# Sequence 9: energy and movement

**Fiche de synthèse mobilisée** (collection en français) :

- **Fiche n°9** : énergie cinétique et travail d'une force

**Sommaire des activités ETLV** :



## ACTIVITY 1: Freefall of a ball

**Objective**: verifying the work-energy theorem during freefall

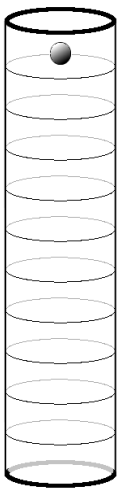
### DOCUMENT 1: Work-energy theorem

The principle of work and kinetic energy (also known as the work-energy theorem) states that the work done by the sum of all forces acting on a particle equals the change in the kinetic energy of the particle:

$$\sum W(\vec{F}) = \Delta KE = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

where $v_i$ and $v_f$ are the speeds of the particle before and after the application of force $\vec{F}$, and m is the particle's mass.

**Source: wikipedia**



### DOCUMENT 2: Computing speed during freefall

A metal ball weighing 0.1kg falls in air. Its positions can be logged using Python as an array:

```
y = [-0. -0.007848 -0.031392 -0.070632 -0.125568 -0.1955 -0.282528
-0.3845 -0.502272 -0.62 -0.7848 -0.94 -1.130112 -1.34
-1.538208 -1.77]
```

Its speed can be calculated at each position using:

$$v_y[i] = \frac{y[i+1] - y[i]}{t[i+1] - t[i]}$$

So, in Python:

```
vy = np.array([(y[i+1]-y[i])/(t[i+1]-t[i]) for i
   in range(N-1)])
```

**DOCUMENT 3: Computing kinetic energy**

The variation of kinetic energy can be computed as:

$$\Delta KE = \frac{1}{2}mv_y^2$$

and considering that initial speed is null: $KE = \frac{1}{2}mv_y^2$

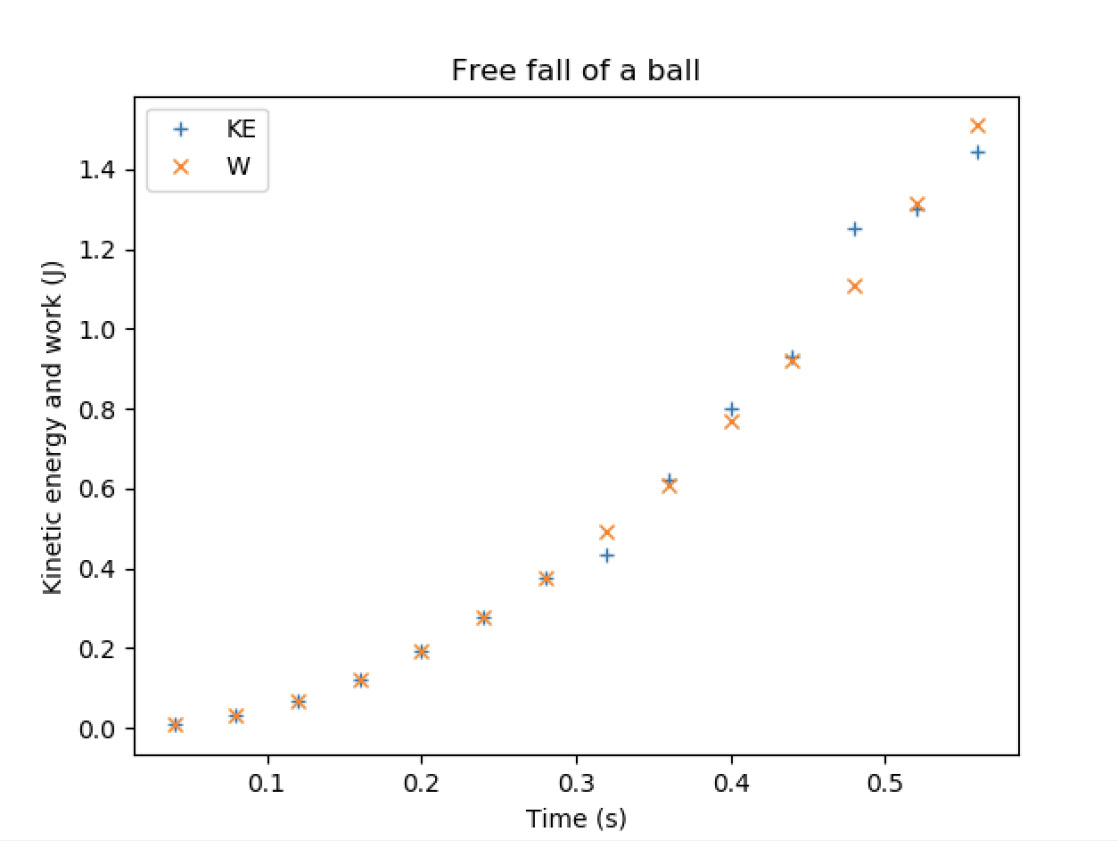
**DOCUMENT 4: Computing work of gravity**

Work of the force gravity can be computed using the formula: $W = -mgy$

Here all values of $y$ are negative. $g = 9.81\text{m.s}^{-2}$

**DOCUMENT 5: Plotting kinetic energy and work against time**

Using the experimental values gathered in document 2, kinetic energy and work have been plotted against time.




## Acquiring vocabulary:

Read the documents. Find a translation for the following expressions:

| English | French |
|---|---|
| freefall (or free fall) | |
| kinetic energy | |
| work | |

| | |
|---|---|
| gravity | |
| speed | |
| null | |
| to compute | |
| to plot y against x | |

■ **Understanding:**

Which force(s) applies(y) during the ball's movement?

