# Mobile phone battery

Students investigate the percentage charge of a mobile phone over time to predict its battery life.

## Visible learning

This lesson incorporates Path content.

### Learning intention

* To be able to plan and conduct a statistical inquiry.

### Success criteria

* I can write an aim and a hypothesis based on a question of interest.
* I can plan how, when and where to collect data.
* I can draw conclusions from data.
* I can interpolate and extrapolate data.

### Syllabus outcomes

A student:

* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly **MAO-WM-01**
* displays and interprets datasets involving bivariate data **MA5-DAT-C-02**
* plans, conducts and reviews a statistical inquiry into a question of interest **MA5-DAT-P-01**

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Table 1: lesson summary

|  |  |  |  |
| --- | --- | --- | --- |
| Section | Summary of activity | Teaching strategies | Teaching points |
| Launch | Students read the news article ‘Apple pays out over claims it deliberately slowed down iPhones’ ([bit.ly/mobilebatteries](https://bit.ly/mobilebatteries)) about the slowing down of batteries in older phones and their reduced battery life. Students discuss issues around experiences with mobile phone batteries. | Pose-Pause-Pounce-Bounce | Students see an issue to be investigated.  |
| Explore | Students create an aim and hypothesis about mobile phone batteries and gather data regarding battery life. Students record the data in [Appendix A](#_Appendix_A_1) before completing a scatter plot. | Visibly random groups of 3Vertical non-permanent surfacesGallery walkPose-Pause-Pounce-BounceTwo stars and a wish | Students investigate by gathering data and organising the data into a table and a graph. |
| Summarise | Students analyse data to see whether there is any association between the 2 variables before finding the line of best fit by eye and the equation of the line. | Visibly random groups of 3Vertical non-permanent surfacePose-Pause-Pounce-Bounce | Students draw a line of best fit and create a model. |
| Apply | Students apply the model to a scenario before completing their own investigation on a topic of their choice. | Visibly random groups of 3Vertical non-permanent surfaceGallery walkTwo stars and a wish | Students apply their learning by creating their own investigation. |

## Activity structure

### Launch

1. Show students the article about the slowing down of batteries in older phones ‘Apple pays out over claims it deliberately slowed down iPhones’ ([bit.ly/mobilebatteries](https://bit.ly/mobilebatteries)).

This article is about a lawsuit that Apple users have launched regarding the deliberate slowing down of batteries in iPhone products.

1. Use the Pose-Pause-Pounce-Bounce questioning strategy (PDF 557 KB) (<https://bit.ly/posepausepouncebounce>) to ask students about the article and their experiences with mobile phone batteries and charging.
2. Ask students to consider how long their mobile phone batteries generally last and what factors may affect the battery life.

### Explore

1. Assign students into visibly random groups of 3 ([bit.ly/visiblegroups](https://bit.ly/visiblegroups)) at vertical non-permanent surfaces ([bit.ly/VNPSstrategy](https://bit.ly/VNPSstrategy)). Ask students to brainstorm how they might investigate the battery life of a mobile phone.

The battery life of a mobile phone is the length of time it would take for the phone to become flat after being fully charged. Some students may acknowledge that data regarding the battery life of a mobile phone is readily available as part of the technical specifications of mobile phones. This information could be used to conclude its accuracy.

1. Use the Pose-Pause-Pounce-Bounce questioning strategy to ask students what the ‘aim’ of an investigation is and its purpose. Students should consider where they develop an aim in science experiments as part of this discussion.

An aim is to gather information about a particular group or subject. For example, to find the average battery life of a mobile phone, to find how much battery is used by using different features on a phone (for example, roaming, watching clips, and so on).

1. Have each group write an aim for a mobile phone battery investigation.
2. Use the Pose-Pause-Pounce-Bounce questioning strategy to ask students what the ‘hypothesis’ of an investigation is. Students should make a connection to where they develop hypotheses in science as part of this discussion.

Hypothesis: a supposition or proposed explanation made based on limited evidence as a starting point for further investigation (NESA 2023). (An example could be that older model phones' batteries drain faster than newer phones.

1. Have the groups write a hypothesis for the mobile phone battery investigation.
2. Students complete a gallery walk ([bit.ly/DLSgallerywalk](https://bit.ly/DLSgallerywalk)) to look at other groups’ aims and hypotheses and give peer feedback using the Two stars and a wish strategy ([bit.ly/DLSpeerfeedback](https://bit.ly/DLSpeerfeedback)).
3. Use the Pose-Pause-Pounce-Bounce questioning strategy to discuss the best aims and hypotheses from the class and why they were rated as the best.
4. Groups should review their aim and hypothesis based on the feedback they received during the gallery walk and the features that were present in the samples that were determined the best.
5. Continuing in groups of 3, students are to consider how they might gather data for their investigation.
6. Use the Pose-Pause-Pounce-Bounce questioning strategy to discuss the different methods that students came up with.

Due to rules around mobile phone use in schools, students may need to gather data at home over a weekend or the teacher may need to provide this data for the students. Students may also gather data from a secondary source.

A sample method is shown below, but students could be allowed to follow through with the method they determined.

