Energy Transformations

1. Copy and complete these examples of energy transformations.

a) Car moving at a steady speed along level road: chemical energy -> \_\_\_\_\_\_\_\_

b) Car accelerating along level road: chemical energy -> \_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_

c) Car braking: kinetic energy -> \_\_\_\_\_\_\_\_

d) Car freewheeling downhill (engine switched off): \_\_\_\_\_\_\_\_ -> \_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_

1. A locomotive exerts a pull of 10000 N to pull a train a distance of 400 m.

How much work is done?

1. A gardener does 1200 J pushing a wheelbarrow with a force of 100 N.

How far did she push the barrow?

1. A man uses up 1000 J by pulling a heavy load for 20 m. What force did he use?
2. A girl is pushing her bike with a force of 80 N and uses up 4000 J of energy.

How far did she push the bike?

1. A man weighing 600 N climbs stairs in an office block which are 40 m high.

How much work does he do?

1. A worker pushes a 4 kg crate along the ground for 3 m using a force of 20 N, then lifts the crate up to a ledge 1 m high. How much work does he do altogether?

**Work, Power and Time**

1. A man pushes a wheelbarrow for 60 m using a 50 N force. If he takes 10 s, what is his average power?
2. The man’s son pushes the wheelbarrow for 60 m using the same force as his father, but he takes 13 s to do it.
3. How does a) his work b) his power compare to his father’s?
4. A machine lifts a load of 4000 N to a height of 5 m in 20 s. What is its power?
5. A boy who weighs 600 N can run upstairs of vertical height 8 m in 12 s.
   1. What is his power?
   2. A girl who weighs 500 N takes 10 s to run up the stairs. What is her power?
   3. Do they do equal amounts of work?
6. Describe how you could estimate the average power of a student who is running up a flight of stairs. List measurements you would take, how you would obtain these, and indicate how you would calculate the result.
7. A lift can raise a total mass of 800 kg up 10 m in 40 s. What is its power?
8. A weight lifter lifts a mass of 250 kg from the ground to a height of 1.5 m in a time of 2 seconds. What was his average power during the lift?
9. A lift in a building can take a maximum of 10 people of average mass 70 kg. The mass of the lift is 500 kg.
   1. What is the total weight of a full lift?
   2. What is the power needed to raise the lift up 30 m in 10 s?
10. A bucket of water of weight 250 N is to be lifted up a 30 m well by a 500 W motor.

How long will it take to raise the bucket?

* 1. What will be the power of the electric motor of a lift which can raise a load of 4000 N at a steady speed of 2 ms-1?
  2. What is the energy transformation?

**Gravitational potential energy**

1. A chairlift raises a skier of mass 60 kg to a height of 250 m. How much potential energy does the skier gain?
2. A brick of mass 3 kg rests on a platform 25 m above the ground on a building site.
   1. How much potential energy is stored in the brick?
   2. If the brick falls 25 m to the ground, how much potential energy will it lose?
   3. What form of energy will the brick gain?
3. Estimate how much gravitational potential energy **you** would gain if you were lifted 30m up to the top of a fun-ride.
4. An apple, mass 100 g, has 300 J of potential energy at the top of the Eiffel Tower.

What is the height of the Eiffel Tower?

1. An astronaut of mass 70 kg climbs to a height of 5 m on the moon and gains 560 J of gravitational potential energy. What must be the gravitational field strength on the moon?

**Kinetic energy**

1. You are provided with an air track and vehicles, a light gate and timer and some elastic bands. Describe how you could use this apparatus to establish how kinetic energy depends on velocity. Include details of any measurements you would take and any additional measuring equipment needed.
2. Calculate the kinetic energy of the following:
   1. a 5 kg bowling ball moving at 4 ms-1
   2. a 50 kg skier moving at 20 ms-1
   3. a 0.02 kg bullet moving at 100 ms-1.
3. 1. How much kinetic energy does a 800 kg car have at a speed of 10 ms-1?
   2. If it doubles its speed to 20 ms-1, calculate its new kinetic energy?
4. A cyclist who is pedalling down a slope reaches a speed of 15 ms-1. The cyclist and her cycle together have a mass of 80 kg.
   1. Calculate the total kinetic energy.
   2. Name two sources of this kinetic energy.
5. Calculate an **approximate** value for the kinetic energy of an Olympic 100 m sprinter as he crosses the line (time for race is about 10 s).
6. What is the speed of a stone of mass 2 kg if it has 36 J of kinetic energy?
7. A motor cyclist and his bike have a total mass of 360 kg and kinetic energy of 87120J.

What is his speed?

1. The apple in question 21 is dropped from the top of the Eiffel Tower.
   1. How much kinetic energy would it have just before hitting the ground?
   2. What will be its velocity as it hits the ground?
2. A car of mass 1000 kg is travelling at 20 ms-1.
   1. How much kinetic energy does it have?
   2. If the maximum braking force is 5 kN, what will be the minimum braking distance?
   3. If the driver has a reaction time of 0.7 s, how far will the car travel during this ‘thinking time’?
   4. What will the total stopping distance be?