Time series investigation for juniors.

(Levels 2 – 6)

Name: _____

Created by Elizabeth Sneddon

Current Level (circle one):

2 / 3 / 4 / 5 / 6

Goal Level (circle one):

2 / 3 / 4 / 5 / 6

Problem and Plan

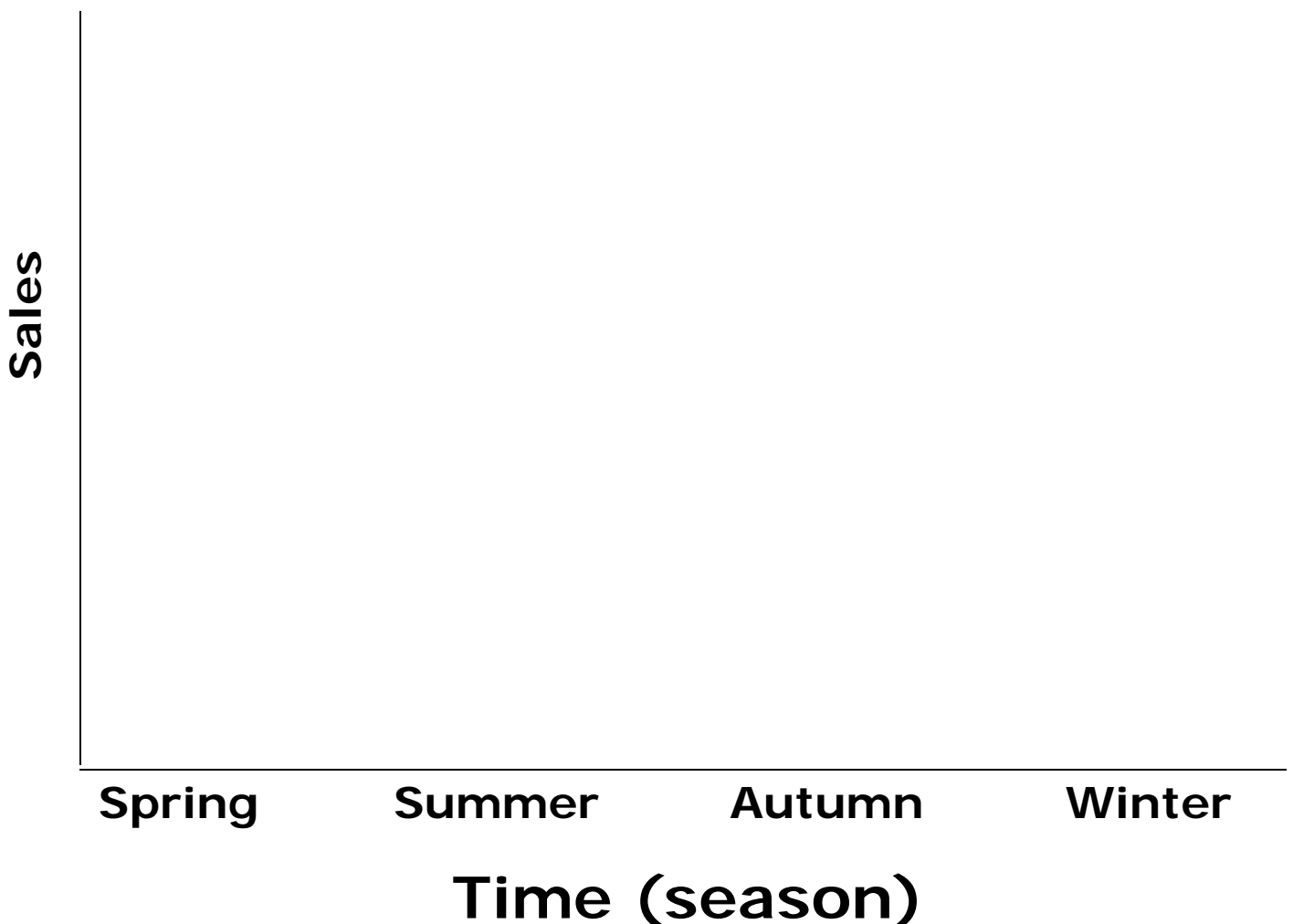Time series data is about data that is collected over time.

Exercises:

Problem – I wonder if the Umbrella Shop sells more umbrellas in summer or winter?

Plan – Over the last year, the Umbrella Shop has recorded how many umbrellas they sold each season.

1) Predict what you think the graph may look like on the axis below.

Sales

Spring   Summer   Autumn   Winter

Time (season)

2) Do you think that this pattern (of bigger sales in winter and smaller sales in summer) would repeat itself every year? Explain why/why not.

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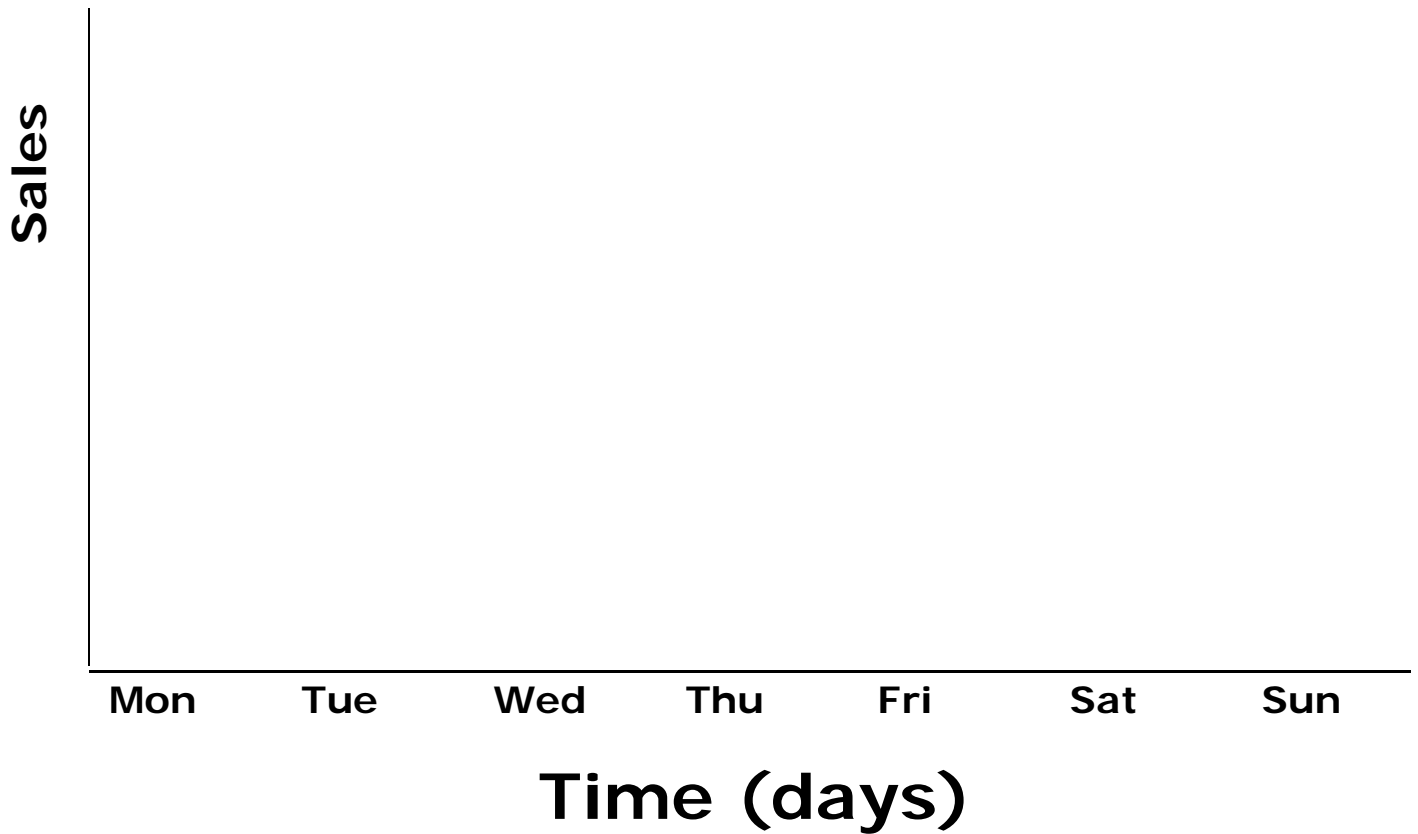3) Why might it be good to have several years of data to look for patterns?

_____

_____

4) Predict what you think the graph of toy sales might look like on the axis below.

Sales

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Time (months)

5) Predict what you think the graph of movie ticket sales might look like on the axis below.

Sales

| | | | | | | |
|Mon|Tue|Wed|Thu|Fri|Sat|Sun|

Time (days)

6) Predict what you think the graph of food sales from a cafe might look like on the axis below.

