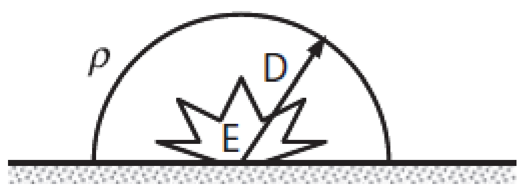
1. The *Stokes number*, St, used in particle-dynamics studies, is a dimensionless combination of *five* variables: acceleration of gravity g, viscosity μ, density ρ, particle velocity U, and particle diameter D. (a) If St is proportional to μ and inversely proportional to g, find its form. (b) Show that St is actually the quotient of two more traditional dimensionless groups.

2. A pendulum has an oscillation period T which is assumed to depend upon its length L, bob mass m, angle of swing θ, and the acceleration of gravity. A pendulum 1 m long, with a bob mass of 200g, is tested on earth and found to have a period of 2.04s when swinging at 20°. (a) What is its period when it swings at 45°? A similarly constructed pendulum, with L = 30 cm and m = 100 g, is to swing on the moon (g = 1.62 m/s2) at θ = 20°. (b) What will be its period?

3. Use dimensional analysis to determine the energy E released in an intense point blast if the blastwave propagation distance D into an undisturbed atmosphere of density r is known as a function of time t following the energy release.



4. To good approximation, the thermal conductivity k of a gas depends only on the density ρ, mean free path l, gas constant R, and absolute temperature T. For air at 20°C and 1 atm, k ≈ 0.026 W/m ·K and k ≈ 6.5E−8 m. Use this information to determine k for hydrogen at 20°C and 1 atm if l ≈ 1.2E−7 m.

5. A student needs to measure the drag on a prototype of characteristic length d_p moving at velocity U_p in air at sea-level conditions. He constructs a model of characteristic length d_m, such that the ratio d_p/d_m = a factor f. He then measures the model drag under dynamically similar conditions, in sea-level air. The student claims that the drag force on the prototype will be identical to that of the model. Is this claim correct? Explain.