GIVE FEEDBACK

CONTINUE >

The principle of conservation of energy is a fundamental physical law.

This section outlines the principle of conservation of energy and applies it to the mechanical energy of mechanical systems.

< BACK GIVE FEEDBACK OK

The principle of conservation of energy

Shown below is one of the most fundamental laws of nature.

Energy can be neither created nor destroyed, only transformed from one form to another.

GIVE FEEDBACK

OK

Which of the following is a correct description of the principle of conservation of energy?

Click the correct answer.

- Energy can be neither created nor destroyed, only transformed from one form to another
- Energy cannot be transformed from one form to another, only created or destroyed
- The total energy in a body is always constant
- The total energy in a body cannot be transformed from one form to another
- The energy in a body cannot be transformed from one body to another

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

The principle of __________ of __________ states that energy can be neither created nor destroyed, only transformed from one form to another.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

The principle of conservation of energy states that energy can be neither ________ nor ________, only ________ from one form to another.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

What is the name of the fundamental law of nature that states that energy can be neither created nor destroyed, only transformed from one form to another?

Click the correct answer.

- The principle of conservation of energy
- The law of diminishing returns
- Newton's laws of motion
- The law of gravitational attraction
- The second law of thermodynamics

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

The mathematical expression of the principle of the conservation of mechanical energy

Let us examine the relationship between the most common forms of mechanical energy: potential and kinetic energy.

The conservation of energy principle can be stated as follows:

$$PE_1 + KE_1 = PE_2 + KE_2$$

where:

PE_1 is the potential energy stored in a body in its initial state

KE_1 is the kinetic energy of a body in its initial state

PE_2 is the potential energy stored in a body in its final state

KE_2 is the kinetic energy of a body in its final state

This equation is true only if no external work is done on the body and no loss of mechanical energy occurs due to friction.

GIVE FEEDBACK

OK

Type your answer in the box.

In the equation $PE_1 + KE_1 = PE_2 + KE_2$ the symbol PE_1 refers to the initial ______ energy and the symbol KE_2 refers to the ______ kinetic energy.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following are correct descriptions for the symbols in the equation $PE_1 + KE_1 = PE_2 + KE_2$?

Check all that apply.

- [ ] PE_1 is the initial potential energy
- [ ] PE_2 is the final potential energy
- [ ] KE_1 is the initial kinetic energy
- [ ] KE_2 is the final strain energy
- [ ] PE_2 is the initial kinetic energy
- [ ] KE_1 is the initial strain energy
- [ ] PE_1 is the final kinetic energy
- [ ] KE_2 is the final kinetic energy

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match the symbol from the equation $PE_1 + KE_1 = PE_2 + KE_2$ with the correct description.

Drag statements on the right to match the left.

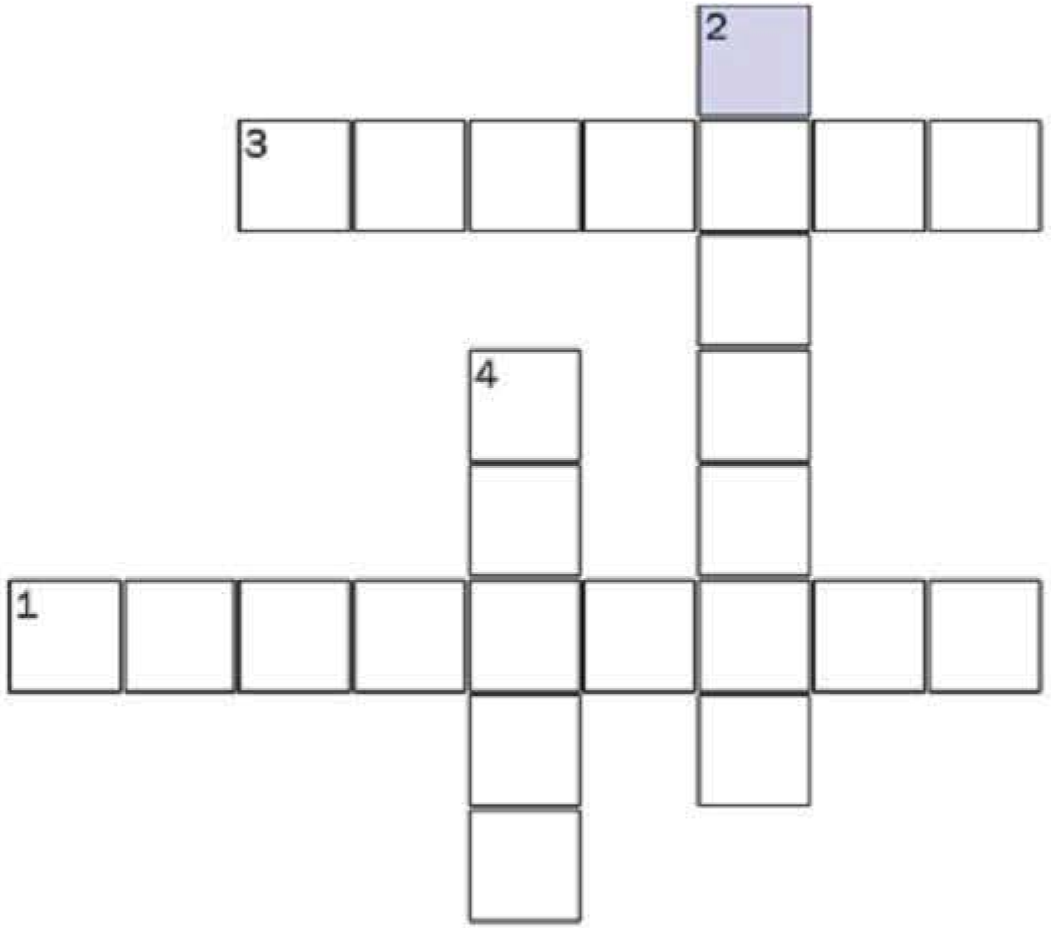
PE_1	The initial potential energy
PE_2	The final potential energy
KE_1	The initial kinetic energy
KE_2	The final kinetic energy

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Conservation of energy

1



1) When considering the conservation of mechanical energy, PE refers to the __________ energy.

