**Work and Energy**

**Question 1:**

aa. A marble hits a note card and slides to a stop. Which one of the following statements is true of the marble?

a. The kinetic energy is constant.

b. The kinetic energy is increasing.

c. The kinetic energy is decreasing.

d. The gravitational potential energy is decreasing.

e. The gravitational potential energy is increasing.

**Question 2:**

aa. Ben Laborin applies a force to push a crate from the bottom to the top of an inclined plane. The task of moving the crate along the incline is easier than lifting it straight up because \_\_\_\_\_. Select all that apply.

a. less work is required when using the inclined plane

b. more work is required when using the inclined plane

c. less force is required when using the inclined plane

d. the crate weighs less when it is placed on the inclined plane

e. ... nonsense! It is more difficult to push it up an incline because the distance is further.

**Question 3:**

aa. A toy car is moving along with 2.14 Joules of kinetic energy. If the speed of the car is doubled, then its new kinetic energy will be \_\_\_\_\_\_\_.

a. 0.54 J b. 1.07 J c. 4.28 d. 8.56 J

e. still 2.14 J

**Question 4:**

aa. Which would ALWAYS be true of an object possessing a kinetic energy of 0 joules?

a. It is at rest. b. It is moving. c. It is accelerating.

d. It is on the ground. e. It is above the ground.

ab. It is moving on the ground. ac. It is moving above ground level.

ad. It is at rest above ground level

**Question 5:**

aa. A force is applied to a root beer mug to accelerate it across a level counter-top. Which one of the following statements is true of the mug?

a. The kinetic energy is constant.

b. The kinetic energy is decreasing.

c. The kinetic energy is increasing.

d. The gravitational potential energy is decreasing.

e. The gravitational potential energy is increasing.

**Question 6:**

aa. Power is defined as the \_\_\_\_\_\_\_ is done.

a. angle at which work b. amount of work which

c. direction at which work d. the rate at which work

**Question 7:**

aa. If the unit of mass is the lump, and the unit of distance is the jump, and the unit of time is the thump, then the unit of power is the \_\_\_\_\_.

a. lump·jump·thump2 b. lump·jump/thump

c. lump·jump/thump2 d. lump·jump2·thump3

e. lump·jump2/thump3

**Questions 8-9:**

Two physics students, Will N. Andable and Ben Pumpiniron, are in the weightlifting room. Will lifts the 100-pound barbell over his head 10 times in one minute; Ben lifts the 100-pound barbell over his head 10 times in 10 seconds.

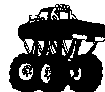
aa. Which student does the most work?

a. Will b. Ben c. Both the same

aa. Which student delivers the most power?

a. Will b. Ben c. Both the same

**Question 10:**

aa, Mr. H’s car, with a 60.0-horsepower engine is able to accelerate from 0 to 60 mi/hr in 24 seconds (when it's running well). He dreams of purchasing an all-terrain 4-wheeler with a 240.0-horsepower engine. How many seconds would it take Mr. H’s dream car to accelerate from 0 to 60 mi/hr?

a. 1.5 s b. 3 s c. 6 s

d. 48 s e. 96 s ab. none of these

**Question 11:**

aa. Work is always done on an object when \_\_\_\_\_.

a. a student does a physics lab

b. a person works hard at his job

c. a force is exerted on the object

d. the object moves at a constant speed

e. a force acts on the object to cause a displacement

**Questions 12-18:**

Read the following descriptions and identify the situation as an example of **positive work** being done, **negative work** being done, or **no work** being done.

aa. A teacher pushes against a wall for a couple of hours and becomes exhausted.

This is an example of \_\_\_\_\_\_\_\_\_ work being done.

a. positive b. negative c. no

aa. A boy exerts a force on a wagon to pull it along the sidewalk.

This is an example of \_\_\_\_\_\_\_\_\_ work being done.

a. positive b. negative c. no

aa. A softball player slows down while sliding across the infield dirt during a slide into third base.

This is an example of \_\_\_\_\_\_\_\_\_ work being done.

a. positive b. negative c. no

aa. An upward force is applied to a pile of snow to lift it up off the driveway.

This is an example of \_\_\_\_\_\_\_\_\_ work being done.

a. positive b. negative c. no

aa. A driver slams on the brakes and her high speed car skids to a stop as the light turns red.

This is an example of \_\_\_\_\_\_\_\_\_ work being done.

a. positive b. negative c. no

aa. A hockey player makes a sudden slap of the puck to accelerate it to a high speed.

This is an example of \_\_\_\_\_\_\_\_\_ work being done.

a. positive b. negative c. no

aa. While hanging a picture in their dorm room, Denise holds the picture against the wall for several moments while Jodi inspects its appearance and position.

This is an example of \_\_\_\_\_\_\_\_\_ work being done.

a. positive b. negative c. no

**Question 19:**

aa. When a horizontal force is exerted upon an object to do work upon it, then the work causes and is equal to the \_\_\_\_\_\_\_ …

a. change in height b. change in direction

c. change in momentum d. change in acceleration

e. change in kinetic energy

**Question 20:**

aa. A hammer has 12 J of kinetic energy. When striking a nail in a wall, it ultimately comes to a rest position. The amount of work done on the hammer by the nail is \_\_\_\_ J.

a. 0 b. +12 J c. -12 J d. insufficient info

**Question 21:**

aa. The brakes are applied to a car and it abruptly slows down. The kinetic energy changes from 300 000 J to 100 000 J. The work done on the car is \_\_\_\_\_ J.

a. + 100 000 b. - 100 000 c. + 200 000 d. - 200 000

e. + 300 000 ab. - 300 000 ac. + 400 000 ad. - 400 000

**Question 22:**

aa. A friction force most often does *negative work* upon an object. The significance of the *negative* is that \_\_\_\_\_\_\_.

a. friction acts in a downward direction

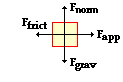
b. friction causes the system to lose energy

c. friction causes the system to gain energy

d. work is a vector and friction acts leftward on objects

e. friction is a type of force that is hard to be positive about

**Question 23:**

aa. A 5-Newton force is applied to a 2-kg object to move it across a horizontal surface at a constant speed for a distance of 4 meters. The free-body diagram is shown at the right. Which of the following forces are doing work upon the object - either positive or negative? Select all that apply.

a. Friction force b. Normal force

c. Gravity force d. Applied force

e. ... nonsense! None of these forces are doing work.

