Video
503
(4:14)

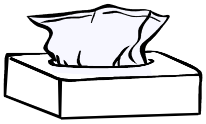
Work, Energy, and Power

Name: ____________________

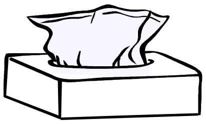
Work …done on an object when a force moves object through a distance

Unit for work is N-m, or J. *F* and *d* must be //.

EX. A 63.4 g facial tissue box is lifted at constant speed from the ground to height 1.08 m. Find work the lifter does on box.



EX. Student carries 63.4 g tissue box 3.2 m ⟶ at constant height Of 1.08 m above floor. How much work does gravity do on box?



Video
506
(4:55)

25 kg mass is pulled 3.4 m across horiz. surface by 170 N horiz. force. Coefficient of friction is 0.33. Find work done by…

…applied force

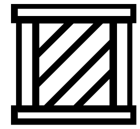
…friction

…gravity.

Now find net work done on mass.

Video 509 (6:16)

17.5 kg mass is pulled 5.43 m → by a 185 N force applied at 21.0° above horizontal. If coefficient of friction is 0.420, find work done by every force acting on mass.



Video 512 (6:20)

Energy →

-- unit is…

kinetic energy:

--

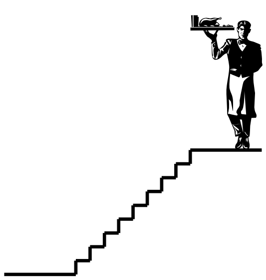
potential energy:

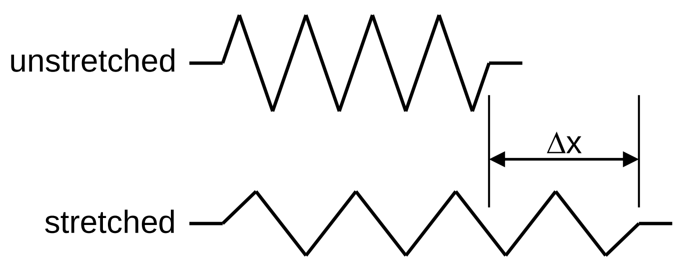
gravitational potential energy (PE_g)

--

elastic potential energy (PE_{elas})

--





Video 515 (9:47)

Law of Conservation of Energy

Energy remains constant, but may change form.

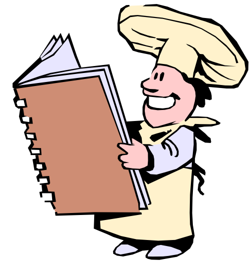
We use this in solving problems if there is…

A. little or no friction (including air resistance)

B. no collision in which significant heat is released

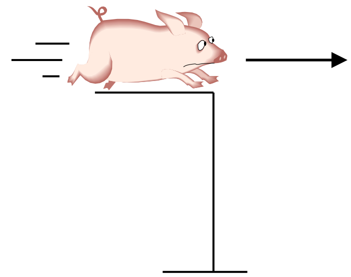
Procedure:

1. Take two snapshots of system.
2. Calculate various energies (KE, PE_g, PE_{elas}) for each snapshot.
3. The sum of these (i.e., the total mechanical energy, ME) for one snapshot equals the sum of these for the other snapshot.



EX. 3.0 kg mass slides ⟶ off a 1.8 m-high shelf at 6.0 m/s ⟶ . Find mass's speed as it hits ground.

	A	B
KE		
PE_g		
PE_{elas}		
ME		



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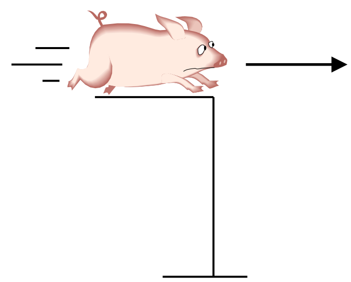
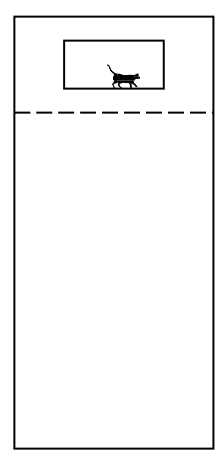


Video 518 (6:35)

A 7.4 kg cat sits at rest on window ledge 1.1 m above the floor on 13^{th} story of apt. bldg. Floor level is 41.0 m above street. Find speed of cat landing on floor.

