Diffraction Demonstration with a Compact Disc

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Here is another way to demonstrate an important physics concept with a readily available object—the compact disc (CD). This time the CD is used as a *reflection* diffraction grating. The sound information code on a CD is pressed as pits into a polycarbonate substrate of the disc and covered with a thin aluminum coating.[1] The standard distance between two adjacent loops of the coded track is 1.6×10^{-6} m. This makes the disc suitable as a diffraction grating, useful in classroom and laboratory.

Cover the CD with a black paper mask leaving a 1- × 4-cm rectangular window and support the disc so that its plane is vertical and the window horizontal (refer to Fig. 1).

In semidarkness, direct a laser beam at the center of the CD window. The reflected pattern may be projected on a screen placed behind the light source. (The disc may have to be tilted slightly to clear the laser.)

With the laser 1 m from the screen, the distance between the two first-order images is 0.88 m and between the second 2.73 m. These values correspond to laser wavelengths of 644 and 645 nm, in good agreement with 632 nm listed in the manufacturer's manual.

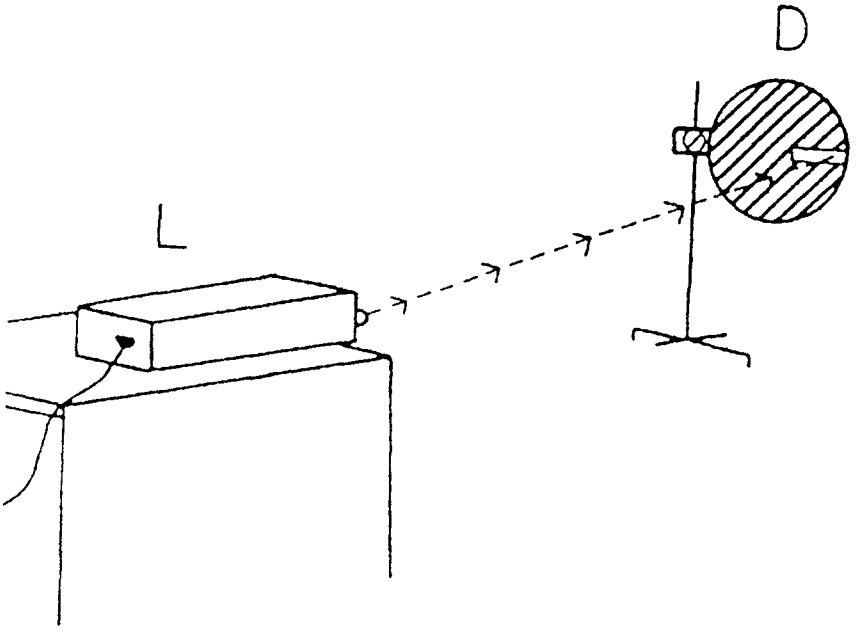

Fig. 1. Experimental arrangement for diffraction with a laser. L, laser; D, compact disc.

In subdued light, the diffraction spectrum of a laser beam is visible in a large lecture room. Students can quickly calculate from distance measurements either the laser wavelength or the spacing between the code loops of the CD.

In the laboratory, the CD may be used with a mercury source. In this case its spectrum should be projected through a converging lens onto the scale of a spectrometer.

Reference

1. K.C. Pohlmann, *The Compact Disk: A Handbook of Theory and Use* (A-R Editions, Madison, WI, 1989).

Free-Body Diagrams

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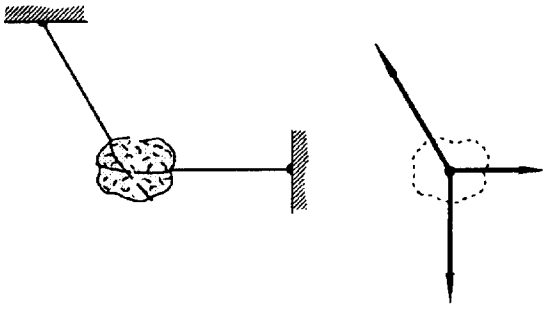
Editor's Note: *On the following pages we reproduce free-body exercises furnished us by James Court of City College of San Francisco. Readers are invited to photocopy and use any or all of the exercises. Graphics were prepared using DrawPerfect 1.1. They can be modified with WordPerfect 5.1 or WordPerfect for Windows and printed on a graphics printer. The author will be happy to supply the file to anyone who asks.*