**Questions 24-25:**

aa. There is a difference between work and kinetic energy. Work is \_\_\_\_\_\_ the system …

a. a property of b. negative for

c. positive for d. something which is done to

e. a quantitative description of ab. a qualitative description of

aa. … and kinetic energy is \_\_\_\_\_ the system.

a. a property of b. negative for

c. positive for d. something which is done to

e. a quantitative description of ab. a qualitative description of

**Question 26:**

aa. An 80-kg baseball player slides into third base. He experiences 60 N of friction force over a distance of 1.2 m. The amount of work done by friction is \_\_\_\_\_ Joule.

a. 16 b. -72 c. 72 d. 400

e. -400 ab. 960 ac. -960

**Question 27:**

aa. For a constant force in the direction of motion, work is calculated as \_\_\_\_\_.

a. weight•speed b. distance•speed

c. force•acceleration d. force•displacement

e. weight•displacement

**Question 28:**

aa. Dennis Elbough pushes on a 53.5-kg box with a forward force of 300 N to move it 17.0 m across the floor. The work done by Dennis on the box is \_\_\_\_\_ J.

a. 0.330 b. 5.61 c. 17.65 d. 95.3 e. 5100

**Question 29:**

aa. The energy possessed by an object as a result of its motion is referred to as \_\_\_\_\_.

a. thermal b. kinetic c. potential d. kinematic

e. mechanical ab. motionary

**Question 30:**

aa. A boy is pulling a wagon along the sidewalk. It has a kinetic energy of 20 J. The boy then applies a forward force of 15 N for 3 m. The new kinetic energy of the wagon is \_\_\_\_\_ J.

a. 25 b. 35 c. 45 d. 60

e. 65 ab. 75 ac. 80

**Question 31:**

aa. The kinetic energy of an object depends upon the \_\_\_\_\_\_\_ of the object. Select all that apply.

a. speed b. mass c. height

d. dimensions e. acceleration

**Question 32:**

aa. An object has a kinetic energy of 36.0 J. If the object's speed is tripled, then its new kinetic energy will be \_\_\_\_ J.

a. 4.00 b. 6.00  c. 12.00 d. 24.00

e. 54.0 ab. 108.0 ac. 216.0 ad. 324.0

**Question 33:**

aa. An object has a kinetic energy of 36.0 J. An object with three times the mass moving at the same speed will have a kinetic energy of \_\_\_\_ J.

a. 4.00 b. 6.00  c. 12.00 d. 24.00

e. 54.0 ab. 108.0 ac. 216.0 ad. 324.0

**Question 34:**

aa. Positive work is done upon a baseball when it is being \_\_\_\_\_.

a. thrown b. caught

c. either thrown or caught (depending on the method of throwing or catching)

d. ... nonsense! Baseball is fun, not work.

**Question 35:**

aa. Negative work is done upon a baseball when it is being \_\_\_\_\_.

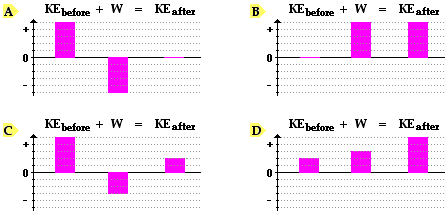
a. thrown b. caught

c. either thrown or caught (depending on the method of throwing or catching)

d. ... nonsense! Baseball is fun, not work.

**Questions 36-41:**

Consider the following work-energy bar charts.



For each physical situation described below, match the situation to the corresponding work-energy bar chart.

aa. A **car** skids from a high speed to a resting position. This corresponds to chart \_\_\_\_.

aa. A **truck** is coasting towards an intersection with a red light. The light turns green and the truck accelerates back up to highway speed.

aa. A **bowling ball** collides with a bowling pin and slows down. This corresponds to chart \_\_\_\_.

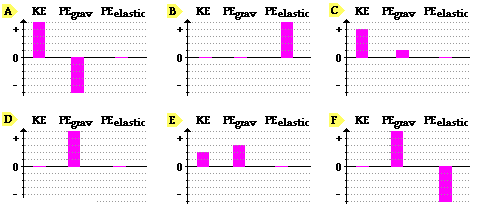
aa. A **sledder** who has reached the bottom of a snow hill and gradually slows down to a stop. This corresponds to chart \_\_\_\_.

aa. A **dragster** accelerates from rest to high speeds. This corresponds to chart \_\_\_\_.

aa. A **hockey puck** is moving forward along the ice when a GBS player accelerates it to high speed with a quick slap of the stick. This corresponds to chart \_\_\_\_.

**Questions 42-45:**

A boy is jumping up and down on a trampoline in repeating fashion. Consider the following four positions of the boy during a particular cycle of his up and down motion. For each position, identify the energy bar chart which best represents the form of energy possessed by the boy. The reference level for zero gravitational potential energy is the height of the body when he is at the lowest position in his path. Of course, two letters will not be used.



aa. The boy is at the highest point of his path (the peak height). This position would be consistent with bar chart\_\_\_\_\_\_\_.

