



# Using Relative Gravimeter to Determine Vertical Gravity Gradients at NIMT

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# Introduction

Gravity of Earth ( $g$ ) :

*“the acceleration that the Earth imparts to objects on or near its surface”*

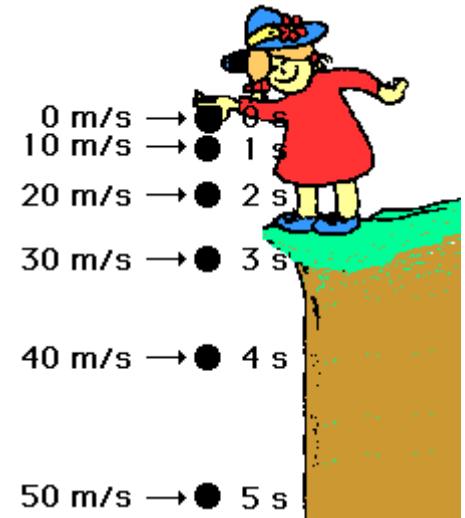
SI unit is  $m/s^2$

Standard gravity ( $g_n$ ) :

*“the nominal 'average' value at the Earth's surface”*



**9.80665**  $m/s^2$

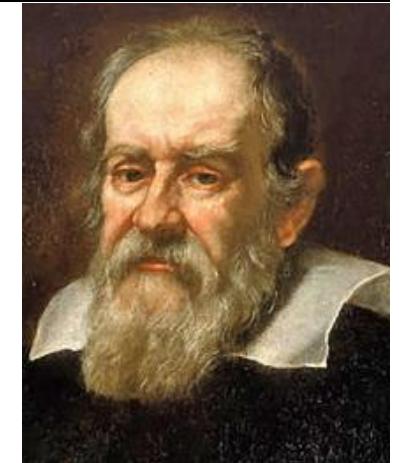


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## The unit of $g$

1 Gal	=	1 cm/s <sup>2</sup>
	=	10 <sup>-2</sup> m/s <sup>2</sup>
	=	10 <sup>6</sup> µGal
1 µGal	=	10 <sup>-8</sup> m/s <sup>2</sup>



Galileo Galilei

## Method to determine “ $g$ ”

1. Calculation : International Gravity Formula (IGF)
2. Measurement :
  - 1) Absolute gravimeter
  - 2) Relative gravimeter



## International Gravity Formula 1967

$$g_{\phi,h} = g_{0,0} \left( 1 + A \sin^2 \phi - B \sin^2 2\phi \right) - 3.086 \times 10^{-6} h$$

$g_{\phi,h}$  = Value of  $g$  at latitude  $\phi$  and height  $h$ , m/s<sup>2</sup>

