

## PHYSICS – Sample D orbit velocity database

**TOTAL MARKS (out of 24) FOR THIS INVESTIGATION = 16**

### **PERSONAL ENGAGEMENT: Best-fit Mark = 1**

**Evidence of personal engagement:** There is some independent thinking and initiative in that the student looked at several databases for the same information (and there were indeed a few slight difference). The student was aware of taking average values for non-circular orbits. (Markband 1)

**Justification given for research question:** There is no evidence of personal significance here. (Markband 0)

**Evidence of personal input and initiative in designing, implementation or presentation:** The design and implementation was as one would expect, with no original or insightful variations. However, the student appeared to be well focused and determined to follow through with the appropriate design, so there is some, if even little, evidence of personal input. (Markband 1)

### **EXPLORATION: Best-fit Mark = 3**

**Topic of investigation identified, research question described:** The student is really just confirming an established equation. However, the student is aware of taking average speeds (not velocities) and average distances, and confirming a known equation like this using a database is a legitimate investigation. Instead of a hypothesis the student should have said they were to confirm the equation. The student should have made explicit the assumption used. (Markband 5)

**Background information:** The student has identified the relevant equation but it would have been appropriate for some scientific detail, perhaps the derivation of the equation and comments about the relevance and assumptions of the equation. This would have been well within high school level. The background is thus extremely brief and shallow. (Markband 2)

**Appropriate methodology, consideration of reliability and sufficiency of data:** The student follows an obvious and straightforward method. The student is wise to consult several databases, as there are a few slight differences in data (as already mentioned) and to take averages (as already mentioned). But one of the sources lists speeds rather than days. Some mention should have been made of this. The amount of data is also appropriate. There is competence but no originality here. (Markband 4)

**Evidence of significant safety or environmental issues:** This descriptor is an outlier for the given investigation. (Markband outlier)

## ANALYSIS: Best-fit Mark = 5

**Sufficient raw data for a valid conclusion:** Within the context of the research topic, the data is sufficient. Considering several sources also supports this descriptor. (Markband 6)

**Data processing, accuracy and consistent:** Error analysis seems appropriate for reaching the conclusion; the student gave attention to relevant details but some of the claimed uncertainties seemed too small but this was rectified in the final average speed expressions. (Markband 5)

**Impact of uncertainties on the analysis:** Commensurate with the course and in a basic but appropriate analysis, the impact of uncertainties was nicely expressed. Using the slope to find G and M plus a propagation of uncertainty here is nicely done. Deeper analysis would be expected for a 6 here. (Markband 5)

**Interpretation of processed data:** A sound and detailed interpretation was given for what was a valid conclusion. (Markband 6)

## EVALUATION: Best-fit Mark = 3 (this was a difficult judgment call)

**Conclusion statement, detailed, justified and supported by data:** The conclusion is brief but to the point and is supported by the data. A slightly deeper appreciation is required for the 5-6 markband. (Markband 4)

**Conclusion and accepted theory, described and justified:** The student never established the relevant theory (although mentions it vaguely), straight from the textbook would have worked, but the student did compare their result with the accepted values of G and M. The graph confirmed the equation with less than 1% error, so that counts as being a justification. (Markband 5)

**Strengths and weaknesses, limitations of data and method:** Although the slight uncertainties in the data were appreciated, there were no comments about the assumption of the theory used or the method of averaging. Some insight would be required here for a higher markband. Comments about the reliability of online data could have been expanded too. (Markband 2)

**Realistic and relevant improvements and extensions:** Standard not reached, no improvements or extensions were suggested. The teacher could have advised the student about this when the teacher read a draft. (Markband 0)

## COMMUNICATION: Best-fit Mark = 4

**Presentation of investigation and errors affecting understanding, focus and outcome:** There was sufficient detail, and what was going on was clear and focused. (Markband 4)

**Report structure, focused and coherent:** The report was logical and flowed, with relevant section headings. Some of the calculations could have been presented in a more traditional physics-equation way, however. (Markband 4)

**Report relevance, concise, focus on outcome:** The report was focused and concise, always keeping in mind what the purpose was. (Markband 4)

**Terminology, subject specific:** The use of terms and conventions were mostly appropriate, and the velocity or speed confusion did not hamper an understanding of the report. Some of the calculations and expression of data should have been in a more physics-like style or format. MS Word has a MathType function that is easily accessed and should have been suggested by the teacher. (Markband 3)