**GRAPHING EXERCISE A**

Plot a displacement-time graph using the following data recorded as an object moves in a straight line. Plot the graph firstly by hand on graph grid paper. Then plot the graph using a Microsoft Excel spreadsheet (or similar software).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Time (s) | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 |
| Displacement (m) | 0 | 2 | 8 | 12 | 16 | 16 | 16 | 12 |

Use your graph to answer the following questions about the object.

1. How far from its start point is the object after 4 seconds?
2. At what time is the object 10 m from its start point?
3. What is the speed of the object at (i) t = 6 s and at (ii) t = 10 s?
4. What is the velocity of the object at t = 13 s?
5. How far from its start point is the object at t = 14 s?
6. Between which times is the object stationary?
7. Between which times is the magnitude of the velocity highest?
8. If the object has returned to its start point at t = 16 s calculate the average velocity of the object over the final 2 seconds of its journey.

**GRAPHING EXERCISE B**

Plot a velocity-time graph using the following data recorded as a trolley car moves in a straight line. Plot the graph firstly by hand on graph grid paper. Then plot the graph using a Microsoft Excel spreadsheet (or similar software).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Time (s) | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 |
| Velocity (m/s) | 0 | 2 | 8 | 12 | 16 | 16 | 16 | 12 |

Use your graph to answer the following questions about the trolley car.

1. What is the velocity of the trolley car at (i) t = 6 s and at (ii) t = 10 s?
2. At what time is the trolley car travelling at 10 m/s?
3. Calculate the acceleration of the trolley car at t = 13 s.
4. Between which times is the acceleration of the trolley car zero?
5. Between which times is the magnitude of the acceleration highest?
6. How far does the trolley car move in the first 4 s of its motion?
7. How far is the trolley car from its start point at t = 14 s?
8. If the trolley car has come to a complete stop at t = 16 s determine the average acceleration of the trolley car over the last 2 seconds of its journey.

**Answers appear on next page.**

**Also, read the hints on graph drawing on next page as well.**

**Answers**

Exercise A: a) 8 m, b) 5 s, c) (i) 2 m/s, (ii) 0 m/s, d) -2 m/s (or 2 m/s back towards start point), e) 12m, f) t = 8 s & t = 12 s, g) t = 2 s & t = 4 s, h) -6 m/s (or 6 m/s back towards start point).

Exercise B: a) (i) 12 m/s away from start point, (ii) 16 m/s away from start point, b) 5 s, c) -2 m/s2 (or 2 m/s2 in the opposite direction to motion, d) t = 8 s & t = 12 s, e) t = 2 s & t = 4 s, f) 12m (hint: calculate the area under the graph from t = 0 s to t = 4 s), g) 152 m, h) -6 m/s2 (or 6 m/s2 in opposite direction to motion).

**Hints on drawing graphs by hand:**

* Use a sharp pencil, a ruler for straight lines and draw the graph on grid paper.
* Choose a sensible scale that allows the graph to fill as much of the graph paper as possible. The larger your graph, the more accurate will be any calculations you perform from it.
* Always label your axes with the name of the quantity being graphed and the appropriate units. (eg velocity (m/s) )
* Always give your graph a title. (eg Light Intensity versus Distance from Light Source)
* Always plot the **independent variable** on the x-axis and the **dependent variable** on the y-axis. See below for definitions if you need them.
* Ensure your data points are clearly visible on the graph. The data points must be visible even after you have drawn your line of best fit through them. At university level you will have to include error bars on every data point showing the error inherent in your data.
* In most experiments, the data you collect will require you to draw a “line of best fit” rather than simply “joining the dots” from one data point to the next. For hand-drawn graphs at secondary school level a line of best fit can be drawn by eye. For more accurate results the line of best fit can be calculated using some maths called linear regression. Microsoft Excel spreadsheets can do this for you.

**Independent and Dependent Variables**

The two main variables in an experiment are the independent and dependent variable. An **independent variable** is the variable that is changed or controlled in a scientific experiment to test the effects on the dependent variable. A **dependent variable** is the variable being tested and measured in a scientific experiment. The dependent variable is 'dependent' on the independent variable. As the experimenter changes the independent variable, the effect on the dependent variable is observed and recorded.

For example, a scientist wants to measure how light intensity varies with distance from a light source. The distance from the light source would be controlled by the scientist. This would be the independent variable. The various values of light intensity at the chosen distances would be measured and recorded. Light intensity is the dependent variable.

When results are plotted in graphs, the convention is to use the independent variable as the x-axis and the dependent variable as the y-axis.