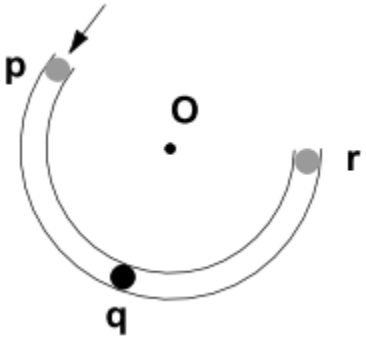
Conceptual Questions

1. The figure below shows a boy swinging on a rope, starting at a point higher than A. Consider the following distinct forces:
    1. A downward force of gravity.
    2. A force exerted by the rope pointing from A to O.
    3. A force in the direction of the boy's motion.
    4. A force pointing from O to A.

Which of the above forces is (are) acting on the boy when he is at position A? [1]

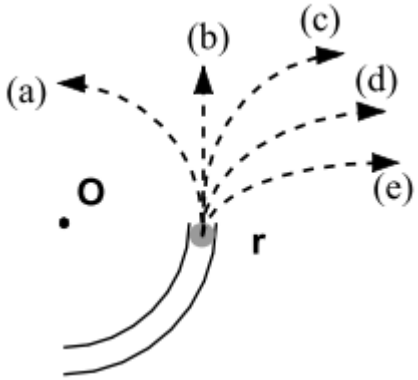
(a) 1 only. (c) 1 and 3. (e) 1, 3, and 4.
(b) 1 and 2. (d) 1, 2, and 3.



2. The accompanying figure shows a frictionless channel in the shape of a segment of a circle with center at "O". The channel has been anchored to a frictionless horizontal table top. You are looking down on the table. Forces exerted by the air are negligible. A ball is shot at high speed into the channel at "p" and exists at "r". Consider the following distinct forces:
    1. A downward force of gravity.
    2. A force exerted by the channel pointing from q to O.
    3. A force in the direction of motion.
    4. A force pointing from O to q.

Which of the above forces is (are) acting on the ball when it is within the frictionless channel at position "q"?[2]

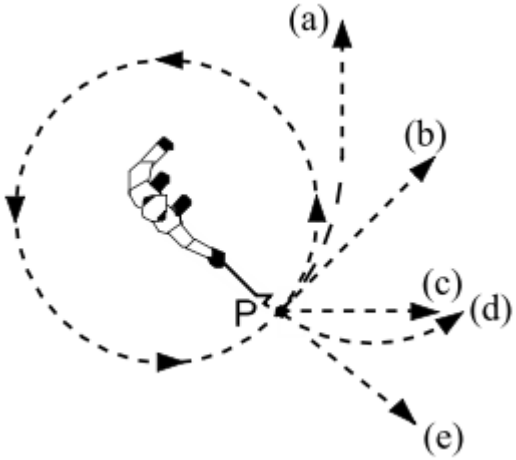
(a) 1 only. (c) 1 and 3. (e) 1, 3, and 4.
(b) 1 and 2. (d) 1, 2, and 3.



3. Which path in the figure on the right would the ball from question #2 most closely follow after it exits the channel at "r" and moves across the frictionless table top?[3]

[1] Force Concept Inventory, Hestenes, Halloun, Wells, and Swackhamer, #18
[2] Force Concept Inventory, Hestenes, Halloun, Wells, and Swackhamer, #5
[3] Force Concept Inventory, Hestenes, Halloun, Wells, and Swackhamer, #6

4. A steel ball is attached to a string and is swung in a circular path in a horizontal plane as illustrated in the accompanying figure to the right. At the point P indicated in the figure, the string suddenly breaks near the ball. If these events are observed from directly above as in the figure, which path would the ball most closely follow after the string breaks? [4]



5. When a ball at rest hangs by a single vertical string, tension in the string is ***mg***. If the ball is made to move in a horizontal circle so that the string describes a cone, string tension
   (a) is ***mg***.
   (b) is greater than ***mg***, always.
   (c) is less than ***mg***, always.
   (d) may be greater or less than ***mg*** depending on the speed of the ball.[5]

6. What is the chance of a light car safely rounding an unbanked curve on an icy road as compared to that of a heavy car: worse, the same, or better? Assume that both cars have the same speed and are equipped with identical tires. Account for your answer.[6]

7. A stone is tied to a string and whirled around in a circle at a constant speed. Is the string more likely to break when the circle is horizontal or when it is vertical? Account for your answer, assuming the constant speed is the same in each case.[7]

8. Would a change in the earth's mass affect (a) the banking of airplanes as they turn, (b) the banking of roadbeds, (c) the speeds with which satellites are put into circular orbits, and (d) the performance of the loop-the-loop motorcycle stunt? In each case, give your reasoning.[8]

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[4] Force Concept Inventory, Hestenes, Halloun, Wells, and Swackhamer, #7
[5] 60 Questions – Basic Physics, Paul G, Hewitt, #14
[6] Physics, 7th Edition, Cutnell & Johnson, Chapter 5 Conceptual Questions, #8
[7] Physics, 7th Edition, Cutnell & Johnson, Chapter 5 Conceptual Questions, #14
[8] Physics, 7th Edition, Cutnell & Johnson, Chapter 5 Conceptual Questions, #13

9. The last cycle in a washing machine is always the spin cycle, during which the drum rotates at high speed about a vertical axis. Explain how the spin cycle removes water from clothing.[9]