$g_{0,0}$  = Value of  $g$  at mean see level, 9.7803184 m/s<sup>2</sup>

$h$  = Height above the mean see level, m

$A$  = 0.0053024

$B$  = 0.0000059

**Uncertainty ~ 50 ppm**



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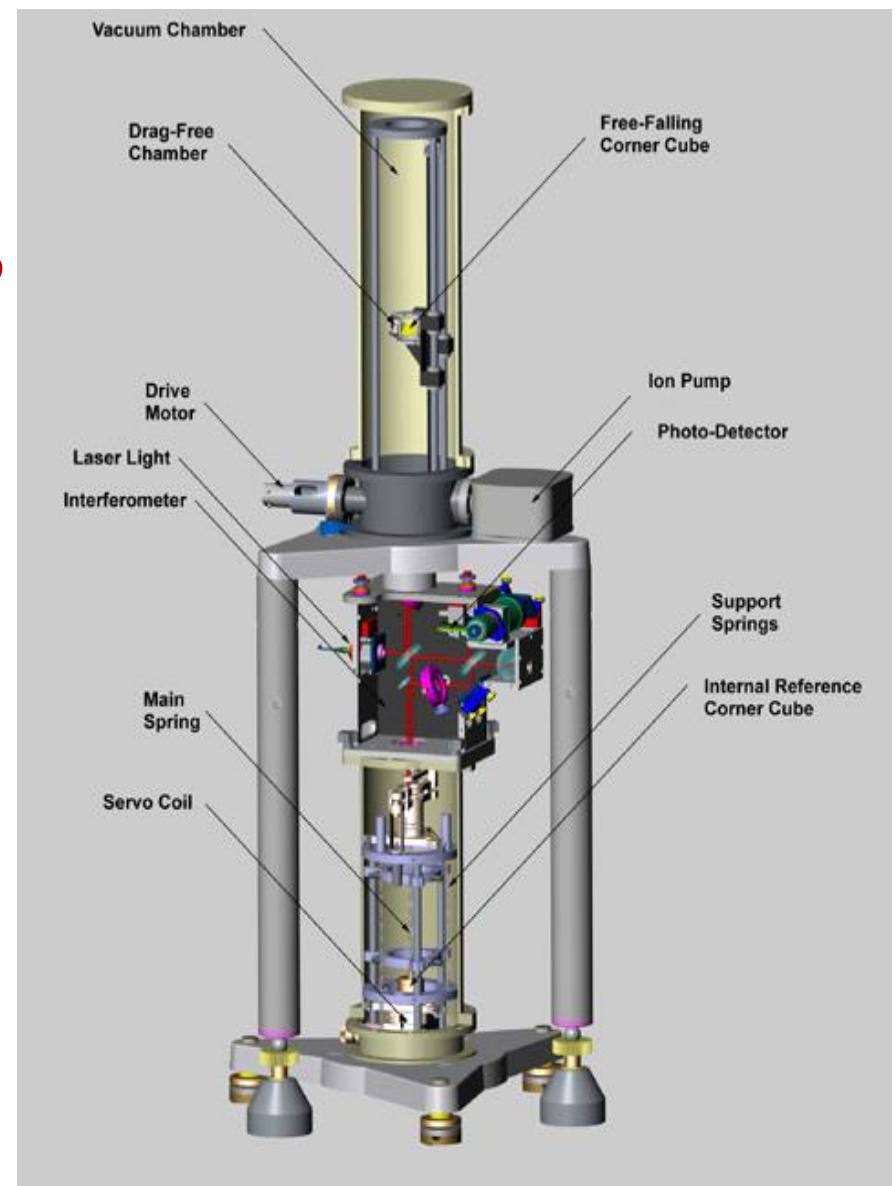
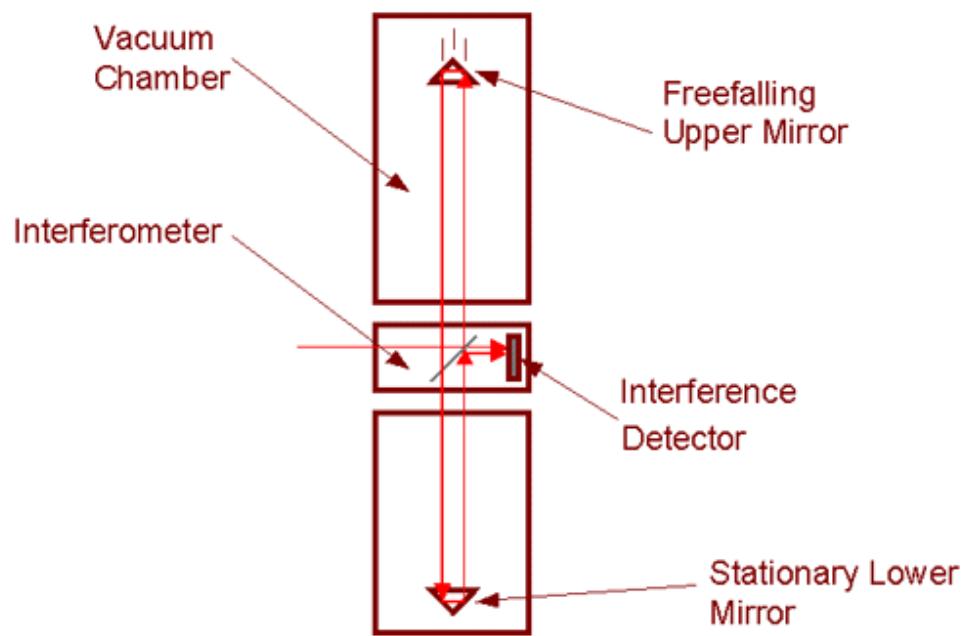
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# Gravimeters