1. Starting with a fully charged mobile phone, students are to record the charge of a phone at regular intervals over many days, excluding nighttime, in the table from Appendix A ‘Record sheet’:

Table 2: record sheet

| Time after start, t (hours) | Percentage charge, C (%) |
| --- | --- |
| 0 | 100% |
| 2 |       |
| 4 |       |
| 6 |       |

The table is given as a reference guide. Students would add in the hours since the start of recording. For example, start data collection at 4 pm Wednesday ($t = 0$), record time at 6 pm
($t=2$), 8 pm ($t=4$), 10 pm ($t=6)$ and possibly 6 am ($t=14$).

1. Determine the independent and dependent variables.
2. Issue each group with an A3 piece of graph paper in a plastic sleeve.

Blackline masters of graph paper can be accessed on MathsLinks ‘Graph paper’ ([bit.ly/Graph\_paper\_mathlinks](https://bit.ly/Graph_paper_mathlinks)).

1. Each group selects one person’s data from the group and creates a scatter plot of their data with the independent variable on the $x$-axis and the dependent variable on the $y$-axis.

### Summarise

1. Have each group of 3:
* discuss whether the data has any association, and if so what direction and strength
* draw a line of best fit by eye and work out the equation of the line.
1. Using either the graph or the equation of the line of best fit, predict when the charge will become 0% and hence use it to estimate the battery life of the mobile phone involved in the test.

If they have the actual data for this, have students compare the prediction from the model to the data and discuss why it may differ.

1. Battery life is dependent on many different factors, like types of usage. Some phones go into battery saver mode at around 20% battery life remaining. By examining the variation of the time data of the model, predict a timeframe for the battery life that will have 20% remaining.

Alternatively, students could also look at how long it takes to drop from 100% to 50% and then 50% to 0%. If we were to look at the 2 sections separately, do we get 2 different models? How much do they differ?

1. Use the Pose-Pause-Pounce-Bounce questioning strategy to ask students what other factors could affect the battery life.
2. Pose the following scenario to the class:

Jack is looking to go camping for a few days. He fully charges his phone before he leaves at 5 pm Friday and arrives home at 9 pm Sunday. He only has the phone for emergencies.

1. Based on the model of the mobile phone they used for the investigation above, have groups discuss whether the phone battery would last the trip.

### Apply

1. Working in newly formed random groups of 3 at vertical non-permanent surfaces, have groups select a topic to investigate. Suggestions for investigation include:
* screen time versus mobile phone battery charge time
* body measurement growth versus clothing size
* arm span versus height
* neck circumference versus waist circumference
* height versus shoe size
* number of people in household versus the cost of electricity bill
* temperature versus number of students wearing jumpers.
1. Have students write an aim and hypothesis for their investigation.
2. Students plan how and where they will collect data for their investigation.
3. Students conduct their experiment or survey and collect data.
4. Issue students with graph paper and have them create a scatter plot before describing the association between the variables.
5. Students draw a line of best fit and establish the equation of the model.
6. Students should consider their model and use it to interpolate from within their data and extrapolate a solution outside their data.
7. Students should discuss if there are any conclusions they could draw from their data and if there are any limitations to their model. They should report this in their workbook.
8. Students display their scatter plot on a vertical non-permanent surface using adhesive putty, alongside their aim, hypothesis, and conclusions in their workbooks.
9. Students complete a gallery walk and give peer feedback using the Two stars and a wish strategy ([bit.ly/DLSpeerfeedback](https://bit.ly/DLSpeerfeedback)). As part of the feedback, groups should discuss whether they agree or disagree with the findings and why.

## Assessment and differentiation

### Suggested opportunities for differentiation

**Launch**

* Students’ discussion is about their experience with mobile phone batteries. There is no correct or incorrect answer so students should be able to share their experiences or beliefs.

**Explore**

* **Students could be given data from which to create a scatter plot.**
* **Students could use technology to draw a scatter plot and create a line of best fit.**

**Summarise**

* **Challenge students to find the time to reach different battery percentages by solving the equation for the line of best fit.**

**Apply**

* Students choose their investigation topic. Students can select an area where they feel confident in collecting the data and producing a model to test a hypothesis.
* Students could be provided with data to assist them in creating the model.
* Students can be challenged to select an area where there may not be an obvious association.

### Suggested opportunities for assessment

 **Explore**

* Teachers can assess students' understanding of creating an aim or hypothesis by observing group discussions.
* Teachers can assess students' understanding of drawing scatter plots by observing group discussions.

**Summarise**

* **Teachers can observe students’ understanding of creating a model by observing their work on vertical non-permanent surfaces.**
* **Group’s scatter plots can be collected as evidence of understanding.**

**Apply**

* The aim, hypothesis, and created model can be collected and used as evidence of understanding. This section of the lessons could be given as a summative assessment.

## Appendix A

### Record sheet

Complete the table from the data collected.

|  |  |
| --- | --- |
| Time after start, t (hours) | Percentage charge, C (%) |
| 0 | 100% |
| 2 |  |
| 4 |  |
| 6 |  |
| 8 |  |
| 10 |  |
| 12 |  |
|  |  |
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## References

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