Sales

6am   8am   10am   12noon   2pm   4pm   6pm   8pm

Time (hours)
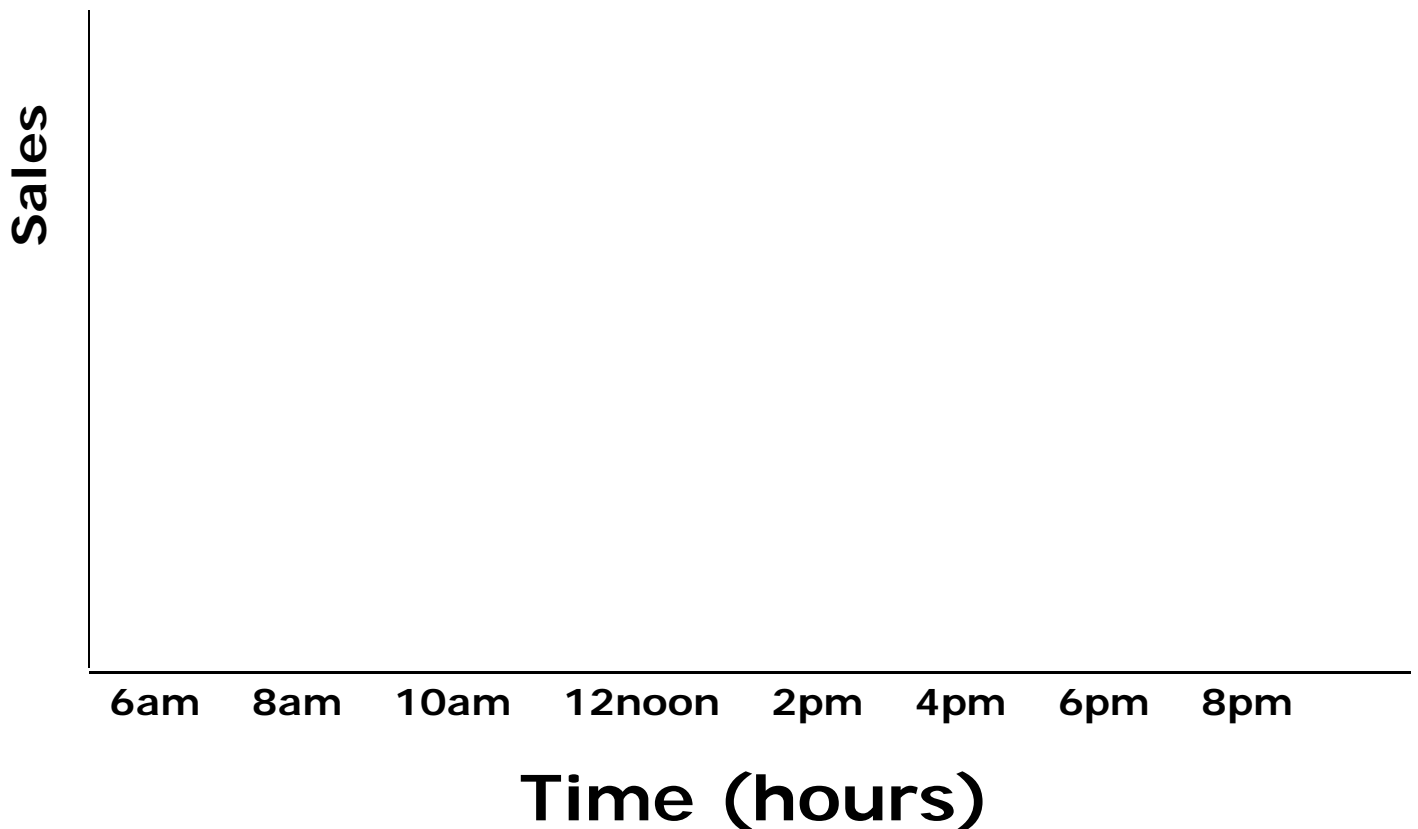
Data

We need two variables:

- time
- either count or measurement data (E.g. sales, economic data, births, etc)

Exercise:

1) Write down all the different units of time that you can think of.

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2) Why would we connect the data points together rather than drawing the co-ordinates separately? Explain.
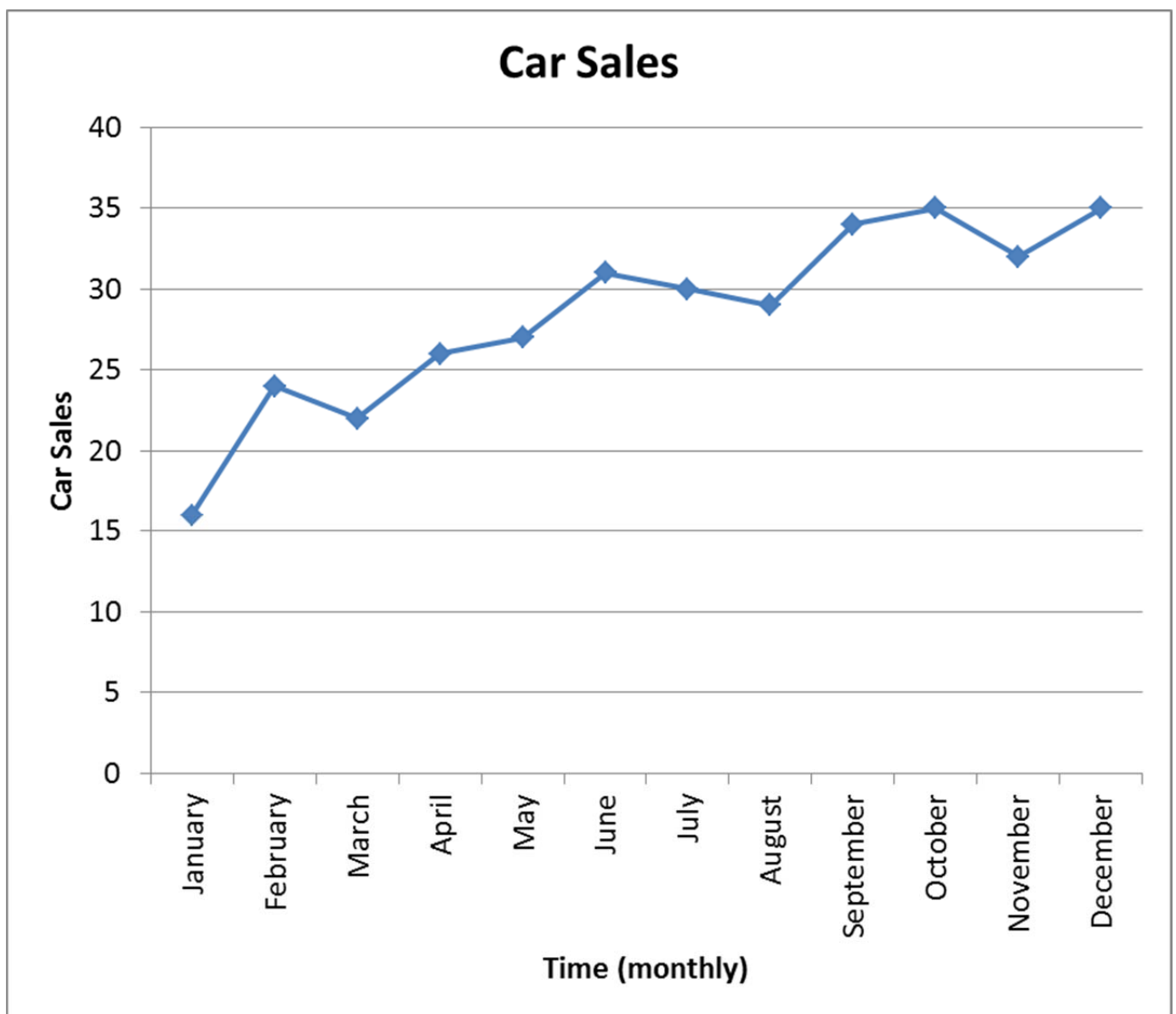
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Analysis

Graphs

With time series data, we draw a line graph. The connections between the dots show that the data is connected.

Line Graph

Below is an example of a line graph.

Car Sales

How to draw a line graph.

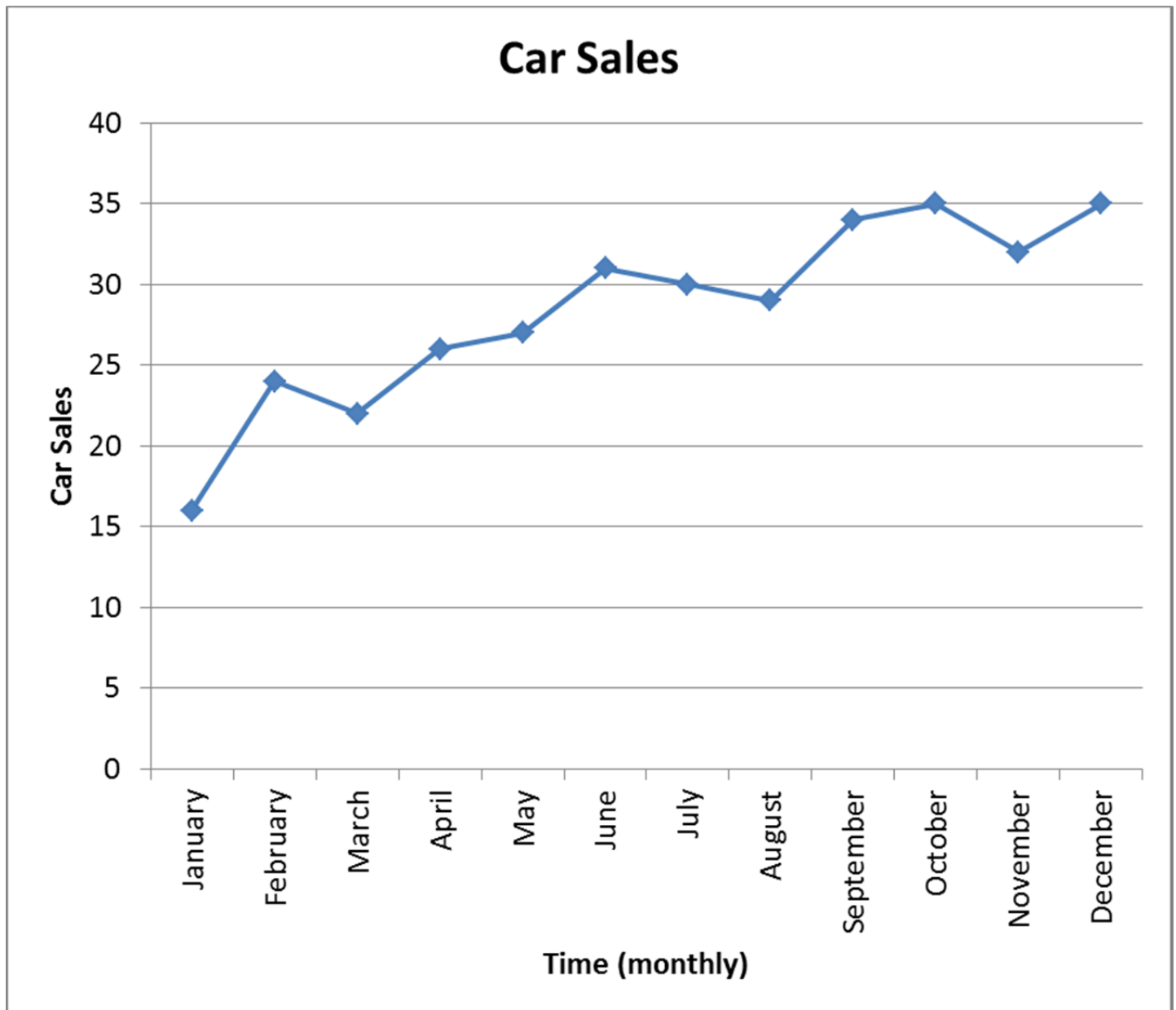Consider this data set of how many car sales were made each month over the year.

