PHYSICS 534

ANSWERS

EXERCISE-03 **Variation**

ZEEMAN

Pieter Zeeman received the Nobel prize for physics in 1902 for his work on magnetism in radiation.

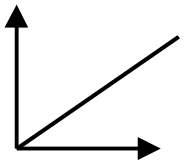
There are four relationships (or variations) which are very important in science. They are called:

- **DIRECT**
- **DIRECT-SQUARED**
- **INDIRECT** (or **INVERSE**)
- **INDIRECT-SQUARED** (or **INVERSE-SQUARED**)

When dealing with changing variables, one variable is said to be independent while the other variable takes on a specific value which "depends" upon the value of the independent variable. When plotting the dependent and independent variables, it is customary to plot the independent value along the horizontal or x-axis and the dependent variable along the vertical or y-axis (x is the domain and y is the range).

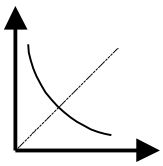
- **DIRECT VARIATION** $y = kx$ (known also as a "linear" relationship)

When two variables vary **directly**, it means that as the independent variable increases or decreases, the dependent variable also increases or decreases. If, for example, the independent variable doubles, then the dependent variable also doubles. And if, for example, the independent variable becomes half, the dependent variable also becomes half. Thus, we have a **direct** relationship. (Direct-squared is similar)



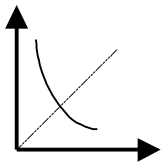
- **INDIRECT-VARIATION** $y = k/x$ or $yx = k$

In an indirect relationship, the two variables vary indirectly (or inversely) to each other. This means that as one quantity goes up, the other quantity goes down. Or, if one quantity goes down, the other quantity goes up. Thus, for example, if one variable doubles, then the other variable becomes half (the reciprocal of 2 is 1/2). If one quantity becomes 10 times bigger, then the other variable becomes 1/10, etc. And, if one variable becomes half, then the other variable becomes double (the reciprocal of 1/2 is 2/1 or 2). Thus, if one variable becomes 1/12, the other variables become 12 times greater, etc.



- **INVERSE-SQUARED VARIATION**

An inverse-squared relationship is similar to an inverse relationship in that as the value of one variable goes up, the value of the other variable goes down and vice-versa. However, what makes this relationship different is that the amount of change is much greater. In fact, as the name of the relationship suggests, the amount of increase or decrease is "squared". Thus, for example, if one variable ***doubles***, then the other variable becomes ***1/4***, that's the reciprocal of two squared or $(1/2)^2$. And, if the value of one variable becomes ***half***, then the value of the other variable becomes ***four*** times greater, that's the reciprocal of 1/2 squared or $(2/1)^2$.



The graph of an inverse-squared relationship looks similar to an indirect relationship. However, while the graph of an indirect relationship is symmetrical about the 45^o line, the inverse-squared graph is not symmetrical. Here are some examples:

➢ ***Remember***: ① Two variables vary **directly** if their quotient is a constant: $y/x = k$.

② Two variables vary **indirectly** if their product is a constant: $xy = k$.

State the type of ***variation*** for each of the following situations:

