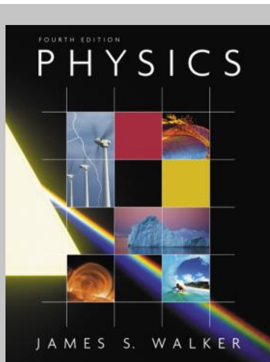

ConcepTest Clicker Questions

Chapter 7

Physics, 4th Edition

James S. Walker

Question 7.1 To Work or Not to Work

Is it possible to do work on an object that remains at rest?

a) yes

b) no

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Is it possible to do work on an object that remains at rest?

a) yes

b) no

Work requires that a force acts over a distance. If an object does not move at all, there is no displacement, and therefore no work done.

Question 7.2a Friction and Work I

A box is being pulled across a rough floor at a constant speed. What can you say about the work done by friction?

a) friction does no work at all

b) friction does negative work

c) friction does positive work

Question 7.2a Friction and Work I

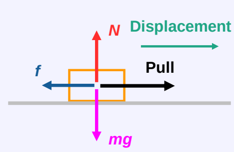
A box is being pulled across a rough floor at a constant speed. What can you say about the work done by friction?

a) friction does no work at all

b) friction does negative work

c) friction does positive work

Friction acts in the opposite direction to the displacement, so the work is negative. Or using the definition of work ($W = F(\Delta r)\cos\theta$), because $\theta = 180^\circ$, then $W < 0$.



Question 7.2b Friction and Work II

Can friction ever do positive work?

a) yes

b) no

Question 7.2b Friction and Work II

Can friction ever do positive work?

a) yes
b) no

Consider the case of a box on the back of a pickup truck. If the box moves along with the truck, then it is actually the force of friction that is making the box move.

Question 7.2c Play Ball!

In a baseball game, the catcher stops a 90-mph pitch. What can you say about the work done by the catcher on the ball?

a) catcher has done positive work
b) catcher has done negative work
c) catcher has done zero work

Question 7.2c Play Ball!

In a baseball game, the catcher stops a 90-mph pitch. What can you say about the work done by the catcher on the ball?

a) catcher has done positive work
b) catcher has done negative work
c) catcher has done zero work

The force exerted by the catcher is opposite in direction to the displacement of the ball, so the work is negative. Or using the definition of work ($W = F\,(\Delta r)\cos\theta$), because $\theta = 180^\circ$, then $W < 0$. Note that because the work done on the ball is negative, its speed decreases.

Follow-up: What about the work done by the ball on the catcher?

Question 7.2d Tension and Work

A ball tied to a string is being whirled around in a circle. What can you say about the work done by tension?

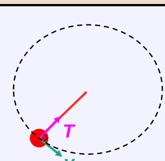
a) tension does no work at all
b) tension does negative work
c) tension does positive work

Question 7.2d Tension and Work

A ball tied to a string is being whirled around in a circle. What can you say about the work done by tension?

a) tension does no work at all
b) tension does negative work
c) tension does positive work

No work is done because the force acts in a perpendicular direction to the displacement. Or using the definition of work ($W = F\,(\Delta r)\cos\theta$), because $\theta = 180^\circ$, then $W < 0$.

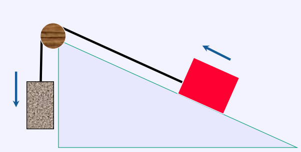


Follow-up: Is there a force in the direction of the velocity?

Question 7.3 Force and Work

A box is being pulled up a rough incline by a rope connected to a pulley. How many forces are doing work on the box?

a) one force
b) two forces
c) three forces
d) four forces
e) no forces are doing work



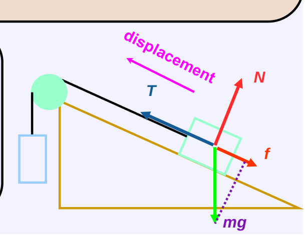
Question 7.3 Force and Work

A box is being pulled up a rough incline by a rope connected to a pulley. How many forces are doing work on the box?

a) one force
b) two forces
c) three forces
d) four forces
e) no forces are doing work

Any force not perpendicular to the motion will do work:

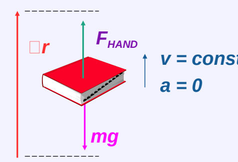
N does *no work*
T does positive work
f does negative work
mg does negative work