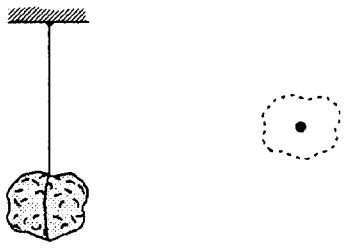
Free-Body Diagrams

In each case, a rock is acted on by one or more forces. All drawings are in a vertical plane, and friction is negligible except where noted. Draw accurate free-body diagrams showing all forces acting **on the rock**. Please use a ruler, and do it in pencil so you can correct mistakes. The first one is done as an example.

1. Static

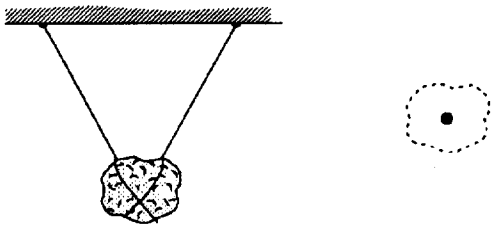


2. Static

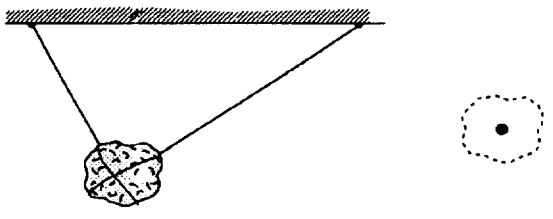


3. Rock is falling. No air friction.

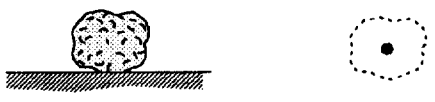
4. Static



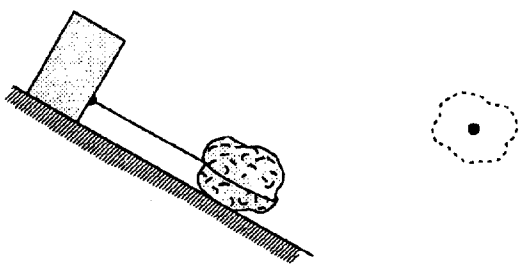
5. Static



6. Static

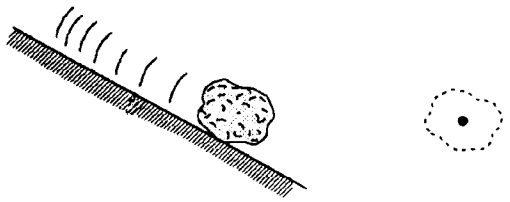


7. Static

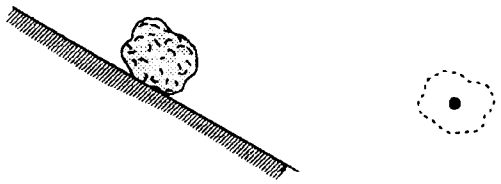


8. Static

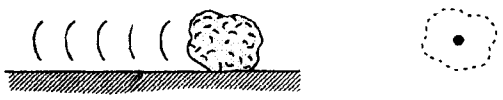
9. Sliding without friction.