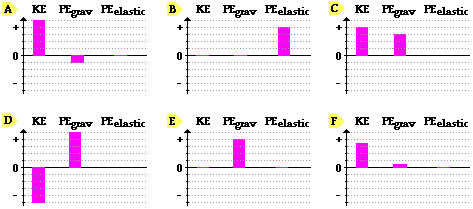
aa. The boy is at the midway point of his upward path. This position would be consistent with bar chart \_\_\_\_\_\_\_.

aa. The boy has just touched the trampoline surface but has not yet pushed it downwards below its normal resting position. This position would be consistent with bar chart \_\_\_\_\_\_\_.

aa. The boy is at the lowest point in the cycle, having compressed the springs of the trampoline the maximum amount below their normal resting position. This position would be consistent with bar chart \_\_\_\_\_\_\_.

**Question 46-49:**

A child receives a spring-loaded toy dart gun. The dart is prepared to fire by compressing the dart against the springs. When the trigger is pulled, the elastic potential energy of the springs push the rubber dart out of the gun. Suppose the child uses the dart gun to shoot a dart straight up into the air. The dart is loaded into the gun (position **A**) at the child's waist level. The dart is launched upward at high speed (position **B** is when the dart has just left the gun). The dart continues upward to its peak (position **C**) and then falls back to the ground (position **D** is the position of the dart when it is a mere pico-meter above the ground). Match the various positions of the flight of the dart to the corresponding energy bar chart. The reference level for zero gravitational potential energy is the height of the dart at position A.



aa. Position **A** corresponds to bar chart \_\_\_\_\_.

aa. Position **B** corresponds to bar chart \_\_\_\_\_.

aa. Position **C** corresponds to bar chart \_\_\_\_\_.

aa. Position **D** corresponds to bar chart \_\_\_\_\_.

**Question 50-54:**

For the following descriptions of a motion, identify whether the object being described encounters a change in kinetic energy, a change in potential energy, a change in both types of energy or in neither type of energy.

aa. A 2.5-kg cart is pulled from the floor to the top of a box along an inclined plane at a constant speed.

a. Change in KE b. Change in PE

c. Change in both KE and PE d. Neither KE nor PE change

aa. A cart starts from rest on top of an inclined plane and rolls down to the floor.

a. Change in KE b. Change in PE

c. Change in both KE and PE d. Neither KE nor PE change

aa. A small Hot Wheels car moving along the floor hits a computer diskette box and skids to a stop.

a. Change in KE b. Change in PE

c. Change in both KE and PE d. Neither KE nor PE change

aa. A raindrop completes the last 100 feet of its fall at a terminal velocity.

a. Change in KE b. Change in PE

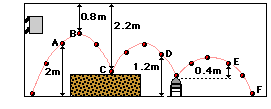
c. Change in both KE and PE d. Neither KE nor PE change

aa. A roller coaster car descends the first hill of the Shockwave roller coaster.

a. Change in KE b. Change in PE

c. Change in both KE and PE d. Neither KE nor PE change

**Question 55:**

aa. The diagram at the right shows six positions of a ball bouncing across the physics room. Enter the six letters of the positions in order of increasing potential energy (from smallest to largest).

**Question 56:**

aa. The total mechanical energy of an object is \_\_\_\_. Select all that apply

a. equal to the work done upon the object

b. the final energy minus the initial energy

c. the sum of its initial energy and its final energy

d. the sum of its kinetic energy and its potential energy

e. simply the initial energy of the object before its motion begins

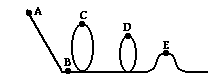
ab. the amount of energy an object possesses as a result of its motion

ac. the amount of energy an object possesses as a result of its position

**Question 57:**

aa. An object starts from rest with a potential energy of 1200 J and free-falls towards the ground. After it has fallen to a height that is equal to one-sixth of its original height, its potential energy is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J and its kinetic energy is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J.

**Questions 58-61:**

Consider the diagram at the right in answering the next several questions. Five locations along a roller coaster track are shown. Assume that there are negligible friction and air resistance forces acting upon the coaster car.

aa. Rank the five locations in order of increasing total mechanical energy (TME), beginning with the smallest. If two (or more) locations have equal amounts of TME, then order those two (or more) positions alphabetically.

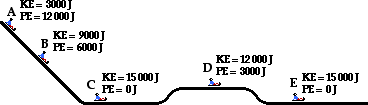
aa. Rank the five locations in order of increasing potential energy, beginning with the smallest. If two (or more) locations have equal amounts of PE, then order those two (or more) positions alphabetically.

aa. Rank the five locations in order of increasing kinetic energy, beginning with the smallest. If two (or more) locations have equal amounts of KE, then order those two (or more) positions alphabetically.

aa. Rank the five locations in order of increasing speed, beginning with the smallest. If two (or more) locations have equal speeds, then order those two (or more) positions alphabetically.

**Question 62:**

aa. Consider the motion of a sledder shown in the diagram below.



The kinetic energy (KE) and potential energy (PE) values are shown for various locations. In this example, \_\_\_\_. Select all that apply.

a. kinetic energy is conserved

b. potential energy is conserved

c. total mechanical energy is conserved

d. None of the above are true.

**Question 63:**

aa. If the total mechanical energy of an object is conserved, then \_\_\_\_. Select all that apply.

a. the total amount of KE and PE gradually decreases to 0 Joules

b. the initial amount of KE equals the final amount of PE

c. there is neither any KE nor PE in either the initial or the final state

d. the sum of the KE and the PE is the same for the initial state as it is for the final state

e. the sum of the kinetic energy (KE) and the potential energy (PE) is 0 Joules

**Question 64:**

aa. Consider the types of forces present in the following physical situation:

A car is skidding to a stop.

In this situation, the total mechanical energy of the car \_\_\_\_.

a. will definitely change

b. will remain constant

c. will probably change, but might not if it is skidding to a stop while moving uphill

d. ... nonsense! None of these predictions are possible without actual energy values.

**Question 65:**

aa. Consider the types of forces present in the following physical situation:

A parachutist is falling downward, encountering a large amount of air resistance.

In this situation, the total mechanical energy of the car \_\_\_\_.

a. will definitely change

b. will remain constant

c. will probably change, but might not if it is skidding to a stop while moving uphill

d. ... nonsense! None of these predictions are possible without actual energy values.

