

**FREE FALL**

Voľný pád

# Key words

- to drop: we drop a ball → a ball is dropped
- to fall: the ball falls *downwards/ with downward acceleration*
- to pull: \_\_\_\_\_ force pulls all objects near the Earth`s surface
- to accelerate: \_\_\_\_\_ accelerates all bodies at the same way
- to slow/to decelerate/to retard:  
the air slows...a banknote much more than  
a steel/plastic/lead ball
- to reach/ hit the ground
- to take (time) to reach the ground

# History

- Aristotle ([/'æri,stɒtəl/](#); 384 – 322 BC) was a [Greek philosopher](#) and scientist, he discovered that free falling objects fall with acceleration, it depends on mass of the objects
- Galileo Galilei ( [\[gali'le:ɔ gali'leɪ\]](#); 15 February 1564 – 8 January 1642), was an [Italian astronomer](#), [physicist](#), [engineer](#), [philosopher](#), and [mathematician](#). Galileo had [dropped balls](#) of the same material, but different [masses](#), from the [Leaning Tower of Pisa](#) to demonstrate that their time of descent was independent of their mass. This was contrary to Aristotle`s teaching.

# Acceleration of free fall - g

- it varies from the poles to the equator less than 1%
- it decreases if a body moves away from the Earth out into space
- it depends on mass of body which causes gravitational pull (the Earth, the Moon)
- $g = 10\text{m.s}^{-2}$  value for our calculations
- the experiment measuring  $g$ : measuring time taken for a steel ball dropped through a known height  $h =$  travelled distance  $s$
- how to calculate distance  $s$  of accelerated motion?

$$s = \text{_____} \rightarrow h = \text{_____} \rightarrow g = 2h/t^2$$

# *(optional)* Throwing upwards

- a body thrown upwards with initial speed  $u = +30\text{ms}^{-1}$
- from A to B the body decelerate:  $v = u - gt$  ;  $s = ut - \frac{1}{2}gt^2$   
(if we make agreement that  $u = -30\text{ms}^{-1} \rightarrow v = -u + gt$ ;  
 $s = \underline{\hspace{2cm}}$ )
- in B:  $v = 0$  height is  $\underline{\hspace{2cm}}$  , we can calculate time of rising :  
 $t_{AB} = \underline{\hspace{2cm}}$
- from B to C the body accelerate with  $a = \underline{\hspace{2cm}}$
- what distance does the body move from B to C?  
 $s_{AB} = \underline{\hspace{2cm}}$

# Practice

Assume  $g=10\text{ms}^{-2}$  and there is no air resistance.

1. A rock falls from height of 45m.

- a) How long does it take to reach the ground?
- b) What is its velocity as it hits the ground?

Solution: a)  $h=45\text{m}$ ;  $t=?$

$$h = \frac{1}{2}gt^2 \rightarrow t^2 = \frac{2h}{g} = \frac{2 \cdot 45}{10} = 9$$
$$t = 3\text{s}$$

b)  $v = ?\text{ms}^{-1}$

$$v = gt = 10 \cdot 3 = 30 \text{ms}^{-1}$$

The rock takes 3s to reach the ground and hits the ground at velocity  $30 \text{ms}^{-1}$ .