

Conceptual Questions

1. A 100-kg sofa needs to be moved across a level floor. The coefficient of static friction between the sofa and the floor is 0.40. Two physics students decide to apply a force F on the sofa. One student recommends that the force be applied upward at an angle θ above the horizontal. The other student recommends that the force be applied downward at an angle θ below the horizontal. Explain which student has the better ideas and why.¹

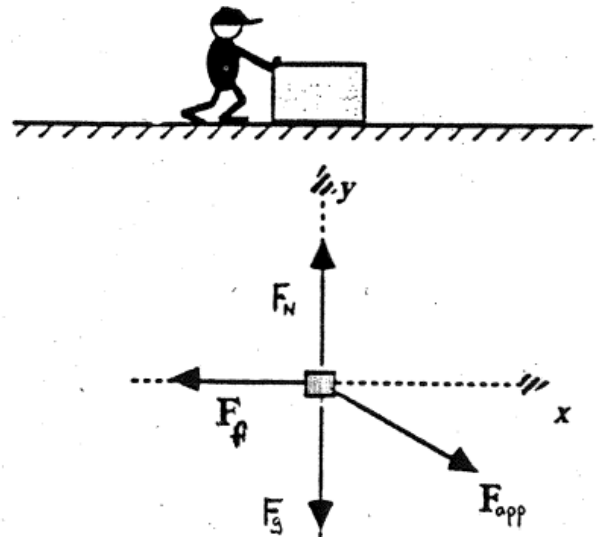
2. A weight hangs from a ring at the middle of a rope, as the drawing illustrates. Can the person who is pulling on the right end of the rope ever make the rope perfectly horizontal? Explain your answer in terms of the forces that act on the ring.²



3. An object is held in place by friction on an inclined surface. The angle of inclination is increased very slowly until the object just starts moving. If the surface is kept at this angle, the object³

- a) slows down c) moves at uniform speed
b) speeds up d) none of the above

4. A person pushes a crate so that it moves at constant velocity toward the right. A free body diagram for the crate is shown (forces not to scale). Which choice below represents the relative magnitudes of the forces?⁴



- a) $F_{app} = F_f$ and $F_N = F_g$
b) $F_{app} = F_f$ and $F_N > F_g$
c) $F_{app} = F_f$ and $F_N < F_g$
d) $F_{app} > F_f$ and $F_N = F_g$
e) $F_{app} > F_f$ and $F_N > F_g$

¹ Physics Book Two, Irwin Publishing, Chapter 2 Conceptual Questions, #7

² Physics, 7th Edition, Cutnell & Johnson, Chapter 4 Conceptual Questions, #26

³ Peer Instruction – A User's Guide, Mazur, Forces CT 9

⁴ Peer Instruction – A User's Guide, Mazur

5. An object sliding up an inclined plane will slow down as a result of both the force of friction and the force of gravity. As the angle of inclination of the ramp increases, the component of the force of gravity along the ramp increases, but the friction force will decrease (since the normal force decreases). If the coefficient of kinetic friction between the object and the ramp is 1.000, which of the following situations would bring the object to rest in the least amount of time?⁵
- Small angles of ramp inclination
 - Large angles of ramp inclination
 - 45° ramp inclination
 - Deceleration is constant for all angles of ramp inclination

Problems

6. Three movers are applying forces $F_1 = 100 \text{ N [W}20^\circ\text{N]}$, $F_2 = 200 \text{ N [E}40^\circ\text{S]}$, and $F_3 = 300 \text{ N [S]}$ on a 300-kg grand piano. If μ_k for the piano is 0.10, determine
- the net force acting on the piano
 - the acceleration of the piano⁶
7. A worker drags a 20-kg bag of cement across a floor by applying a force of 100 N at an angle of 50° to the horizontal. If the coefficient of kinetic friction between the cement bag and the floor is 0.30, determine the acceleration of the bag.⁷
8. While mopping the deck, a sailor pushes with a force of 30 N down on the handle of his mop at an angle of 45° to the horizontal. If the mop accelerates horizontally at 1.0 m/s² and the coefficient of kinetic friction is 0.10, what is the mass of the mop?⁸
9. Arlene is to walk across a “high wire” strung horizontally between two buildings 10.0 m apart. The sag in the rope when she is at the midpoint is 10.0°, as shown. If her mass is 50.0 kg, what is the tension in the rope at this point?⁹

⁵ Almeida, F., Physics Department, Victoria Park C.I.

