Conceptual Questions

1. You have two springs that are identical except that spring ***1*** is stiffer than spring ***2***. On which spring is more work done (a) if they are stretched using the same force, (b) if they are stretched the same distance?[1]

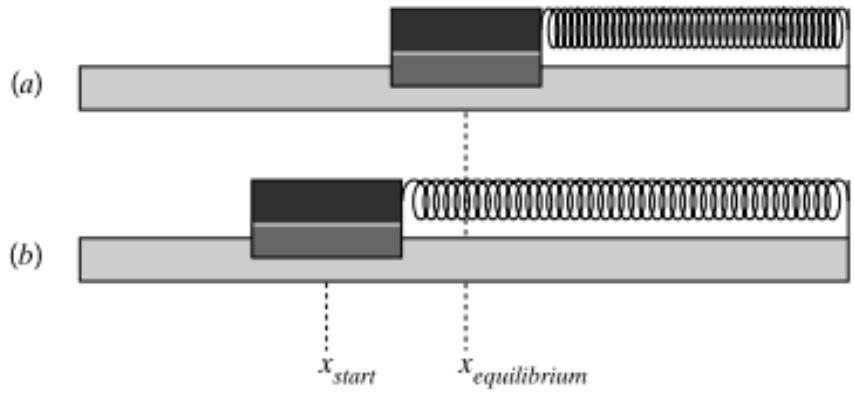
2. The drawing shows identical springs that are attached to a box in two different ways. Initially, the springs are unstrained. The box is then pulled to the right and released. In each case the initial displacement of the box is the same. At the moment of release, which box, if either, experiences the greater net force due to the springs? Provide a reason for your answer.[2]

3. A coil spring of mass ***m*** rests upright on a table. If you compress the spring by pressing down with your hand and then release it, can the spring leave the table? Explain.[3]

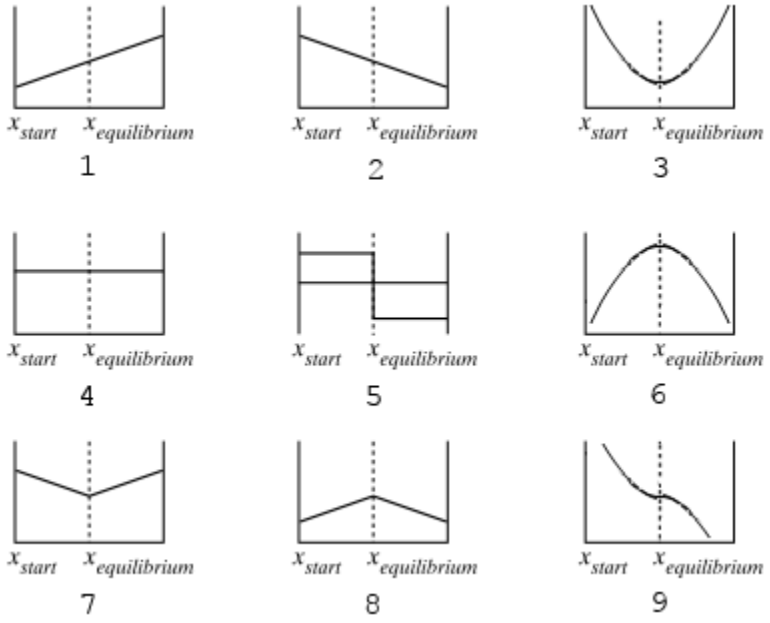
4. An object hangs motionless from a spring. When the object is pulled down, the sum of the elastic potential energy of the spring and the gravitational potential energy of the object and Earth.[4]

