Steve Smith Tuition: Physics Notes

$E = mc^2$ $F = G\frac{Mm}{r^2}$ $\sin\theta_m = \frac{m\lambda}{d}$ $h\nu = \phi + \frac{1}{2}mv^2$

Physics Notes : Straight Line Graphs

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Notes

None.

Prerequisites

None.

Document History

Date	Version	Comments
28th August 2014	1.0	Initial creation of the document.

1 Questions

1.1 Dropping a Stone

A stone is dropped from rest down a vertical well. The distance s fallen down the well is the following function of time t:

$$s = \frac{1}{2}gt^2$$

If you drew a graph of s (up the y-axis) against t^2,

(a) What would be the gradient of the line?

(b) What would be the y-intercept?

1.2 Internal Resistance

The potential difference across the terminals of a battery V is given by the following function of current I:

$$V = -rI + E$$

where r is the internal resistance of the cell and E is the cell's EMF (electro-motive force). If you drew a graph of V (up the y-axis) against I,

(a) What would be the gradient of the line?

(b) What would be the y-intercept?

1.3 Einstein's Famous Equation

Einstein came up with a very famous equation relating energy E and mass m:

$$E = mc^2$$

where c is the velocity of light.

You want to draw a straight line of this relationship.

(a) Which variable (E or m) would you have up the y-axis?

(b) Which variable (E or m) would you have along the x-axis?

(c) What would be the gradient of the line?

(d) What would be the y-intercept?

1.4 Newton's Gravitational Formula

The force of gravity F between any two masses (such as mine, M, and Britney Spears', m) is given by:

$$F = \frac{GmM}{r^2}$$

where G is a constant (called the gravitational constant), and r is the distance between the masses. Which of the following would yield a straight-line graph?

(a) F (up the y-axis) against r^2 (along the x-axis)

(b) F (up the y-axis) against r (along the x-axis)

(c) F (up the y-axis) against $\frac{1}{r}$ (along the x-axis)

(d) F (up the y-axis) against $\frac{1}{r^2}$ (along the x-axis)

And what would be the gradient of the graph?

1.5 Energy of a Photon

The energy of a photon E is related to its frequency f by the equation:

$$E = hf$$

where h is called Planck's constant.

(a) If you carried out an experiment that created photons of different frequencies, then measured the energies of the photons (somehow!), what graph would you draw to find the value of Planck's constant?

(b) How can you use your graph to obtain the value of the constant?

1.6 Photoelectric Effect Equation

The photoelectric equation is:

$$hf = \Phi + \tfrac{1}{2}mv^2$$

(a) Explain what all the symbols mean.

(b) What graph would you draw if you wanted the y-intercept to be Φ and the gradient to be $\frac{1}{2}m$?

1.7 SUVAT!

One of the SUVAT equations is:

$$v^2 = u^2 + 2as$$

(a) What do all these variables represent?

(b) What graph would you draw if you wanted the gradient to be $2a$?

(c) What would be the y-intercept of this graph?

1.8 Ohm's Law

In an experiment, a circuit was set up with a battery of unknown potential difference, V. In the experiment, the resistance R of the resistor (the only component) was varied, and the current I measured with an ammeter. Since, from Ohm's Law:

$$I = \frac{V}{R}$$

(a) What graph would you draw to have the potential difference V as the gradient?

(b) What would be the y-intercept of the graph?

2 Answers

2.1 Dropping a Stone

The gradient would be $\frac{1}{2}g$ and the y-intercept (or rather, the s-intercept!) would be 0. That's because you can write the equation as:

$$\begin{array}{ccccc} s & = & \frac{1}{2}g & t^2 & + & 0 \\ y & = & m & x & + & c \end{array}$$

2.2 Internal Resistance

The gradient of the line would be $-r$ and the y-intercept would be E because you can write the equation as:

$$\begin{array}{ccccc} V & = & -r & I & + & E \\ y & = & m & x & + & c \end{array}$$

2.3 Einstein's Famous Equation

I would draw a graph of E (up the y-axis) against m (along the x-axis). The gradient of the graph would be c^2 and the y-intercept would be 0. That's because you can write the equation as:

$$\begin{array}{ccccc} E & = & c^2 & m & + & 0 \\ y & = & m & x & + & c \end{array}$$

2.4 Newton's Gravitational Formula

You want to draw the graph of F (up the y-axis) against $\frac{1}{r^2}$. The gradient would be equal to GmM. That's because you can write the equation as:

$$\begin{array}{ccccc} F & = & GmM & \frac{1}{r^2} & + & 0 \\ y & = & m & x & + & c \end{array}$$

2.5 Energy of a Photon

I would draw a graph of E (up the y-axis) against f (along the x-axis). The gradient of the line would be h. That's because you can write the equation as:

$$\begin{array}{ccccc} E & = & h & f & + & 0 \\ y & = & m & x & + & c \end{array}$$

2.6 Photoelectric Effect Equation

(a)

h: Planck's constant;

f: the frequency of the arriving photon;

Φ: the work function;

m: the mass of the ejected electron;

v: the velocity of the ejected electron.

(b) I would draw a graph of hf against v^2. The y-intercept would be Φ. That's because you can write the equation as:

$$\begin{array}{ccccc} hf & = & \frac{1}{2}m & v^2 & + & \Phi \\ y & = & m & x & + & c \end{array}$$

2.7 SUVAT!

(a)

u and v are the initial and final velocities;

a is the acceleration;

s is the distance.

(b) I would draw a graph of v^2 (up the y-axis) against s (along the x-axis). The gradient of the line would be $2a$. The y-intercept would be u^2. That's because you can write the equation as:

$$\begin{array}{ccccc} v^2 & = & 2a & s & + & u^2 \\ y & = & m & x & + & c \end{array}$$

2.8 Ohm's Law

I would draw a graph of I (up the y-axis) against $\frac{1}{R}$ (along the x-axis). The y-intercept of the line would be 0. That's because you can write the equation as:

$$\begin{array}{ccccccc} I & = & V & \frac{1}{R} & + & 0 \\ y & = & m & x & + & c \end{array}$$