Physics Problem Solving

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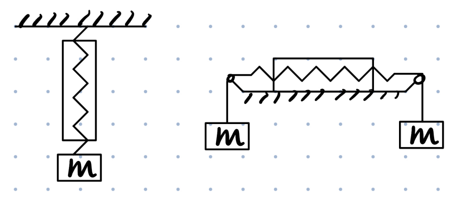

Figure: Setup

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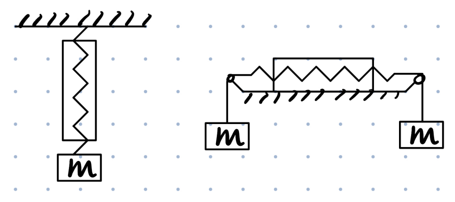

Figure: Setup

You may assume that the Newton-metres are massless.

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- What the newton-metre actually reads is the pull on only one end.
- This is very reasonable, due to the first setup, and usually we hold the other end on a fixed end/with our hand, which we do not usually account for the pull twice.

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We know from GCSE Physics that friction is to oppose relative motion of two surfaces.
In other words, static friction exists, if when the friction is removed the surfaces will slide relatively opposite to the direction of a friction.

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A person is climbing up along a climbing rope. Determine the direction of friction they experience.

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- Therefore, to oppose this motion, the friction will have to act upwards.

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- When we climb up, one of our arms and some of our body remain stationary, while the other arm and most of our body accelerates upwards, thanks to the arm providing the force upwards.
- The arms which remains stationary has to provide some extra upwards force to push the body upwards. To balance this, there is extra friction provided (extra in the sense of being equal to our weight).

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A tank contains water to a depth of 1.0m. Water emerges from a small hole in the vertical side of the tank at 20cm below the surface. Determine:

1. the speed at which the water emerges from the hole
2. the distance from the base of the tank at which the water strikes the floor on which the tank is standing.

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Substituting values, with the height of water above the hole $h = 20\text{cm}$,

$$v = \sqrt{2 \times 9.81 \times 0.2} = 1.98\,\text{m}\,\text{s}^{-1}.$$

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Now considering the horizontal motion of the water,

$$d = 1.98 \times 0.404 = 0.80\text{m} = 80\text{cm}.$$

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The pulley system in the figure consists of two pulleys of radii a and b rigidly fixed together, but free to rotate about a common horizontal axis. The weight W hangs from the axle of a freely suspended pulley P, which can rotate about its axle. If section A of a rough rope is pulled down with velocity V:

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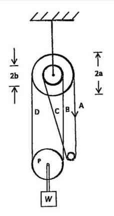

Figure: Pulley System

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$$V = \omega_a a \;\Rightarrow\; \omega_a = \frac{V}{a} \quad \text{and} \quad V_B = \omega_b b.$$

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Substituting $\omega_a = \frac{V}{a}$ into the expression for V_B using $\omega_a = \omega_b$,

$$V_B = \omega_b b = \omega_a b = \frac{V}{a} b.$$

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W rises as a result of the difference in speeds of ropes D and B since a greater length of rope D is pulled than length of rope B is pushed in a given time. Therefore, the centre of P and W rise with speed V_W,

$$V_W = \frac{1}{2}\left(V - \frac{b}{a}V\right)$$

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The factor of a half is required because length of rope on both sides of W must decrease by a length l for W to rise a length W.