**Question 66:**

aa. Consider the types of forces present in the following physical situation:

A roller coaster car is coasting down the first drop of the track. Assume that resistance forces have no effect on the car's motion.

In this situation, the total mechanical energy of the car \_\_\_\_.

a. will definitely change

b. will remain constant

c. will probably change, but might not if it is skidding to a stop while moving uphill

d. ... nonsense! None of these predictions are possible without actual energy values.

**Question 67:**

aa. There are various forms of energy that are of major interests to scientists of biology, chemistry, and physics. The form of energy that is associated with kinetic and potential energy is known as \_\_\_\_\_\_\_ energy.

a. work b. physical c. chemical d. thermal

e. isolated ab. mechanical ac. conservation of

**Question 68:**

aa. An 80-kg baseball player slides into third base. He experiences 60 N of friction force over a distance of 1.2 m. The amount of work done by friction is \_\_\_\_\_ Joule.

a. 16 b. 72 c. -72 d. -400

e. 400 ab. 960 ac. -960

**Question 69:**

aa. A force acting upon an object to cause a displacement is known as \_\_\_\_\_.

a. potential b. work c. energy d. kinetic

**Question 70:**

aa. **TRUE** or **FALSE**:

To a physicist, holding a heavy chair at arm's length for several minutes would not be considered as an example of work.

a. True b. False

**Question 71:**

aa. **TRUE** or **FALSE**:

Because work can be either positive or negative, it is a vector quantity; its sign (+ or -) is indicative of the direction of the vector.

a. True b. False

**Question 72:**

aa. **TRUE** or **FALSE**:

The reference level for zero potential energy must be chosen as the height of the object in the initial location.

a. True b. False

**Question 73:**

aa. **TRUE** or **FALSE**:

The total amount of mechanical energy of an object is always conserved. (If not, then give an example of a situation in which it is not conserved.)

a. True b. False

**Question 74:**

aa. **TRUE** or **FALSE**:

If the energy of a projectile is being transformed from potential energy to kinetic energy, then the total amount of energy is not conserved.

a. True b. False

**Question 75:**

aa. **TRUE** or **FALSE**:

If a specific force is a conservative force, then the amount of work required by that force to move an object from location A to location B does not depend upon whether the *path* from A to B is a direct path or a more *round-about path*.

a. True b. False

**Question 76:**

aa. **TRUE** or **FALSE**:

AAA

a. True b. False

**Question 77:**

aa. **TRUE** or **FALSE**:

The potential energy of an object can be positive or negative. This is an indication that potential energy is a vector.

a. True b. False

**Question 78:**

aa. **TRUE** or **FALSE**:

An object that is moving cannot have potential energy.

a. True b. False

**Question 79:**

aa. **TRUE** or **FALSE**:

An object that is at rest cannot have kinetic energy.

a. True b. False

**Question 80:**

aa. When the force that causes the displacement is \_\_\_\_\_\_\_\_\_\_\_\_ the displacement, *positive* work is done upon the object.

a. larger than b. at right angles to

c. in the same direction as d. in the opposite direction as

**Question 81:**

aa. When the force that causes the displacement is \_\_\_\_\_ the displacement, *negative* work is done upon the object.

a. larger than b. at right angles to

c. in the same direction as d. in the opposite direction as

**Question 82:**

aa. There are a variety of units for work. Which of the following would be fitting units of work (though perhaps not standard)? Select all that apply.

a. Joule b. N·m c. kg·m/s

d. kg ·m/s2 e. kg·m/s2·m

**Question 83:**

aa. Suppose that an average-sized squirrel (mass of approximately 1 kg) does an average push-up, applying a 10-N force to displace its body upward for an average arm-length of 10 cm (0.1 m). The amount of work done is \_\_\_\_\_ Joule.

a. 0.1 b. 1 c. 10 d. 100

e. ...nonsense! A squirrel can't do work.

**Question 84:**

aa. The type of energy possessed by an object as a result of its vertical position is \_\_\_\_ energy.

a. work b. kinetic c. potential d. mechanical

**Questions 85-89:**

For the following descriptions of a motion, identify whether the object being described encounters a change in kinetic energy, a change in potential energy, a change in both types of energy or in neither type of energy.

aa. A 2.5-kg cart is pulled from the floor to the top of a box along an inclined plane at a constant speed.

a. Change in KE b. Change in PE

c. both A and B d. neither A nor B

aa. A cart starts from rest on top of an inclined plane and rolls down to the floor.

a. Change in KE b. Change in PE

c. both A and B d. neither A nor B

aa. A small Hot Wheels car moving along the floor hits a computer diskette box and skids to a stop.

a. Change in KE b. Change in PE

c. both A and B d. neither A nor B

aa. A raindrop completes the last 100 feet of its fall at a terminal velocity.

a. Change in KE b. Change in PE

c. both A and B d. neither A nor B

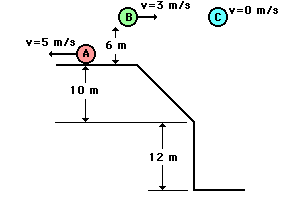
aa. A roller coaster car descends the first hill of the Shockwave roller coaster.

a. Change in KE b. Change in PE

c. both A and B d. neither A nor B

**Question 90:**

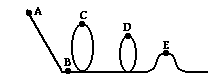
aa. The diagram below shows a 2-kg ball at three different heights and speeds.