1. The **speed** of a car and the **distance** traveled for a specified time period. **Direct**

2. The **speed** of a car and the **time** of travel for a specified distance. **Indirect**

3. The **cost** of buying pens and the **number** of pens bought. **Direct**

4. The **heat** of a flame and the **distance** from the flame. **Indirect**

5. The **sound** of a noise and the **distance** from the noise. **Indirect**

6. The **number** of workers doing a job and the **time** needed to complete the job. **Indirect**

7. The **brilliance** of a lamp and the **distance** from the lamp. **Indirect**

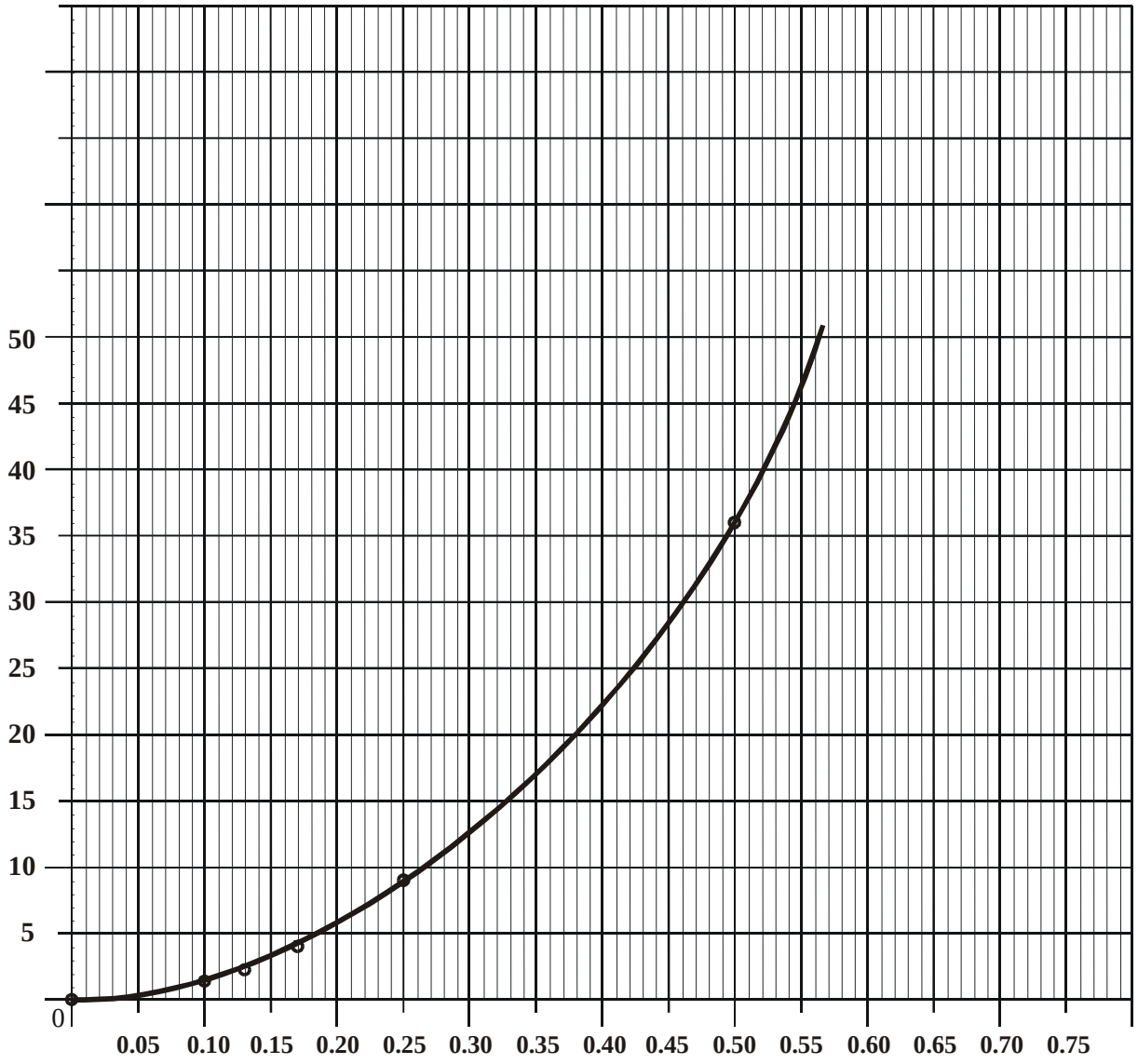
8. The **mass** of an object and the **force** required to move it. **Direct**

9. The **temperature** of a plate of food and **time**. **Indirect**

10. The **weight** of books and the **number** of books which may be stored on a shelf. **Indirect**

11. The following data was obtained from an experiment. Plot A versus B and tell what kind of relationship your graph indicates (plot A along the y-axis and B along the x-axis):

A	36	9.0	4.0	2.3	1.4	0
B	0.50	0.25	0.17	0.13	0.10	0



12. What kind of relationship does your graph indicate? **Direct squared**

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