Month	Car Sales
January	16
February	24
March	22
April	26
May	27
June	31
July	30
August	29
September	34
October	35
November	32
December	35

1) Draw the horizontal axis, putting time on this axis. . Remember to label your axis

2) Draw the vertical axis. Look at what your largest data value is. Remember to label your axis

3) Use dots to mark the data points on the axis. Then connect these points together with a line. Your graph should look like the example on page 7.

Exercise:

1) Below is data on car sales over the last year, from a car sales yard down the road.

Car Sales

a) Describe how you see this yards car sales.

_____

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_____

b) Is the number of cars sold by a car yard a good indication of how well it is doing? What other factors might be involved?

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2) The dataset below shows the total ticket sales from the cinema complex Movietime.

Day	Date	Tickets sold
Sunday	June 9	622
Monday	June 10	205
Tuesday	June 11	271
Wednesday	June 12	583
Thursday	June 13	710
Friday	June 14	1416
Saturday	June 15	1784
Sunday	June 16	812
Monday	June 17	407
Tuesday	June 18	590
Wednesday	June 19	608
Thursday	June 20	802
Friday	June 21	1196
Saturday	June 22	1345
Sunday	June 23	310
Monday	June 24	414
Tuesday	June 25	415
Wednesday	June 26	834
Thursday	June 27	1221
Friday	June 28	1468
Saturday	June 29	1582

Draw both axes with the appropriate scale and label, and plot the points to create a line graph of movie ticket sales.

c) What does 'total daily ticket sales' mean here?

_____

_____

d) How many movie tickets were sold on June 13th?

_____

e) Do you think more or less tickets were sold on 24th June than 23rd?

_____

f) Could it be guaranteed that fewer tickets would be sold on any Monday than would be sold on the Saturday before? Explain why/why not.

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3) The dataset below shows the total chemist sales (in millions of dollars) from June 2009 to June 2013.

Chemist sales ($million)	
Jun-2009	204.6
Sep-2009	211.8
Dec-2009	242
Mar-2010	226.3
Jun-2010	208.9
Sep-2010	223.9
Dec-2010	257.8
Mar-2011	238.6
Jun-2011	233.5
Sep-2011	243.4
Dec-2011	268.9
Mar-2012	245.4
Jun-2012	236.6
Sep-2012	250.7
Dec-2012	269.8
Mar-2013	251.2
Jun-2013	242.3

Draw both axes with the appropriate scale and label, and plot the points to create a line graph of chemist sales.
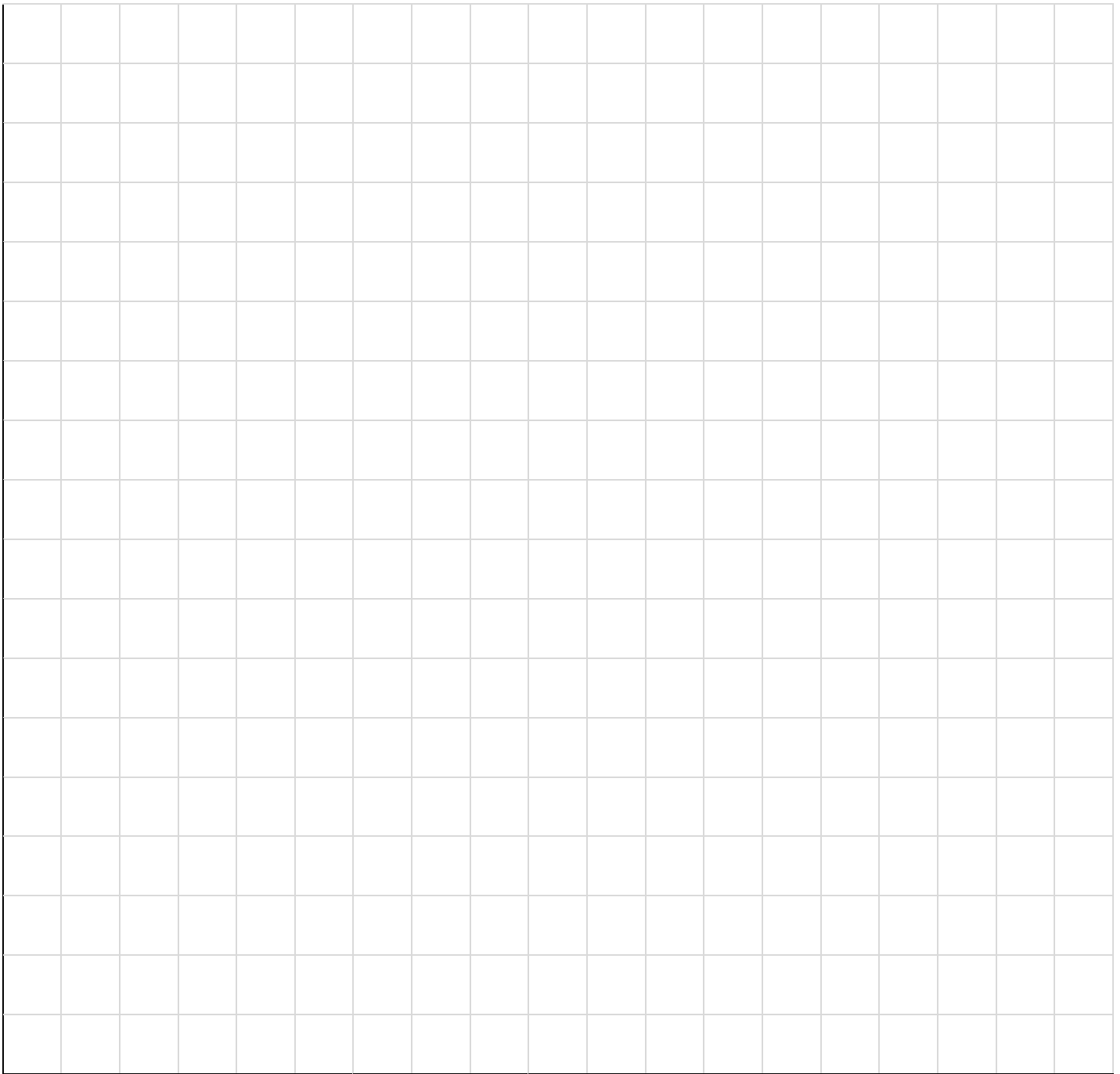
a) What does 'chemist sales' mean here?

_____

_____

b) How much money was spent in chemists from January 2010 to March 2010?

_____

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_____

c) How much money was spent at chemists over all of 2010?

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d) Over what months are chemist sales higher?

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e) Why would there be more sales in December? Explain.

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Analysis

Here are the features you need to analyse.

- Trend
- Seasonality

We will now go through each feature, before putting it all together.

Trend

1) Draw a trend line through the graph.

   - Try to get it through the middle, with about half of the data values above the line, and half below the line.

2) Describe whether the trend (line of best fit) has a positive, negative or zero gradient.

3) Lastly, write a sentence about the trend. Describe:

   - The direction – is it going up, down or has no trend

   - How much it is increasing or decreasing by.

Sentence Framework:

Level 2 / 3 / 4:

I notice that the data has an ___**increasing / decreasing / no**___ trend.