# Absolute Gravimeter (FG5-X)

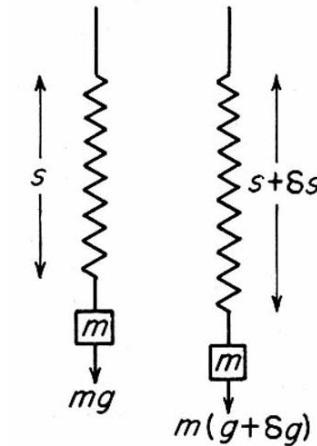
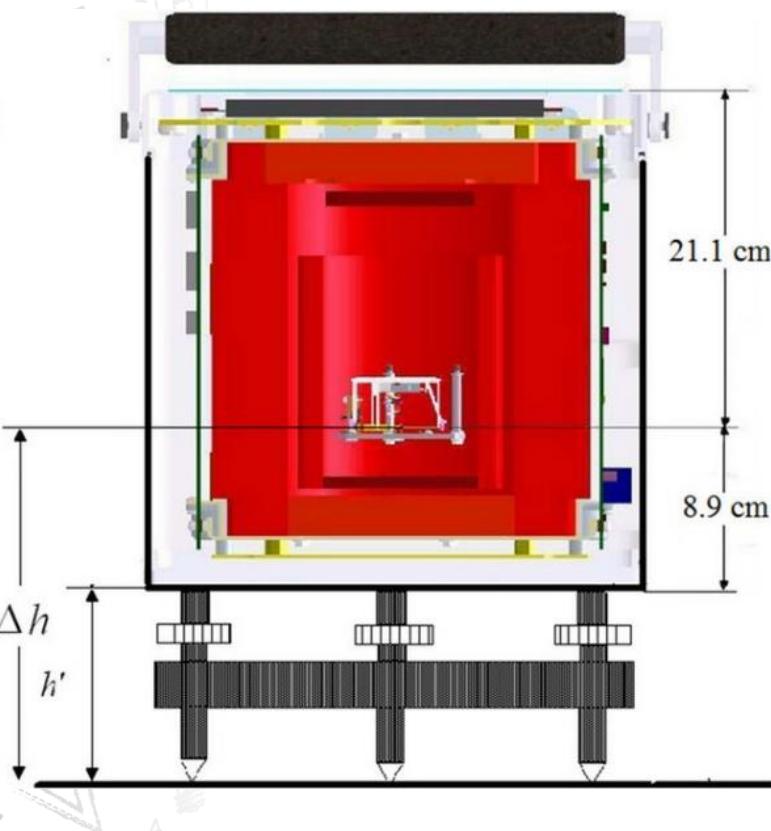
*“Free fall drop method”*