	A	B
KE		
PE_g		
PE_{elas}		
ME		



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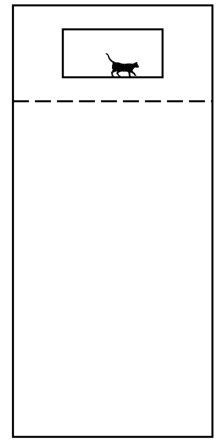
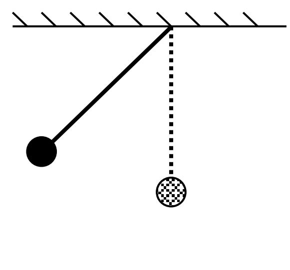
	A	B
KE		
PE_g		
PE_{elas}		
ME		



Video 521 (7:29)

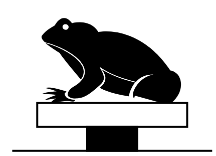
A 2.0 m pendulum hangs from ceiling that is 3.0 m above floor. If 8.0 kg bob is released from rest 1.5 m above floor, find its speed at bottom of its path.

	A	B
KE		
PE_g		
PE_{elas}		
ME		



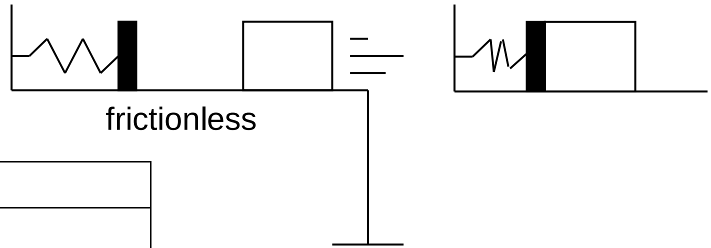
EX. A 0.38 kg object rests on spring w/spring constant 6.0×10^3 N/m. Orig. spring length is 82 cm, but it has been compressed to 52 cm. When spring is released, object goes how high?

	A	B
KE		
PE_g		
PE_{elas}		
ME		



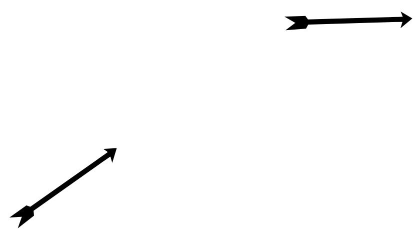
Video 524 (8:28)

Horiz. spring is attached to wall. An 8.5 kg mass is slid across a frictionless, horiz. surface at 2.8 m/s. When mass hits spring, spring compresses 45 cm. If surface is 1.4 m above ground, find spring constant.



	A	B
KE		
PE_g		
PE_{elas}		
ME		

EX. Arrow of unknown mass is launched at an unknown angle w/initial speed 45 m/s. At top of its path, its speed is 35 m/s. How high does arrow fly?



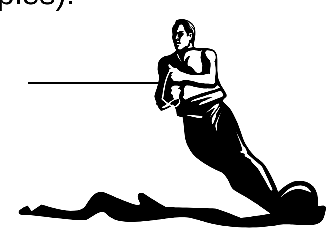
At what angle was arrow launched?

Video 527 (7:27)

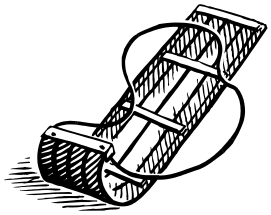
The Work-Kinetic Energy Theorem

When friction and other heat losses are NOT negligible, the conservation of energy procedure is invalid. Thus, we turn to the work-kinetic energy theorem (which could, incidentally, be used in any of the previous examples).

EX. From rest, a 72 kg object is pulled on a level surface by a horiz. 238 N force. If coeff. of kinetic friction is 0.28, how far will object have traveled by the time its speed reaches 5.0 m/s?



EX. A 12 kg object slides ⟶ on ice w/initial speed 2.2 m/s. If coeff. of kinetic friction is 0.030, how far will object slide?



Video 530 (5:41)

A 12.5 kg mass begins from rest at top of a frictionless, 4.0 m-long, 32º incline. Find speed at bottom.

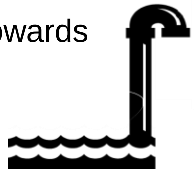
Now find v_f when $\mu_k = 0.27$.

Video 539 (7:40)

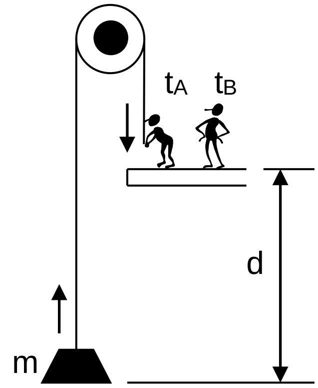
Power →

Unit for power is the…

EX. A flooded basement contains 1.2 x 10^8 kg of water that must be pumped upwards 2.5 m. In what time would a 373 kW pump empty the basement?