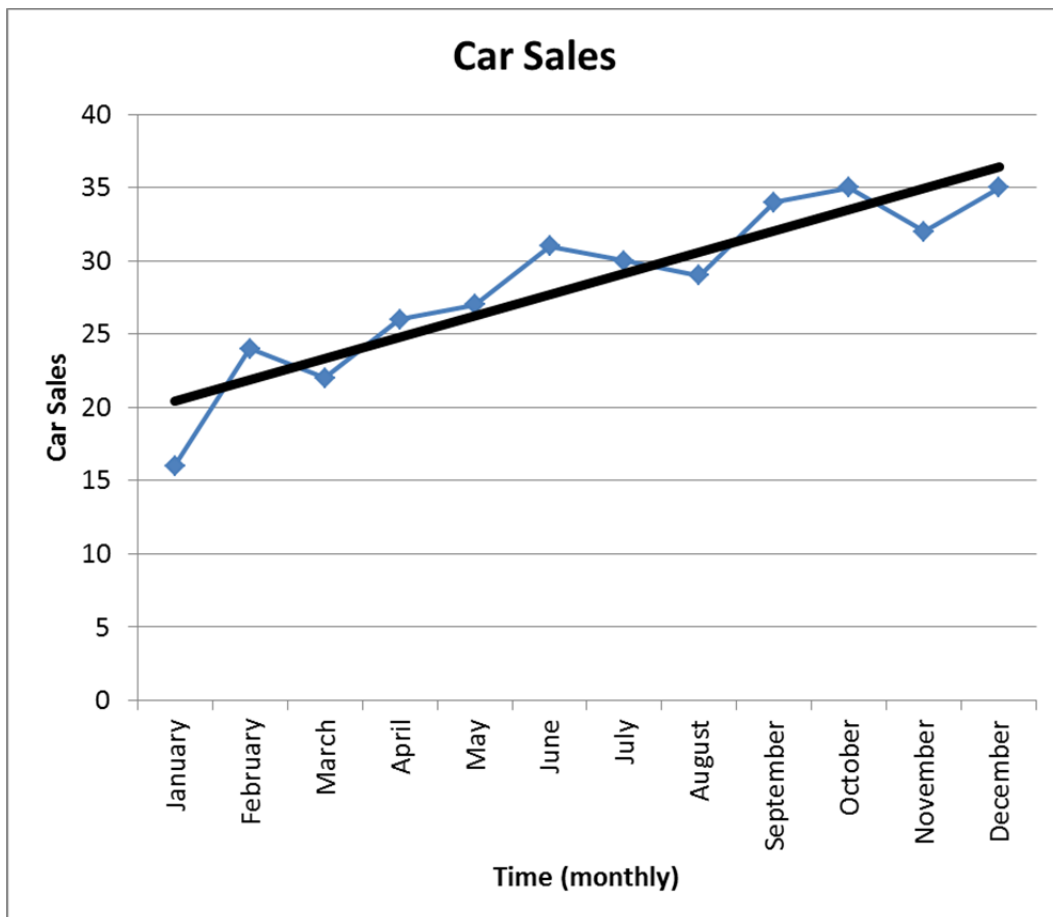This is because the line of best fit is going **up / down / straight across** .

Level 5:

I notice that the ___**context**___ has an ___**increasing / decreasing / no**___ trend.

The line of best fit starts at ___**initial trend value**___ and changes to ___**final trend value**___.

Level 6:

For every 1 ___**time unit**___ increase, **measurement increases / decreases** by ___**# units**___.

Example

Level 2 / 3 / 4:

I notice that the data has an increasing trend. This is because the line of best fit is going up.

Level 5:

I notice that the car sales has an increasing trend.

The line of best fit starts at 21 and changes to 36.

Level 6:

For every one month increase, the number of car sales increases by 1.3.

OR

The number of car sales is increasing by around 15 cars over the year.

Seasonality

If you have data that covers more than one time period (for example several years), we can notice if there is a common pattern that occurs each season (e.g. summer, autumn, January, etc).

STEP 1

Figure out if you have seasons that you can compare. Some examples may be:

Seasons: Summer, Autumn, Winter, Spring.

Months: January, February, March, April, May, June, July, August, September, October, November, December.

Days: Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday.

Hours: 1am, 2am, 3am, 4am, 5am, 6am, 7am, 8am, 9am, 10am, 11am, 12noon, 1pm, 2pm, 3pm, 4pm, 5pm, 6pm, 7pm, 8pm, 9pm, 10pm, 11pm, 12pm.

STEP 2

Match up and highlight repeating seasons. For example, match up and highlight all the Spring seasons.

Example

2012				2013			
Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring

STEP 3

Notice whether each season (e.g. Summer) is always above, below, or the same as the trend line.

STEP 4

Write sentences about the seasons. Describe:

- How many seasons there are.
- Whether each season is above, below, or the same as the trend.

STEP 5 (Level 6)

Can you link this to the context, and explain why the seasons may be above or below the trend?
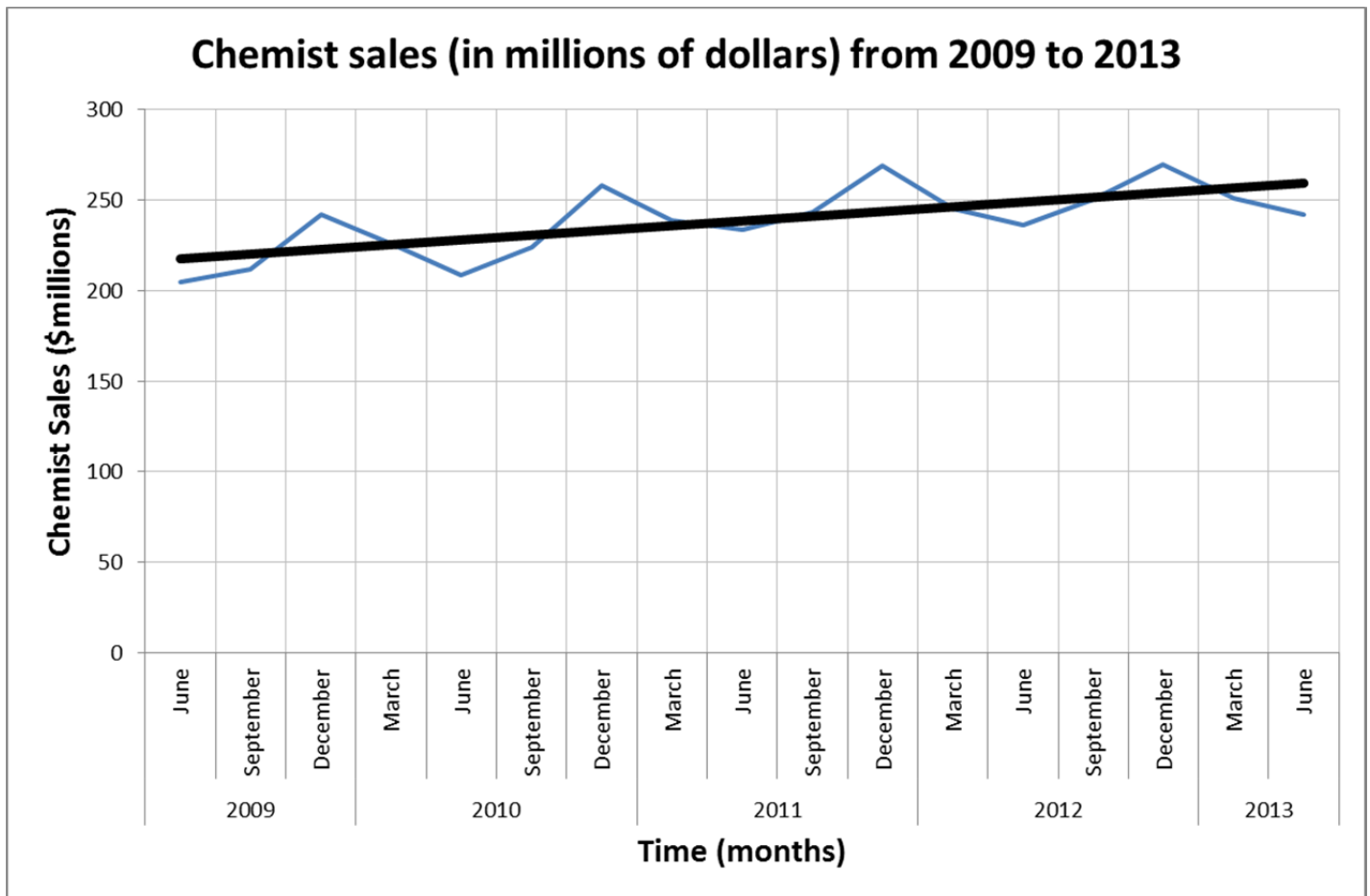
Sentence Framework:

I notice that the data has number seasons. They are: **autumn, winter, spring and summer / January, February, etc / Monday, Tuesday, etc / 1am, 2am, 3am, etc**

I notice that **season 1** is always **above / below / the same as** the trend.

I notice that **season 2** is always **above / below / the same as** the trend.

Etc.

Example

Chemist sales (in millions of dollars) from 2009 to 2013

I notice that there are 4 seasons: March, June, September, December.

This means that the March season is the total chemist sales from January, February and March.

The June season is the total chemist sales from April, May and June.

The September season is the total chemist sales from July, August and September.

The December season is the total chemist sales from October, November and December.