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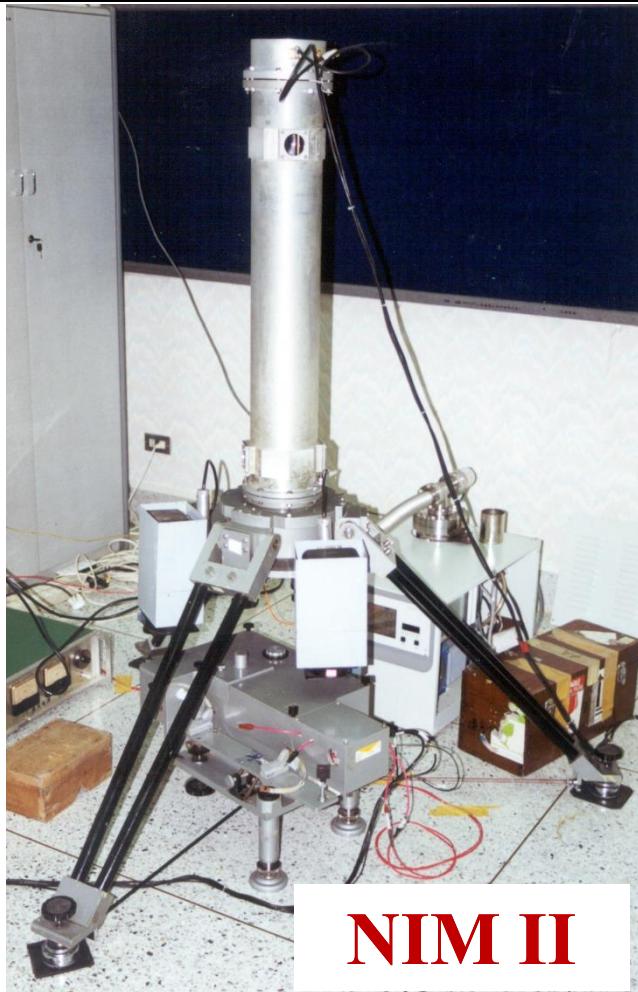
# Relative Gravimeter (CG-5)



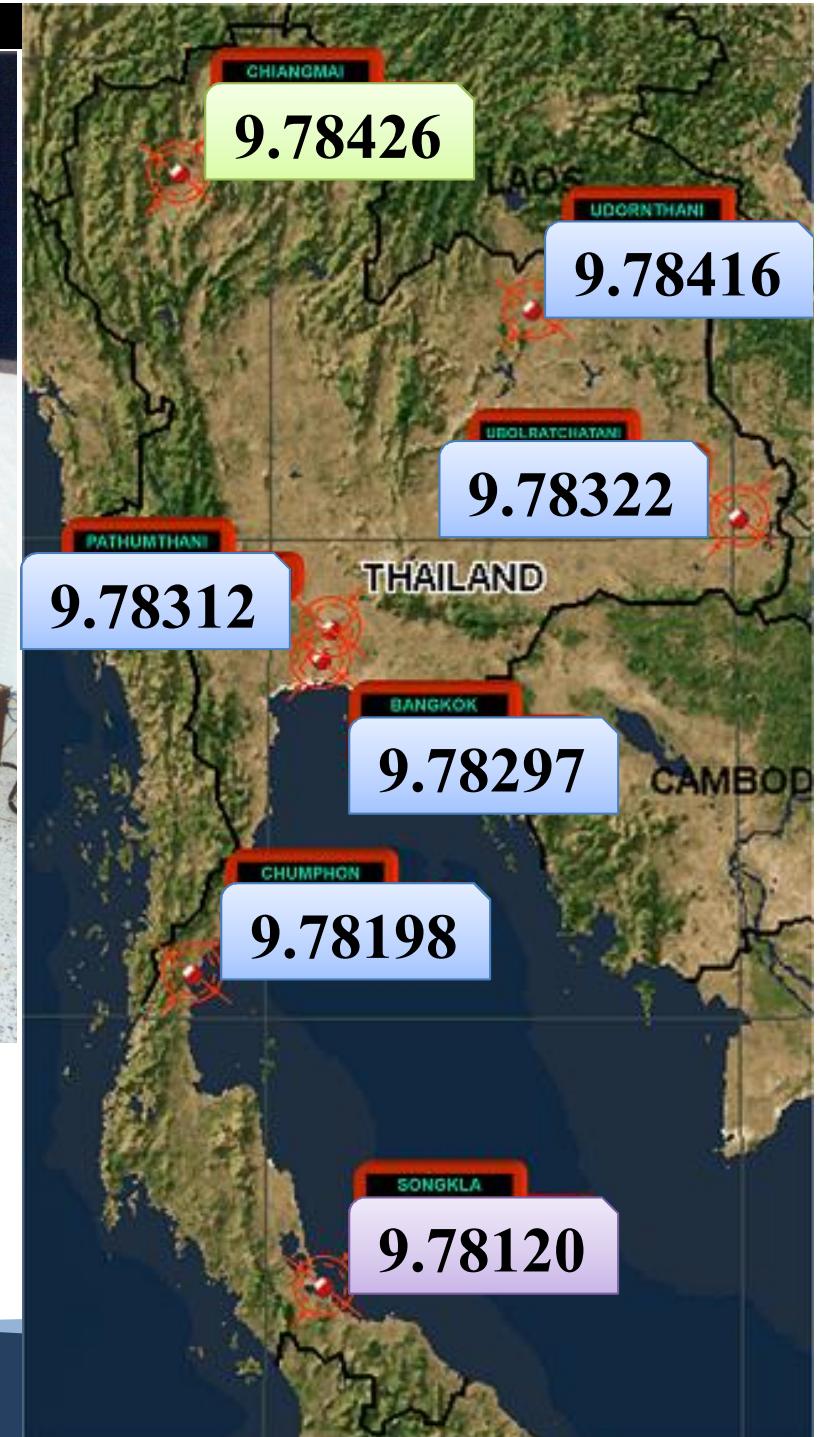
$$\begin{aligned}F &= mg = ks \\m \cdot \Delta g &= k \cdot \Delta s \\ \Delta g &= \frac{k}{m} \cdot \Delta s\end{aligned}$$



