

University Physics 1A

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Work-Energy Theorem

$$\frac{1}{2}mv^2 = \text{kinetic energy in joules}$$

Constant Force with a Varying Direction of Motion

An iceboat is tethered by a rope to a post so that it can move around an arc of a circle of radius $R = 100.0m$. The wind exerts a constant force $F = 150N$ on the boat. What is the work done by the wind on the boat as it rotates through 90.0° ?

$$\begin{aligned} W &= \int \vec{F} \cdot d\vec{s} \\ &= \int F ds \cos(\theta) \\ &= F \int \cos(\theta) ds \\ &= F \int \cos(\theta) r d\theta \\ &= Fr \int_0^{90} \cos(\theta) d\theta \\ &= (150N)(100)(\sin(90) - \sin(0)) \\ &= 15000J \end{aligned}$$

If the boat starts from rest, what is its speed at the end of this motion (again, friction is negligible)?

$$W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$
$$15000J = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$
$$v_f = \sqrt{\frac{30000J}{m}}$$

The mass of the iceboat is the same as the problems from the Activities Manual (250kg).

$$v_f \approx 11 \frac{m}{s}$$

You can find all my notes at <http://omgimanerd.tech/notes>. If you have any questions, comments, or concerns, please contact me at alvin@omgimanerd.tech