

## Energy



Physics Clicker Quizzes

*By what factor does the kinetic energy of a car change when its speed is tripled?*

- A no change at all
- B factor of 3
- C factor of 6
- D factor of 9
- E factor of 12

**D** factor of 9

Since the kinetic energy is  $\frac{1}{2}mv^2$ , if the speed increases by a factor of 3, then the KE will increase by a factor of 9.

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

- A  $2v_1 = v_2$
- B  $\sqrt{2}v_1 = v_2$
- C  $4v_1 = v_2$
- D  $v_1 = v_2$
- E  $8v_1 = v_2$

**B**  $\sqrt{2}v_1 = v_2$

Since the kinetic energy is  $\frac{1}{2}mv^2$ , 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.

*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?*

- A quarter as much
- B half as much
- C the same
- D twice as much
- E four times as much

**D** twice as much

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

$$\Delta KE = W_{\text{net}} = F d$$

$$\Delta KE = mg d$$

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?

*In the previous question, just before hitting the ground, what is the final speed of the heavy stone compared to the light one?*

- A quarter as much
- B half as much
- C the same
- D twice as much
- E four times as much

**C** the same

All freely falling objects fall at the same rate, which is  $g$ . Since the **acceleration is the same for both**, and the **distance is the same**, then the **final speeds will be the same** for both stones.

*A child on a skateboard is moving at a speed of 2 m/s. After a force acts on the child, her speed is 3 m/s. What can you say about the work done by the external force on the child?*

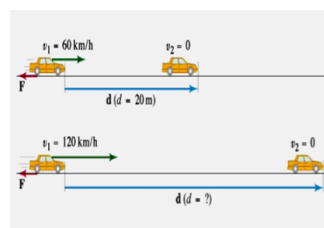
- A positive work was done
- B negative work was done
- C zero work was done

**A** positive work was done

The kinetic energy of the child increased because her speed increased. This **increase in KE** was the result of **positive work being done**. Or, from the definition of work, since  $W = \Delta KE = KE_f - KE_i$  and we know that  $KE_f > KE_i$  in this case, then the **work  $W$  must be positive**.

**Follow-up:**  
What does it mean for negative work to be done on the child?

*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.*



- A 20 m
- B 30 m
- C 40 m
- D 60 m
- E 80 m


**E**      **80 m**

$F d = W_{\text{net}} = \Delta KE = 0 - 1/2 m v^2$

thus:  $F d = 1/2 m v^2$

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

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?



A  $m_1$   
 B  $m_2$   
 C they will go the same distance

**B**       **$m_2$**

With the **same  $\Delta KE$** , 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?

A golfer making a putt gives the ball an initial velocity of  $v_0$ , but he has badly misjudged the putt, and the ball only travels one-quarter of the distance to the hole. If the resistance force due to the grass is constant, what speed should he have given the ball (from its original position) in order to make it into the hole?

A  $2 v_0$   
 B  $3 v_0$   
 C  $4 v_0$   
 D  $8 v_0$   
 E  $16 v_0$

**A**       **$2 v_0$**

In traveling **4 times the distance**, the resistive force will do **4 times the work**. Thus, the ball's **initial KE must be 4 times greater** in order to just reach the hole — this requires an **increase in the initial speed by a factor of 2**, since  $KE = 1/2 m v^2$ .

**Is it possible for the kinetic energy of an object to be negative?**

YES  
  
NO

**NO**

The **kinetic energy** is  $\frac{1}{2}mv^2$ . The **mass** and the **velocity squared** will always be **positive**, so **KE must always be positive**.

*Is it possible for the gravitational potential energy of an object to be negative?*

YES

NO

**YES**

**Gravitational PE is  $mgh$** , where **height  $h$**  is measured relative to some **arbitrary reference level where  $PE = 0$** . For example, a book on a table has positive PE if the zero reference level is chosen to be the floor. However, if the **ceiling is the zero level**, then the **book has negative PE on the table**. It is only **differences** (or changes) in PE that have any physical meaning.

*You and your friend both solve a problem involving a skier going down a slope, starting from rest. The two of you have chosen different levels for  $y = 0$  in this problem. Which of the following quantities will you and your friend agree on?*

A) skier's PE    B) skier's change in PE    C) skier's final KE

A    only B

B    only C

C    A, B, and C

D    only A and C

E    only B and C

**E    only B and C**

The **gravitational PE depends upon the reference level**, but the **difference  $\Delta PE$  does not!** The work done by gravity must be the same in the two solutions, so  **$\Delta PE$  and  $\Delta KE$  should be the same**.

*How does the work required to stretch a spring 2 cm compare with the work required to stretch it 1 cm?*

A    same amount of work

B    twice the work

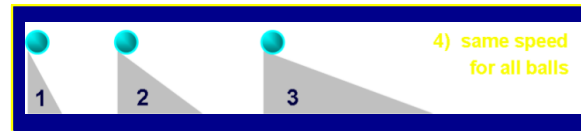
C    4 times the work

D    8 times the work

**C** 4 times the work

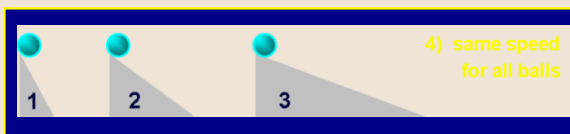
The elastic potential energy is  $\frac{1}{2} kx^2$ . So in the second case, the elastic PE is 4 times greater than in the first case. Thus, the work required to stretch the spring is also 4 times greater.

Three balls of equal mass start from rest and roll down different ramps. All ramps have the same height. Which ball has the greater speed at the bottom of its ramp?



**D** same

All of the balls have the same initial gravitational PE, since they are all at the same height ( $PE = mgh$ ). Thus, when they get to the bottom, they all have the same final KE, and hence the same speed ( $KE = \frac{1}{2} mv^2$ ).



**Follow-up:**  
Which ball takes longer to get down the ramp?

You throw a ball straight up into the air. In addition to gravity, the ball feels a force due to air resistance. Compared to the time it takes the ball to go up, the time it takes to come back down is:

- A smaller
- B the same
- C greater

**C** greater

Due to air friction, the ball is continuously losing mechanical energy. Therefore it has less KE (and consequently a lower speed) on the way down. This means it will take more time on the way down !!

**Follow-up:**  
How does the force of air resistance compare to gravity when the ball reaches terminal velocity?

Engine #1 produces twice the power of engine #2. Can we conclude that engine #1 does twice as much work as engine #2?

- YES
- NO

**No**

**No!! We cannot conclude anything about how much work each engine does. Given the power output, the work will depend upon how much time is used. For example, engine #1 may do the same amount of work as engine #2, but in half the time.**