10. Static friction prevents sliding.

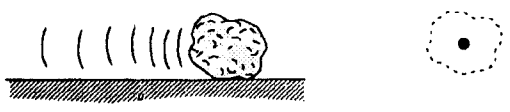


11. Sliding at constant speed without friction.

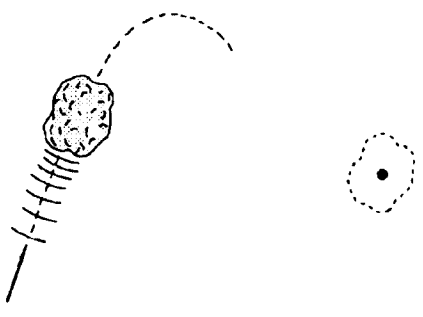


12. Falling at constant (terminal) velocity.

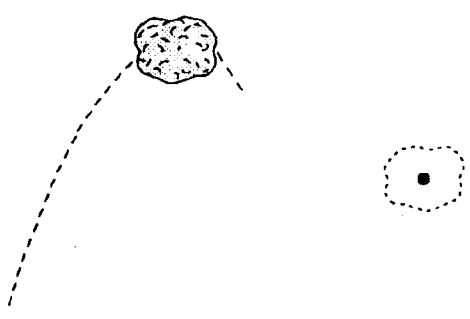
13. Decelerating because of kinetic friction.



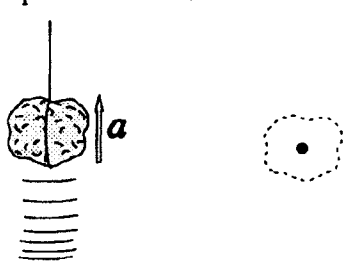
14. Rising in a parabolic trajectory.



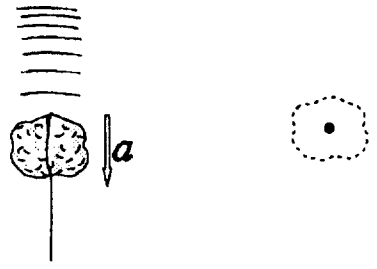
15. At the top of a parabolic trajectory.



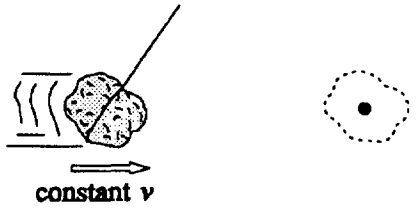
16. Tied to a rope and pulled straight upward. Accelerating upward at 9.8 m/s^2. No friction.



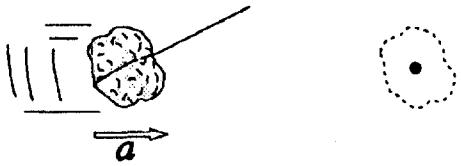
17. Tied to a rope and pulled straight downward. Accelerating downward at 19.6 m/s^2. No friction.



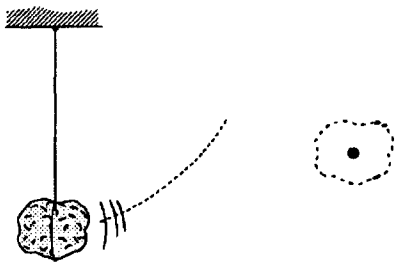
18. Tied to a rope and pulled so that the rock moves horizontally at constant velocity. Note: There must be air friction in this case.



19. Tied to a rope and pulled so that the rock accelerates horizontally at 2g. No air friction



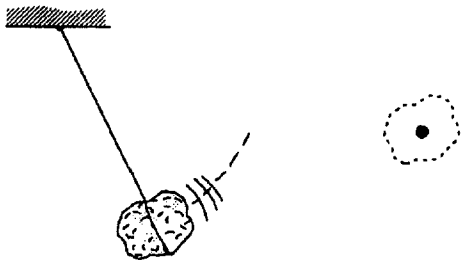
20. Swinging on a rope, at lowest position. No friction.



