Fields Data Handling Exercise 2.1

Finding G from data

# Introduction

In this exercise you are going to use experimental data on the six planets closest to the Sun to determine the gravitational constant G.

*You are strongly advised to use a spreadsheet like Excel to complete this task, especially if you are unfamiliar with doing so. Use this as an opportunity to learn how. Your teacher will be glad to help you do so.*

# Data

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Planet | Radius *r* / m | | | Surface field strength *g* / N kg-1 | | |
| Mercury | 2.40 × 106 | 2.43 × 106 | 2.44 × 106 | 3.76 | 3.74 | 3.78 |
| Venus | 6.04 × 106 | 6.11 × 106 | 6.11 × 106 | 8.73 | 8.80 | 8.79 |
| Earth | 6.36 × 106 | 6.40 × 106 | 6.39 × 106 | 9.85 | 9.78 | 9.81 |
| Mars | 3.41 × 106 | 3.35 × 106 | 3.38 × 106 | 3.81 | 3.79 | 3.79 |
| Jupiter | 7.13 × 107 | 7.14 × 107 | 7.14 × 107 | 24.95 | 24.92 | 24.83 |
| Saturn | 6.10 × 107 | 6.00 × 107 | 6.02 × 107 | 10.40 | 10.38 | 10.41 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Planet | Mean radius *r* / m | Mass *M* / kg | Mean surface field strength *g* / N kg-1 | *G /* N m2 kg-2 |
| Mercury |  | 3.30 × 1023 |  |  |
| Venus |  | 4.87 × 1024 |  |  |
| Earth |  | 5.98 × 1024 |  |  |
| Mars |  | 6.42 × 1023 |  |  |
| Jupiter |  | 1.90 × 1027 |  |  |
| Saturn |  | 5.67 × 1026 |  |  |

# Questions

1. Using the data above:
   1. Calculate the mean values of the radius for each planet.
   2. Calculate the mean values of surface field strength for each planet.
   3. Use the equation to complete the last column of the table.
   4. Calculate your mean value for the gravitational constant *G*.
   5. Calculate the percentage difference of your mean value from the accepted value of 6.67 x 10-11 N m2 kg-2.
2. On graph paper or by using a spreadsheet such as Microsoft Excel or by inserting a chart in your copy of this document:
   1. Plot a graph of surface field strength *g* (on the y-axis) against (on the x-axis).
   2. Calculate the gradient of the line of best fit.
   3. Calculate the difference between the gradient and your mean value of *G*.
   4. Calculate the percentage difference between the gradient and your mean value of *G*.
   5. Calculate the difference between the gradient and the accepted value of *G*.
   6. Calculate the percentage difference between the gradient and the accepted value of *G.*

# References

* [Ben Ryder (former Head of Physics at Sherborne) on plotting scientific data in Microsoft Excel](https://www.youtube.com/watch?v=HyCghkVPgPY)
* [Doug McNally gives some additional tips on how to make a scientific graph in Excel](https://www.youtube.com/watch?v=657w2QjURvs)