# 1<sup>st</sup> Gravity Survey in Thailand (2000)



NIMT + NIM(China)



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# NIMT's Gravimeters

Accuracy:  $\pm 2\mu\text{Gal}$   
(observed agreement  
between FG5-X  
instruments)



**Absolute Gravimeter (FG5-X)**

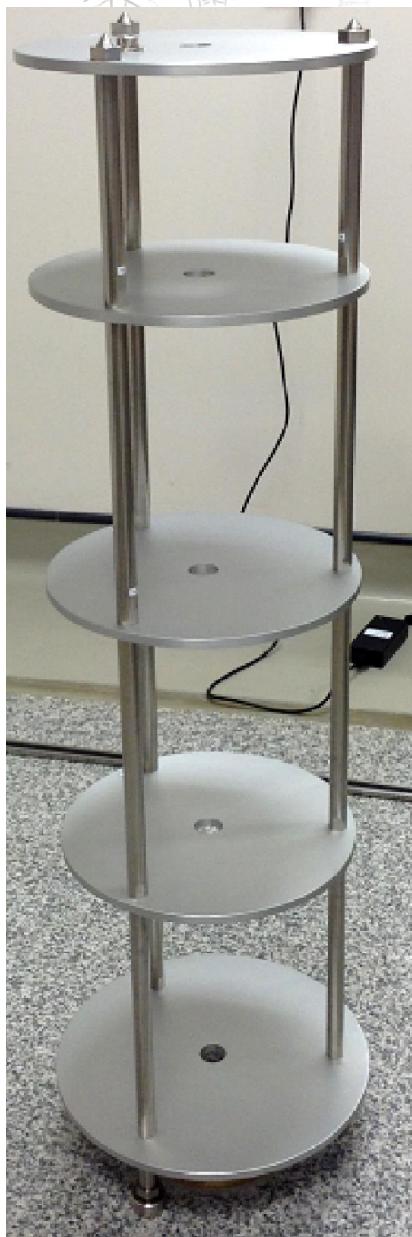


Resolution 1  $\mu\text{Gal}$   
Repeatability  $< 5 \mu\text{Gal}$

**Relative Gravimeter (CG-5)**



# Determination Method

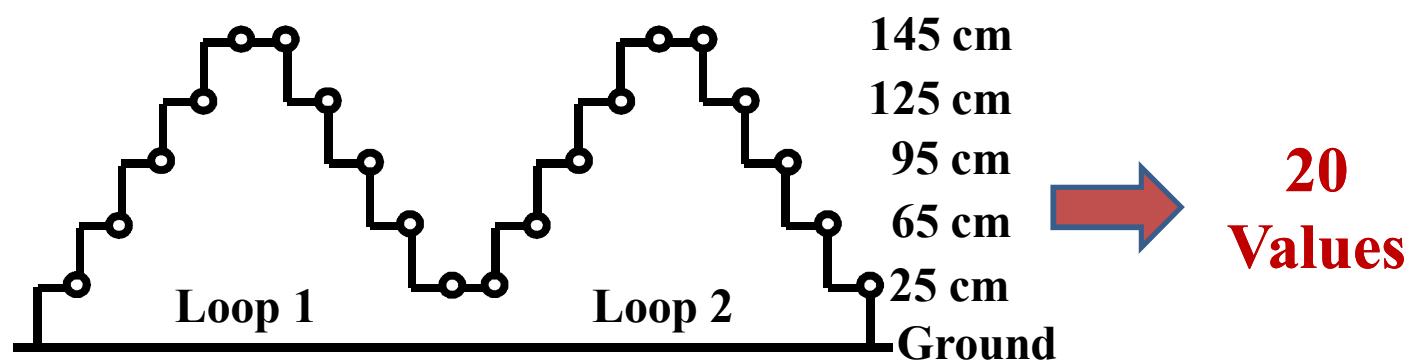


**Measurement options :**

- 60 seconds / measurement cycle
- 5 measurement cycles / point



**1 Value**





25 cm

# Measurement setup



145 cm



65 cm



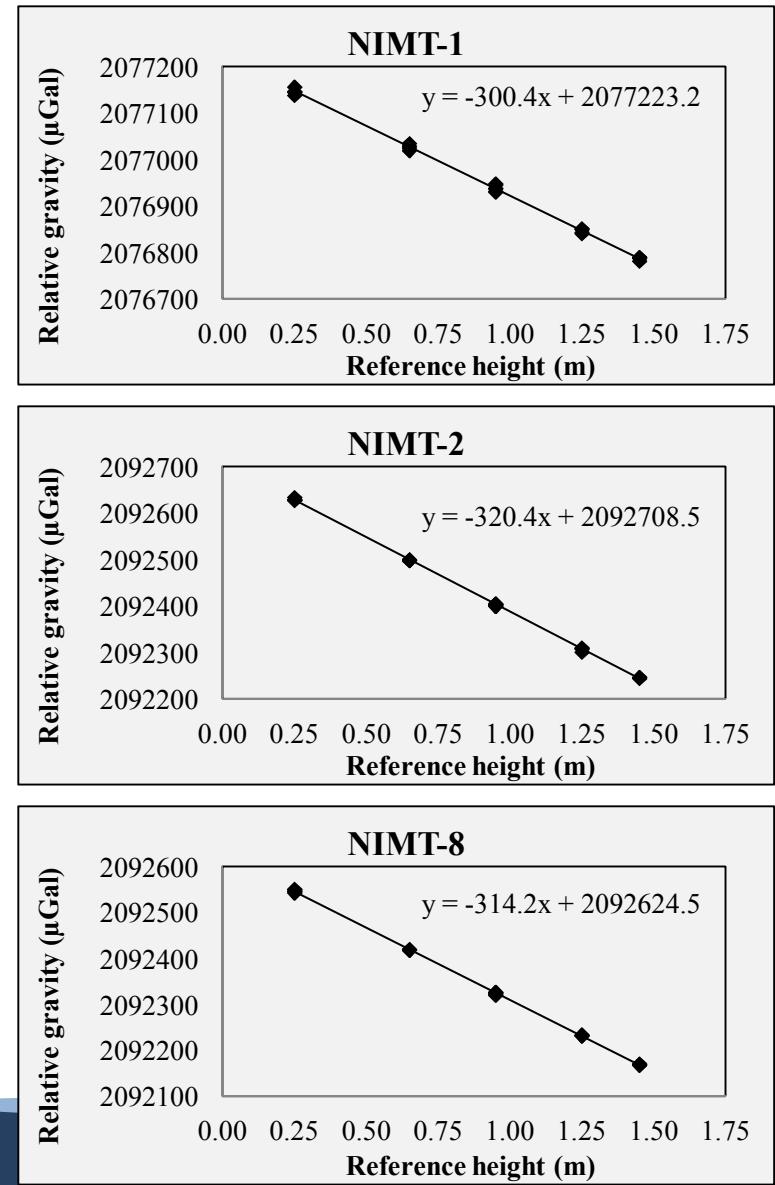
95 cm



125 cm

# Results

Height above the ground (m)	Relative gravity ( $\mu\text{Gal}$ )		