2) When considering the conservation of mechanical energy, KE refers to the __________ energy.

3) When considering the conservation of mechanical energy, a subscript of 1 refers to the __________ conditions.

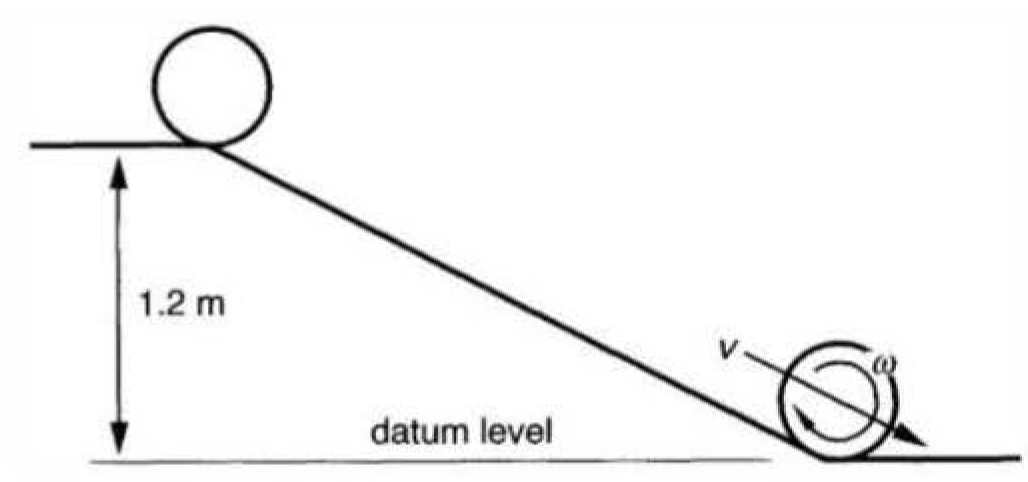
4) When considering the conservation of mechanical energy, a subscript of 2 refers to the __________ conditions.

Done | Hint | Challenge

Calculations involving conversion from potential energy into kinetic energy—Example 2

A metal cylinder of diameter 100 mm and mass 30 kg is allowed to roll freely down an incline as shown in the figure.

If it starts from rest at the top of the incline, what will be its linear and rotational speeds at the bottom of the incline?



Example 2	Solution—initial conditions	Solution—final conditions	Solution 2

GIVE FEEDBACK

OK

Calculations involving conversion from potential energy into kinetic energy—Example 2

In situations involving rotating parts, kinetic energy of rotation must be taken into account when calculating the overall energy balance.

When the cylinder begins to roll from the top of the incline, its initial potential energy is:

$$\begin{aligned} PE_1 &= m\,g\,h \\ &= 30 \times 9.81 \times 1.2 \\ &= 353.2 \text{ J} \end{aligned}$$

and its initial kinetic energy is zero because it starts from rest:

$$KE_1 = 0$$

Example 2	Solution—initial conditions	Solution—final conditions	Solution 2

Calculations involving conversion from potential energy into kinetic energy—Example 2

When the cylinder reaches the bottom of the incline, its final potential energy is zero: $PE_2 = 0$

The final kinetic energy of the cylinder at the bottom of the incline consists of two parts due to a combination of linear motion of its centre of mass down the incline and the rotation about its own axis. Kinetic energy associated with linear velocity v is given by:

$$\text{linear } KE_2 = \frac{1}{2} m v^2 = \left(\frac{1}{2}\right)(30) v^2 = 15 v^2$$

Kinetic energy of rotation depends on the mass moment of inertia, which for a cylindrical object is found from:

$$I = \frac{1}{2} m r^2 = \left(\frac{1}{2}\right)(30)(0.05)^2 = 0.0375 \text{ kg.m}^2$$

$$\text{Hence rotational } KE_2 = \frac{1}{2} I \omega^2 = \left(\frac{1}{2}\right)(0.0375)\omega^2$$

Example 2	Solution—initial conditions	Solution—final conditions	Solution 2

GIVE FEEDBACK

OK

Calculations involving conversion from potential energy into kinetic energy—Example 2

Now the conservation of energy principle can be stated as follows: $PE_1 + KE_1 = PE_2 + KE_2$ (linear) $+ KE_2$ (rotation)

$$\therefore 353.2 + 0 = 0 + \frac{30 v^2}{2} + \frac{0.0375 \omega^2}{2}$$

We must recognise that the centre of mass of the cylinder moves down the incline with linear velocity which is related to the angular velocity of its rotation about its axis: $v = r\omega = 0.05\omega$

Substitution of $v = 0.05\omega$ into the above conservation of energy equation yields:

$$353.2 + 0 = 0 + \frac{30(0.05\omega)^2}{2} + \frac{0.0375 \omega^2}{2}$$

Solving this equation for angular velocity gives: $\omega = 79.24\ \mathrm{rad/s} = 12.6$ revolutions per second

Hence linear velocity: $v = 0.05 \times 79.24 = 3.96\ \mathrm{m/s}$

Example 2	Solution—initial conditions	Solution—final conditions	Solution 2

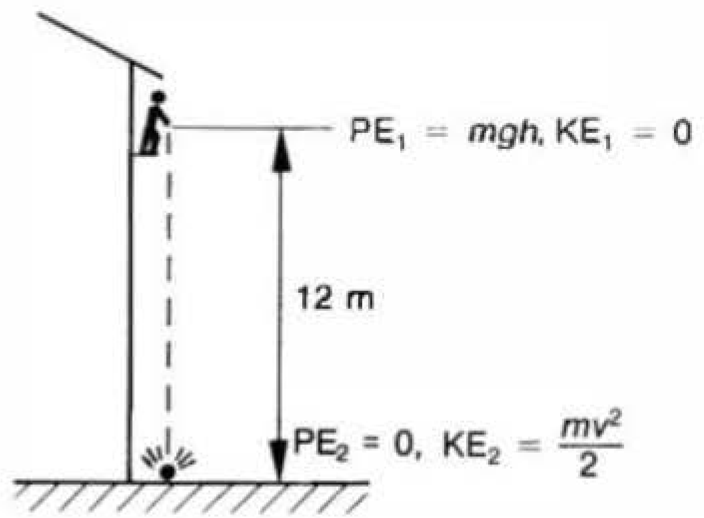
GIVE FEEDBACK

OK

Calculations involving conversion from potential energy into kinetic energy—Example 1

An object of mass 3 kg is dropped from a height of 12 m.

