Gravitational Potential Energy

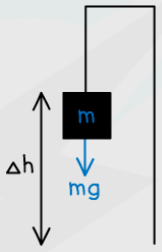
- Gravitational potential energy is energy stored in a mass due to its position in a gravitational field
- When a heavy object is lifted, work is done since the object is provided with an upward force against the downward force of gravity
    - Therefore **energy is transferred to the object**
- This equation can therefore be derived from the work done

Derivation of GPE = mgh

CONSIDER A MASS **m** LIFTED THROUGH HEIGHT **h**

THE WEIGHT OF THE MASS IS **mg** WHERE **g** IS THE GRAVITATIONAL FIELD STRENGTH

$W = F \times d = mg \times \Delta h$



DUE TO ITS NEW POSITION, THE BODY IS NOW ABLE TO DO EXTRA WORK EQUAL TO $mg\Delta h$

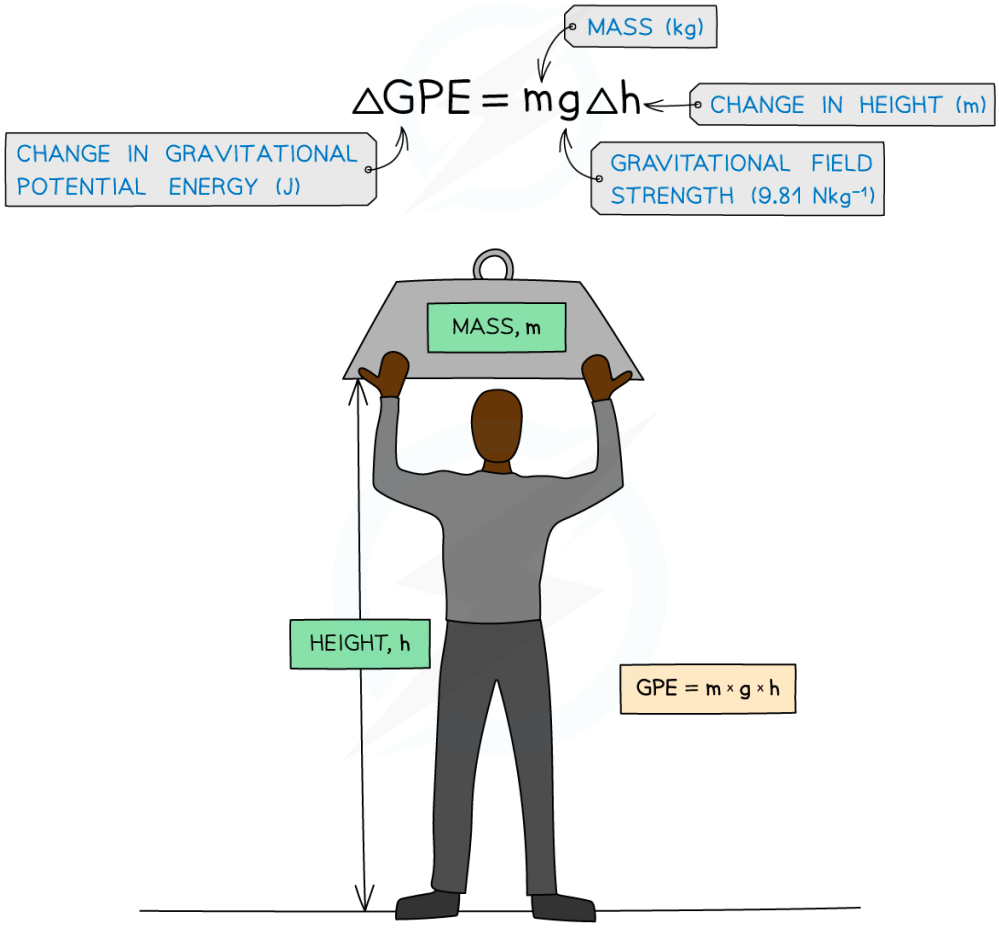
CHANGE IN POTENTIAL ENERGY = $mg\Delta h$

IF WE CONSIDER THE MASS TO HAVE 0 POTENTIAL ENERGY AT GROUND LEVEL

$\Delta GPE = mg\Delta h$

"Δ" REFERS TO "CHANGE IN"