	NIMT-1	NIMT-2	NIMT-8
0.25	2077157	2092634	2092551
0.65	2077035	2092499	2092420
0.95	2076948	2092400	2092321
1.25	2076851	2092301	2092234
1.45	2076789	2092246	2092171
1.45	2076789	2092247	2092169
1.25	2076850	2092310	2092232
0.95	2076938	2092402	2092327
0.65	2077030	2092499	2092419
0.25	2077146	2092628	2092543
0.25	2077147	2092629	2092548
0.65	2077026	2092498	2092419
0.95	2076946	2092405	2092326
1.25	2076843	2092308	2092232
1.45	2076782	2092246	2092169
1.45	2076789	2092245	2092168
1.25	2076841	2092309	2092232
0.95	2076931	2092404	2092325
0.65	2077020	2092500	2092419
0.25	2077139	2092629	2092546



# Vertical Gravity Gradients

Location	Gravity gradient $\pm$ Standard error ( $\mu\text{Gal m}^{-1}$ )
NIMT-1	$300.4 \pm 3.1$
NIMT-2	$320.4 \pm 1.5$
NIMT-8	$314.2 \pm 1.2$

The normal value of vertical gradient is 308.6  $\mu\text{Gal/m}$ .



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# Summary

1. For high accuracy work, it is necessary to know the vertical gravity gradient exactly, depending on location.
2. The gravity gradients for three locations observed in this work range from  $300.4 \mu\text{Gal m}^{-1}$  to  $320.4 \mu\text{Gal m}^{-1}$ .

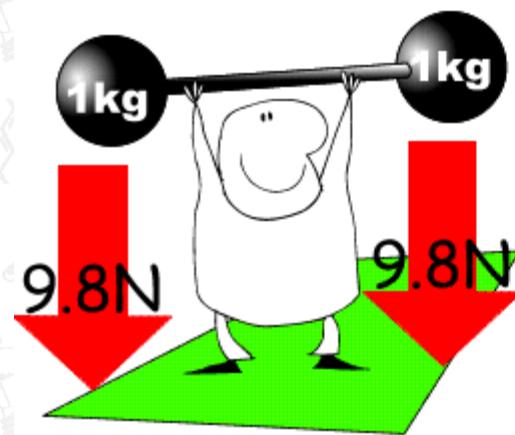


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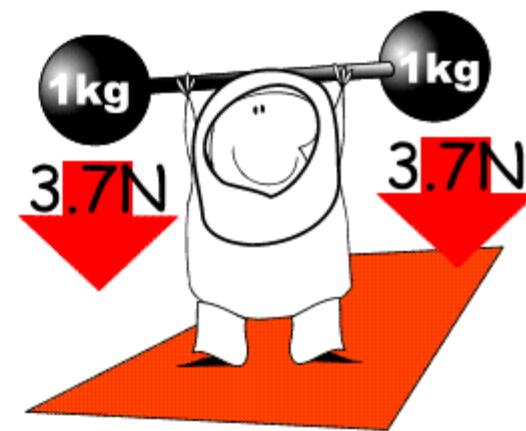
**Earth**

$$g = 9.8 \text{N/kg}$$



**Mars**

$$g = 3.7 \text{N/kg}$$



**Thank you for your attention**



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