June

I'll start with matching up and highlighting every June.
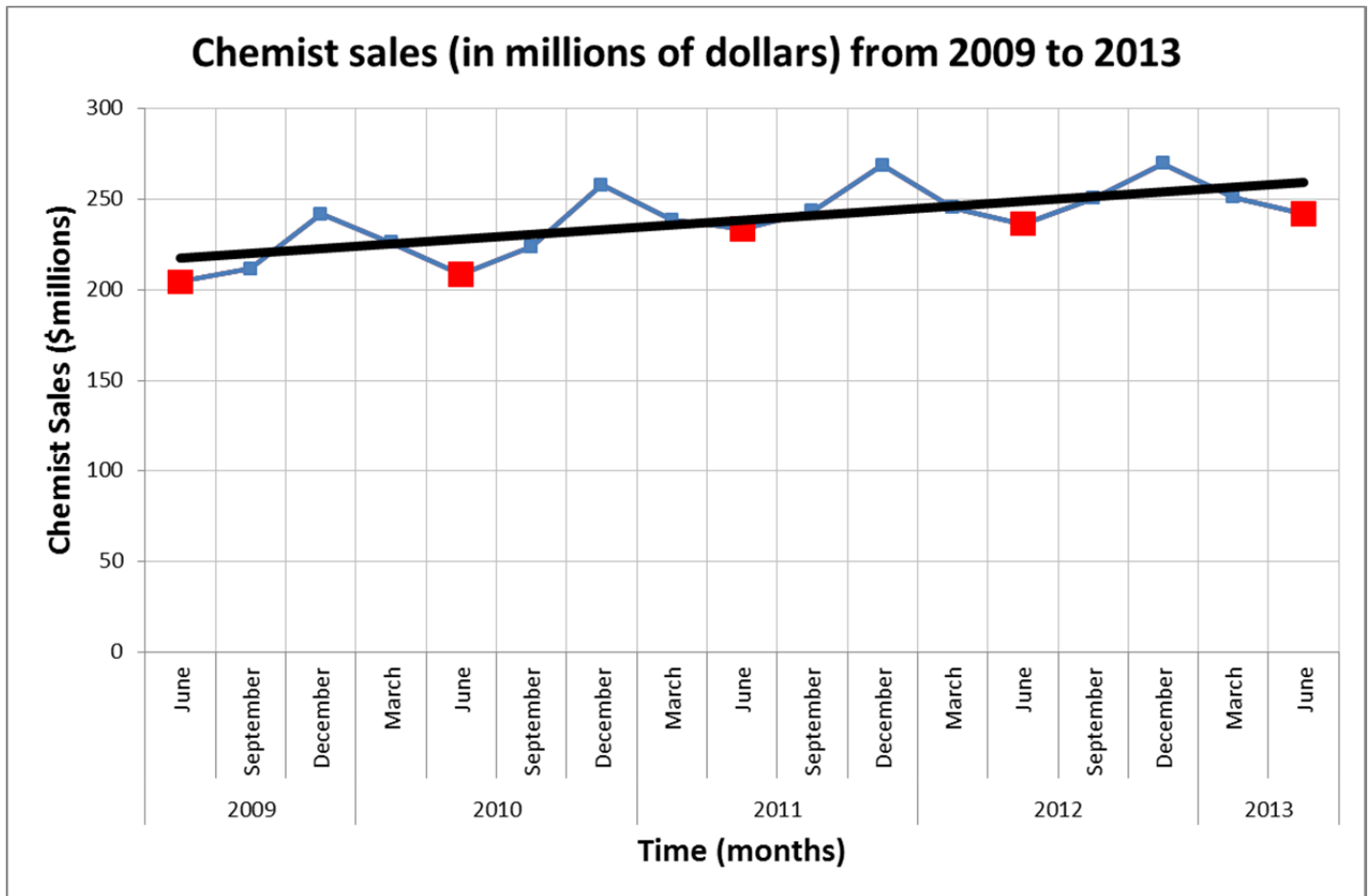
I notice that the June chemist sales are always under the trend.

This may be because in the months of April, May and June these are the autumn seasons, where people are quite healthy generally speaking after a warm summer. Therefore they don't have big demands on sunscreen (in summer) or flu medication (in winter).

September

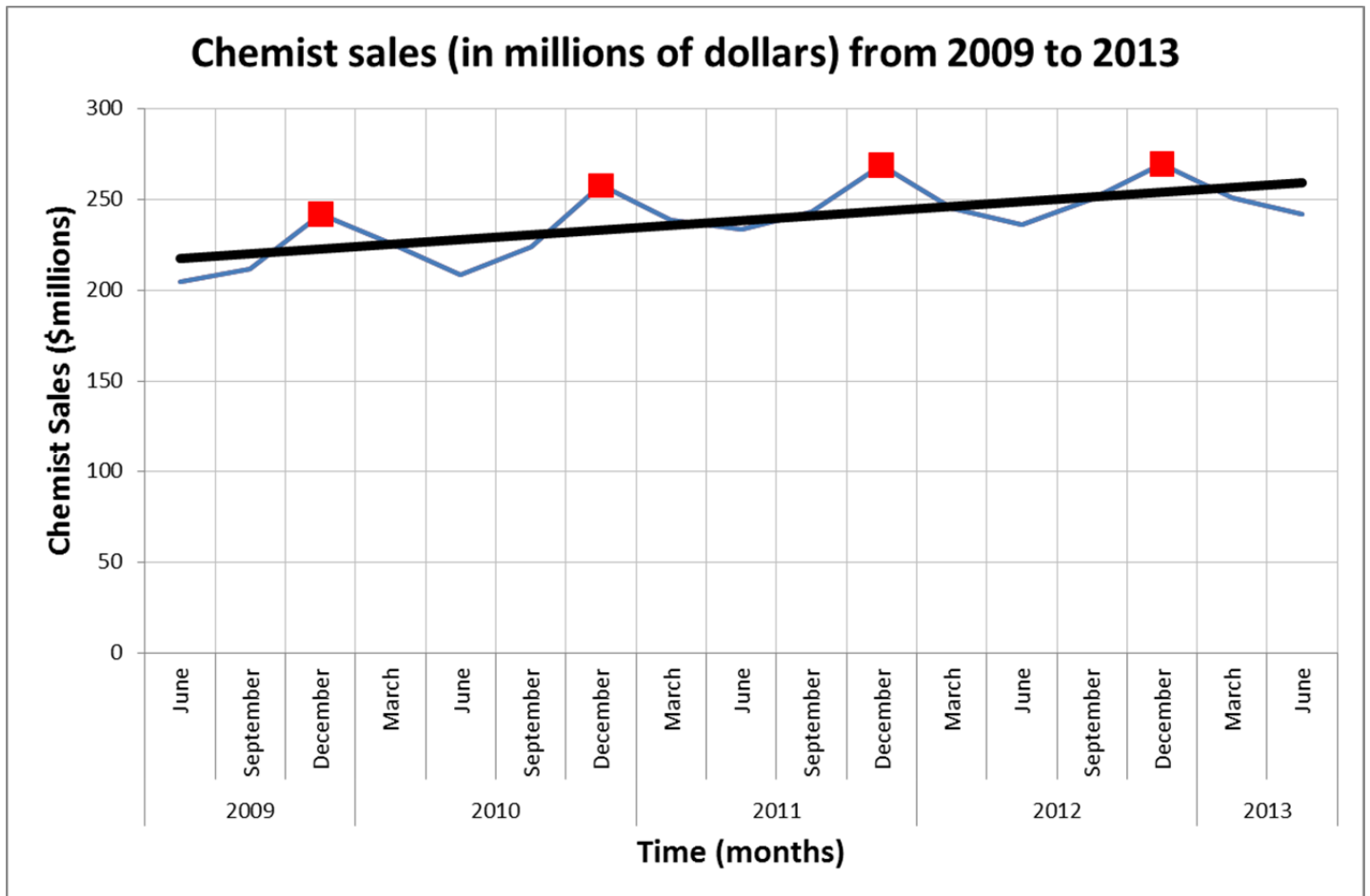**Chemist sales (in millions of dollars) from 2009 to 2013**
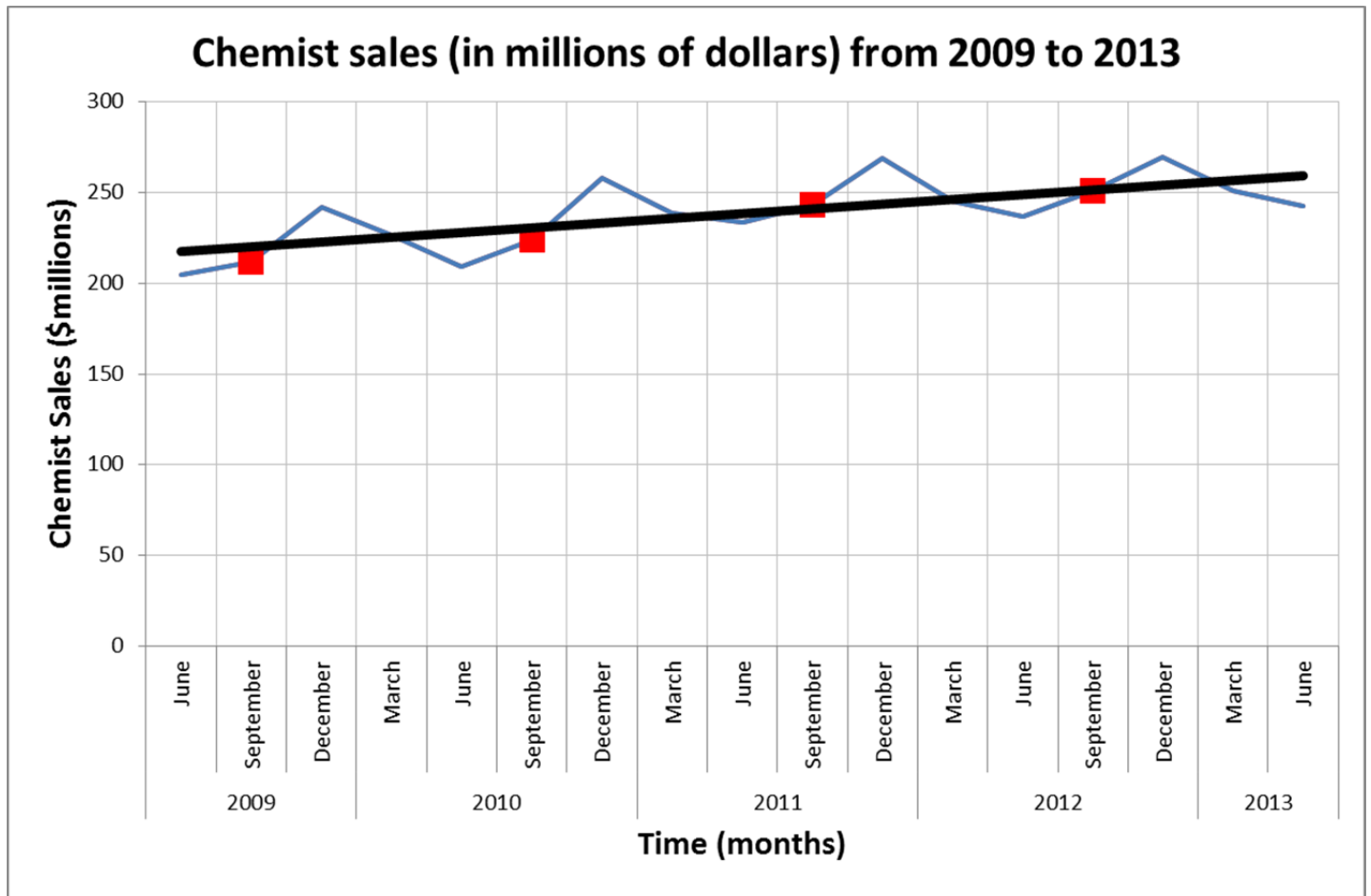
I notice that the September chemist sales are either just under the trend or the same as the trend.

