flowchart TD A[Observation] --> B[Defining the Problem] --> C[Setting up Hypothesis or Methods] --> D[Predictions Based on Hypothesis (Deduction)] --> E[Experiments and Empirical Verification] --> F[Formulating the Hypothesis or Principle] %% Observation Details subgraph Observation_Details direction TB A_note1[Primary basis for any scientific method.] A_note2[If it cannot be observed, it cannot be scientifically tested.] A_note3[Note: Applies only to natural sciences.] A_note4[Example: Cannot examine historical events like past battles this way.] A_note1 --> A_note2 --> A_note3 --> A_note4 end A -.->|Details| Observation_Details %% Hypothesis Details subgraph Hypothesis_Details direction TB C_note1[Solution defined by the scientist.] C_note2[May be a hypothesis or a method.] C_note3[Different hypotheses can be set up when analyzing data.] Occam[Occam's Razor] Occam_note[Choose the hypothesis with fewer assumptions.] Occam_warning[Note: Only a philosophical recommendation.] Examples1[Examples: Kepler's Laws, Hooke's Law] C_note1 --> C_note2 --> C_note3 --> Occam Occam --> Occam_note --> Occam_warning --> Examples1 end C -.->|Details| Hypothesis_Details %% Predictions Details subgraph Predictions_Details direction TB D_note1[Involves making forecasts.] D_note2[Useful predictions must be tested.] D_note3[Hypotheses need examination.] Falsifiability[Falsifiability (Karl Popper)] Falsifiability_note[Hypothesis is falsifiable if it can be contradicted.] Example2[Example: "All swans are white" is falsifiable.] Criticism[Criticism of Popper's Method] Criticism_note[Inconsistencies may be due to theory or insufficient information.] Uranus[Example: Discovery of Neptune explained Uranus's movement.] D_note1 --> D_note2 --> D_note3 --> Falsifiability Falsifiability --> Falsifiability_note --> Example2 Falsifiability --> Criticism --> Criticism_note --> Uranus end D -.->|Details| Predictions_Details %% Experiments Details subgraph Experiments_Details direction TB E_note1[Involves repeatability and reproducibility.] E_note2[Same results under identical conditions.] E_note1 --> E_note2 end E -.->|Details| Experiments_Details

The main steps of the scientific method

1) **Observation** : this is the primary basis for any scientific method. If it cannot be observed, then it cannot be scientifically tested.

Important note: this point only applies to the natural sciences. For example, if we would like to analyze a battle which happened back in the era of the Rakoczy revolution, we cannot examine the task this way because it has already happened.

2) **Defining the problem**: after the observation procedure we have to define the problem in a way that it can give us a further guide and goal as well.

3) **Setting up the hypothesis or methods**: the solution for the given problem has to be done in a certain way which is defined by the scientist. It may be a hypothesis, or if the problem covers a larger area it may be a whole method. When the data have to be analysed different hypotheses can be set up for the task. In this case scientists usually use the so-called Occam’s razor, which is the following: if we have one or more hypotheses which cover the same area (at least partially) we have to analyze the one which consists of more straightforward facts or fewer assumptions. But be careful! This method has proven to be very useful but it’s only a philosophical recommendation. Its correctness can not be proven in every case.

(Astronomical example: Kepler’s law of physics, physical example: Hooke’s law - “an elastic deformation of the body is proportional to the force causing the deformation”)

4) **Predictions** based on the hypothesis or method (deduction). Every scientific method will necessarily involve certain forecasts. The ones which prove to be useful for further scientific progress

have to be tested. The hypotheses made during the scientific progress have to be examined. One of the criteria during these tests is called falsifiability. This criterion comes from Karl Popper (a scientific philosopher).

Falsifiability in this case has to be seen in the following way: if there is any kind of way (even just logical) which can contradict our hypothesis, then it is falsifiable. (For example: all swans are white. Of course there are black swans so the statement is not true, therefore falsifiable).

Criticism of the Popper method: If the observation is inconsistent with the theory, then it is equally possible that the theory is correct or wrong or the required information is insufficient or false. (Astronomical example: our observations about Uranus let us predict that its movement behavior contradicts Newtonian laws. Levellier and Adams tried to explain this by saying that this movement is caused by an unknown planet's interference. Galle was the one who managed to find Neptune, which was unknown up to that time.

5) **Experiments and empirical verification**: This scientific method strictly involves repeat-ability and reproducibility as well. Experimental reproducibility means that the same results can be reproduced by setting the same given conditions (within a given interval of tolerance).

6) Wording/**setting up the hypothesis** or principal.