Using the conservation of energy principle, calculate the velocity with which it strikes the ground.



Example 1	Solution—initial conditions	Solution—final conditions	Solution 1

GIVE FEEDBACK

OK

Calculations involving conversion from potential energy into kinetic energy—Example 1

Before the object is dropped, its kinetic energy KE_1 is zero and its potential energy relative to the ground is:

$$
\begin{aligned}
PE_1 &= m\,g\,h \\
&= 3 \times 9.81 \times 12 \\
&= 353.2\ \text{J}
\end{aligned}
$$

Example 1	Solution—initial conditions	Solution—final conditions	Solution 1

GIVE FEEDBACK

OK

Calculations involving conversion from potential energy into kinetic energy—Example 1

When it strikes the ground, its height above ground is zero, therefore $PE_2 = 0$.

Its kinetic energy is:

$$\begin{aligned} KE_2 &= \frac{1}{2} m\, v^2 \\ &= \frac{1}{2}(3)\, v^2 \\ &= 1.5\, v^2 \end{aligned}$$

Example 1	Solution—initial conditions	Solution—final conditions	Solution 1

Calculations involving conversion from potential energy into kinetic energy—Example 1

Substitute into $PE_1 + KE_1 = PE_2 + KE_2$:

$$353.2 + 0 = 0 + 1.5\,v^2$$
$$\therefore v = 15.3 \text{ m/s}$$

Example 1	Solution—initial conditions	Solution—final conditions	Solution 1

GIVE FEEDBACK

OK

Calculate the initial energy of the metal cylinder. (Answer in joules correct to one decimal place.)

+ − · ÷ $\frac{\square}{\square}$ $\square^2$ $\sqrt{\square}$ Clear

Clear line

(□) ≤ π m $\overline{\square}$ ↵ ? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Type your answer in the box.

An object of mass 23 kg is dropped from a height of 12 m.

The potential energy of the object before it is dropped is ______ J. (Answer correct to the nearest joule.)

The kinetic energy before the object is dropped is ______ J. (Answer correct to the nearest joule.)

The potential energy of the object when it hits the ground is ______ J. (Answer correct to the nearest joule.)

Using the conservation of energy principle, the velocity with which the object strikes the ground is ______ m/s. (Answer correct to two decimal places.)

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

If it starts from rest at the top of the incline, what will be the metal cylinder's linear speed at the bottom of the incline? (Answer in m/s correct to two decimal places.)

$$v = 0.15 \text{ m} \cdot 38.123 \text{ rad/s}$$

+ − · ÷ $\frac{\square}{\square}$ $\square^2$ $\sqrt{\square}$ Clear

$(\square)$ ▼ ≤ ▼ π $\square \times 10^{\square}$ m ▼ ? Undo

$\overline{\square}$

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

If it starts from rest at the top of the incline, what will be the metal cylinder's rotational speed at the bottom of the incline? (Answer in rad/s correct to three decimal places.)

+ − · ÷ $\frac{\square}{\square}$ $\square^2$ ▾ $\sqrt{\square}$ Clear

Clear line

$|\square|$ ▾ ≤ ▾ π s ▾ $\overline{\square}$ ↵ ? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Type your answer in the box.

An object of mass 15 kg is dropped from a height of 4 m.

The potential energy of the object before it is dropped is ______ J. (Answer correct to the nearest joule.)

The kinetic energy before the object is dropped is ______ J. (Answer correct to the nearest joule.)

The potential energy of the object when it hits the ground is ______ J. (Answer correct to the nearest joule.)

Using the conservation of energy principle, the velocity with which the object strikes the ground is ______ m/s. (Answer correct to two decimal places.)

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A metal cylinder of diameter 300 mm and mass 16 kg is allowed to roll freely down an incline from a height of 2.5 m above ground level.

SMALL MEDIUM LARGE

Calculate the initial energy of the metal cylinder. (Answer in joules correct to one decimal place.)

Clear | Clear line | Undo

Click and type your answer here

CHALLENGE | SUBMIT | SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required.
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

HINT

A metal cylinder of diameter 300 mm and mass 16 kg is allowed to roll freely down an incline from a height of 2.5 m above ground level.

SMALL MEDIUM LARGE

If it starts from rest at the top of the incline, what will be the metal cylinder's rotational speed at the bottom of the incline? (Answer in rad/s correct to three decimal places.)

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required.
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

A metal cylinder of diameter 300 mm and mass 16 kg is allowed to roll freely down an incline from a height of 2.5 m above ground level.

SMALL MEDIUM LARGE

If it starts from rest at the top of the incline, what will be the metal cylinder's linear speed at the bottom of the incline? (Answer in m/s correct to two decimal places.)

