ConcepTest 6.1 Kinetic Energy

Car #1 has twice the mass of car #2, but they both have the same kinetic energy. How do their speeds compare?

1) $2\, v_1 = v_2$
2) $\sqrt{2}\, v_1 = v_2$
3) $4\, v_1 = v_2$
4) $v_1 = v_2$
5) $v_1 = \sqrt{2}\, v_2$

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Since the kinetic energy is $\frac{1}{2} m v^2$, and the mass of car #1 is greater, then car #2 must be moving faster. If the ratio of m_1/m_2 is 2, then the ratio of v^2 values must also be 2. This means that the ratio of v_2/v_1 must be the square root of 2.

ConcepTest 6.2 Free Fall

Two stones, one twice the mass of the other, are dropped from a cliff. Just before hitting the ground, what is the kinetic energy of the heavy stone compared to the light one?

1) quarter as much
2) half as much
3) the same
4) twice as much
5) four times as much

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Consider the work done by gravity to make the stone fall distance *d*:

$\Delta KE = W_{net} = F\,d\,\cos\theta$

$\Delta KE = mg\,d$

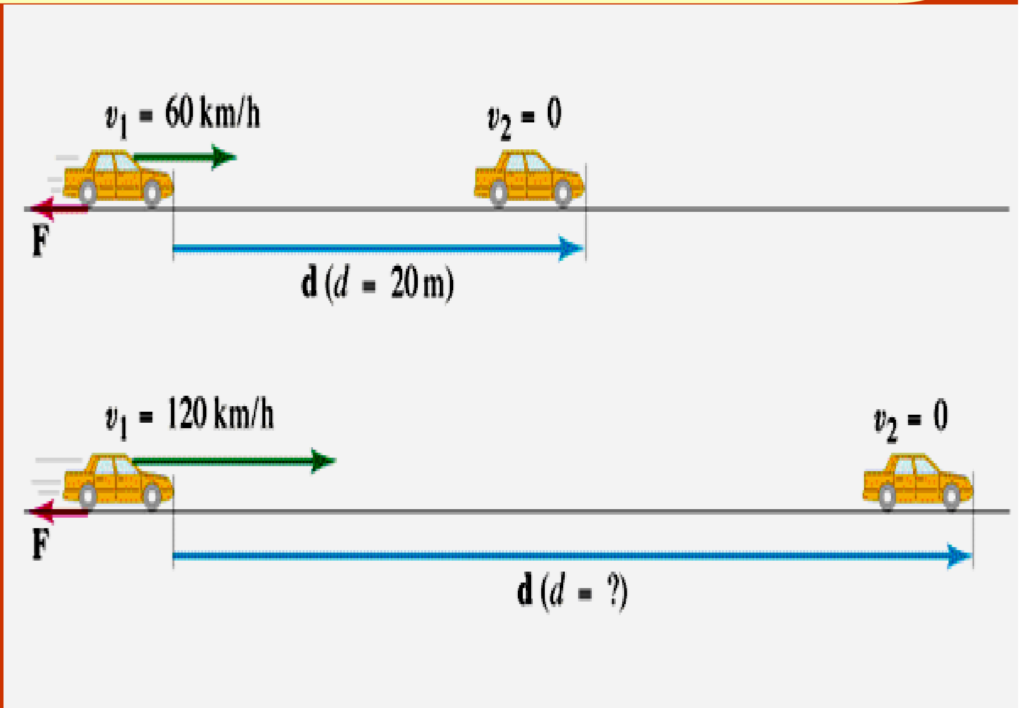
Thus, the stone with the greater mass has the greater KE, which is twice as big for the heavy stone.

Follow-up: How do the initial values of gravitational PE compare?

ConcepTest 6.3 Slowing Down

If a car traveling 60 km/hr can brake to a stop within 20 m, what is its stopping distance if it is traveling 120 km/hr? Assume that the braking force is the same in both cases.

1) 20 m
2) 30 m
3) 40 m
4) 60 m
5) 80 m



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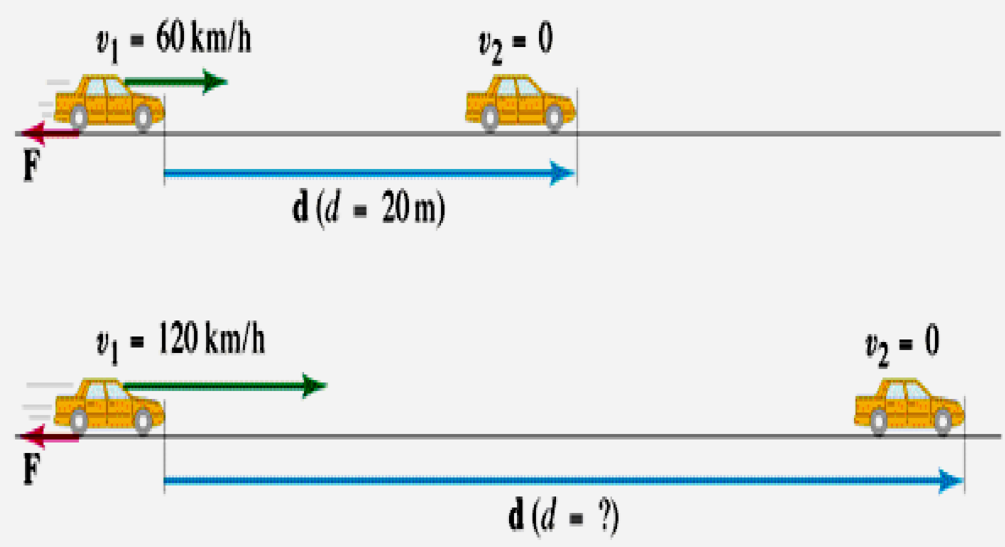
$F\,d = W_{net} = \Delta KE = 0 - 1/2\ mv^2$

