

Section 5E

Correlation and Causality

A **correlation** exists between two variables when higher values of one variable consistently go with higher values of another variable or when higher values of one variable consistently go with lower values of another.

Establishing a correlation does **not** necessarily mean that a change in one variable *causes* a change in the other variable.

A **scatter diagram** is a graph in which each point represents the values of two variables.

- Assign one variable to each axis and appropriately label the axes.
- Plot (graph) the points given by the data.
- Do NOT connect the points.

We can use a scatter diagram to look for correlation between the two variables.

Relationships Between Variables

Positive correlation – both variables tend to increase together

Negative correlation – the two variables tend to change in opposite directions

- one variable increases while the other variable decreases

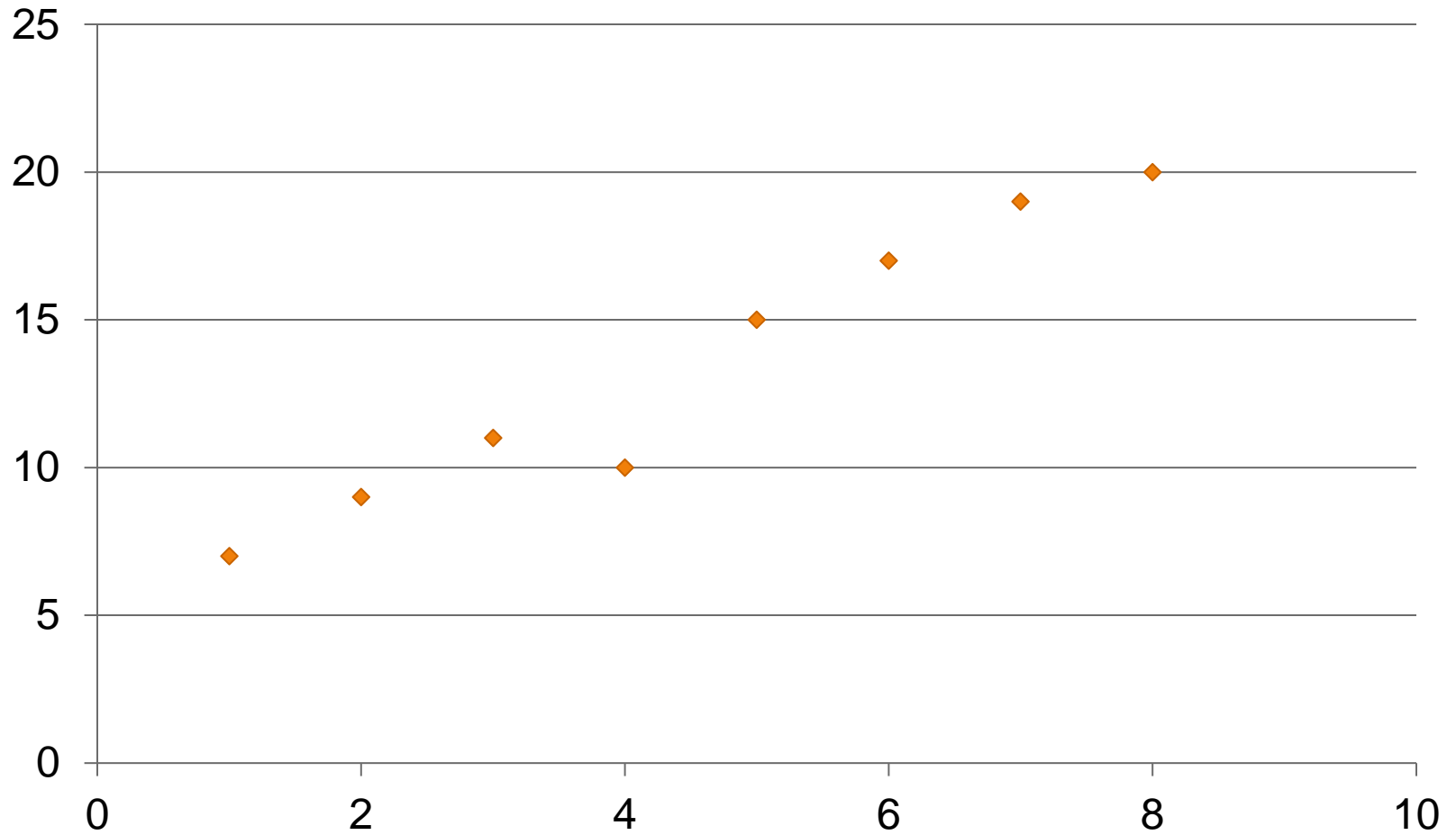
No correlation – no apparent relationship between the two variables