⁶ Physics Book Two, Irwin Publishing, Chapter 2 Problems, #38

⁷ Physics Book Two, Irwin Publishing, Chapter 2 Problems, #39

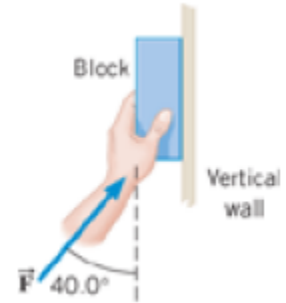
⁸ Physics Book Two, Irwin Publishing, Chapter 2 Problems, #43

⁹ Physics 6th Edition, Giancoli, Chapter 4 Problems, #23

10. A pair of fuzzy dice is hanging by a string from your rearview mirror. While you are accelerating from a stoplight to 28 m/s in 6.0 s, what angle ϑ does the string make with the vertical?¹⁰

11. The weight of the block in the drawing is 88.9 N. The coefficient of static friction between the block and the vertical wall is 0.560.

- What minimum force is required to prevent the block from sliding down the wall?
- What minimum force is required to start the block moving up the wall?¹¹



12. The coefficient of static friction between hard rubber and normal street pavement is about 0.8. On how steep a hill (maximum angle) can you leave a car parked?¹²

13. A rescue worker slides a box of supplies from rest down a hill to a group of trapped campers. The hill is inclined at 25° to the horizontal and is 200 m long. If the coefficient of kinetic friction on the hill is 0.45,

- what is the acceleration of the box as it goes down the hill?
- at what speed does the box reach the bottom of the hill?¹³

14. A small block of mass m is given an initial speed v_0 up a ramp inclined at an angle ϑ to the horizontal. It travels a distance d up the ramp and comes to rest. Determine a formula for the coefficient of kinetic friction between the block and ramp.¹⁴

¹⁰ Physics 6th Edition, Giancoli, Chapter 4 Problems, #32

¹¹ Physics, 7th Edition, Cutnell & Johnson, Chapter 4 Problems, #60

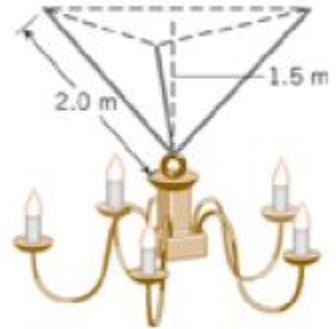
¹² Physics 6th Edition, Giancoli, Chapter 4 Problems, #40

¹³ Physics Book Two, Irwin Publishing, Chapter 2 Problems, #46

¹⁴ Physics 6th Edition, Giancoli, Chapter 4 Problems, #60

15. A penguin slides at a constant velocity of 1.4 m/s down an icy incline. The incline slopes above the horizontal at an angle of 6.9° . At the bottom of the incline, the penguin slides onto a horizontal patch of ice. The coefficient of kinetic friction between the penguin and the ice is the same for the incline as for the horizontal patch. How much time is required for the penguin to slide to a halt after entering the horizontal patch of ice?¹⁵

16. A 44-kg chandelier is suspended 1.5 m below a ceiling by three wires, each of which has the same tension and the same length of 2.0 m . Find the tension in each wire.¹⁶



17. A bicyclist of mass 65 kg (including the bicycle) can coast down a 6.0° hill at a steady speed of 6.0 km/h because of air resistance. How much force must be applied to climb the hill at the same speed and same air resistance?¹⁷

18. A While moving in, a new homeowner is pushing a box across the floor at a constant velocity. The coefficient of kinetic friction between the box and the floor is 0.41 . The pushing force is directed downward at an angle θ below the horizontal. When θ is greater than a certain value, it is not possible to move the box, ***no matter how large the pushing force is***. Find that value of θ .¹⁸

¹⁵ Physics, 7th Edition, Cutnell & Johnson, Chapter 4 Problems, #85

¹⁶ Physics, 7th Edition, Cutnell & Johnson, Chapter 4 Problems, #57

¹⁷ Physics 6th Edition, Giancoli, Chapter 4 Problems, #65

¹⁸ Physics, 7th Edition, Cutnell & Johnson, Chapter 4 Problems, #111