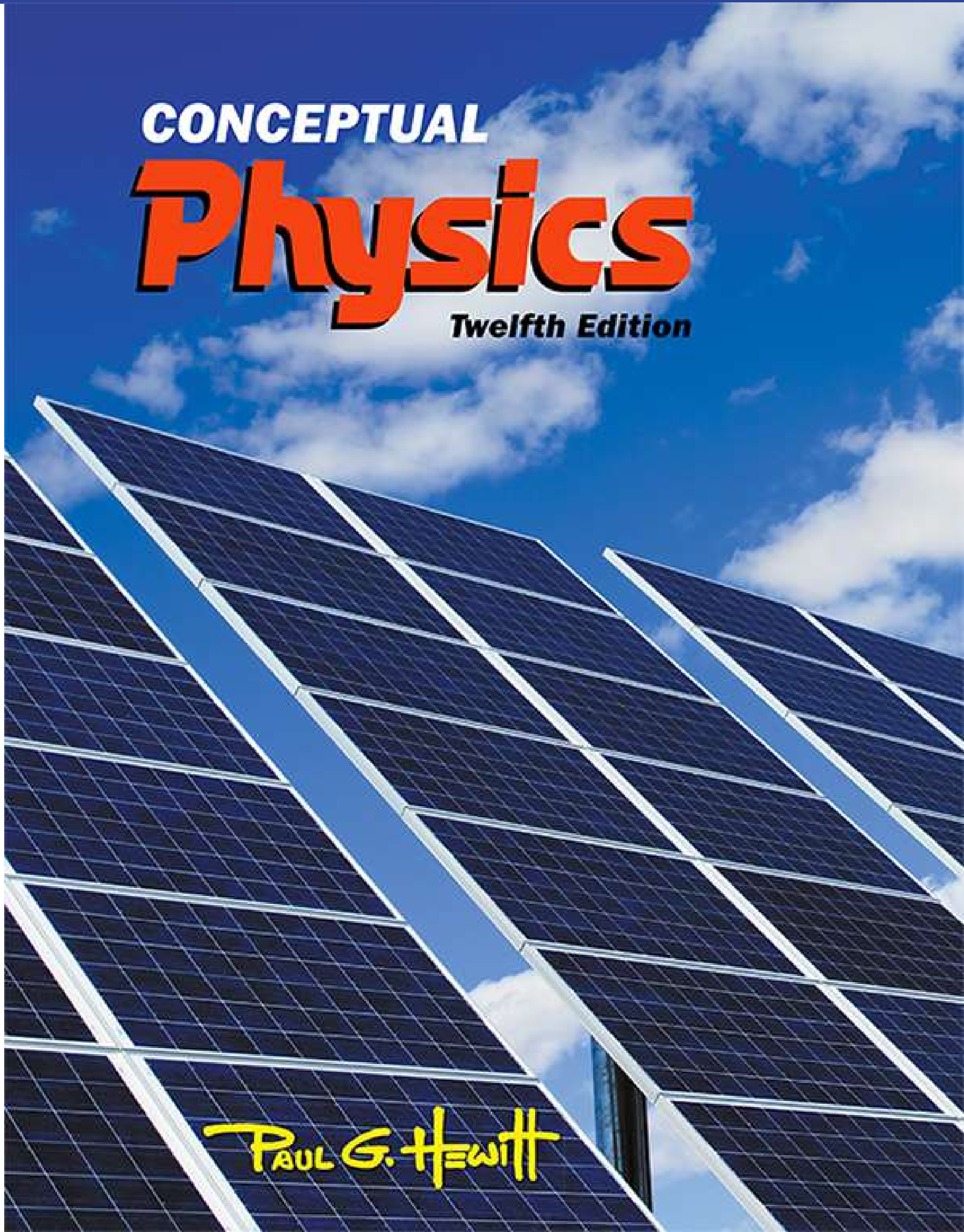
Chapter 7: Energy

Section 5: Conservation of Energy



Review: What are the equations for….

