50 N.
   (b) 30 N − 20 N = 10 N.

2. (a) Net force is zero (because velocity is constant!).
   (b) Friction = -100 N.
   (c) zero.

3. $$\textit{Speed} = \frac{\textit{distance}}{\textit{time}} = \frac{24\ \text{m}}{0.5\ \text{s}} = 48\ \frac{\text{m}}{\text{s}}.$$

4. $$\textit{Speed} = \frac{\textit{distance}}{\textit{time}} = \frac{4\ \text{km}}{0.5\ \text{h}} = 8\ \frac{\text{km}}{\text{h}}.$$

5. $$\textit{Acceleration} = \frac{\textit{change in velocity}}{\textit{time}} = \frac{25\ \text{m/s}}{5\ \text{s}} = 5\ \frac{\text{m}}{\text{s}^2}.$$

6.

Time (*in seconds*)	Velocity (*in meters/second*)	Distance (*in meters*)
0	0	0
1	10	5
2	20	20
3	30	45
4	40	80
5	50	125
6	60	180
7	70	245
8	80	320
9	90	405
10	100	500

7. (a) d = ? From $\bar{v} = \frac{d}{t} \Rightarrow d = \bar{v}t$.

(b) First, we need a consistent set of units. Since speed is in m/s, let's convert minutes to seconds: $5.0 \text{ min} \times \frac{60 \text{ s}}{1 \text{ min}} = 300 \text{ s}$. Then $d = \bar{v}t = 7.5 \text{ m/s}^2 \times 300 \text{ s} = 2300 \text{ m}$.

8. (a) $\bar{v} = \frac{d}{t} = \frac{2\pi r}{t}$.

(b) $\bar{v} = \frac{2\pi r}{t} = \frac{2\pi(400 \text{ m})}{40 \text{ s}} = 63 \text{ m/s}$.

9. Since it starts going up at 30 m/s and loses 10 m/s each second, its time going up is 3 seconds. Its time returning is also 3 seconds, so it's in the air for a total of 6 seconds. Distance up (or down) is $\frac{1}{2} gt^2 = 5 \times 3^2 = 45$ m.

Or from $d = vt$, where average velocity is $\frac{(30+0)\text{m/s}}{2} = 15 \text{ m/s}$, and time is 3 seconds, we also get $d = 15 \text{ m/s} \times 3 \text{ s} = 45 \text{ m}$.

10. (a) The velocity of the ball at the top of its vertical trajectory is instantaneously zero.
(b) One second before reaching its top, its velocity is 10 m/s.
(c) The amount of change in velocity is 10 m/s during this 1-second interval (or any other 1-second interval).
(d) One second after reaching its top its velocity is -10 m/s—equal in magnitude but oppositely directed to its value 1 second before reaching the top.
(e) The amount of change in velocity during this (or any) 1-second interval is 10 m/s.
(f) In 2 seconds, the amount of change in velocity, from 10 m/s up to 10 m/s down, is 20 m/s (not zero!).
(g) The acceleration of the ball is 10 m/s² before reaching the top, when reaching the top, and after reaching the top. In all cases acceleration is downward, toward the Earth.

11. $d = v_{ave}t = \dfrac{v_f + v_o}{2} \times \dfrac{v_f - v_o}{a} = \dfrac{v_f^2 + v_f v_o - v_f v_o - v_o^2}{2a} = \dfrac{v_f^2 - v_o^2}{2a}$.

$$d = v_{ave}t = \left(\frac{v_f + v_o}{2}\right) \times \left(\frac{v_f - v_o}{a}\right) = \frac{v_f^2 - v_o^2}{2a}.$$

12. (a) a = ? Since time is not a part of the problem we can use the formula $v_f^2 - v_0^2 = 2ad$ and solve for acceleration a. Then, with $v_o = 0$ and $d = x$, $a = \dfrac{v^2}{2x}$.

(b) $a = \dfrac{v^2}{2x} = \dfrac{\left(1.8 \times 10^7 \ \frac{\text{m}}{\text{s}}\right)^2}{2(0.10 \text{ m})} = 1.6 \times 10^{15} \ \dfrac{\text{m}}{\text{s}^2}$.