Rank the three states in order of increasing total mechanical energy (i.e., KE + PE). List your three letters in increasing order of mechanical energy, beginning with the position of least mechanical energy.

least TME most TME

**Questions 91-94:**

Consider the diagram at the right in answering the next several questions. Five locations along a roller coaster track are shown. Assume that there are negligible friction and air resistance forces acting upon the coaster car.

aa. Rank the five locations in order of increasing total mechanical energy (TME), beginning with the smallest. If two (or more) locations have equal amounts of TME, then place an equal sign (“=”) between their letters.

least TME most TME

aa. Rank the five locations in order of increasing potential energy, beginning with the smallest. If two (or more) locations have equal amounts of PE, then place an equal sign (“=”) between their letters.

least TME most TME

aa. Rank the five locations in order of increasing kinetic energy, beginning with the smallest. If two (or more) locations have equal amounts of KE, then place an equal sign (“=”) between their letters.

least TME most TME

aa. Rank the five locations in order of increasing speed, beginning with the smallest. If two (or more) locations have equal speeds, then place an equal sign (“=”) between their letters.

least TME most TME

**Question 95:**

aa. A cat starts from rest with a potential energy of 600 J and free-falls towards the ground. After it has fallen to a height of one-fourth of its original height, its total mechanical energy is \_\_\_\_.

a. 150 J b. 450 J c. 600 J

d. Nonsense! This cannot be determined without mass, speed and height information.

**Question 96:**

aa. An object starts from rest with a potential energy of 600 J and free-falls towards the ground. After it has fallen to a height of one-fourth of its original height, its potential energy is \_\_\_\_.

a. 150 J b. 450 J c. 600 J

d. Nonsense! This cannot be determined without mass and height information.

**Question 97:**

aa. An object starts from rest with a potential energy of 600 J and free-falls towards the ground. After it has fallen to a height of one-fourth of its original height, its kinetic energy is \_\_\_\_.

a. 150 J b. 450 J c. 600 J

d. Nonsense! This cannot be determined without mass and speed information.

**Questions 98-105:**

For the following situations, cross out terms to reduce the work-energy equation to a more simplified form. Cross out any terms that are zero or are unchanging. Apply the equation to the object in **bold-faced** lettering.

aa. A physics student applies a force parallel to an inclined plane to pull **a cart** from ground level up the incline at a constant speed.

KEinitial + PEinitial + Wnc = KEfinal + PEfinal

aa. A **Hot Wheels car** starts from rest on the top of an inclined plane, rolls down the incline, hits a box on the ground and slides to a stop.

KEinitial + PEinitial + Wnc = KEfinal + PEfinal

aa. A **skydiver** falls from 5000 feet to 1000 feet at a terminal velocity.

KEinitial + PEinitial + Wnc = KEfinal + PEfinal

aa. A hockey player slaps a **hockey puck** with the hockey stick, accelerating it from rest to a high speed across the ice.

KEinitial + PEinitial + Wnc = KEfinal + PEfinal

aa. A physics teacher lifts a **pile of snow** from the ground and hurls it into the air at a high speed.

KEinitial + PEinitial + Wnc = KEfinal + PEfinal

aa. A **car** starts from rest on top of a hill and accelerates to the bottom of the hill. Ignore frictional effects.

KEinitial + PEinitial + Wnc = KEfinal + PEfinal

aa. A **car** is moving rapidly at the bottom of a hill when it runs out of gas and coasts up the hill to a final stopping position.

KEinitial + PEinitial + Wnc = KEfinal + PEfinal

aa. A **physics student** runs from floor level up a flight of stairs at a constant speed.

KEinitial + PEinitial + Wnc = KEfinal + PEfinal

**Question 106:**

aa. A non-conservative force does negative work upon an object. The meaning of the "negative" is that the force \_\_\_\_\_. Choose the one best answer.

a. has a negative magnitude b. is a number less than zero

c. removes energy from the system d. is directed in the negative direction

e. ... nonsense! In physics, like poetry, words mean whatever you want them to.

**Questions 107-115:**

For the following questions, a physical situation is described. For each situation determine if the total mechanical energy (TME) of the object (in **bold-face text**) is conserved, increased, or decreased.

aa. A force is applied to a **root beer mug** to accelerate it across a level counter-top.

a. The TME decreases b. The TME increases c. The TME is conserved

aa. A force is applied to a **cart** to raise it up an inclined plane at constant speed.

a. The TME decreases b. The TME increases c. The TME is conserved

aa. A **cart** starts from rest and rolls down an inclined plane. Ignore frictional effects.

a. The TME decreases b. The TME increases c. The TME is conserved

aa. A **physics student** runs up a flight of stairs at constant speed.

a. The TME decreases b. The TME increases c. The TME is conserved

aa. A **baseball** makes its flight through the air. (Neglect Fair.)

a. The TME decreases b. The TME increases c. The TME is conserved

aa. A **skydiver** falls with a terminal velocity.

a. The TME decreases b. The TME increases c. The TME is conserved

aa. A **car** skids to a stop while traveling down a steep hill.

a. The TME decreases b. The TME increases c. The TME is conserved

aa. A **pendulum bob** is tied to a string and swings back and forth. (Neglect Fair.)

a. The TME decreases b. The TME increases c. The TME is conserved

aa. A **Hot Wheels car** hits a computer diskette box and slides to a stop.

a. The TME decreases b. The TME increases c. The TME is conserved

**Calculations and Long Answer Questions**

**Question 116:**

aa. A car is moving across a level highway with a speed of 22.6 m/s. The brakes are applied and the wheels become locked as the 1210-kg car skids to a stop. The braking distance is 123 meters.

a. Determine the initial kinetic energy of the car.

b. Determine the work done upon the car.

c. Determine the braking force (magnitude only) acting upon the car.

**Question 117:**

aa. Carol, who has a mass of 46.5-kg, is doing the Powerhouse lab. Her sole ambition in life is to become a member of the school’s **Horsepower Club**. To do so, she must generate a power of 750 Watts. With what time must she ascend the 2.04-meter high staircase in order for her to become a member of this prestigious club?

**Question 118:**

aa. Jack runs up the stairs at a constant speed, elevating his 64.8 kg body a vertical distance of 2.05 meters in a time of 1.28 seconds.

a. Determine the work done by the stairs on Jack.

b. Determine Jack's power rating.