…momentum? momentum = mv

…work? work W = Fd

…power? power P = W/t

….gravitational PE? PE = $wh = mgh$

…kinetic energy? KE = $(1/2)mv^2$

Q1) Which is a vector? momentum

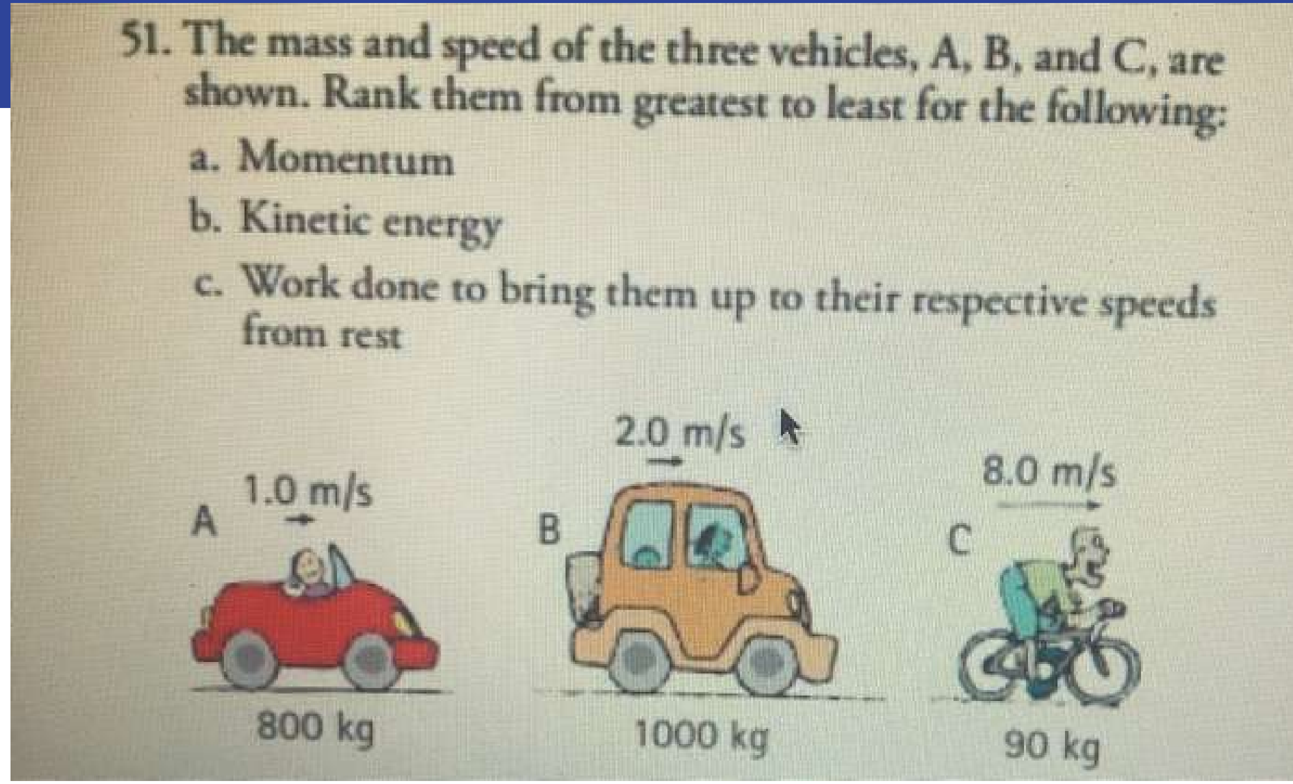
Q2) Which has units of joules? W, PE and KE

Q3) Work energy theorem:

$$W = \Delta KE$$

$$Fd = \Delta(1/2)mv^2$$

Ex 1:



51. The mass and speed of the three vehicles, A, B, and C, are shown. Rank them from greatest to least for the following:

a. Momentum

b. Kinetic energy

c. Work done to bring them up to their respective speeds from rest

	momentum mv	$KE = (1/2)\,mv^2$	W
A.	(800)(1)	$(1/2)(800)(1^2)$	400 J
B.	(1000)(2)	$(1/2)(1000)(2^2)$	2000 J
C.	(90)(8)	$(1/2)(90)(8^2)$	2880 J