$$v = 0.15\ \text{m} \cdot 38.123\ \text{rad/s}$$

Clear

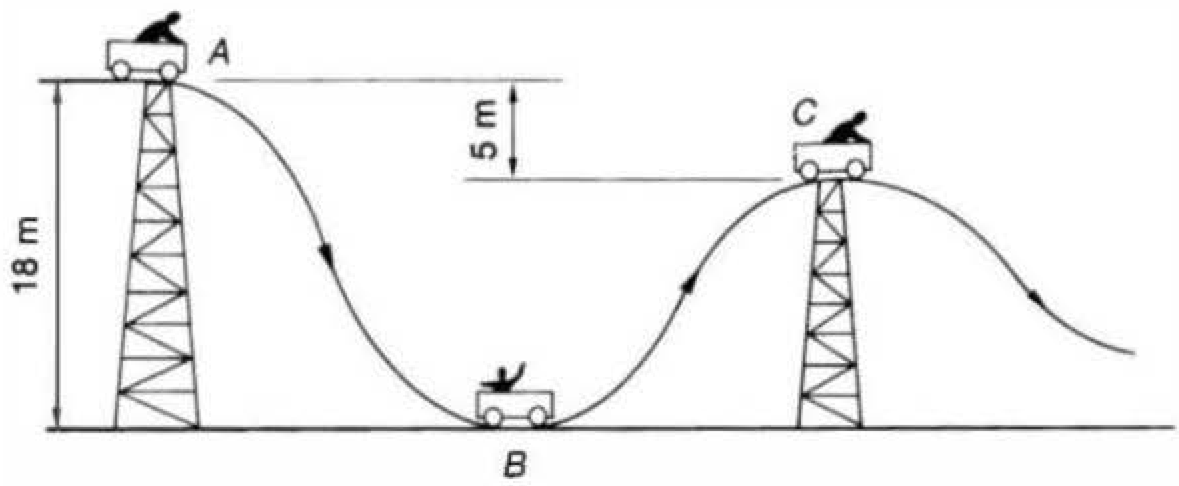
Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

Calculations involving conversion from kinetic energy into potential energy—Example

A car of a roller coaster has a mass of 500 kg and is released from a height of 18 m at the top of the first incline. Calculate its velocity at the lowest point and also at the top of the second incline, which is 5 m below the top of the first incline.



Example	Solution—energy at point A	Solution—energy at point B	Solution—energy at point C	Solution—conservation of energy

GIVE FEEDBACK

OK

Calculations involving conversion from kinetic energy into potential energy—Example

Calculate potential and kinetic energy at point A:

$$\begin{aligned} PE_A &= m\,g\,h \\ &= (500)(9.81)(18) \\ &= 88{,}290 \text{ J} \end{aligned}$$

$$\begin{aligned} KE_A &= \frac{1}{2} m\,v^2 \\ &= 0 \qquad \text{(since } v = 0\text{)} \end{aligned}$$

Example	Solution—energy at point A	Solution—energy at point B	Solution—energy at point C	Solution—conservation of energy

GIVE FEEDBACK

OK

Calculate potential and kinetic energy at point B:

$PE_B = 0$ (since $h = 0$)

$$KE_B = \frac{1}{2} m v^2$$
$$= \left(\frac{1}{2}\right)(500) v_B^2$$
$$= 250 v_B^2$$

Example	Solution—energy at point A	Solution—energy at point B	Solution—energy at point C	Solution—conservation of energy

GIVE FEEDBACK

OK

Calculations involving conversion from kinetic energy into potential energy—Example

Calculate potential and kinetic energy at point C:

$$\begin{aligned} PE_C &= m\,g\,h \\ &= 500 \times 9.81 \times 13 \\ &= 63{,}765\ \text{J} \end{aligned}$$

$$\begin{aligned} KE_C &= \frac{1}{2} m\,v^2 \\ &= \left(\frac{1}{2}\right)(500)\,v_C^2 \\ &= 250\,v_C^2 \end{aligned}$$

Example	Solution—energy at point A	Solution—energy at point B	Solution—energy at point C	Solution—conservation of energy

GIVE FEEDBACK

OK

Calculations involving conversion from kinetic energy into potential energy—Example

Equating total energy $PE + KE$ for all points gives:

$$88{,}290 + 0 = 0 + 250\,v_B^2 = 63{,}765 + 250\,v_C^2$$

from which $v_B = 18.8\ \mathrm{m/s}$ and $v_C = 9.9\ \mathrm{m/s}$.

Example	Solution—energy at point A	Solution—energy at point B	Solution—energy at point C	Solution—conservation of energy

GIVE FEEDBACK

OK

Using the principle of conservation of energy, determine the maximum height above the starting point that the car reaches. (Answer in metres correct to two decimal places.)

+ − · ÷ Clear

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Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Calculate the car's initial kinetic energy. (Answer in kJ.)

Clear

Clear line

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Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Based on the angle of the hill, determine the distance up the ramp of the hill that the car travels before it comes to rest. (Answer in metres correct to two decimal places.)

+ − · ÷ Clear

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π m ? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

A 1200 kg car is rolling at $72\,\mathrm{km/h}$ at the base of a 30^{o} hill.

The car is rolling in the direction that will cause it to roll up the hill.

SMALL MEDIUM LARGE

Calculate the car's initial kinetic energy. (Answer in kJ.)

Clear
Clear line
Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

A 1200 kg car is rolling at $72\,\mathrm{km/h}$ at the base of a $30°$ hill.

The car is rolling in the direction that will cause it to roll up the hill.

SMALL MEDIUM LARGE

Type your answer in the box.

If the base of the hill is taken as the reference datum, the car's initial potential energy is ______ J.

When the car comes to a stop up the hill, its final kinetic energy is ______ J.

The car's final potential energy is ______ J.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

A 1200 kg car is rolling at $72\,\mathrm{km/h}$ at the base of a 30^{o} hill.

The car is rolling in the direction that will cause it to roll up the hill.

SMALL MEDIUM LARGE

Using the principle of conservation of energy, determine the maximum height above the starting point that the car reaches. (Answer in metres correct to two decimal places.)

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

A 1200 kg car is rolling at $72\,\mathrm{km/h}$ at the base of a 30^{o} hill.

The car is rolling in the direction that will cause it to roll up the hill.

SMALL MEDIUM LARGE

Based on the angle of the hill, determine the distance up the ramp of the hill that the car travels before it comes to rest. (Answer in metres correct to two decimal places.)

Clear
Clear line
Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Type your answer in the box.

A 2 kg ball is rolled up an inclined plane with an initial velocity of 5 m/s.

The total initial energy is ______ J.

The height above ground level that the ball reaches is ______ m. (Answer correct to two decimal places.)

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

If the base of the hill is taken as the reference datum, the car's initial potential energy is ______ J.

When the car comes to a stop up the hill, its final kinetic energy is ______ J.