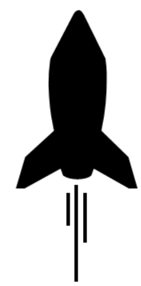


EX. An 85 kg mass must be raised to height 4.5 m. Person A does so in 1 minute, 24 seconds; Person B does so in 2 minutes, 48 seconds. Find work AND power done by A AND by B.



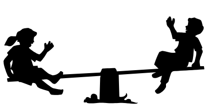
Video 542 (7:03)

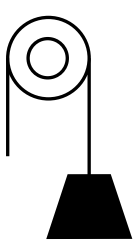
A 5.0×10^2 kg rocket accelerates upward from rest to 540 m/s in 2 minutes, 46 seconds. If air resistance is 1.5×10^3 N, find avg. power of rocket engine.

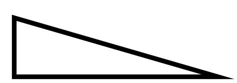


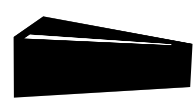
Video 545 (9:40)

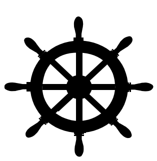
Simple Machines

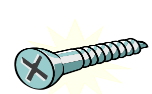












Levers

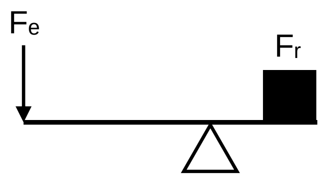
F_e =

F_r =

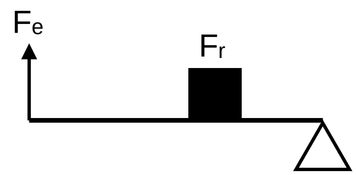
d_e =

d_r =

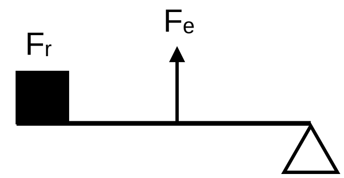
1st Class



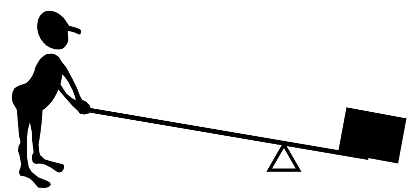
2nd Class



3rd Class



The Math of Simple Machines



work input:

work output:

"Effort" deals ^{w}/force you apply;

"resistance" refers to force from load.

For **ideal** machines…

i.e.,

The <u>ideal mechanical advantage</u> (IMA) is…

For **real** machines…

and <u>actual mechanical advantage</u> (AMA) < IMA

(Note that, for ideal machines, IMA = AMA.)

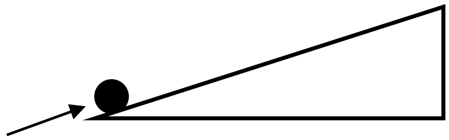
NO machine...

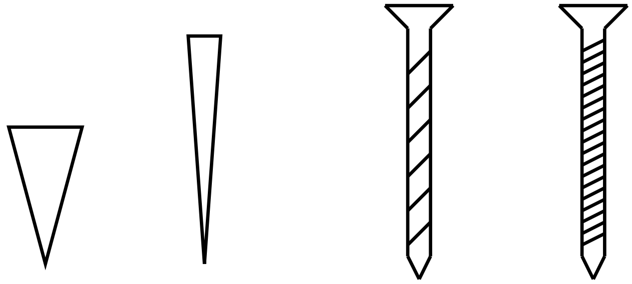
<u>Efficiency</u> (Eff) tells how closely a real machine comes to being an ideal machine. It is a %.

For object being pushed up an inclined plane:

…effort distance d_e = ramp length L, and

…resistance distance d_r = ramp height h.



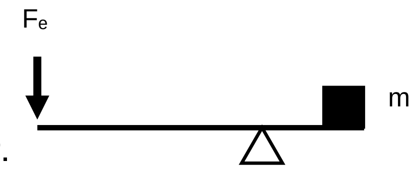


Therefore…

As IMA ↑, F_e and d_e .

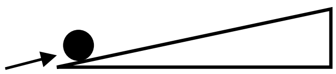
Video 548 (4:46)

First class lever is 2.13 m long. Effort force is 320 N ↓ and is 1.60 m from fulcrum. 85 kg mass to be lifted is 0.53 m from fulcrum. Find IMA, AMA, and efficiency of lever.



Video 551 (2:50)

Ramp of length 3.2 m allows 54 kg mass to be pushed up 73 cm above floor. If force req'd to push mass up ramp is 230 N, find IMA, AMA, and efficiency of ramp.



Video 554 (3:42)