- Law of conservation of energy:
  - Energy cannot be created or destroyed; it may be transformed from one form into another, but *the total amount of energy never changes.*
  - In equation form:

Total energy **before** = Total energy **after**

PE + KE + heat = PE + KE + heat

If friction or heat can be ignored:

PE + KE = PE + KE

total mechanical energy = total mechanical energy

Total energy before = total energy after

- Example: Energy transforms without net loss or net gain in the operation of a pile driver.

before:

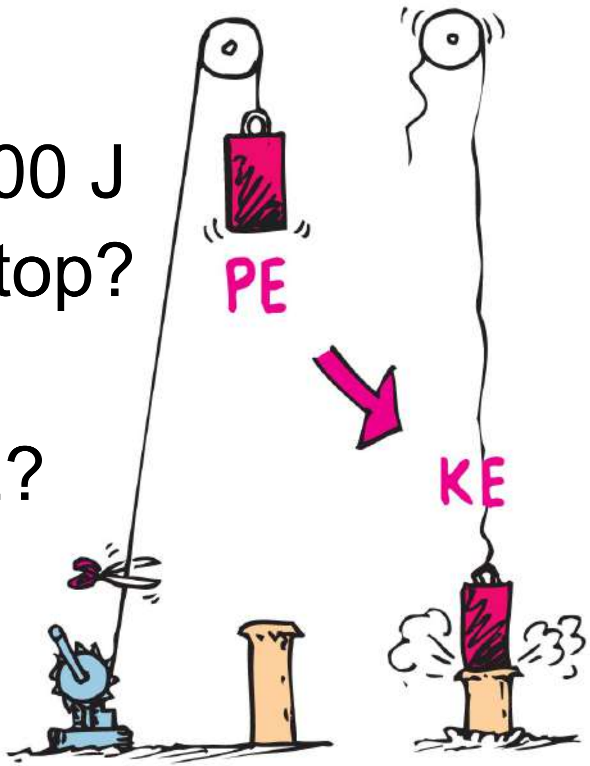
At top, PE = 50,000 J

How much KE at top?

0 J

How much total E?

50,000 J



after:

How much total E as it hits?

50,000 J

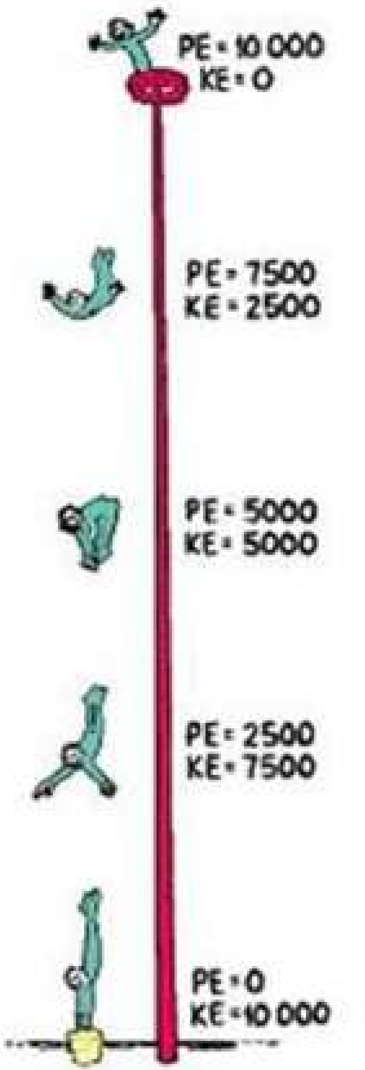
How much PE?

