Energy

Energy is the ability to make a change in the universe.

All energy is measured in units of JOULES (J) ← $N \cdot m$ $\frac{kg\,m^2}{s^2}$

There are many types of energy. The ones we do this year are:

There are 2 main categories of energy

Ep (PE) potential energy - stored, able to change some property in the universe later

Ep in springs: $E_p = \frac{1}{2}kx^2$ ← k = spring constant (N/m) ← x = stretch or compress (m)

Gravitational Ep: $E_p = mgh$ ← m = mass (kg) ← g = accel due to gravity $9.8\frac{m}{s^2}$ ← h = height from low point (m)

Energy stored as mass: $E = \Delta mc^2$ ← c = speed of light $3.00 \times 10^8 \frac{m}{s}$ ↖ change in mass in nuclear reaction

Kinetic Energy Ek (KE): energy forms in use right now

Energy of a moving mass: $E_k = \frac{1}{2}mv^2$ V ← velocity $(\frac{m}{s})$

Heat or thermal energy: E_H ← moving molecules ← assume this is zero

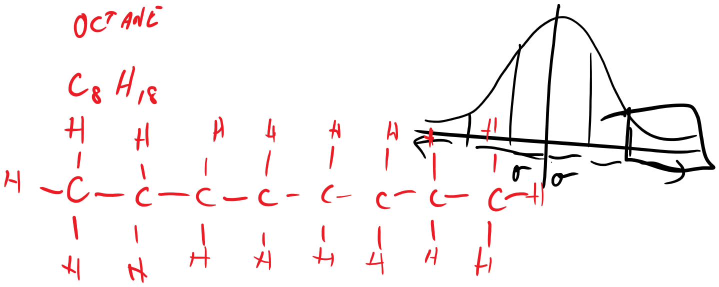
Electrical Energy: $E_e = VIt$

V ← voltage (V)
I ← current (A)
t ← time (s)

$9.8 \frac{m}{s^2})$

m)

$\frac{m}{s}$



angle

Energetic Examples:

1) A cat of mass 5.0 kg is moving at 4.0 m/s what is its kinetic energy?

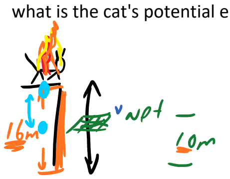
$E_k = \frac{1}{2}mv^2$
$= \frac{1}{2}(5)(4)^2 = 40J$

2) A spring with constant 120 N/m is stretched from 2 cm to 12 cm what is its elastic energy?

$\Delta X = 12 - 2$
$= 10\text{ cm} \div 100$
$= .1\text{ m}$

$E_p = \frac{1}{2}kx^2$
$= \frac{1}{2}(120)(.1)^2 = 0.60J$

3) A cat on fire has mass 8.0 kg and is on the edge of a cliff that is 16 m above the ground. If there is a safety net 10 m above the ground what is the cat's potential energy a) measured from the net
b) Measured from the ground



$E_p = mg\Delta h$
$= (8)(9.8)6$
$= 470\text{ J}$

$E_p = mg\Delta h$
$= 8(9.8)(16) = 1.25 \times 10^3 J$

4) ~~An atom of Uranium has mass [illegible] kg what energy is stored in its mass?~~ SKIP

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5) If the specific heat capacity of copper is 390 J /kg°C how much energy is required to raise the temperature of 2 kg of copper by 30°C?

$E_H = mc\Delta T$
$= 2(390)(30)$
$= 2.34 \times 10^4 J$

Kinetic Energy	Potential energy
	1, 3, 5

Kinetic Energy

1 - 3

hints: use F_g to find m

use kinematics to find v

Potential energy

1, 3, 5

hint: it's all about the height

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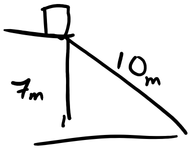
P.3 1-3

Kinetic Energy

Back of P.1



cat

$+E_k$

.25

The Work/energy Theorem

When work is done it results in a change in the energy of an object.

W = ΔE

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This could be a change in Ep or Ek or Ep + Ek!