Question 7.4 Lifting a Book

You lift a book with your hand in such a way that it moves up at constant speed. While it is moving, what is the total work done on the book?

a) $mg \times \Delta r$
b) $F_{HAND} \times \Delta r$
c) $(F_{HAND} + mg) \times \Delta r$
d) zero
e) none of the above



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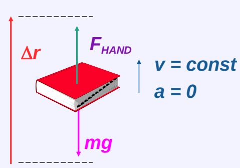
a) $mg \times \Delta r$
b) $F_{HAND} \times \Delta r$
c) $(F_{HAND} + mg) \times \Delta r$
d) zero
e) none of the above

The total work is zero because the net force acting on the book is zero. The work done by the hand is positive, and the work done by gravity is negative. The sum of the two is zero. Note that the kinetic energy of the book does not change either!



Follow-up: What would happen if F_{HAND} were greater than mg?

Question 7.5a Kinetic Energy I

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

Question 7.5a Kinetic Energy I

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

Because 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.

Follow-up: How would you achieve a KE increase of a factor of 2?

Question 7.5b Kinetic Energy II

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) $8v_1 = v_2$

Question 7.5b Kinetic Energy II

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

a) $2v_1 = v_2$
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c) $4v_1 = v_2$
d) $v_1 = v_2$
e) $8v_1 = v_2$

Because 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.

Question 7.6a Free Fall I

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

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a) quarter as much
b) half as much
c) the same
d) twice as much
e) four times as much

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?

Question 7.6b Free Fall II

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

Question 7.6b Free Fall II

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

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

Question 7.7 Work and KE

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

Question 7.7 Work and KE

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

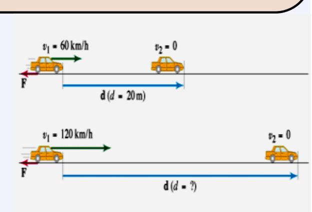
The kinetic energy of the child increased because her speed increased. This increase in KE was the result of positive work being done. Or, from the definition of work, because $W = \Delta KE = KE_f - KE_i$ and we know that $KE_f > KE_i$ in this case, then the work W must be positive.

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

Question 7.8a 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.

a) 20 m
b) 30 m
c) 40 m
d) 60 m
e) 80 m



Question 7.8a Slowing Down

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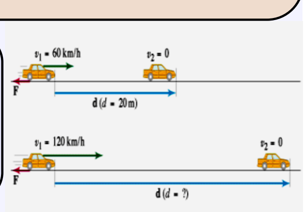
a) 20 m
b) 30 m
c) 40 m
d) 60 m
e) 80 m

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

and thus, $|F|\,d = \frac{1}{2}mv^2$.

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



Question 7.8b Speeding Up I

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?

a) 0 → 30 mph
b) 30 → 60 mph
c) both the same

Question 7.8b Speeding Up I

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a) 0 → 30 mph
b) 30 → 60 mph
c) both the same

The change in KE ($\frac{1}{2}mv^2$) involves the *velocity squared*.
So in the first case, we have: $\frac{1}{2}m\,(30^2 - 0^2) = \frac{1}{2}\,m\,(900)$
In the second case, we have: $\frac{1}{2}m\,(60^2 - 30^2) = \frac{1}{2}\,m\,(2700)$
Thus, the bigger energy change occurs in the second case.

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

Question 7.8c Speeding Up II

The work W_0 accelerates a car from 0 to 50 km/hr. How much work is needed to accelerate the car from 50 km/hr to 150 km/hr?

a) $2\,W_0$
b) $3\,W_0$
c) $6\,W_0$
d) $8\,W_0$
e) $9\,W_0$

Question 7.8c Speeding Up II

The work W_0 accelerates a car from 0 to 50 km/hr. How much work is needed to accelerate the car from 50 km/hr to 150 km/hr?

a) $2\ W_0$
b) $3\ W_0$
c) $6\ W_0$
d) $8\ W_0$
e) $9\ W_0$

Let's call the two speeds v and $3v$, for simplicity.

We know that the work is given by $W = \Delta\text{KE} = \text{KE}_f - \text{Ke}_i$.

