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PHYSICS 140 - General Physics 1, Fall 2007

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<http://hdl.handle.net/2027.42/64964>
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Ch 6 topics:
  • work, kinetic energy

Notices:
  • first midterm exam Thursday, 4 Oct, 6:00-7:30 pm
  • Review next TUESDAY evening (8:00 pm)
Grade distribution of practice midterm (@2pts/problem)

mean = 30.9
std dev = 5.2
median = 32
Why do you write to me, “God should punish the English”? I have no close connection to either one or the other. I see only with deep regret that God punishes so many of his children for their numerous stupidities, for which he himself can be held responsible; in my opinion, only his nonexistence could excuse him. (to a Swiss colleague, 1915)

The meaning of the word “truth” varies according to whether we deal with a fact of experience, a mathematical proposition, or a scientific theory. “Religious truth” conveys nothing clear to me at all.

My comprehension of God comes from the deeply held conviction of a superior intelligence that reveals itself in the knowable world. In common terms, one can describe it as “pantheistic” (Spinoza).

Work

Work is a measure of the energy transferred to or from a system through the action of forces.

Given a constant force $F$ applied as an object moves through a displacement $d$, we define the work done, $W$, on the object by the applied force as the scalar product of the force and displacement vectors

$$W = F \cdot d$$

This is equivalent to $W=F_{\parallel}d$, where $F_{\parallel}$ is the component of the force directed along the direction of the displacement. Alternately, the work is $W=Fd_{\parallel}$ where $d_{\parallel}$ is the component of the displacement directed along the direction of the force.

The SI unit of work is the Joule (1J = 1Nm).

Note: 1 (food) Calorie = 4,184 Joules = 4.184 kJ
Work is a **scalar quantity** that can be **positive**, **negative**, or **zero** depending on the relative orientations of $F$ and $d$.

As the chest moves to the right in this diagram, tension in the rope is doing positive work on the chest, while kinetic friction is doing negative work on it.

\[
W_{\text{tot}} = W_{\text{rod}} + W_{\text{friction}}
\]
\[
W_{\text{rod}} = F_{\text{rod}} \cdot d > 0
\]
\[
W_{\text{friction}} = f_k \cdot d < 0
\]
Work is moving 7.5 tons of stone!

15,000 lbs on 5 pallets
378 pavers/pallet (~3.5 kg each)
32 pavers/trip ~ 12 trips/pallet
First 2 pallets: ~750 pavers
~0.2m distance with force~$mg$

$m=3.5$ kg

Approximate Total Work

$=750 \times (3.5\text{kg} \times 10\text{m/s}^2) \times 0.2\text{m}$

$\sim 5.2\text{ kJ} \sim 1.2\text{ Calorie}$

(1 Krispy Kreme sugar donut has 200 Calories!)

3 tons down, 4.5 more to go…
A tow-truck is towing a car up a steep 20 deg incline. The tow line makes an angle of 30 deg with the incline. If $T$ is the tension in the line, what is the work done by tension on the car as it is towed a distance $d$ along the hill?

1) $T \, d$
2) $T \cos(20) \, d$
3) $T \cos(30) \, d$
4) $T \cos(50) \, d$
5) $mg \, d$
Kinetic energy and the work-kinetic energy theorem

The energy of motion is known as \textit{kinetic energy}. A mass \( m \) moving with velocity \( v \) has an amount of kinetic energy

\[
K = \frac{1}{2} m v^2
\]

Kinetic energy can be changed by the action of forces.

The \textit{work-kinetic energy theorem} states that the change in kinetic energy over some time interval \( \Delta t = t_f - t_i \) equals the total work done

\[
W_{\text{tot}} = \Delta K = K_f - K_i = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2
\]

Here \( v_f \) and \( v_i \) are the final and initial speeds of the object of mass \( m \), and \( W_{\text{tot}} \) is the work done by the \textit{net force} acting on the object over the time interval \( \Delta t \).
Lance Armstrong

Basic idea: maximize speed/kinetic energy by minimizing (negative) work done by air drag and other sources of friction and maximizing the work done by pedaling.
A pendulum consists of a ball of mass $m$ suspended from a string of length $L$ and negligible mass. The pendulum is extended from the vertical by an initial angle $\theta$ and then released. At the moment the pendulum passes back through the vertical, how much work has been done on the ball by the force of gravity?

1. $mgL$
2. $mgL \sin \theta$
3. $-mgL \cos \theta$
4. $mgL (1 - \cos \theta)$
5. $mgL (\cos \theta - 1)$
powertap data from run #1

exercise: compare to expectation from gravity, \( g \cdot \sin(\theta) \), based on Beal Ave. vertical profile