SCIENCE 10 HONOURS ENERGY Name:

Energy is Energy is measured in

Energy is transferred when work is done, but it is also usually transformed from one kind of energy to another. There are many kinds of energy: gravitational potential energy (any raised object has energy and can do work when it falls), kinetic energy (any moving object has energy to do work on any object it hits), heat energy, chemical potential energy, elastic energy (an object that is compressed, stretched or twisted can do work), electrical energy, nuclear energy

Gravitational Potential Energy

The energy stored in an object due to its position above the surface of the Earth is called gravitation potential energy, E_p.

$$\Delta E_p = mgh$$

How much gravitational potential energy does a 4.0 kg rock gain if it is lifted 25m?

How much potential energy is lost by a 61.2kg boy falling 0.500 m out of bed?

1. A crane lifts a 1500kg car 20m straight up.
    a. How much potential energy does the car gain?

    b. How much potential energy does the crane transfer to the car?

2. A 4.00kg ball drops from a height of 5.00m to the ground and bounces back to a height of 3.00m.
   a. How much potential energy does the ball lose on the trip down?

   b. How much energy does the ball regain on the trip back up?

   c. What is the net loss of potential energy during the bounce?

If we select a position where the object's potential energy is zero (the lowest point in the problem), the equation is now: $E_p = mgh$ where h is measured vertically from the zero position in meters.

A 10.0kg rock is on top of a house 3.00m high on the edge of a cliff 20.0m high. What is the gravitational potential energy of the rock:
   a. relative to the roof of the house?

   b. relative to the floor of the house?

   c. relative to the bottom of the cliff?

3. A man on a flying trapeze stands on a platform 20m above the ground holding the trapeze. The trapeze is 10m long and is attached to a kite 26m above the ground. The man swings down and lets go of the rope on the upswing. He has a mass of 60kg. Calculate his potential energy relative to the ground when he is at each of the following heights.
   a. 20 m (on platform)

b. 16 m (bottom of swing)

c. 18 m (lets go of trapeze)

d. 9.0 m (halfway to ground)

4. Repeat question 3, calculating his potential energy relative to a point 16 m above the ground.

Kinetic Energy

The energy of a moving object is kinetic energy.

$$E_k = \frac{1}{2}mv^2$$

What is the kinetic energy of a 6.0kg curling stone sliding at 4.0m/s?

5. What is the kinetic energy of a 0.500kg ball thrown at 30.0m/s?

6. What is the kinetic energy of a 25.0g bullet travelling at 3600 km/h?

7. What is the mass of an object travelling at 20m/s with a kinetic energy of 4000 J?

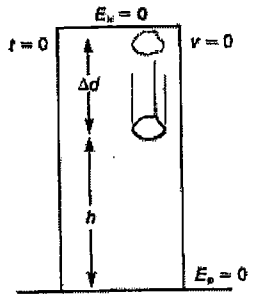
8. What is the speed of a 1.5kg rock falling with a kinetic energy of 48J?

9. A 0.50kg rubber ball is thrown into the air. At a height of 20m above the ground, it is travelling at 15m/s.
   a. What is the ball's kinetic energy?

   b. What is its gravitational potential energy relative to the ground?

Conservation of Energy

In any transfer or transformation of energy, the total amount of energy remains constant.



Imagine a large rock inside a tall vacuum chamber.

The rock is released at the top of the chamber and falls, accelerating at 9.8m/s^2.

As it falls, its gravitational potential energy decreases, and its kinetic energy increases.

The rock has a mass of 2.0kg and falls from a height of 490m. Complete the following table:

Time (s)	Speed (m/s)	Distance fallen (m)	Height (m)	Kinetic energy (J)	Potential energy (J)	Total energy (J)
0						
5						
10						

What do you notice about the total energy?

Law of Conservation of Energy:

A 20kg rock falls 50m in a vacuum, from rest.
What is the rock's loss of gravitational potential energy?

What is its gain in kinetic energy?

What is the final speed of the rock?

10. What is the speed of a 70.0kg rock after it has fallen freely for 1000m?

11. How far would a 1.00kg ball have to fall freely to reach a speed of 100km/hr?

12. How fast would you have to throw a 2.0kg rock straight up so that it would reach a height of 20m?

Some Practice For You: Please do these on a separate piece of paper.

1. What is the gravitational potential energy of a 61.2kg person standing on the roof of a 10-storey building relative to each of the following levels (each storey is 2.50m high)?
   a. the 10^{th} floor
   b. the sixth floor
   c. the first floor

2. A 10000kg airplane lands, descending a vertical distance of 10km while travelling 100km measured along the ground. What is the plane's loss of potential energy?

3. A coconut falls out of a tree 12.0m above the ground and hits a bystander 3.00m tall on top of the head. It bounces back up1.50m before falling to the ground. If the mass of the coconut is 2.00kg, calculate the potential energy of the coconut relative to the ground at each of the following times.
   a. while it is still in the tree
   b. when it hits the bystander on the head.
   c. when it bounces up to its maximum height
   d. when it lands on the ground
   e. when it rolls into a groundhog hole and falls 2.50m to the bottom of the hole

4. Calculate the kinetic energy of a 45g golfball travelling at
   a. 20m/s b. 40m/s c. 60m/s

5. When the speed of an object doubles, does its kinetic energy double? Explain your answer.

6. How fast must a 1000kg car be moving to have a kinetic energy of:
   a. 2.0×10^3 J b. 2.00×10^5 J

7. A 50kg bicyclist on a 10kg bicycle speeds up from 5.0m/s to 10m/s
   a. what was the total kinetic energy before accelerating?
   b. what was the total kinetic energy after accelerating?

8. At the moment when a shotputter releases a 5.00kg shot, the shot is 3.00m above the ground and travelling at 15.0m/s. It reaches a maximum of height of 8.00m above the ground and then falls to the ground. If air resistance is negligible,
   a. what was the potential energy of the shot as it left the hand, relative to the ground?
   b. what was the kinetic energy of the shot as it left the hand?
   c. what was the total energy of the shot as it left the hand?
   d. what was the total energy of the shot as it reached its maximum height?
   e. what was the potential energy of the shot at its maximum height?
   f. what was the kinetic energy of the shot at its maximum height?
   g. what was the kinetic energy of the shot just as it struck the ground?

1a. 1.50×10^3 J 1b. 7.50×10^3 J 1c. 1.50×10^4 J 2. 9.8×10^8 J 3a. 235J
3b. 58.8J 3c. 88.2J 3d. 0 J 3e. -49 J
4a. 9.0 J 4b. 36 J 4c. 81 J 5. No, 4X because v^2
6a. 2.0 m/s 6b. 20. m/s 7a. 7.5×10^2 J 7b. 3.0×10^3 J
8a. 147 J 8b. 563 J 8c. 710 J 8d. 710 J 8e. 392 J
8f. 318 J 8g. 710 J