The car's final potential energy is ______ J.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A 1.6 kg ball is rolled up an inclined plane with an initial velocity of 4 m/s.

The total initial energy is ______ J. (Answer correct to one decimal place.)

The height above ground level that the ball reaches is ______ m. (Answer correct to three decimal places.)

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Expanding the mathematical expression of the principle of the conservation of mechanical energy to include strain energy

When interaction of mechanical components involves an elastic member, such as a coil spring, the conservation of energy equation must be extended to allow for the elastic strain energy of the compressed or extended spring where apprpriate.

$$PE_1 + KE_1 + SE_1 = PE_2 + KE_2 + SE_2$$

where:

PE_1 is the potential energy stored in a body in its initial state

KE_1 is the kinetic energy of a body in its initial state

SE_1 is the strain energy of a body in its initial state

PE_2 is the potential energy stored in a body in its final state

KE_2 is the kinetic energy of a body in its final state

SE_2 is the strain energy of a body in its final state

GIVE FEEDBACK

OK

Type your answer in the box.

In the equation $PE_1 + KE_1 + SE_1 = PE_2 + KE_2 + SE_2$ the symbol SE_1 refers to the initial ________ energy and the symbol KE_2 refers to the ________ kinetic energy.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match the symbol from the equation $PE_1 + KE_1 + SE_1 = PE_2 + KE_2 + SE_2$ with the correct description.

Drag statements on the right to match the left.

PE_1	The initial potential energy
KE_1	The initial kinetic energy
SE_1	The initial strain energy
PE_2	The final potential energy
KE_2	The final kinetic energy
SE_2	The final strain energy

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

In the equation $PE_1 + KE_1 + SE_1 = PE_2 + KE_2 + SE_2$:

The symbol SE refers to the ________ energy, the symbol PE refers to the ________ energy and the symbol KE refers to the ________ energy.

A subscript of 1 refers to the initial condition and a subscript of 2 refers to the ________ condition.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Which of the following are correct descriptions for the symbols in the equation
$PE_1 + KE_1 + SE_1 = PE_2 + KE_2 + SE_2$?

Check all that apply.

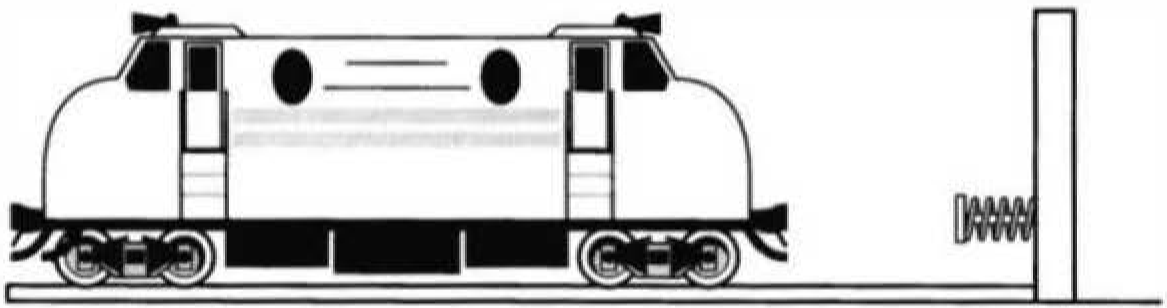
- [ ] SE_1 is the initial strain energy
- [ ] KE_1 is the initial kinetic energy
- [ ] PE_2 is the final potential energy
- [ ] SE_2 is the final strain energy
- [ ] PE_1 is the final potential energy
- [ ] KE_1 is the final potential energy
- [ ] SE_2 is the final kinetic energy
- [ ] KE_2 is the initial potential energy

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Calculations involving conversion from potential energy into strain energy

A locomotive of mass 25 t is to be brought to rest in 125 mm from a velocity of 1.8 km/h by two buffer springs. What must the spring modulus be for each of the two springs? Assume the engine is disengaged.



Example	Convert the velocity to m/s	Solution—initial conditions	Solution—final conditions	Solution—conservation of energy

GIVE FEEDBACK

OK

Calculations involving conversion from potential energy into strain energy

Velocity before impact is:

$$\begin{aligned} v &= 1.8 \text{ km/h} \\ &= 0.5 \text{ m/s} \end{aligned}$$

Example	Convert the velocity to m/s	Solution—initial conditions	Solution—final conditions	Solution—conservation of energy

GIVE FEEDBACK

OK

Calculations involving conversion from potential energy into strain energy

The energy levels of the locomotive and spring just before impact are:

$$PE_1 = 0$$

$$KE_1 = \frac{1}{2} m v^2$$

$$= \left(\frac{1}{2}\right)(25{,}000)(0.5)^2$$

$$= 3{,}125 \text{ J}$$

$$SE_1 = 0$$

Example	Convert the velocity to m/s	Solution—initial conditions	Solution—final conditions	Solution—conservation of energy

GIVE FEEDBACK

OK

Calculations involving conversion from potential energy into strain energy

After the impact, when the locomotive is brought to rest, the springs will be compressed by 0.125 m, and the energy levels will be as follows:

$$PE_2 = 0$$
$$KE_2 = 0$$
$$SE_2 = 2 \times \left(\frac{1}{2}\right) k \,(0.125)^2$$
$$= 0.01563\,k$$

Note: This is multiplied by two because there are two springs acting on the train.

Calculations involving conversion from potential energy into strain energy

Substitute into the conservation of energy equation:

$$PE_1 + KE_1 + SE_1 = PE_2 + KE_2 + SE_2$$
$$0 + 3{,}125 + 0 = 0 + 0 + 0.01563\,k$$

Hence the required spring modulus for each spring is found to be:

$$k = 200 \times 10^3\ \text{N/m}$$
$$= 200\ \text{N/mm}$$

Example	Convert the velocity to m/s	Solution—initial conditions	Solution—final conditions	Solution—conservation of energy

GIVE FEEDBACK

OK

A 98 kg person is connected to a stretched horizontal bungy spring.

The spring has a spring constant of 127 N/m and it is stretched 7 metres from its free length.