thus: $|F|\,d = 1/2\ mv^2$

Therefore, if the speed **doubles**, the stopping distance gets **four times larger**.



ConcepTest 6.4 Speeding Up

A car starts from rest and accelerates to 30 mph. Later, it gets on a highway and accelerates to 60 mph. Which takes more energy, the 0→30 mph, or the 30→60 mph?

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2) 30 → 60 mph
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The change in KE ($1/2\ mv^2$) involves the *velocity squared*.

So in the first case, we have: $1/2\ m\ (30^2 - 0^2) = 1/2\ m\ (900)$

In the second case, we have: $1/2\ m\ (60^2 - 30^2) = 1/2\ m\ (2700)$

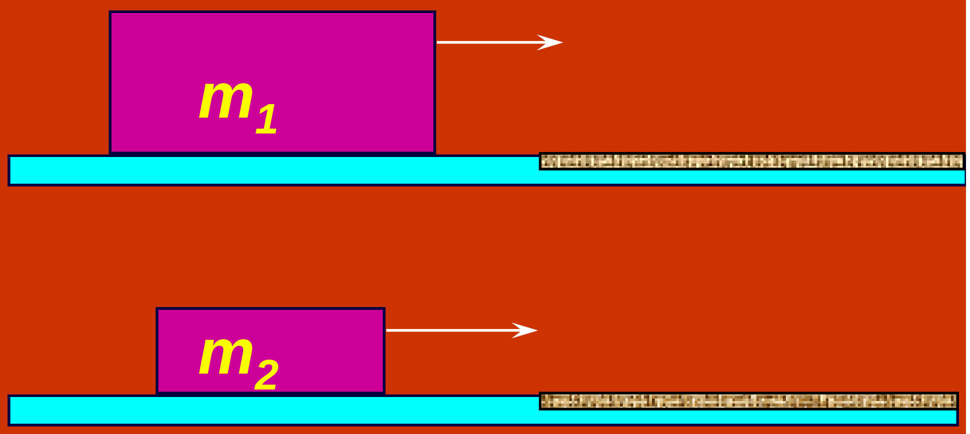
Thus, the bigger energy change occurs in the second case.

Follow-up: How much energy is required to stop the 60-mph car?

ConcepTest 6.5 Work and Energy I

Two blocks of mass m_1 and m_2 ($m_1 > m_2$) slide on a frictionless floor and have the **same kinetic energy** when they hit a long rough stretch ($\mu > 0$), which slows them down to a stop. **Which one goes farther?**

1) m_1
2) m_2
3) they will go the same distance



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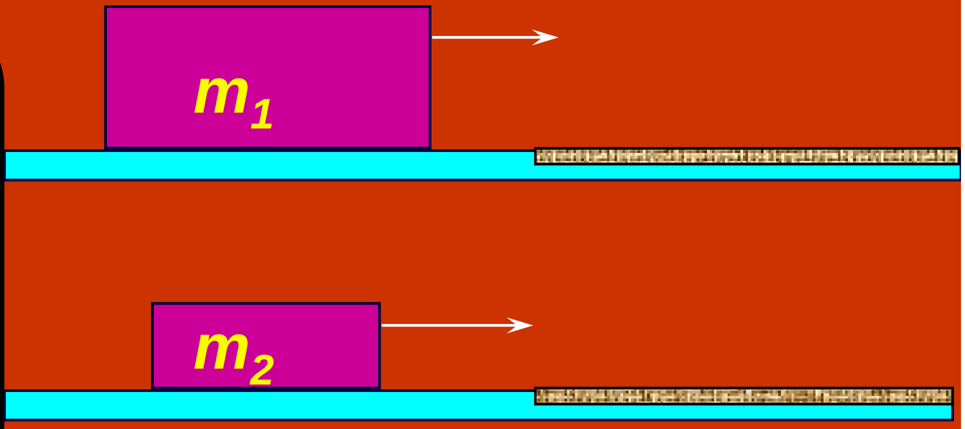
With the same ΔKE, both blocks must have the same work done to them by friction. The friction force is less for m_2 so stopping distance must be greater.



Follow-up: Which block has the greater magnitude of acceleration?