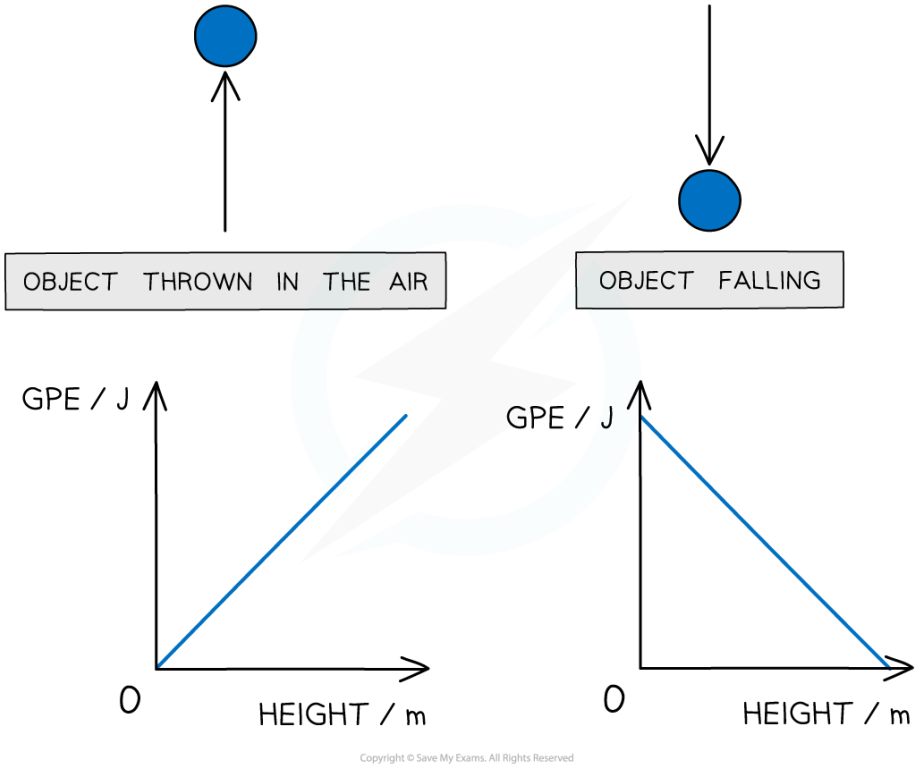
- Gravitational potential energy (GPE) is energy stored in a mass due to its position in a gravitational field
    - If a mass is **lifted** up, it will **gain** GPE (converted **from** other forms of energy)
    - If a mass **falls**, it will **lose** GPE (and be converted **to** other forms of energy)
- The equation for gravitational potential energy for energy changes in a **uniform gravitational field** is:



- The potential energy on the Earth's surface at ground level is taken to be equal to 0
- This equation is only relevant for energy changes in a **uniform gravitational field** (such as near the Earth's surface)

GPE v Height graphs

- The two graphs below show how GPE changes with height for a ball being thrown up in the air and when falling down



Graphs showing the linear relationship between GPE and height

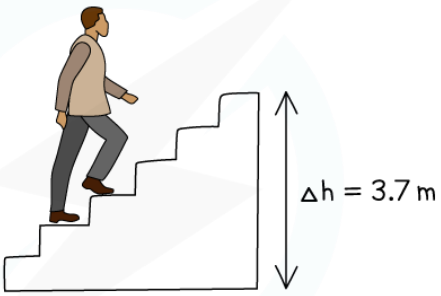
- Since the graphs are straight lines, GPE and height are said to have a **linear** relationship
- These graphs would be identical for GPE against time instead of height

Worked example

To get to his apartment a man has to climb five flights of stairs.
The height of each flight is 3.7 m and the man has a mass of 74 kg.
What is the approximate gain in the man's gravitational potential energy during the climb?

A. 13 000 J **B.** 2700 J **C.** 1500 J **D.** 12 500 J

ANSWER: A



STEP 1

GPE EQUATION

$\Delta GPE = mg\Delta h$

STEP 2

FIND h

$\Delta h = 5 \times 3.7\,m = 18.5\,m$

5 FLIGHTS OF STAIRS

STEP 3

SUBSTITUTE VALUES INTO GPE EQUATION

$\Delta GPE = 74 \times 9.81 \times 18.5 = 13000\,J$ (2 s.f.)