   a) increases b) stays the same c) decreases

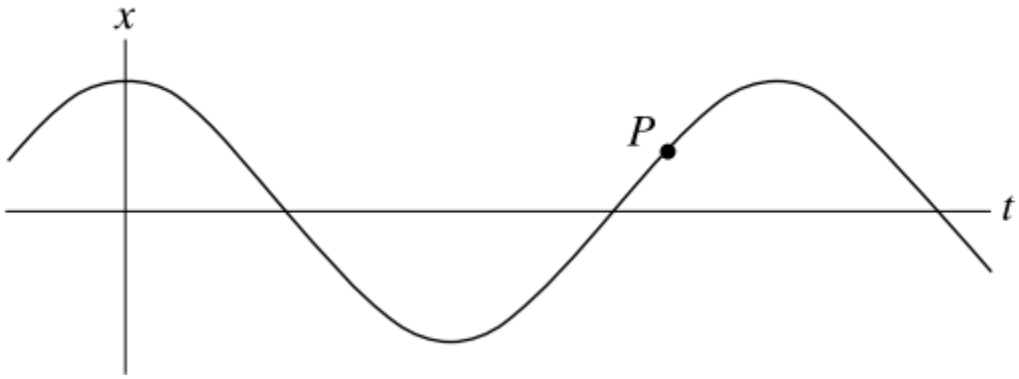
5. In part (a) of the figure, an air track cart attached to a spring rests on the track at the position $x_{equilibrium}$ and the spring is relaxed. In (b),the cart is pulled to the position x_{start} and released. It then oscillates about $x_{equilibrium}$. Which graph correctly represents the potential energy of the spring as a function of the position of the cart?[5]



[1] Physics 6th Edition, Giancoli, Chapter 6 Questions, #7
[2] Physics, 7th Edition, Cutnell & Johnson, Chapter 10 Conceptual Questions, #2
[3] Physics 6th Edition, Giancoli, Chapter 6 Questions, #12
[4] Peer Instruction – A User's Guide, Mazur, Oscillations CT 6
[5] Peer Instruction – A User's Guide, Mazur, Interactions CT 7 (modified)



6. A mass attached to a spring oscillates back and forth as indicated in the position vs. time plot below. At point ***P***, the mass has [6]



   a) positive velocity and positive acceleration.
   b) positive velocity and negative acceleration.
   c) positive velocity and zero acceleration.
   d) negative velocity and positive acceleration.
   e) negative velocity and negative acceleration.
   f) negative velocity and zero acceleration.
   g) zero velocity but is accelerating (positively or negatively).
   h) zero velocity and zero acceleration.

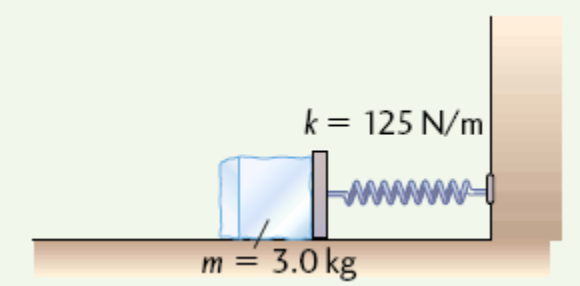
7. A particle is oscillating in simple harmonic motion. The time required for the particle to travel through one complete cycle is equal to the period of the motion, no matter what the amplitude is. But how can this be, since larger amplitudes mean that the particle travels farther? Explain.[7]

[6] Peer Instruction – A User's Guide, Mazur, Oscillations CT 4
[7] Physics, 7th Edition, Cutnell & Johnson, Chapter 10 Conceptual Questions, #7

Problems

8. A small truck is equipped with a rear bumper that has a spring constant of 5×10^7 N/m. The bumper can be compressed up to 15 cm without causing damage to the truck. What is the maximum velocity with which a solid 1000-kg car can collide with the bumper without causing damage to the truck?[8]

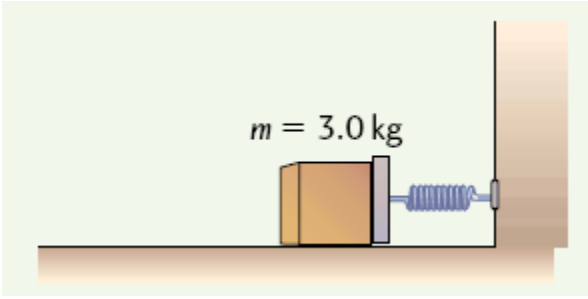
9. The diagram shows a 3.0-kg block of ice held against a spring with a force constant of 125 N/m. The spring is compressed by 12 cm.[9]



a) Calculate the speed of the ice just as it leaves the spring.

b) Calculate the speed of the ice just as it leaves the spring if the coefficient of friction between the plank and the ice is 0.10 (and assuming the spring is prevented from travelling past its equilibrium position).