SMALL MEDIUM LARGE

Determine the initial strain energy.

(Answer in joules correct to one decimal place).

Clear

Clear line

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Click and type your answer here

CHALLENGE

INSTRUCTIONS

- No intermediate steps are required.
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

A 98 kg person is connected to a stretched horizontal bungy spring.

The spring has a spring constant of 127 N/m and it is stretched 7 metres from its free length.

SMALL MEDIUM LARGE

Now that we know the initial strain energy is 3,111.5J, determine the maximum speed that the person will reach after the bungy is released.

(Answer in metres per second correct to two decimal places).

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required.
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

A 75 kg person is connected to a stretched horizontal bungy spring.

The spring has a spring constant of 117 N/m and it is stretched 8 m from its free length.

SMALL MEDIUM LARGE

Calculate the initial energy of the system. (Answer to the nearest joule.)

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required.
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

HELP

A 75 kg person is connected to a stretched horizontal bungy spring.

The spring has a spring constant of 117 N/m and it is stretched 8 m from its free length.

SMALL MEDIUM LARGE

Now that we know the initial energy is 3,744 J, calculate the velocity of the person at the instant when the spring reaches its free length after it is released. (Answer correct to the nearest m/s.)

Clear
Clear line
Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Calculate the initial energy of the system. (Answer to the nearest joule.)

Clear

Clear line

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Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
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Hint Each hint will reduce the credit received for this question

Now that we know this initial strain energy is 3,111.5J, determine the maximum speed that the person will reach after the bungy is released.

(Answer in metres per second correct to two decimal places).

+ − · ÷ Clear

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π m ? Undo

↵

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint Each hint will reduce the credit received for this question

Now that we know the initial energy is 3,744 J, calculate the velocity of the person at the instant when the spring reaches its free length after it is released. (Answer correct to the nearest m/s.)

Clear

Clear line

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Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint Each hint will reduce the credit received for this question

Determine the initial strain energy.

(Answer in joules correct to one decimal place).

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE

SUBMIT

SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

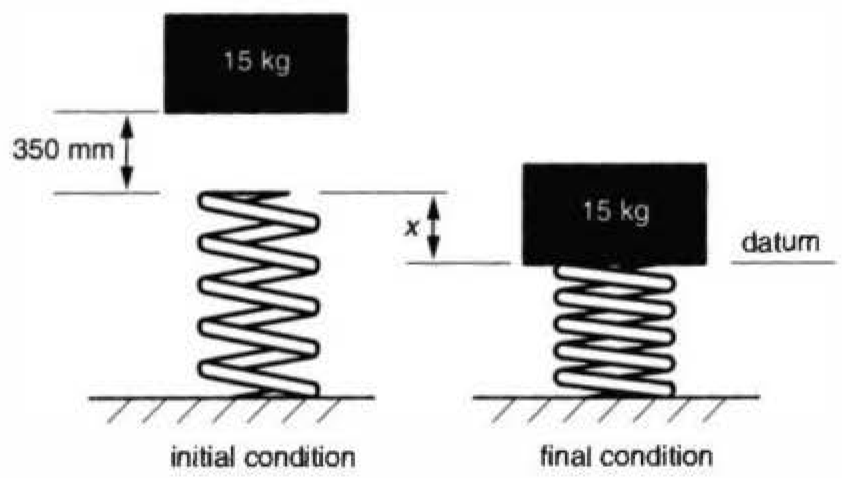
Hint

Each hint will reduce the credit received for this question

Calculations involving conversion from kinetic energy into strain energy

A block of mass 15 kg falls 350 mm and strikes a coil spring of modulus 10 N/mm.

What will be the maximum compression of the spring?



Example	Solution—potential energy	Solution—kinetic energy	Solution—strain energy	Solution—conservation of energy	Discussion

GIVE FEEDBACK

OK

When the mass comes momentarily to rest and before rebound occurs, the spring will experience its maximum compression x. The lowest position of the mass, corresponding to the maximum compression of the spring, will be $(0.35 + x)$ metres below its initial level. If the lowest position is taken as the datum level, potential energies of the mass will be:

$$PE_1 = m\,g\,h$$
$$= 15 \times 9.81 \times (0.35 + x)$$
and $PE_2 = 0$

Example	Solution—potential energy	Solution—kinetic energy	Solution—strain energy	Solution—conservation of energy	Discussion

GIVE FEEDBACK

OK

Kinetic energy is zero in both cases, since the block comes momentarily to rest:

$$\therefore\ KE_1 = KE_2 = 0$$

Calculations involving conversion from kinetic energy into strain energy

The initial strain energy in the spring is zero:

$$SE_1 = 0$$

and the final strain energy of the compressed spring is given by:

$$\begin{aligned} SE_2 &= \frac{1}{2} k x^2 \\ &= \left(\frac{1}{2}\right)(10{,}000)\, x^2 \\ &= 5{,}000\, x^2 \end{aligned}$$

Example	Solution—potential energy	Solution—kinetic energy	Solution—strain energy	Solution—conservation of energy	Discussion

GIVE FEEDBACK

OK

Calculations involving conversion from kinetic energy into strain energy

Substitute into the conservation of energy equation and solve for the unknown x:

$$PE_1 + KE_1 + SE_1 = PE_2 + KE_2 + SE_2$$
$$15 \times 9.81 \times (0.35 + x) + 0 + 0 = 0 + 0 + 5{,}000\,x^2$$
$$51.5 + 147.2\,x = 5{,}000\,x^2$$

Rearrange into the usual form of a quadratic equation and solve:

$$5{,}000\,x^2 - 147.2\,x - 51.5 = 0$$

$$x = \frac{(147.2 \pm \sqrt{\{(-147.2)^2 - (4)(5{,}000)(-51.5)\}})}{((2)(5{,}000))}$$

$$\therefore x_1 = 0.1173\text{ m},\; x_2 = -0.0878\text{ m}$$

Example	Solution—potential energy	Solution—kinetic energy	Solution—strain energy	Solution—conservation of energy	Discussion

GIVE FEEDBACK

OK

From the two alternative mathematical answers obtained when solving the quadratic equation, we must choose the positive one as representing the greatest amount of deformation suffered by the spring at the end of compression. As a result the spring will be compressed by the maximum amount of 117 mm.