Perfect correlation – all data points lie on a straight line

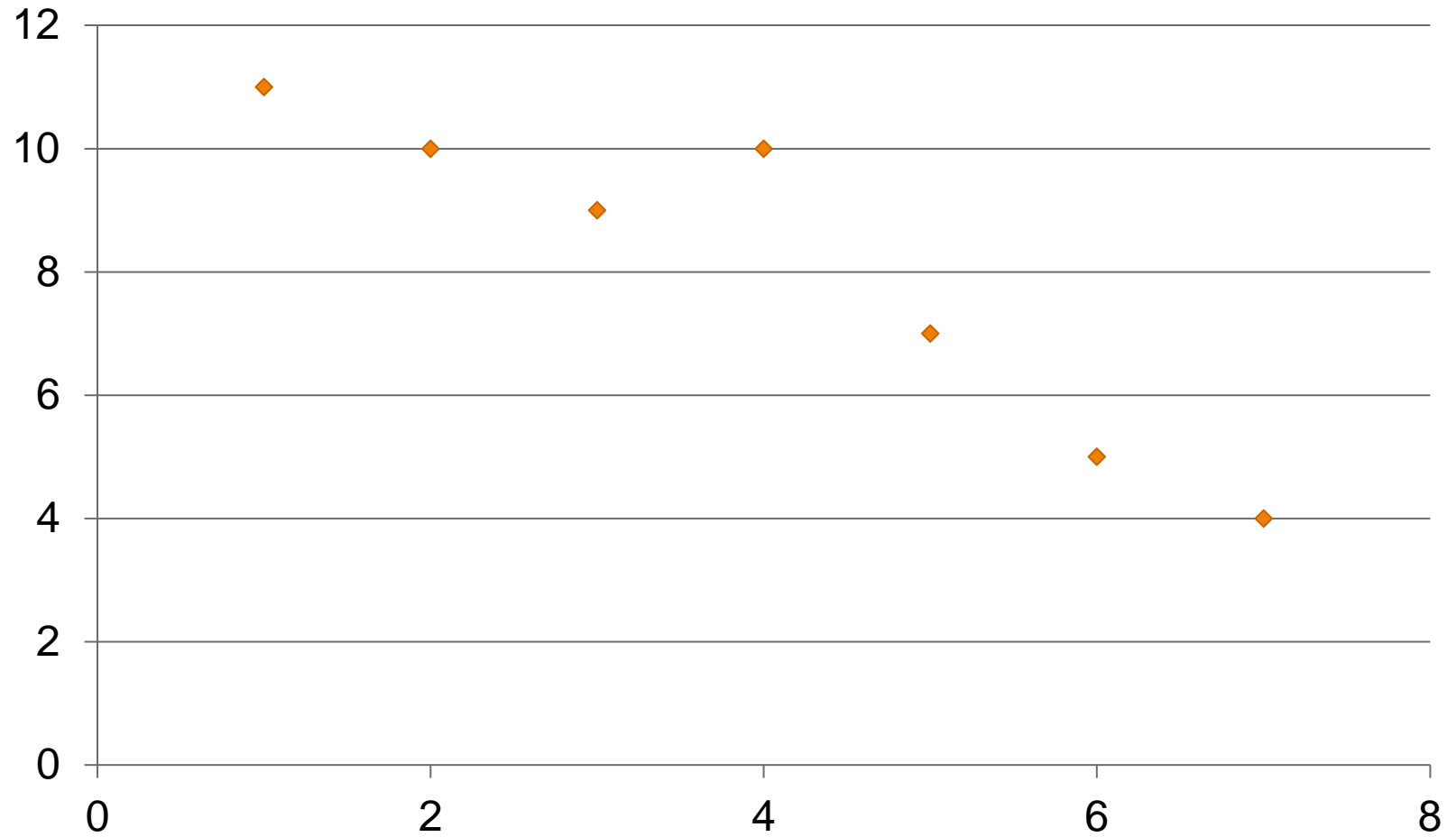
Strength of correlation

stronger correlation – points more closely follow the general trend

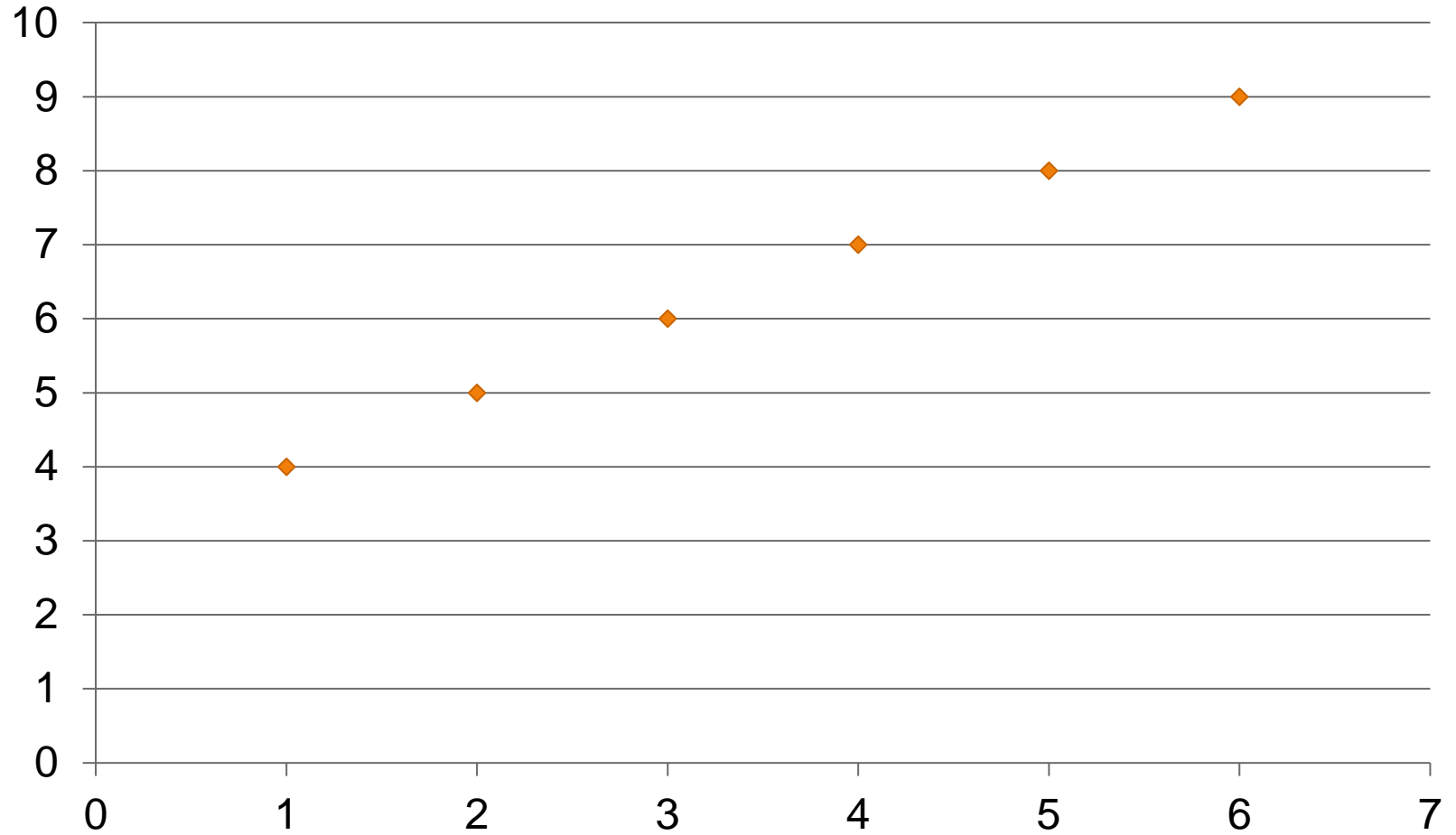
Positive Correlation



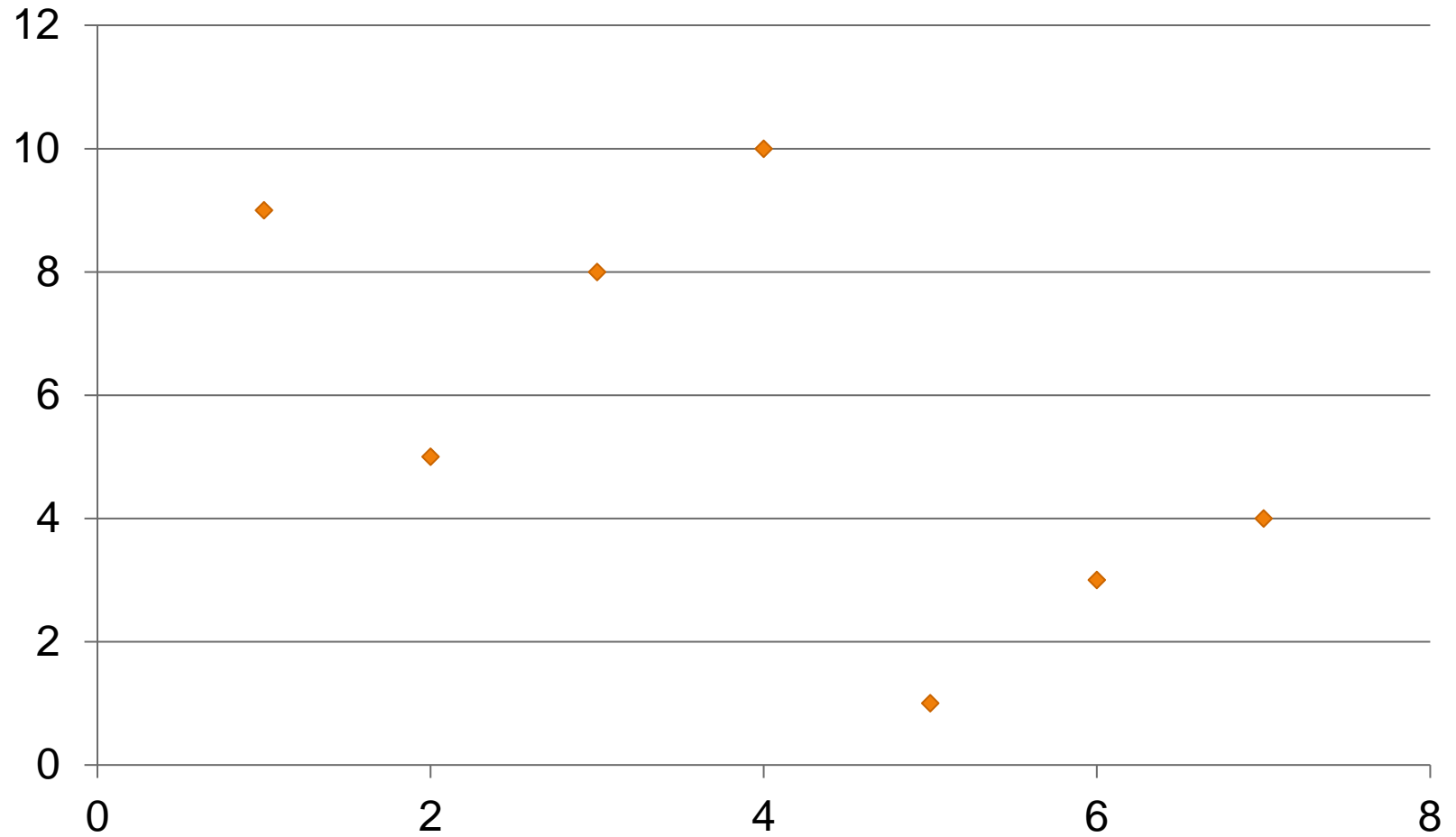
Negative Correlation



Perfect Correlation



No Correlation



Possible Explanations for a Correlation

The correlation may be a *coincidence*.

Both variables might be directly influenced by some *common underlying cause*.

One of the correlated variables may actually be a *cause* of the other.

Guidelines for Establishing Causality

1. Look for situations where the effect is correlated with the suspected cause with other factors that vary.
2. Among groups that differ only in the presence or absence of the suspected cause, check that the effect is similarly present or absent.
3. Look for evidence that larger amounts of the suspected cause produce larger amounts of the effect.
4. If the effect might be produced by other potential causes, make sure that the effect still remains after accounting for these other potential causes.
5. If possible, test the suspected cause with an experiment.
6. Try to determine the physical mechanism by which the suspected cause produces the effect.

Levels of Confidence in Causality

Possible cause – a correlation is discovered, but cannot yet determine whether the correlation implies causality

- legal system – often the reason for starting an investigation

Probable cause – have good reason to suspect the correlation involves cause

- legal system – general standard for getting a judge to grant a search warrant or wiretap

Cause beyond reasonable doubt – a physical model has been found that is so successful in explaining how one thing causes another that it seems unreasonable to doubt the causality

- legal system – usual standard for conviction

Note that reasonable doubt does not mean beyond all doubt.