**Question 119:**

aa. During peak shopping season at a busy shopping center, an escalator elevates 1144 passengers a vertical distance of 8.18 meters over the course of 28.8 minutes. If the average mass of the passengers is 63.2 kg, determine the power delivered by the escalator to the people.

**Question 120:**

aa. An 892-kg sports car accelerates from rest to a speed of 32.8 m/s in 3.16 seconds. Determine the average power (in horsepower units) of the engine during these 4.75 seconds. (1 hp = 746 W)

**Question 121:**

aa. Renatta Gass applies a rightward force of 513 Newton to her 1360 kg car to displace it rightward across the ice. She does a total of 56900 Joules of work on the car. Determine the displacement (in meters) of the car.

**Question 122:**

aa. A 3.50-kg bucket of water is tied to a rope and lifted vertically upward at a constant speed of 1.87 m/s for a displacement of 28.4 m. Determine the work (in Joules) done upon the bucket.

**Question 123:**

aa. Hans Full is pulling on a rope to drag his backpack to school across the ice. He pulls upwards and rightwards with a force of 23.8 Newton at an angle of 64.9 degrees to drag his backpack a horizontal distance of 269 meters to the right. Determine the work (in Joules) done upon the backpack.

**Question 124:**

aa. Anna Litical is doing the It's All Uphill Lab. She applies a 13.8-Newton force parallel to the inclined plane in order to pull a cart up a hill inclined at an angle of 56.1 degrees. If she drags the cart a distance of 184 cm, then how much work (in Joules) does she do upon the cart?

**Question 125:**

aa. A 797-gram squirrel does 72.0 pushups, displacing itself by a distance of 14.2 cm for each pushup. Determine the work (in Joules) done on the squirrel.

**Question 126:**

aa. Georgia runs up the stairs, elevating his 45.6 kg body a vertical distance of 2.87 meters in a time of 2.27 seconds. Determine the power (in Watts) done by the stairs on Georgia’s body.

**Question 127:**

aa. During peak shopping season at Northbrook Court, an escalator elevates 1190 passengers a vertical distance of 8.28 meters over the course of 37.4 minutes. If the average mass of the passengers is 58.4 kg, determine the power (in Watts) delivered by the escalator to the people.

**Question 128:**

aa. An 1180-kg car moving at 72.4 mi/hr brakes to a stop. Determine the amount of kinetic energy that is transformed into heat by the brake linings of the car.

**Question 129:**

aa. A 27.8-N child is in a swing attached to ropes that are 2.87 m long. Find the gravitational potential energy (in J) of the child relative to its lowest point if the swing is pulled back such that the cables make a 33.4-degree angle with the vertical.

**Question 130:**

aa. A 16.5-kg child is pushing an empty box across a living room floor. The child exerts a constant rightward force of 13.7 N upon the box to move it a distance of 1.76 meters to the right. Determine the work done by the child upon the box.

**Question 131:**

aa. An upward force of 29.4 N is used to carry a 3.0-kg bucket of water at a constant speed for a horizontal displacement of 10.0 m. Determine the work done by the upward force upon the bucket.

**Question 132:**

aa. Jack and Jill are doing a physics lab. They apply a 14.7-Newton force to a 3-kg cart to pull it up an inclined plane at a constant speed. The plane is inclined at a 30-degree angle. Jack and Jill are exerting a force on the cart that is parallel to the inclined plane in order to displace it 2.0 meters along the incline to a final height of 1 meter. Determine the work done by the applied force upon the cart.

**Question 133:**

aa. A 5.2-kg softball player is sliding into third base. Once she hits the dirt, a 431-N force of friction acts upon her to slow her down as she slides a distance of 1.43 meters across the distance. Determine the work done by friction upon the softball player.

**Question 135:**

aa. Li Ping Phar, the esteemed Chinese ski jumper, has a mass of 52.8 kg. He is moving with a speed of 28.9 m/s at a height of 48.4 meters above the ground. Determine the total mechanical energy (in J) of Li Ping Phar.

**Question 136:**

aa. A 138 gram ball is moving upward with a speed of 67.4 m/s when at a height of 36.9 meters above the ground. Determine the total mechanical energy (in J) of the ball.

**Question 137:**

aa. You push a wheelbarrow a distance of 56.2 m at a constant speed for 23.5 s by exerting a 155-N force horizontally. What power do you develop?

**Question 138:**

aa. A 1030-kg car is moving along a horizontal surface with a speed of 23.6 m/s. How much work (in J) must be done by the brakes to bring this car to rest in 6.34 seconds?

**Question 139:**

aa. A 2.09-kg physics cart starts from rest at the top of a 0.715-meter high incline. Determine the speed (in m/s) of the cart after it has rolled to a height of 0.159 meters. (Neglect the effect of friction forces.)

**Question 140:**

aa. A 34.6-gram Hot wheels car is moving along the ground with a speed of 2.57 m/s. It approaches a hill inclined at 20.9 degrees to the horizontal. It rolls up the hill and then back down. To what height (in meters) will the ball roll up the incline? (Ignore any effects of rotation and friction.)

**Questions 141-143:**

A 46.6-kg cross-country skier uses her poles to accelerate from rest to a speed of 6.14 m/s in 39.0 seconds.

aa. What was the skier's original kinetic energy (when at rest)?

aa. What was the skier's kinetic energy when moving at 6.14 m/s?

aa. How much work was done upon the skier by use of the poles?

**Questions 144-146:**

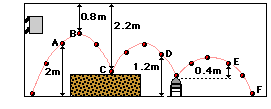
An 856-kg car moving with a speed of 30.0 m/s (at A) puts on the brakes and slows down to a speed of 12.0 m/s (at B).

aa. What is the kinetic energy of the car at position A?

aa. What is the kinetic energy of the car at position B?

aa. How much work is done on the car between positions A and B?

**Question 147:**

aa. The diagram at the right shows six positions of a 0.300-kg ball bouncing across a 3.0-meter high physics room. Information regarding the vertical position is shown.

a. Suppose that the floor is the reference level for zero potential energy, determine the gravitational potential energy of the 0.300-kg ball at position ....