The alternative negative answer is also meaningful. It describes the amount by which the spring would be stretched after rebound if the block was attached to the spring, as by a hook, during the initial impact. However, since the negative answer does not represent the maximum amount of compression, and does not constitute a direct answer to the question asked, it should be discarded.

Example | Solution—potential energy | Solution—kinetic energy | Solution—strain energy | Solution—conservation of energy | Discussion

GIVE FEEDBACK
OK

A 50 kg person falls from rest on to a trampoline from a height of 2 metres.

The trampoline has a spring modulus of 29430 N/m.

SMALL MEDIUM LARGE

Determine the expression for the initial potential energy.

(Consider the datum to be the stretched spring position).

Clear

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A 50 kg person falls from rest on to a trampoline from a height of 2 metres.

The trampoline has a spring modulus of 29430 N/m.

SMALL MEDIUM LARGE

Determine the maximum deflection of the trampoline mat.

(Answer in centimetres correct to one decimal place).

Clear

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A 100 kg person falls from rest on to a trampoline from a height of 2 m.

The trampoline has a spring modulus of 29430 N/m.

SMALL MEDIUM LARGE

Determine the expression for the initial potential energy. (Consider the datum to be the stretched spring position.)

Clear

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

A 100 kg person falls from rest on to a trampoline from a height of 2 m.

The trampoline has a spring modulus of 29430 N/m.

SMALL MEDIUM LARGE

Determine the maximum deflection of the trampoline mat. (Answer in metres to one decimal place.)

Clear

Clear line

Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Determine the maximum deflection of the trampoline mat.
(Answer in metres to one decimal place.)

Clear

Clear line

? Undo

Click and type your answer here

CHALLENGE SUBMIT SHOW ANSWER

INSTRUCTIONS

- No intermediate steps are required
- If you choose to show steps, write one on each line.
- Write your final answer on the last line.
- The computer will check all your work in detail when you click "Submit".

Hint

Each hint will reduce the credit received for this question

Important limitations of the mathematical expression for the conservation of mechanical energy

In scientific experiments conducted to verify conservation of mechanical forms of energy, in which the effects of friction were eliminated as far as practically possible, it has consistently been found that, provided there was no work done on the system by any external force, the sum of its potential, kinetic and strain energies always remains constant.

The mathematical expression of this principle, as it applies to physical objects and systems of interacting mechanical components, is the one we have been using to solve problems:

$$PE_1 + KE_1 + SE_1 = PE_2 + KE_2 + SE_2$$

This mathematical expression of the principle of conservation of energy has three important limitations:

1. Only mechanical forms of energy are considered
2. Losses of energy due to friction are negligible
3. There is no work input from any external force

GIVE FEEDBACK

OK

Which of the following describe the limitations of the mathematical expression of the principle of conservation of energy?

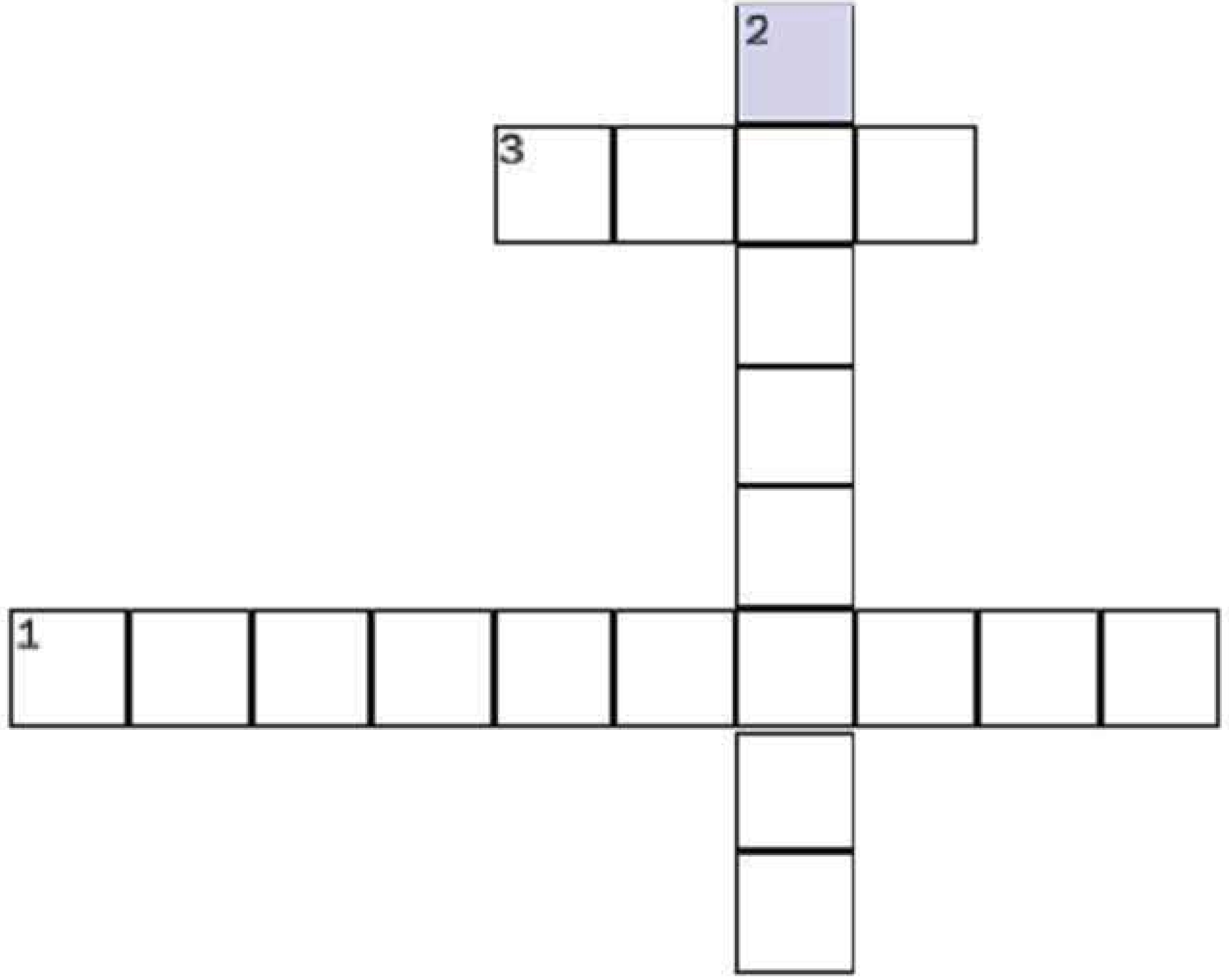
Check all that apply.