Case #1: $W_0 = \frac{1}{2}m\,(v^2 - 0^2) = \frac{1}{2}m\,(v^2)$

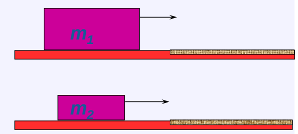
Case #2: $W = \frac{1}{2}m\,((3v)^2 - v^2) = \frac{1}{2}m\,(9v^2 - v^2) = \frac{1}{2}m\,(8v^2) = 8\ W_0$

Follow-up: How much work is required to stop the 150-km/hr car?

Question 7.9a 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?

a) m_1
b) m_2
c) they will go the same distance



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a) m_1
b) m_2
c) they will go the same distance

With the same Δ 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?

Question 7.9b Work and Energy II

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) $16\ v_0$

Question 7.9b Work and Energy II

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a) $2\ v_0$
b) $3\ v_0$
c) $4\ v_0$
d) $8\ v_0$
e) $16\ v_0$

In traveling four times the distance, the resistive force will do four times the work. Thus, the ball's initial KE must be four times greater in order to just reach the hole—this requires an increase in the initial speed by a factor of 2, because $\text{KE} = \frac{1}{2}mv^2$.

Question 7.10 Sign of the Energy I

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

a) yes
b) no

Question 7.10 Sign of the Energy I

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

a) yes

b) 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.

Question 7.11a Time for Work I

Mike applied 10 N of force over 3 m in 10 seconds. Joe applied the same force over the same distance in 1 minute. Who did more work?

a) Mike

b) Joe

c) both did the same work

Question 7.11a Time for Work I

Mike applied 10 N of force over 3 m in 10 seconds. Joe applied the same force over the same distance in 1 minute. Who did more work?

a) Mike

b) Joe

c) both did the same work

Both exerted the same force over the same displacement. Therefore, both did the *same amount of work*. Time does not matter for determining the work done.

Question 7.11b Time for Work II

Mike performed 5 J of work in 10 secs. Joe did 3 J of work in 5 secs. Who produced the greater power?

a) Mike produced more power

b) Joe produced more power

c) both produced the same amount of power

Question 7.11b Time for Work II

Mike performed 5 J of work in 10 secs. Joe did 3 J of work in 5 secs. Who produced the greater power?

a) Mike produced more power

b) Joe produced more power

c) both produced the same amount of power

Because power = work / time, we see that Mike produced 0.5 W and Joe produced 0.6 W of power. Thus, even though Mike did more work, he required twice the time to do the work, and therefore his power output was lower.

Question 7.11c Power

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

a) yes

b) no

Question 7.11c Power

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

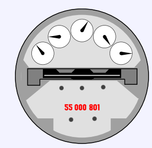
a) yes
b) no

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.

Question 7.12a Electric Bill

When you pay the electric company by the kilowatt-hour, what are you actually paying for?

a) energy
b) power
c) current
d) voltage
e) none of the above



Question 7.12a Electric Bill

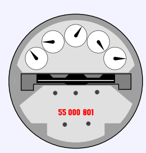
When you pay the electric company by the kilowatt-hour, what are you actually paying for?

a) energy
b) power
c) current
d) voltage
e) none of the above

We have defined: Power = energy / time

So we see that: Energy = power × time

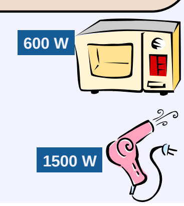
This means that the unit of power × time (watt-hour) is a unit of energy !!



Question 7.12b Energy Consumption

Which contributes more to the cost of your electric bill each month, a 1500-Watt hair dryer or a 600-Watt microwave oven?

a) hair dryer
b) microwave oven
c) both contribute equally
d) depends upon what you cook in the oven
e) depends upon how long each one is on



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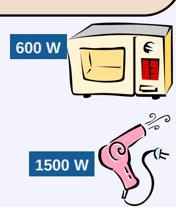
a) hair dryer
b) microwave oven
c) both contribute equally
d) depends upon what you cook in the oven
e) depends upon how long each one is on

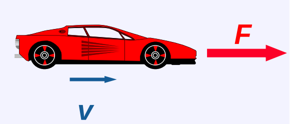
We already saw that what you actually pay for is *energy*. To find the energy consumption of an appliance, you must know more than just the power rating—you have to know how long it was running.