_____

■ **Reasoning:**

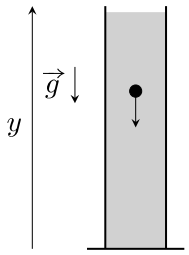
Do the documents allow you to verify the work-energy theorem?

_____

_____

## ACTIVITY 2: Fall of a ball in oil

**Objective**: comparing kinetic energy and work for a fall in oil




### DOCUMENT 1: Computing speed using new data

A metal ball weighing 0.1kg falls in oil. Its positions can be logged using Python as an array:

```
y = np.array([0,-0.0005,-0.011,-0.016,-0.027,-0.0464,-0.0686,-0.0922,-0.116,-0.140,-0.164,-0.189,-0.212,-0.235,-0.259,-0.284])
```

Its speed can still be calculated at each position using:

$$v_y[i] = \frac{y[i+1] - y[i]}{t[i+1] - t[i]}$$

### DOCUMENT 2: Computing kinetic energy

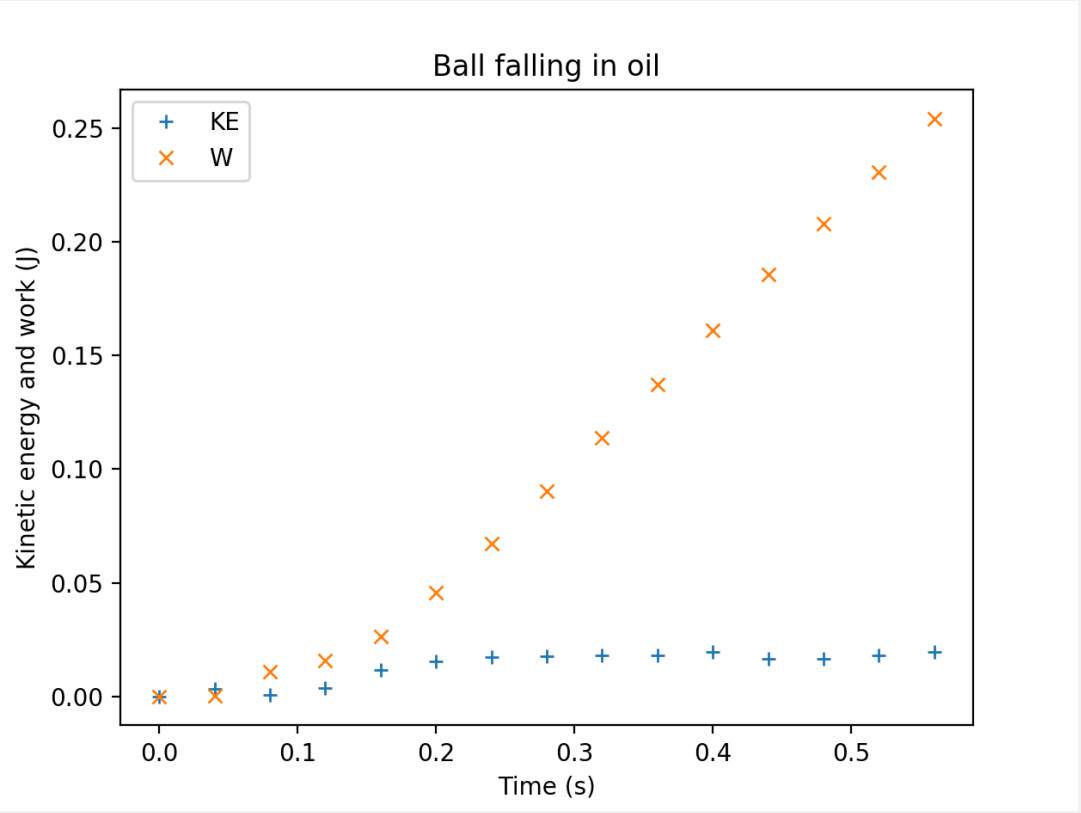
Kinetic energy can also be computed as: $KE = \frac{1}{2}mv_y^2$ considering initial speed as null.

### DOCUMENT 3: Computing work of gravity

Work of the force gravity can be computed using the formula: $W = -mgy$

**DOCUMENT 4: Plotting kinetic energy and gravity work against time**

Using the new experimental values gathered in document 1, kinetic energy and work of gravity have been plotted against time:




■ **Understanding:**

Which force(s) applies(y) during the ball's movement?

_____

■ **Reasoning:**

Do the documents allow you to verify the work-energy theorem?

_____

_____

# Activity summary

What you must remember:
**- speed**
**- force**
**- gravity**
**- kinetic energy**
**- work**

Skills linked to the curriculum**:**

| Compétences | Capacités à maîtriser | Où dans cette séquence ? |
|---|---|---|
| APP | • Utiliser du vocabulaire spécifique | Activités 1 et 2 |
| | • Lire et comprendre des documents scientifiques | Activités 1 et 2 |
| COM | • S'exprimer à l'écrit et à l'oral en utilisant le vocabulaire adapté | Activités 1 et 2 |
| REA | • Établir un bilan de forces.<br>• Effectuer un bilan quantitatif de forces pour un système en mouvement rectiligne uniforme.<br>• Citer et exploiter les relations définissant l'énergie cinétique et le travail d'une force constante lors d'un mouvement rectiligne.<br>• Associer une variation d'énergie cinétique au travail des forces. | Activités 1 et 2 |
| VAL | • Valider un modèle à partir de données expérimentales | Activités 1 et 2 |