Problems

10. What is the maximum speed at which a 1500-kg car can round a curve on a flat road if the radius of the curve is 90 m and the coefficient of static friction is 0.50? Is it necessary to know the mass of the car to solve this problem?[10]

11. A 1000-kg Indy car travels around a curve banked at 25° to the horizontal. If the radius of the curve is 80 m, at what speed must the car be travelling if no friction is present?[11]

12. A 2.0-kg mass is attached to the end of a 3.0 m-long rope and spun in a vertical circle at a speed of 6.6 m/s. Determine the maximum and minimum tensions in the rope. [12]

13. As a pilot comes out of a dive in a circular arc, she experiences an upward acceleration of 9.0 g's.
    a) If the pilot's mass is 60 kg, what is the magnitude of the force applied to her by her seat at the bottom of the arc?
    b) If the speed of the plane is 330 km/h, what is the radius of the plane's arc?[13]

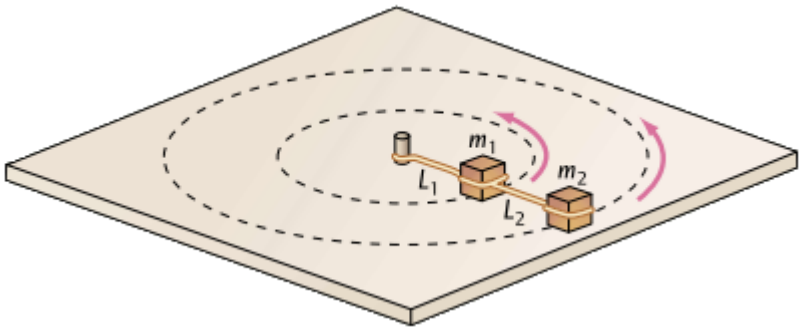
14. A jet ($m = 2.00\times10^5$ kg), flying at 123 m/s, banks to make a horizontal circular turn. The radius of the turn is 3810 m. Calculate the necessary lifting force ***L***. [14]

15. A train traveling at a constant speed rounds a curve of radius 235 m. A lamp suspended from the ceiling swings out to an angle of 17.5° throughout the curve. What is the speed of the train?[15]

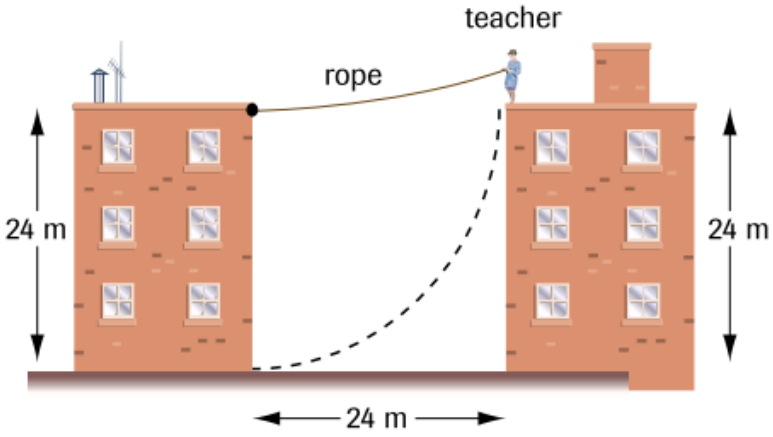
[9] Physics Book Two, Irwin Publishing, Chapter 2 Conceptual Questions, #12
[10] Physics Book Two, Irwin Publishing, Chapter 2 Problems, #56
[11] Physics Book Two, Irwin Publishing, Chapter 2 Problems, #57
[12] Physics Book Two, Irwin Publishing, Chapter 2 Problems, #60
[13] Physics Book Two, Irwin Publishing, Chapter 2 Problems, #61
[14] Physics, 7th Edition, Cutnell & Johnson, Chapter 5 Problems, #25

16. If a curve with a radius of 88 m is perfectly banked for a car traveling at 75 km/h, what must be the coefficient of static friction for a car not to skid when traveling at 95 km/h?[16]

17. A block of mass m_1 is attached to a rope of length L_1, which is fixed at one end to a table. The mass moves in a horizontal circle supported by a frictionless table. A second block of mass m_2 is attached to the first mass by a rope of length L_2. This mass also moves in a circle, as shown below. If the period of the motion is T, find the tension in each rope (assume all ropes are massless).[17]



18. Your favourite physics teacher who is late for class attempts to swing from the roof of a 24-m high building to the bottom of an identical building using a 24-m rope as shown in Figure 5. She starts from rest with the rope horizontal, but the rope will break if the tension force in it is twice the weight of the teacher. How high is the swinging physicist above level when the rope breaks? (Hint: Apply the law of conservation of energy.)[18]



19. A 1200-kg car rounds a curve of radius 67 m banked at an angle of 12°. If the car is traveling at 95 km/h, will friction be required? If so, how much and in what direction?[19]

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[15] Physics 6th Edition, Giancoli, Chapter 5 Problems, #79
[16] Physics 6th Edition, Giancoli, Chapter 5 Problems, #21
[17] Physics Book Two, Irwin Publishing, Chapter 2 Problems, #63
[18] Physics 12, Nelson Education, Chapter 3 Review, #27
[19] Physics 6th Edition, Giancoli, Chapter 5 Problems, #22