This may be because in the months of July, August and September these are the winter seasons, where people purchase more flu medications.

December

Chemist sales (in millions of dollars) from 2009 to 2013

I notice that the December chemist sales are always above the trend.

This may be because in the months of October, November and December these are the spring seasons, where people are still recovering from winter bugs, purchasing sunscreen as the weather gets warmer, and of course in December there is Christmas, and people will likely be purchasing gifts from all shops including the chemist, raising the sales higher than normal.

March

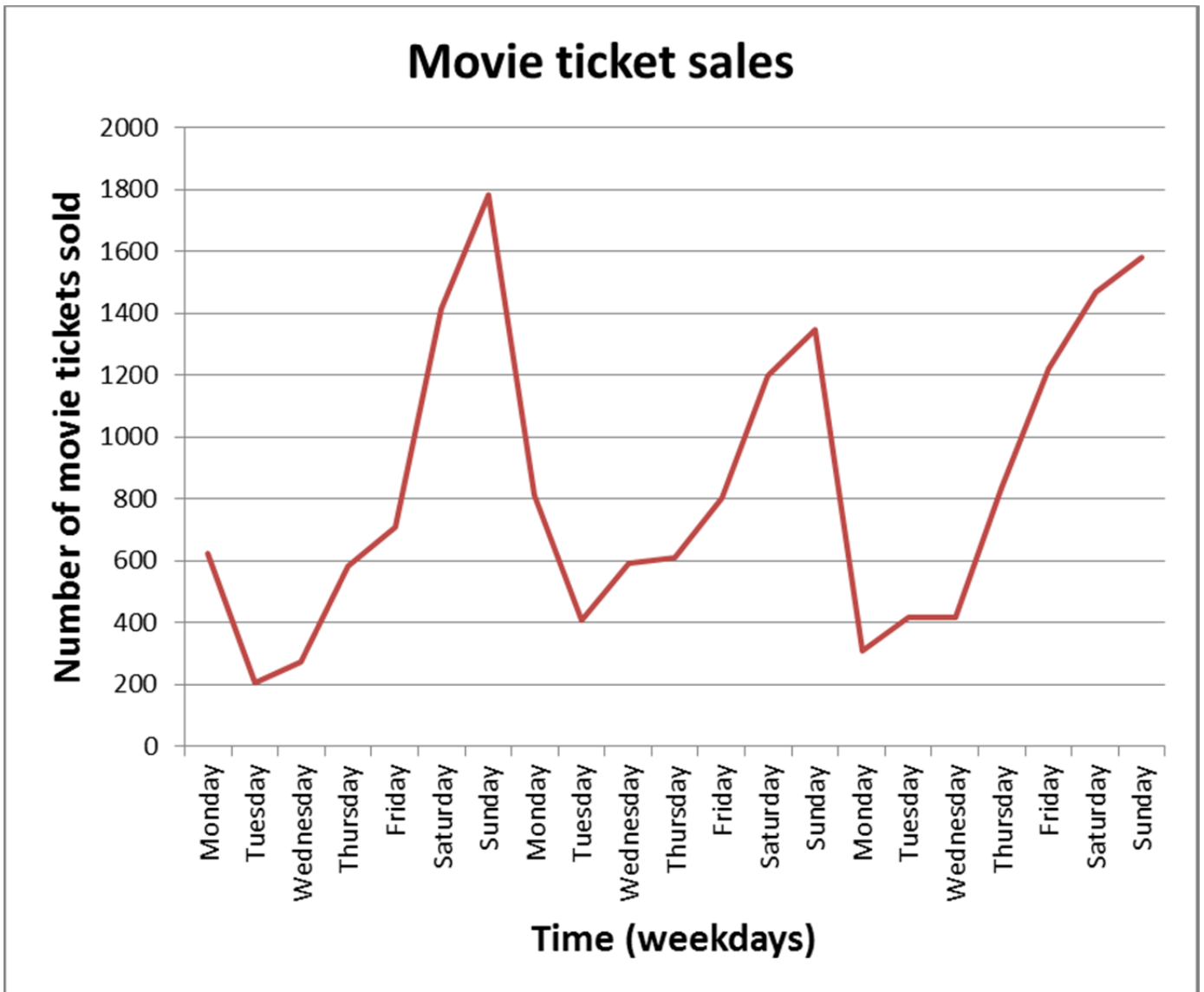## Chemist sales (in millions of dollars) from 2009 to 2013
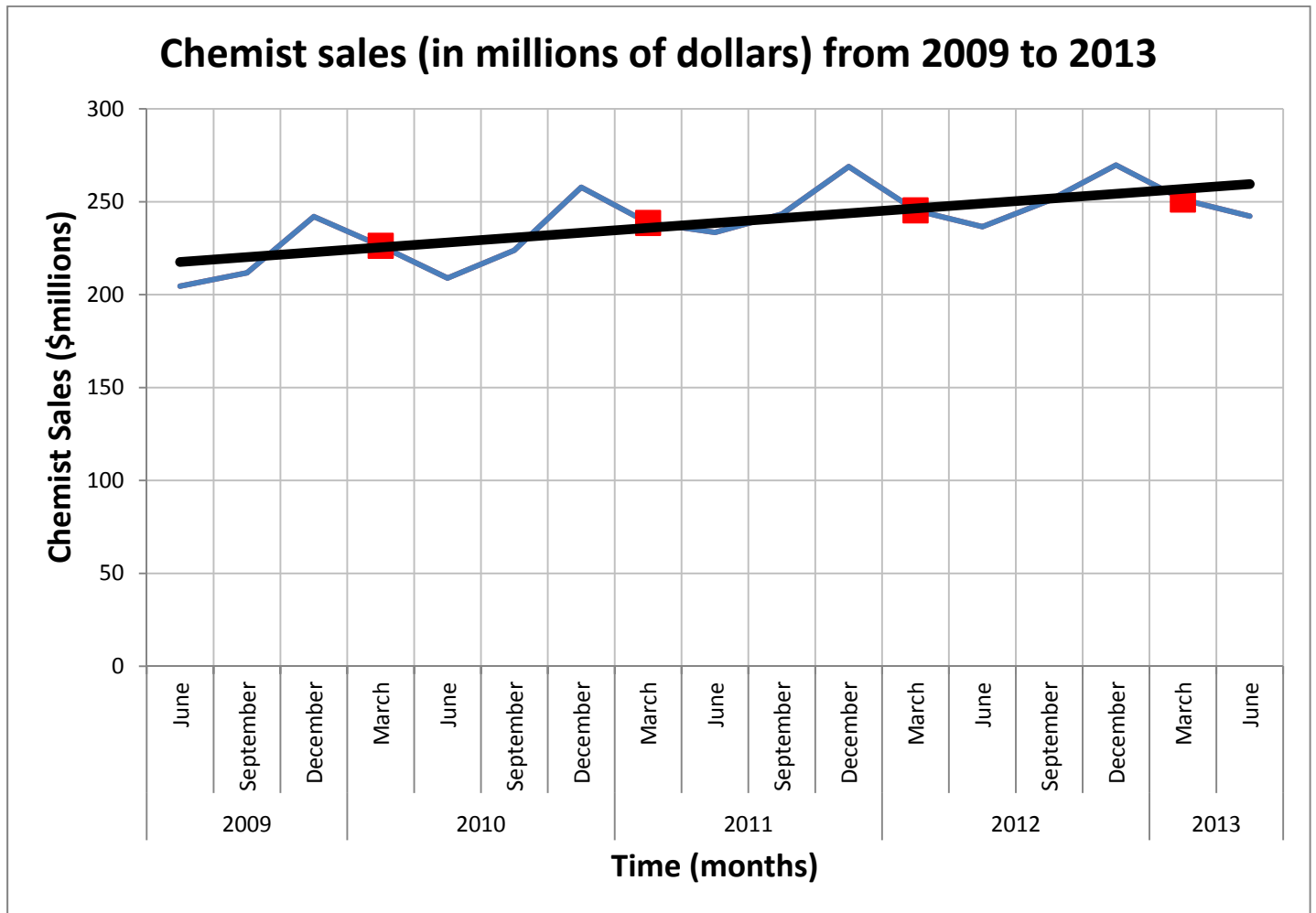
I notice that the March chemist sales are either just under the trend or the same as the trend.

This may be because in the months of January, February and March these are the summer seasons, where people are purchasing more sunscreens.