10. A spring with a force constant of 350 N/m (see below) is compressed 12 cm by a 3.0-kg mass. How fast is the mass moving after only 10 cm of the spring has been released?[10]

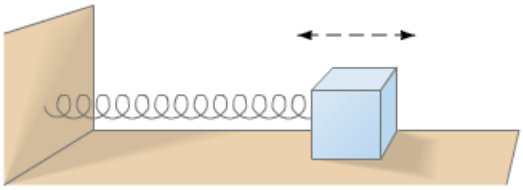


11. A vertical spring (ignore mass), whose spring stiffness constant is 950 N/m, is attached to a table and is compressed down 0.150 m. [11]

a) What upward speed can it give a 0.30-kg ball when released?

b) How high above its original position (spring compressed) will the ball fly?

12. A 0.620-kg wood block is firmly attached to a very light horizontal spring (k = 180 N/m, see below). It is noted that the block-spring system, when compressed 5.0 cm and released, stretches out 2.3 cm beyond the equilibrium position before stopping and turning back. What is the coefficient of kinetic friction between the block and the table? [12]



[8] Physics Book Two, Irwin Publishing, Chapter 5 Problems, #45
[9] Physics Book Two, Irwin Publishing, Chapter 5 Problems, #46 (modified)
[10] Physics Book Two, Irwin Publishing, Chapter 5 Problems, #47
[11] Physics 6th Edition, Giancoli, Chapter 6 Problems, #39
[12] Physics 6th Edition, Giancoli, Chapter 6 Problems, #55

13. A 280-g wood block (see image above) can slide along a table where the coefficient of friction is 0.30. A force of 22 N compresses the spring 18 cm. If the spring is released from this position, how far beyond its equilibrium position will it stretch at its first maximum extension?[13]
14. An engineer is designing a spring to be placed at the bottom of an elevator shaft. If the elevator cable should break when the elevator is at a height ***h*** above the top of the spring, calculate the value that the spring stiffness constant ***k*** should have so that passengers undergo an acceleration of no more than 5.0***g*** when brought to rest. Let ***M*** be the total mass of the elevator and passengers. [14]
15. A mattress manufacturer estimates that 20 springs are required to comfortably support a 100-kg person. When supporting the person, the 20 springs are compressed 3.5 cm. Calculate the spring constant for one spring.[15]
16. A small ball is attached to one end of a spring that has an unstrained length of 0.200 m. The spring is held by the other end, and the ball is whirled around in a horizontal circle at a speed of 3.00 m/s. The spring remains nearly parallel to the ground during the motion and is observed to stretch by 0.010 m. By how much would the spring stretch if it were attached to the ceiling and the ball allowed to hang straight down, motionless?[16]
17. A 0.25-kg mass is attached to the end of a spring that is attached horizontally to a wall. When the mass is displaced 8.5 cm and then released, it undergoes SHM. The amplitude remains constant and $k = 1.4 \times 10^2$ N/m. [17]
    a) How far does the mass move in the first 5 cycles?
    b) What is the period of vibration of the mass-spring system?
18. Prove that the maximum speed of a mass on a spring in SHM is given by $\boldsymbol{2\pi fx}$.[18]
19. A bungee jumper with mass 65.0 kg jumps from a high bridge. After reaching his lowest point, he oscillates up and down, hitting a low point eight more times in 38.0 s. He finally comes to rest 25.0 m below the level of the bridge. Calculate the spring constant and the unstretched length of the bungee cord. [19]

[13] Physics 6th Edition, Giancoli, Chapter 6 Problems, #56
[14] Physics 6th Edition, Giancoli, Chapter 6 Problems, #45
[15] Physics Book Two, Irwin Publishing, Chapter 5 Problems, #49
[16] Physics, 7th Edition, Cutnell & Johnson, Chapter 10 Problems, #11
[17] Physics 12, Nelson Education, Section 4.5 Practice, #18
[18] Physics 12, Nelson Education, Section 4.5 Practice, #26
[19] Physics 6th Edition, Giancoli, Chapter 11 Problems, #27