Mastering Physics Prerequisites
Solving for an Unknown Value
Problems 6-10

6. When solving for the friction force exerted on a 10,000-newton car traveling around a curve of radius 50 meters at a speed of 25 m/sec, a student came up with the following equation.

$$\left[48{,}300\text{ N} - (3.732)F_{fr}\right](0.9659) = F_{fr}(0.2588) + 10{,}000\text{ N}$$

Solve this equation for the fractional force, F_{fr}.

7. Engineers must know that materials expand when heated and contract when cooled. Bridges are designed with expansion joints to prevent stress in the structure on extremely cold or extremely hot days (see figure to the right). The equation that relates the change in the length of a material with temperature is

$$\Delta L = \alpha L \Delta T$$

ΔL is the change in length, α is the thermal expansion coefficient of the material, L is the original length of the material, and ΔT is the temperature change.
What is the change in length, ΔL, of a slab of concrete that is 10 meters long when the temperature changes by 30°F? Note that the thermal expansion coefficient of concrete, α, is $6 \times 10^{-6}/°\text{F}$.

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A 30-foot rail (that trains travel on) will expand by a third of a centimeter when the temperature changes from -10°C to 20°C. What is the thermal expansion coefficient of the rail?

9. An electrical engineer is trying to determine the electric field between two parallel non-conducting plates in which each plate is a 40 cm by 40 cm square with a thickness of 1 mm, and each has a positive charge of 3 nanocoulombs. Her equation is

$$339\frac{\mathrm{Nm^2}}{\mathrm{C}} + E(0.16\ \mathrm{m^2}) = 4\pi(8.99\ \times 10^9\ \mathrm{Nm^2/C^2})(3\ \times\ 10^{-9}\ \mathrm{C})$$

Solve for E.

10. When using Gauss' Law to determine the electric field from a charged conducting disc with a charge of 0.4 nanocoulombs and a radius of 15 cm, a university student came up with the following mathematical expression. Can you calculate the electric field, E, for her?

$$-2E[\pi(15\ \mathrm{cm})^2] = 4\pi(8.99\ \times 10^9\ \mathrm{Nm^2/C^2})(-0.4\ \times\ 10^{-9}\ \mathrm{C})$$