**A**: \_\_\_\_\_\_\_\_\_\_\_ J **B**: \_\_\_\_\_\_\_\_\_\_\_ J

**C**: \_\_\_\_\_\_\_\_\_\_\_ J **D**: \_\_\_\_\_\_\_\_\_\_\_ J

b. Given this same reference level, determine the change in potential energy as the ball travels from location A to location D. (Note: a change in a quantity can be positive or negative.)

PE = \_\_\_\_\_\_\_\_\_\_\_ J

c. Suppose that the top of the teacher's desk (position C) is the reference level for zero potential energy, determine the gravitational potential energy of the 0.300-kg ball at position ....

**A**: \_\_\_\_\_\_\_\_\_\_\_ J **B**: \_\_\_\_\_\_\_\_\_\_\_ J

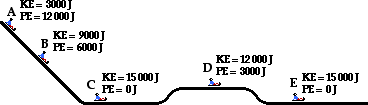
**C**: \_\_\_\_\_\_\_\_\_\_\_ J **D**: \_\_\_\_\_\_\_\_\_\_\_ J

d. Given this same reference level, determine the change in potential energy as the ball travels from location A to location D. (Note: a change in a quantity can be positive or negative.)

PE = \_\_\_\_\_\_\_\_\_\_\_ J

**Question 148:**

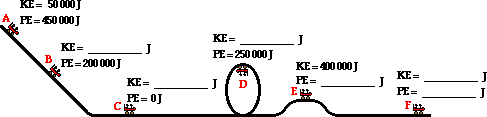
aa. Consider the diagram shown below. The KE and PE values of a sledder are shown.



In moving from position A to position C, the sledder loses \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J of potential energy and gains \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J of kinetic energy.

**Question 149:**

aa. The path of a roller coaster car coasting along a track is shown in the diagram below.



Frictional forces can be assumed to be negligible. Perform an energy analysis and fill in all the blanks.

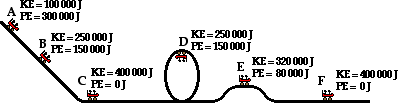
KE at B: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J KE at C: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

KE at D: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J PE at E: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

KE at F: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J PE at F: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**Question 150:**

aa. Consider the diagram below. The kinetic energy and the potential energy of a roller coaster car at various locations are shown.



The total mechanical energy of the car ...

a. ... at position A is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Joules.

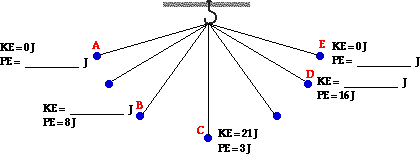
b. ... at position B is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Joules.

c. ... at position D is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Joules.

d. ... at position F is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Joules.

**Question 151:**

aa. The path of a pendulum bob moving to and fro is shown in the diagram below.



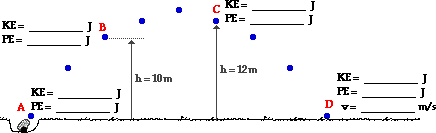
Frictional forces can be assumed to be negligible. Perform an energy analysis and fill in all the blanks.

PE at A: \_\_\_\_\_\_\_\_\_\_\_\_\_\_J KE at B: \_\_\_\_\_\_\_\_\_\_\_\_\_\_J

KE at D: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ J PE at E: \_\_\_\_\_\_\_\_\_\_\_\_\_\_J

**Question 152:**

aa. The path of a projectile moving through the air is shown in the diagram below.



Frictional forces can be assumed to be negligible. Perform an energy analysis and fill in all the blanks. (Given: m = 1.80 kg; Height at A = 0 m, Speed at A = 17.7 m/s)

KE at A = \_\_\_\_\_\_\_\_\_\_\_\_\_\_J PE at A = \_\_\_\_\_\_\_\_\_\_\_\_\_\_J

KE at B = \_\_\_\_\_\_\_\_\_\_\_\_\_\_J PE at B = \_\_\_\_\_\_\_\_\_\_\_\_\_\_J

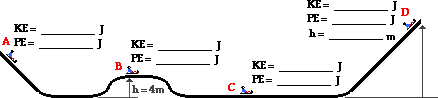
KE at C = \_\_\_\_\_\_\_\_\_\_\_\_\_\_J PE at C = \_\_\_\_\_\_\_\_\_\_\_\_\_\_J

KE at D = \_\_\_\_\_\_\_\_\_\_\_\_\_\_J PE at D = \_\_\_\_\_\_\_\_\_\_\_\_\_\_J

v at D = \_\_\_\_\_\_\_\_\_\_\_\_\_\_m/s

**Question 153:**

aa. The path of a sledder is shown below; upon descending the hill, the sledder ultimately glides up a ramp to a final resting position (at D). Frictional forces can be assumed to be negligible.



Perform an energy analysis and fill in all the blanks. (Given: m = 35.0 kg; Height at A = 7.20 m, Speed at A = 13.0 m/s)

KE at A = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J PE at A = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

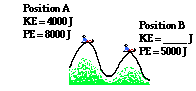
KE at B = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J PE at B = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

KE at C = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J PE at C = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

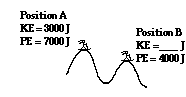
KE at D = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J PE at D = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

h at D = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ m

**Question 154:**

aa. A sledder effortlessly glides from position A across the snow to position B (as shown in the diagram at the right). Resistance forces are negligible. At position B, the kinetic energy of the sledder is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Joules and the total mechanical energy is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Joules. In moving from position A to position B, the sledder lost \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J of potential energy and gained \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J of kinetic energy.

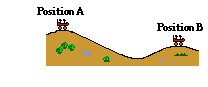
**Question 155:**

Consider the diagram at the right of a skier.

aa. The total mechanical energy of the skier at position A is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J.

aa. If 1000 J of total mechanical energy are lost by the skier (due to resistance forces) in moving from position A to position B, then the kinetic energy at position B will be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J.

