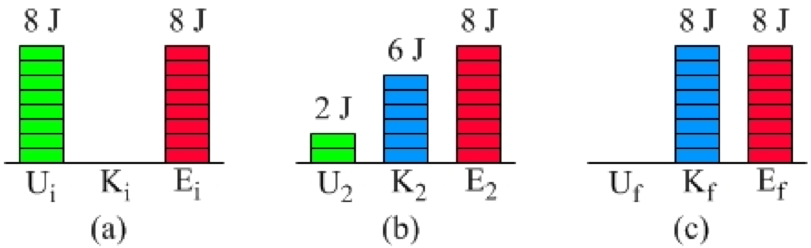
Answers to selected problems from Essential Physics, Chapter 12

1. The force is still 5 N, but in the opposite direction.

3. The block has been moved either to x = –20 cm, or to x = +20 cm. So, the block has either been moved 10 cm to the left, or 30 cm to the right.

5.



7. (a) 2 > 1 = 4 > 3 (b) 2 = 4 > 1 = 3 (c) 2 > 1 = 4 > 3

9. (a) No. The initial energy is all stored in the spring, so changing the mass has no effect on the energy, in this situation. (b) Yes, the energy is proportional to the spring constant, so doubling the spring constant will double the energy. (c) Yes, the energy is proportional to the square of the amplitude, so increasing the amplitude by a factor of $\sqrt{2}$ will double the energy.

11. (a) 1 = 3 > 2 = 4 (b) 4 > 2 = 3 > 1 (c) 2 = 4 > 1 = 3

13. 30.0 N

15. The time-of-flight is 0.535 s. The launch speed of the ball is 4.68 m/s. The spring constant is 76 N/m.

17. (a) 3.43 m (b) 1.2 rad/s

19. (a) 3.09 m (b) 5.73 m/s

21. The maximum speed will be reached at a point higher up the ramp then when there was no friction. Maximum speed will be reached at the point where the forces balance. With friction directed up the slope, the block does not need to compress the spring as much as it did before for there to be no net force acting on the block.

23. 1.48 m

25. $\omega = \pi$ rad/s; $k = \frac{\pi^2}{2}$ N/m; total mechanical energy = 0.582 J; amplitude = 0.4857 m; x = 0.3434 m

(a) 0.291 J (b) 0.291 J

27. (a) The bar graphs apply at two locations, one at a particular distance from the equilibrium point on one side of the equilibrium position, and the other at the same distance from equilibrium on the other side of the equilibrium position.
(b) Both locations are 0.462 m away from the equilibrium position.

29. (a) 0.319 m (b) 42.8°

31. 1.71 s

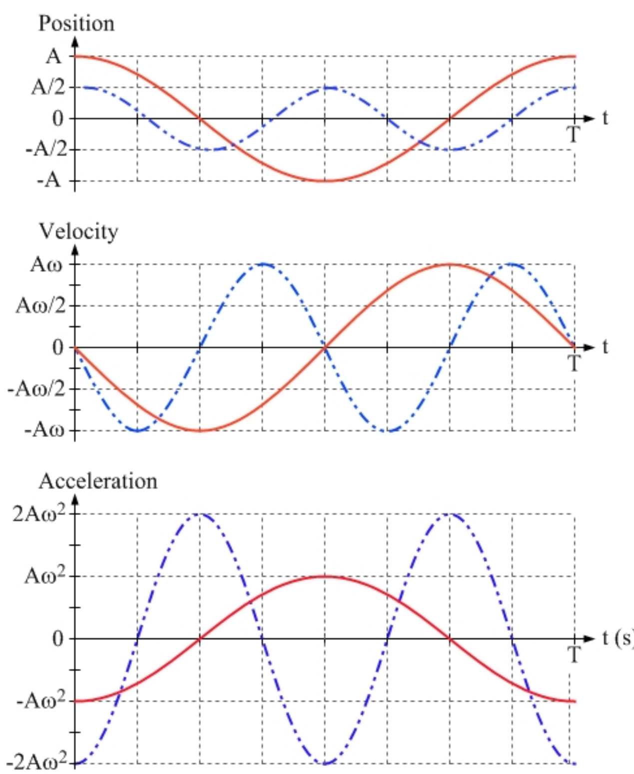
33. (a) 0.67 s (b) 52.8 N/m (c) 4.47 m/s in the negative direction
(d) 13.2 m/s^2 in the positive direction

35. There are four possible answers for this question, one answer for each of the four times the block is a distance of 30 cm from equilibrium in the first complete oscillation. The four possible values of *k* are 1.67 N/m, 18.7 N/m, 47.8 N/m, and 98.9 N/m.

37. (a) The collision cannot be elastic, because the two carts stick together – this is a completely inelastic collision. Immediately after the collision, the two carts are moving at 1.0 m/s, with a total kinetic energy of 0.5 J. All that energy goes into the spring at maximum compression, so the spring must compress 50 cm.

39. 3.00 m

41. The red (solid) lines are for the first case, and the blue (dashed) lines are for the second case. The period and angular frequency referenced on the graphs are for the first case.



43. (a) 2.51 rad/s (b) We need to find the new angular frequency of the turntable, which should now be 3.55 rad/s.

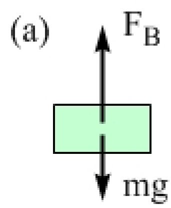
45. (a) 0.31 m/s (b) 0.25 m/s^2

47. $x = A\sin(\omega t)$; $v = A\omega\cos(\omega t)$; $a = -A\omega^2 \sin(\omega t)$, where A = 1.00 m and $\omega = 2.00$ rad/s

49. 34 N/m

51. 0.684 kg

55.



(b) 3.3 m/s^2, up (c) As the block moves, the force of gravity remains the same, but the buoyant force changes, depending on how much of the block is submerged. The buoyant force starts off larger than the force of gravity, goes through a place where it is equal to the force of gravity, and then becomes less than the force of gravity. After the block comes to rest for an instant, it falls back down, eventually returning to the initial state (if we neglect all resistive forces) and the cycle continues.

57. (a) 2.0 m. (b) 4.43 m/s (c) 4.64 m/s
(d) Not surprisingly, the small-angle approximation works best for small angles. 60° is not a small angle, so the approximation leads to a result for the speed which is larger than it should be. The speed calculated using energy conservation in (b) is accurate in this case.

59. 4.9 J