0 J

KE = ? 50,000 J

Ex: Circus diver at top of a pole:

before:



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1. Why is the KE = 0 at the top? v = 0

2. What is the total mechanical energy of the diver when at the top of the pole?

   10,000 J

3. What is the total mechanical energy at any point before he hits the bucket?

   10,000 J

4. As he falls, what kind of energy is transformed into what other kind of energy?

   PE → KE

5. Why is the PE = 0 at the bottom?

   PE = mgh, and h = 0

Ex: Drop a ball from rest

No air resistance:

drop

PE = 10 J
KE = 0 J

PE = 5 J
KE = 5 J

PE = 0 J
KE = 10 J

With air resistance:

PE = 10 J
KE = 0 J

PE = 5 J
heat = 1J
KE = 4 J

PE = 0 J
heat = 2 J
KE = 8 J

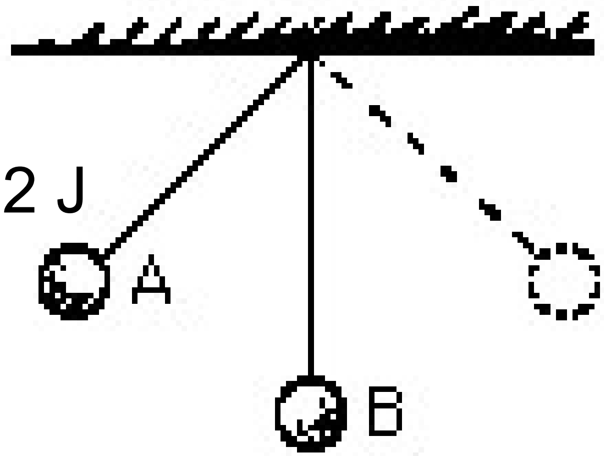
In which case is ball going faster when it hits? no air

In which case is ball warmer when it hits? with air

Ex: Pendulum swinging

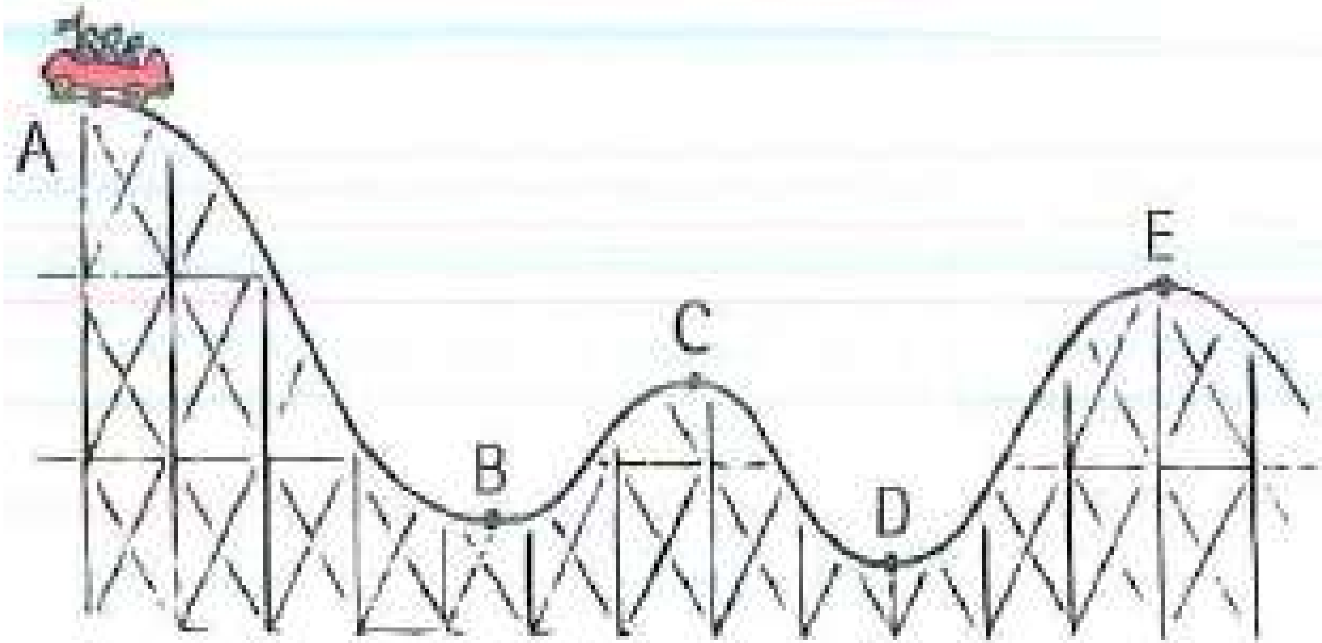
A pendulum is released from rest. It has 2 J of PE when it is released at point A. *Ignore friction.*