A cat of mass 3.0 kg is lifted 2.0 m how much work was done on the cat?

$$W = \Delta E_p$$

$$= E_{pf}$$

$$= mgh_f - \cancel{mgh_0}$$

$$0$$

$$58.8J = 3(9.8)2$$

An engine of a F350 of mass 1200kg, provides acceleration of 4.0 m/s ^{2}. If the truck was moving at 12 m/s and ends at 17 m/s, what work was done?

$$W = \underline{F} \cdot \underline{d}$$

$$F = ma \qquad V_f^2 = V_0^2 + 2ad$$

$= 1200\,(4)$ $17^2 = 12^2 + 2(4)d$ $= \frac{1}{2}\,1200\,17^2 - \frac{1}{2}\,1200\,(1$

$17^2 - 12^2 = d = 18.1\,m$

An airplane at rest on the runway takes off and reaches a height of 500m with velocity of 50 m/s. If its mass is 800 kg what work was done?

$$* \; W = \Delta E_p + \Delta E_k$$

$$W = E_{pf} - E_{po} + E_{kf} - E_{ko}$$

$$* \; W = mgh_f - \cancel{mgh_o} + \frac{1}{2}$$

$$= 800(9.8)(500) + \frac{1}{2}\,800\,(50)^2$$

$$= 4.92 \times 10^6\ J$$

A bunny of mass 500 g is graphed as shown below. If it started at rest What is its final velocity?

The Work/Energy Theorem:

When work is done on or by an object energy changes. Work = ΔE

Example 1: a spring with constant 25 N/m is stretched from 15 to 20 cm, what Work was done on the spring:

$W = \Delta E$

$W = \frac{1}{2}kx^2$

$20 - 15 = 5\ \text{cm}$

$\frac{5}{100} = .05$

$W = \frac{1}{2}(25)(.05)^2$

$= 0.031\ \text{J}$

Exmaple 2: 90 J of work is done accelerating a 10 kg cat from 3.0 m/s, what is Its final velocity:

$90 = \frac{1}{2}m(v_f - v_0)^2$

$\frac{90}{5} = \frac{1}{2}\cancel{(10)}(v_f - v_0)^2$

$90 = 5v_f^2 - 5(3)^2$

$\frac{135}{5} = \cancel{5}v_f^2$

$= \sqrt{27} =$

$W = \Delta E_k$

$90 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2$

$90 = \frac{1}{2}10v_f^2 - \frac{1}{2}(10)3^2$

$90 = 5v_f^2 - 45$

$90 + 45 = 5v_f^2$

$\frac{135}{5} = \cancel{5}v_f^2$

$27 = v_f^2 \quad v_f = 5.2\ \frac{m}{s}$

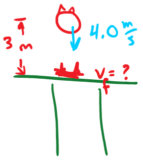
The Law of Conservation of Energy: total before = total after

$E_{po} + E_{ko} = E_{pf} + E_{kf} + E_H$

assume zero Unless I say other wise

Examples: A cat of mass 5.0 kg is dropped from height 6.0 m and strikes the Earth. With what speed does it impact:

A cat is thrown down/up at 4.0 m/s from height 3.0 m above a desk. The 5.0 kg cat hits the desk, what speed had it at impact?



$E_{po} + E_{ko} = E_{kf} + E_{pf} + \cancel{E_H}$

$mgh_0 + \frac{1}{2}mv_0^2 = \frac{1}{2}mv_f^2 +$ [redacted]

$(5)(9.8)3 + \frac{1}{2}5(4^2) = \frac{1}{2}5\ v_f^2$

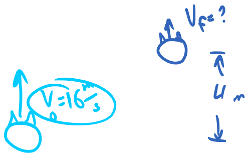
:

$147 + 40 = 2.5v_f^2$

$v_f = 8.65\ \frac{m}{s}$

Energy does not depend on direction

A cat named Blake the Flake is thrown up from the ground with an initial velocity of 16 m/s if Blake's mass is 15 kg what velocity will non-binary Blake have at height 4.0 m?



$E_{po} + E_{ko} = E_{pf} + E_{kf} + \cancel{E_H}$

$+ \frac{1}{2}mv_0^2 = mgh_f + \frac{1}{2}mv_f^2$

$\frac{1}{2}(15)16^2 = 15(9.8)4 + \frac{1}{2}(15)v_f^2$

$1920 = 588 + 7.5v_f^2$

-588

$\frac{1332}{7.5} = \cancel{7.5}v_f^2$

ok

A spring with constant 4000 N/m is compressed 0.03 m, it is used to fire a 3.0 kg cat what velocity will the cat have?

$E_p = \frac{1}{2}kx^2$

$E_{po} + \cancel{E_{ko}} = \cancel{E_{pf}} + E_{kf} + \cancel{E_H}$

[redacted] $kx^2 =$ [redacted] mv_f^2

$\frac{kx^2}{m} = v^2$

$\frac{(4000)(.03)^2}{3} = v^2$

$\sqrt{1.2} = v = 1.1\ \frac{m}{s}$

Ep in a gravitational field:

A cat named Damek is thrown down at 16 m/s from a 20m high tower of doom. What will be the cat's velocity when it "hits the ground"?

J

$E = \Delta m c^2$

energy

in mass

mass change can change

=

involves a nuclear reaction