- [ ] Only mechanical forms of energy are considered
- [ ] Losses of energy due to friction are negligible
- [ ] There is no work input from any external force
- [ ] There is work input from any external force
- [ ] Losses of energy due to friction are important
- [ ] Any form of energy is included

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Model limitations



Complete the sentences that describe the three important limitations of the mathematical model for the conservation of energy.

1) Only ______ forms of energy are considered.

2) Losses of energy due to ______ are negligible.

3) There is no ______ input from any external force.

Done Hint Challenge

What are the three important limitations of the mathematical expression of the principle of conservation of energy?

Click the correct answer.

- Only mechanical forms of energy are considered; losses of energy due to friction are negligible; there is no work input from any external force
- All forms of energy are included; losses of energy due to friction are negligible; there is no work input from any external force
- Only mechanical forms of energy are considered; losses of energy due to friction are important; there is no work input from any external force
- Only mechanical forms of energy are considered; losses of energy due to friction are negligible; there is work input from external forces

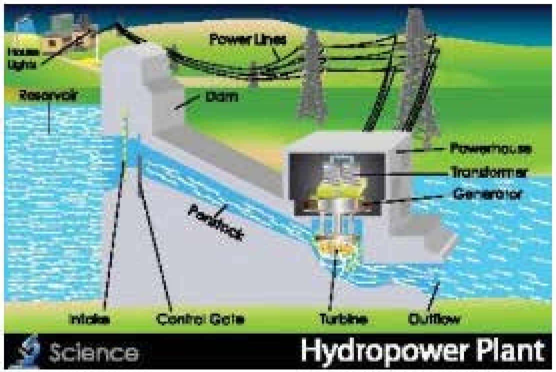
Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Examples of how one form of mechanical energy is transformed into another form of mechanical energy

There are many devices that convert one form of mechanical energy to another form of mechanical energy. An example is given below.

In hydro-electric power stations, potential energy of water in a dam is converted into kinetic energy of water flowing in a pipe. The pipe leads to a turbine which converts the kinetic energy of the water into work output. The work output from the turbine is used to drive an electric generator.



GIVE FEEDBACK

OK

Match each of the examples of conversion between forms of mechanical energy with the correct description.

Drag statements on the right to match the left.

A swing moving towards its maximum height	Converts between kinetic energy and potential energy
A person jumping from a height onto a trampoline	Converts between potential energy, kinetic energy and strain energy
A ball rolling down a hill	Converts between potential energy and kinetic energy
A spring used to launch a projectile	Converts between strain energy, kinetic energy and potential energy

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Choose items that convert between forms of mechanical energy when in operation.

Check all that apply.

- [ ] A swing
- [ ] A slippery slide
- [ ] A slingshot
- [ ] An electric fan
- [ ] A battery-operated toy car
- [ ] A motorcycle

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A swing is an example of the conversion of mechanical energy between ________ energy and ________ energy.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Examples of transformation of mechanical energy into non-mechanical form

There are many devices that convert mechanical forms of energy into non-mechanical energy.

Some examples are given below:

- In hydro-electric power stations, the potential energy of water in a dam is converted into kinetic energy of water flowing in a pipe and then it is converted to electrical energy.
- The brakes of an automobile convert kinetic energy to heat in order to stop the vehicle
- The kinetic energy required to beat a drum is converted to sound energy by the drum

GIVE FEEDBACK

OK

Match each of the examples of conversion between mechanical energy and other forms of energy with the correct description.

Drag statements on the right to match the left.

A piano	Converts kinetic energy to sound energy
Rubbing your hands together	Converts kinetic energy to heat energy
A wind turbine	Converts kinetic energy to electrical energy
A marble dropped onto a drum	Converts potential energy to sound energy

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Choose items that convert mechanical energy to non-mechanical forms of energy when in operation.

Check all that apply.

- [ ] A hydro-electric generator turbine
- [ ] A xylophone
- [ ] An electric drill
- [ ] Automobile brakes
- [ ] A catapult
- [ ] A radio

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A guitar is an example of the conversion of mechanical energy to ________ energy.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Examples of transformation of non-mechanical energy into mechanical form

There are many devices that convert non-mechanical forms of energy into mechanical energy.

Some examples are given below:

- Devices such as electric pumps, fans, machine tools and electric trains transform electrical energy into kinetic energy
- Automobiles convert chemical energy in the fuel into kinetic energy
- Elevators and escalators convert electrical energy into gravitational potential energy

GIVE FEEDBACK

OK

Choose items that convert non-mechanical energy to mechanical forms of energy when in operation.

Check all that apply.

- [ ] An electric train
- [ ] An automobile
- [ ] A guitar
- [ ] An elevator
- [ ] A gas barbeque

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Match each of the examples of conversion to mechanical energy from other forms of energy with the correct description.

Drag statements on the right to match the left.

A car battery	Converts chemical energy to kinetic energy
A human eardrum	Converts sound energy to kinetic energy
An electric motor	Converts electrical energy to kinetic energy
An elevator	Converts electrical energy to gravitational potential energy

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA

Type your answer in the box.

A battery-operated car is an example of the conversion of ______ energy to electrical energy and then to ______ energy.

Do you know the answer?

I KNOW IT | THINK SO | UNSURE | NO IDEA