Question 5.4a Off to the Races I

From rest, we step on the gas of our Ferrari, providing a force F for 4 secs, speeding it up to a final speed v. If the applied force were only ½ F, how long would it have to be applied to reach the *same* final speed?

a) 16 s
b) 8 s
c) 4 s
d) 2 s
e) 1 s



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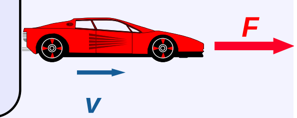
From rest, we step on the gas of our Ferrari, providing a force *F* for 4 secs, speeding it up to a final speed *v*. If the applied force were only ½ *F*, how long would it have to be applied to reach the *same* final speed?

a) 16 s
b) 8 s
c) 4 s
d) 2 s
e) 1 s

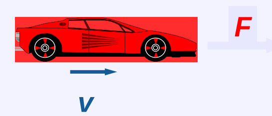
In the first case, the acceleration acts over time $T = 4$ s to give velocity $v = aT$. In the second case, the force is half, therefore the acceleration is also half, so to achieve the ***same final speed***, the time must be doubled.



ConcepTest 5.4b Off to the Races II

From rest, we step on the gas of our Ferrari, providing a force *F* for 4 secs. During this time, the car moves 50 m. If the same force would be applied for 8 secs, how much would the car have traveled during this time?

a) 250 m
b) 200 m
c) 150 m
d) 100 m
e) 50 m



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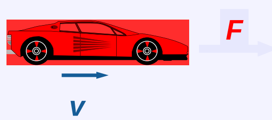
a) 250 m
b) 200 m
c) 150 m
d) 100 m
e) 50 m

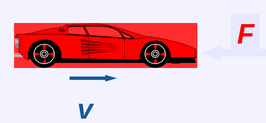
In the first case, the acceleration acts over time $T = 4$ s to give a distance of $x = \frac{1}{2}aT^2$ (why is there no v_0T term?). In the 2nd case, the time is doubled, so the distance is quadrupled because it goes as the square of the time.



ConcepTest 5.4c Off to the Races III

We step on the brakes of our Ferrari, providing a force *F* for 4 secs. During this time, the car moves 25 m but does not stop. If the same force would be applied for 8 secs, how far would the car have traveled during this time?

a) 100 m
b) 50 m < *x* < 100 m
c) 50 m
d) 25 m < *x* < 50 m
e) 25 m

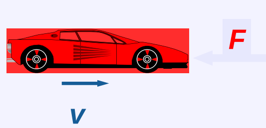


ConcepTest 5.4c Off to the Races III

We step on the brakes of our Ferrari, providing a force *F* for 4 secs. During this time, the car moves 25 m but does not stop. If the same force would be applied for 8 secs, how far would the car have traveled during this time?

a) 100 m
b) 50 m < *x* < 100 m
c) 50 m
d) 25 m < *x* < 50 m
e) 25 m

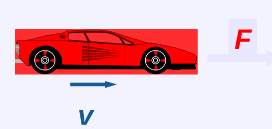
In the first 4 secs, the car has still moved 25 m. However, because the car is slowing down, in the next 4 secs it must cover less distance. Therefore, the total distance must be more than 25 m but less than 50 m.



ConcepTest 5.4d Off to the Races IV

From rest, we step on the gas of our Ferrari, providing a force *F* for 40 m, speeding it up to a final speed of 50 km/hr. If the same force would be applied for 80 m, what final speed would the car reach?

a) 200 km/hr
b) 100 km/hr
c) 90 km/hr
d) 70 km/hr
e) 50 km/hr



ConcepTest 5.4d Off to the Races IV

From rest, we step on the gas of our Ferrari, providing a force F for 40 m, speeding it up to a final speed of 50 km/hr. If the same force would be applied for 80 m, what final speed would the car reach?

a) 200 km/hr
b) 100 km/hr
c) 90 km/hr
d) 70 km/hr
e) 50 km/hr

In the first case, the acceleration acts over a distance $x = 40$ m, to give a final speed of $v^2 = 2ax$ (why is there no v_0^2 term?).
In the 2nd case, the distance is doubled, so the speed increases by a factor of $\sqrt{2}$.