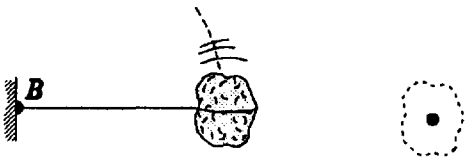
21. Tied to a post and moving in a circle at constant speed on a frictionless horizontal surface. Coming straight out of the paper.

22. Tied to point A by a string. Moving in a horizontal circle at constant speed. Not resting on a solid surface. No friction. Coming straight out of the paper.

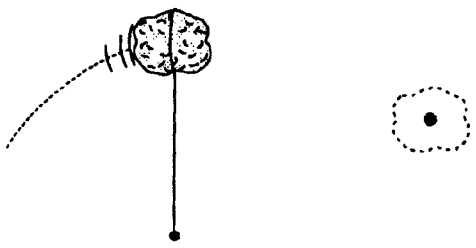
23. Swinging on a rope. No friction.



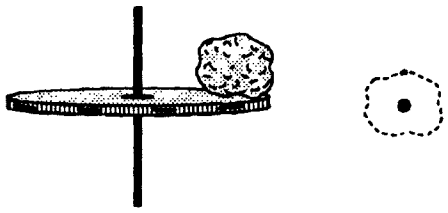
24. Tied to point B. Moving downward in a vertical circle with string horizontal. No friction.



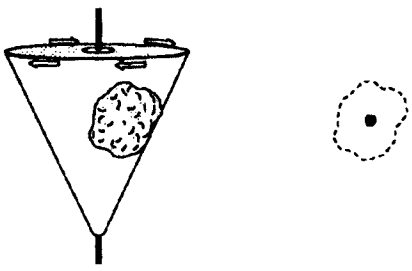
25. Swinging on a rope, at the top of a vertical circle.



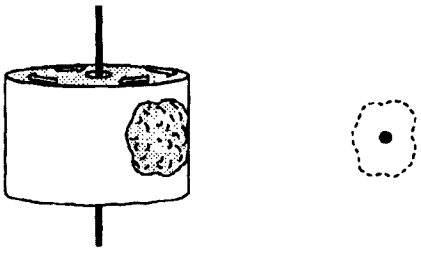
26. Riding on a horizontal disk that is rotating at constant speed about its vertical axis. Friction prevents rock from sliding. Rock is moving straight out of the paper.



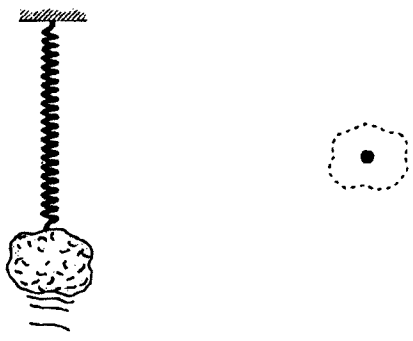
27. Resting against the frictionless inside wall of a cone rotating about its vertical axis at constant speed. Not accelerating vertically. Moving straight out of the paper.



28. Stuck by friction against the inside wall of a drum rotating about its vertical axis at constant speed. Rock is moving straight out of the paper.

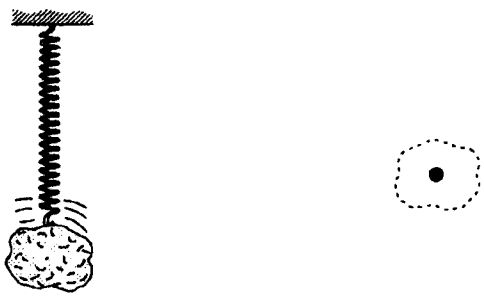


29. Suspended from a spring. Pulled downward slightly and released. No friction.



30. Suspended from a spring. Instantaneously at rest at the top of its travel.

31. Suspended from a spring. Moving downward through the equilibrium position. No friction.



32. Suspended from a spring. Moving upward through the equilibrium position. No friction.