**Questions 156-157:**

A roller coaster car coasts from position A to position B (as shown in the diagram at the right). At position A, it has 33600 J of kinetic energy and 59200 J of potential energy. In moving from A to B, the coaster car loses 12700 J of energy due to work done by resistance forces. At position B it has 29600 J of potential energy.

aa. Determine the amount of total mechanical energy that the coaster car has at position B.

aa. Determine the amount of kinetic energy that the coaster car has at position B.

**Question 158:**

aa. There is a lot of work and energy transformation going on at the McDonalds PlayLand around noon. A 17.4-kg toddler climbs steadily 4.41 m upward from the floor to the top of a slide.

a. How much work did the toddler do during the climbing phase?

b. How much potential energy does the toddler have with respect to the ground?

c. The toddler then slides down the slide to the ground below. What is the change in potential energy of the toddler?

d. Assume all this PE changes back into KE at the bottom of the slide. How much kinetic energy does the toddler have upon reaching the slide's bottom?

**Question 159:**

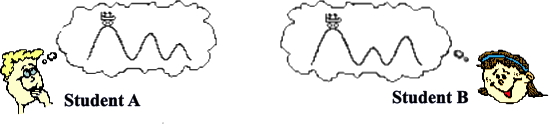
aa. A 412-kg roller coaster car is moving with a speed of 17.9 m/s at the very end of the ShockWave roller coaster track. A hydraulic braking system applies a 11200-Newton force at the loading dock to slow the car to a speed of 2.6 m/s. Over what horizontal distance (in meters) is the force applied?

**Question 160:**

aa. A car is moving across a level highway with a speed of 21.9 m/s. The brakes are applied and the wheels become locked as the 1210-kg car skids to a stop. The braking distance is 132 meters. Determine the braking force (in Newton) acting upon the car.

**Question 161:**

aa. Two classmates are discussing the design of a roller coaster. Student A says that each summit must be lower than the previous one. Student B says that this is nonsense, for as long as the first one is the highest it doesn't matter what height the others are.

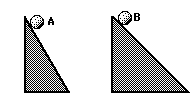


Who do you agree with?

a. Student A b. Student B

Explain your answer and support it with logical reasoning, energy principles, and the language of physics.

**Question 162:**

aa. Two identical balls roll down two hills having different incline angles. Upon which hill (A or B for both) will the ball be traveling fastest when it reaches the bottom? The balls each start from rest at the same height. Ignore all frictional forces.

a. Hill A

b. Hill B

c. Both the same

Explain your answer below.

**Question 163:**

aa. Suzie Lavtaski is at rest on top of a ski slope with an initial height of 1210 meters above the slope's bottom. While descending the hill, a total amount of work of -543574 Joules are done upon her 47.9-kg body. Determine her speed (in m/s) at the bottom of the hill just prior to skidding to a stop.

**Question 164:**

aa. A 0.728-kg volleyball approaches a spiker with a speed of 1.06 m/s and a height of 1.79 m. The player does +25.9 Joules of work upon the ball during the spiking process. Determine the speed (in m/s) of the ball just prior to hitting the ground.

**Question 165:**

aa. A 223-gram baseball leaves the bat with a speed of 45.7 m/s. It sails through the air, encountering air resistance that does a total of -26.3 Joules of work on the ball over the course of its entire trajectory. What is the speed (in m/s) of the ball the instant prior to being caught (at the same height as which it was hit)?

**Question 166:**

aa. A bowling ball is attached to a 2.3-meter long cable and hung from the ceiling. The cable is kept taut and the ball is raised to an initial height of 1.63 meters above the classroom floor. It is released from rest and allowed to swing as a pendulum. Determine its speed (in m/s) when it is at a height of 1.22 meters above the floor.

**Question 167:**

aa. Pete Zaria applies a rightward force of 4.89 Newton over a distance of 1.04 meters to set a 620 gram root beer mug from rest into motion along a level countertop which is elevated at 0.620-meters above the parlor floor. Determine the speed (in m/s) of the root beer mug after Pete is done pushing it. (Assume negligible friction forces.)

**Question 168:**

aa. A 0.276-kg baseball is moving horizontally with a speed of 26.3 m/s when it is caught by the catcher. The catcher's mitt recoils a horizontal distance of 15.5 cm before the ball is brought to a stop. Determine the force (in Newton) that is applied by the catcher to the ball.

**Question 169:**

aa. A physics teacher does 32.6 Joules of work on a 2.17-kg pile of snow to both lift it off the ground and to set it into motion. The pile of snow leaves the shovel with a speed of 2.10 m/s. What is the height (in m) of the snow when it leaves the shovel?

**Question 170:**

aa. A child and sled with a combined mass of 26.3 kg slide down a frictionless hill. The sled starts from rest and acquires a speed of 5.34 m/s by the time it reaches the bottom of the hill. What is the height (in m) of the hill?

**Question 171:**

aa. A baseball player throws a baseball straight up into the air with an initial speed of 26.8 m/s. Find the speed of the ball (in m/s) when it is halfway up to its maximum height.

**Question 172:**

aa. A catcher gives with the ball when he catches a 0.159-kg baseball moving at 25.90 m/s. If he moves his catching glove back a distance of 2.70 cm, what is the average force (in Newton) acting on his hand?

**Question 173:**

aa. A grocery cart weighs 85.3 N. Claire deAisles pushes it 10.4 m across the floor with a constant horizontal force of 52.0 N. If all frictional forces are neglected, what is the final speed (in m/s) of the cart on the floor surface?

**Question 174:**

aa. A 1500-kg car starts from rest at the top of a driveway 6.61 m long that is sloped at an angle of 20 degrees with the horizontal. If an average friction force of 3340 N impedes the motion of the car, find the speed (in m/s) of the car at the bottom of the driveway.