PE 2 J



1. How much KE does it have at A? 0
2. How much total mechanical energy does it have at A? 2 J
3. How much total mechanical energy does it have at B? 2 J
4. How much PE does it have at B? 0 J
5. How much KE does it have at B? 2 J

Rank PE and KE from lowest to highest for the points shown.



PE:	D	B	C	E	A
KE:	A	E	C	B	D

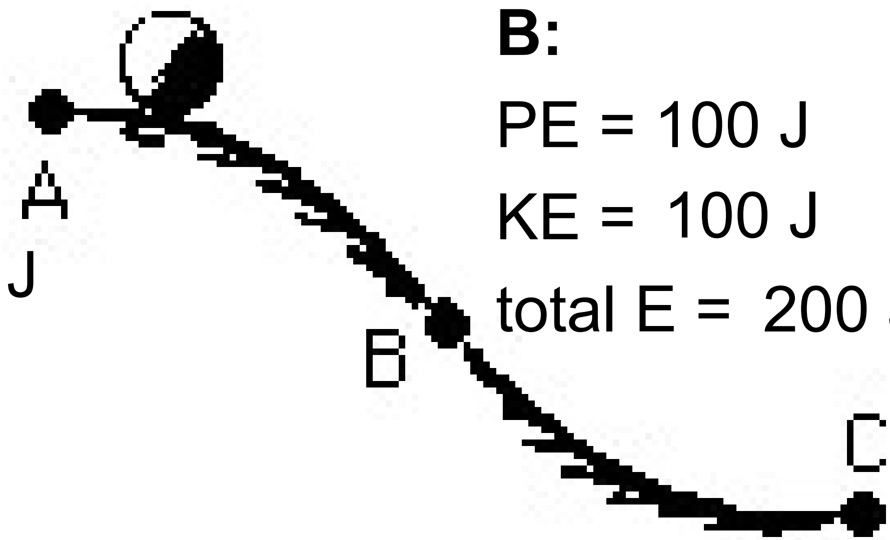
Ex. A boulder starts from rest at A and rolls down a hill. Ignore friction. Find the unknown quantities:

A:

PE = 200 J

KE = 0 J

total E = 200 J



B:

PE = 100 J

KE = 100 J

total E = 200 J

C:

PE = 0 J

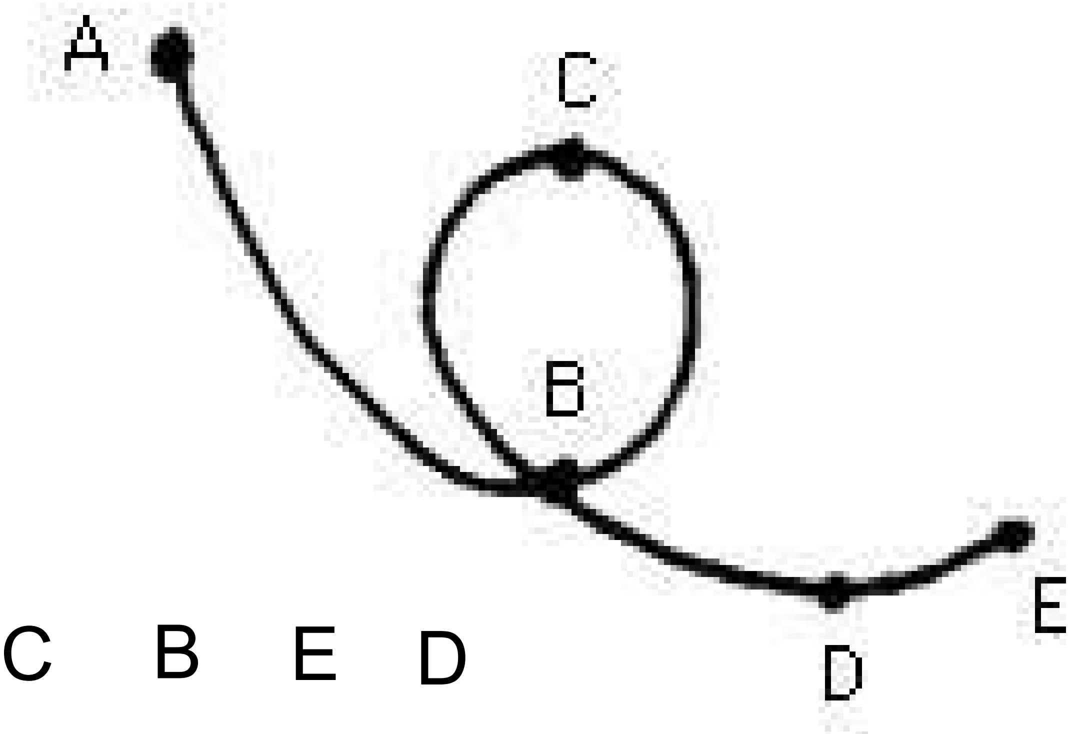
KE = 200 J

total E = 200 J

If it arrives at C with only 170 J of KE, how much mechanical energy was converted to heat?

30 J

Ex: On a roller coaster, ignore friction and rank from most to least:



Gravitational PE: A C B E D

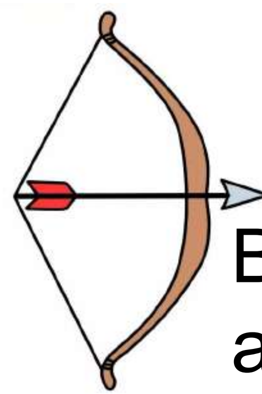
Kinetic KE: D E B C A

Total mechanical energy: same everywhere

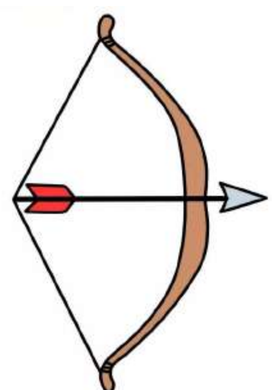
Conservation of Energy
A situation to ponder…

- Consider the system of a bow and arrow. In drawing the bow, we do work on the system and give it potential energy.
- When the bowstring is released, most of the potential energy is transferred to the arrow as kinetic energy and some as heat to the bow.

Do work Fd:



Bow and arrow have PE



Arrow has KE

…but some heat is released.

A situation to ponder…
CHECK YOUR NEIGHBOR

Suppose the potential energy of a drawn bow is 50 joules and the kinetic energy of the shot arrow is 40 joules. Then

A. energy is not conserved.
B. 10 joules go to warming the bow.
C. 10 joules go to warming the target.
D. 10 joules are mysteriously missing.

A situation to ponder…
CHECK YOUR ANSWER

Suppose the potential energy of a drawn bow is 50 joules and the kinetic energy of the shot arrow is 40 joules. Then

C. 10 joules go to warming the bow.

Explanation:

The total energy of the drawn bow, which includes the poised arrow, is 50 joules. The arrow gets 40 joules and the remaining 10 joules warms the bow—still in the initial system.

Ex :

A ball is released from rest at the left of the metal track shown here. Assume it has only enough friction to roll, but not to lessen its speed. Rank these quantities from greatest to least at each point:

a. Momentum

b. KE

c. PE

Momentum:	C	B = D	A
KE:	C	B = D	A
PE:	A	B = D	C

Homework:

- No new homework
- Finish missing assignments.