Exercise:

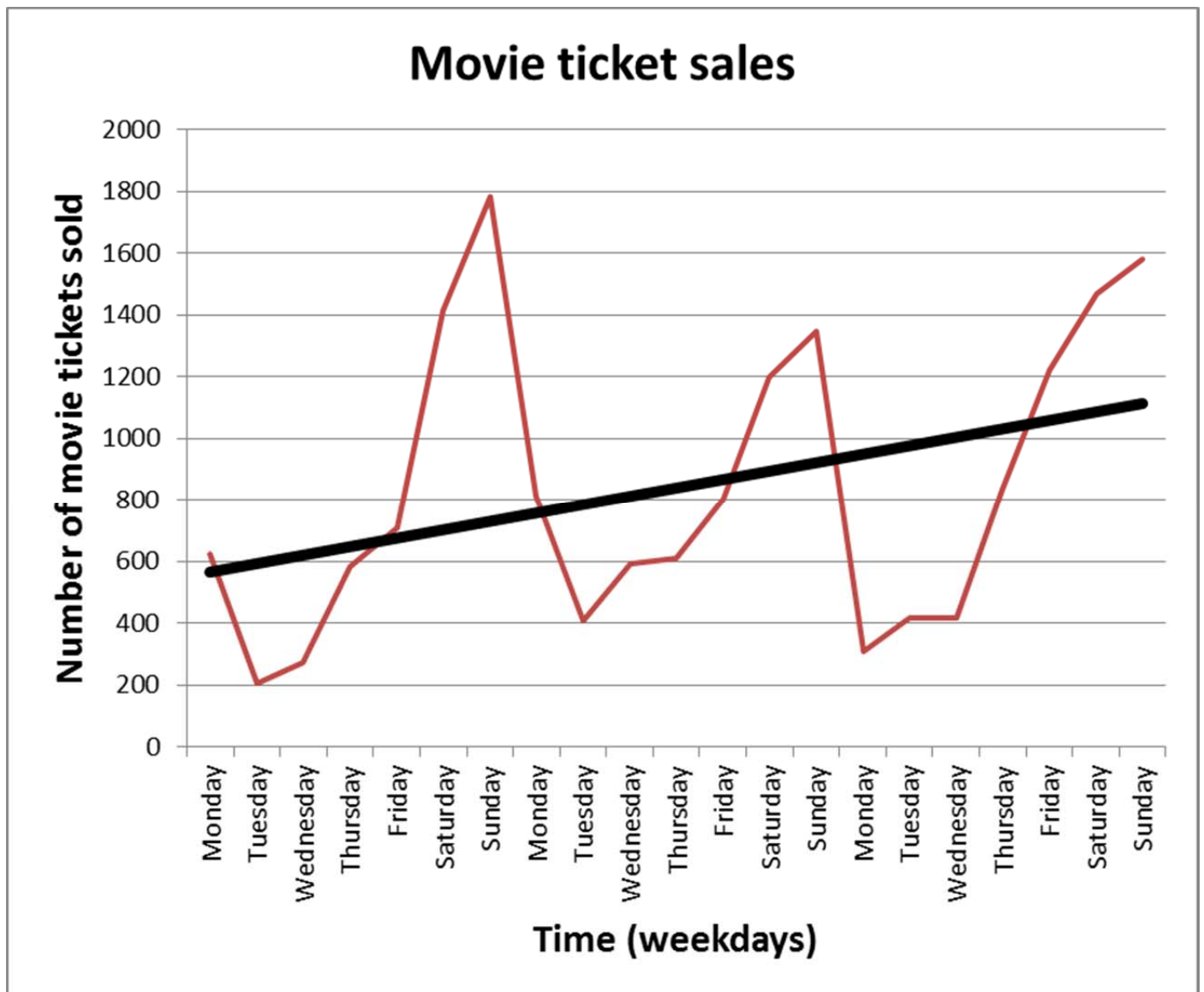1) Here is the graph of movie ticket sales in the last 3 weeks.

Movie ticket sales

a) Draw a trend line through the data in the graph above.

b) What does the trend line show?

I notice ... _____

_____

_____

Here is the graph drawn again with a trend line added. You now want to look at the seasons.

Movie ticket sales

a) What are the seasons, and how many are there for this data?

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b) Match up and highlight all the Monday movie ticket sales. What do you notice?

I notice …_____

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c) Match up and highlight all the Tuesday movie ticket sales. What do you notice?

I notice …_____

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d) Match up and highlight all the Wednesday movie ticket sales. What do you notice?

I notice …_____

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e) Match up and highlight all the Thursday movie ticket sales. What do you notice?

I notice …_____

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f) Match up and highlight all the Friday movie ticket sales. What do you notice?

I notice …_____

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g) Match up and highlight all the Saturday movie ticket sales. What do you notice?

I notice …_____

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h) Match up and highlight all the Sunday movie ticket sales. What do you notice?

I notice …_____

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2) Below is a graph of the amount (in millions of dollars) that people in NZ spent on takeaway foods from 2006 to 2010.

Amount of money spent on takeaways in NZ

a) Draw a trend line through the data in the graph above.
b) What does the trend line show?

I notice ... _____

_____

_____

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_____

You now want to look at the seasons.

c) What are the seasons, and how many are there for this data?

_____

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_____

d) What patterns do you notice with the different seasons?
I notice … _____

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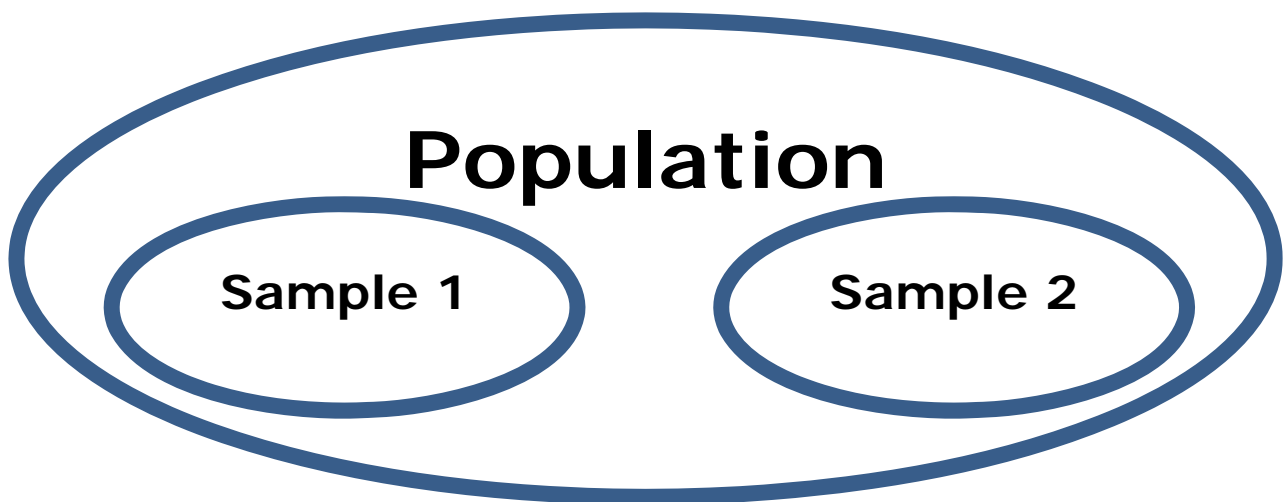
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Conclusion

For your conclusion you need to:

- Make a concluding sentence, stating if there is any trend or seasonality present.

- Discuss variation.

- Discuss which population the sample may be applied to.

Variation

Population

Sample 1

Sample 2

When we look at time series graphs, the patterns are never exactly the same from year to year.

All data has random variation. Some data sets have very little random variation, and other data sets have a lot of random variation.

Example

Chemist sales (in millions of dollars) from 2009 to 2013
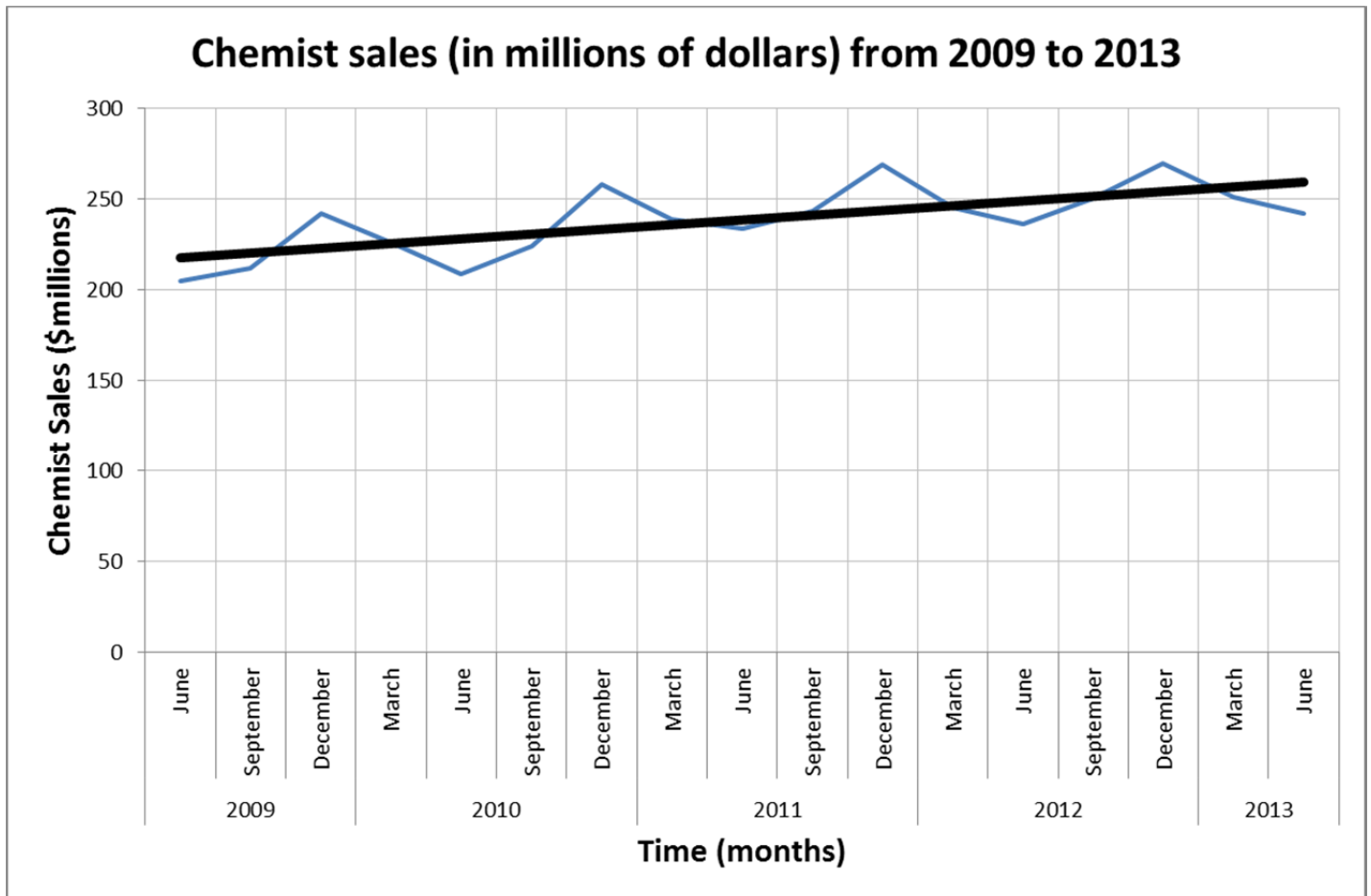
Conclusion:

From our sample, we can conclude that a there is an increasing trend from 2009 to 2013, and a seasonality pattern that regularly repeats each year.
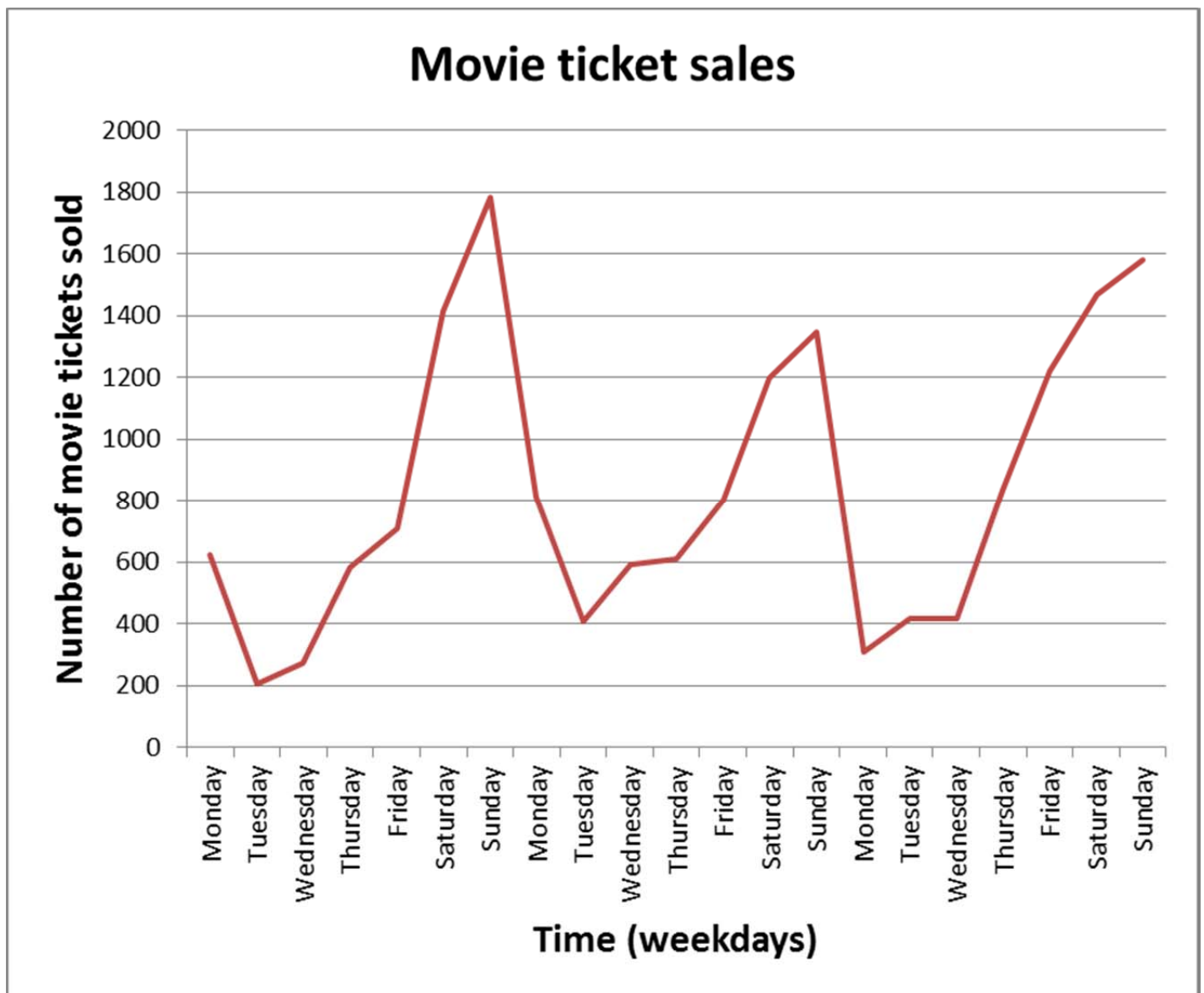
Variation is present in this data set as we can see the pattern is not exactly the same each time.

The data is from the total chemist sales in New Zealand from 2009 to 2013. These results may be similar in countries such as Australia.
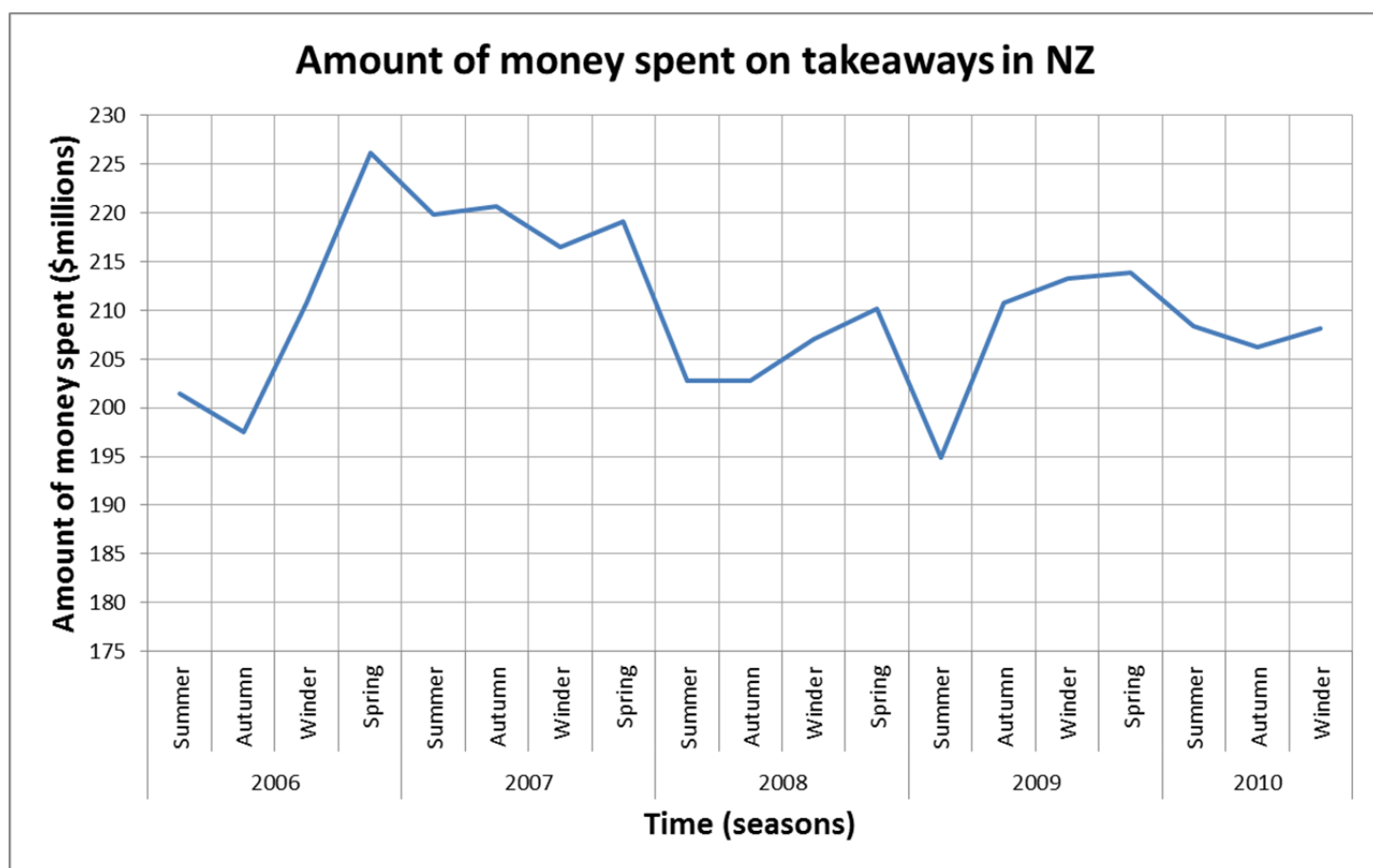
Exercise:

Draw conclusions about the following data.

1) Movie ticket sales in the last 3 weeks.

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2) Chemist sales from 2007 to 2010.

Amount of money spent on takeaways in NZ

Y-axis: Amount of money spent ($millions)
X-axis: Time (seasons)

Summer Autumn Winder Spring | Summer Autumn Winder Spring | Summer Autumn Winder Spring | Summer Autumn Winder Spring | Summer Autumn Winder

2006 | 2007 | 2008 | 2009 | 2010

_____

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Investigation Exercise

Problem

I wonder if there are any patterns in our classes' absence data?

Plan

We will collect data each day, over term the first 4 weeks of term 3.

Then we will record how many students from our class were absent each day.

Data

Week	Day	Number of absences
1	Monday	3
	Tuesday	2
	Wednesday	2
	Thursday	1
	Friday	2
2	Monday	4
	Tuesday	2
	Wednesday	1
	Thursday	1
	Friday	3
3	Monday	4
	Tuesday	2
	Wednesday	2
	Thursday	3
	Friday	4
4	Monday	6
	Tuesday	4
	Wednesday	3
	Thursday	3
	Friday	5

Analysis

Draw a line graph.
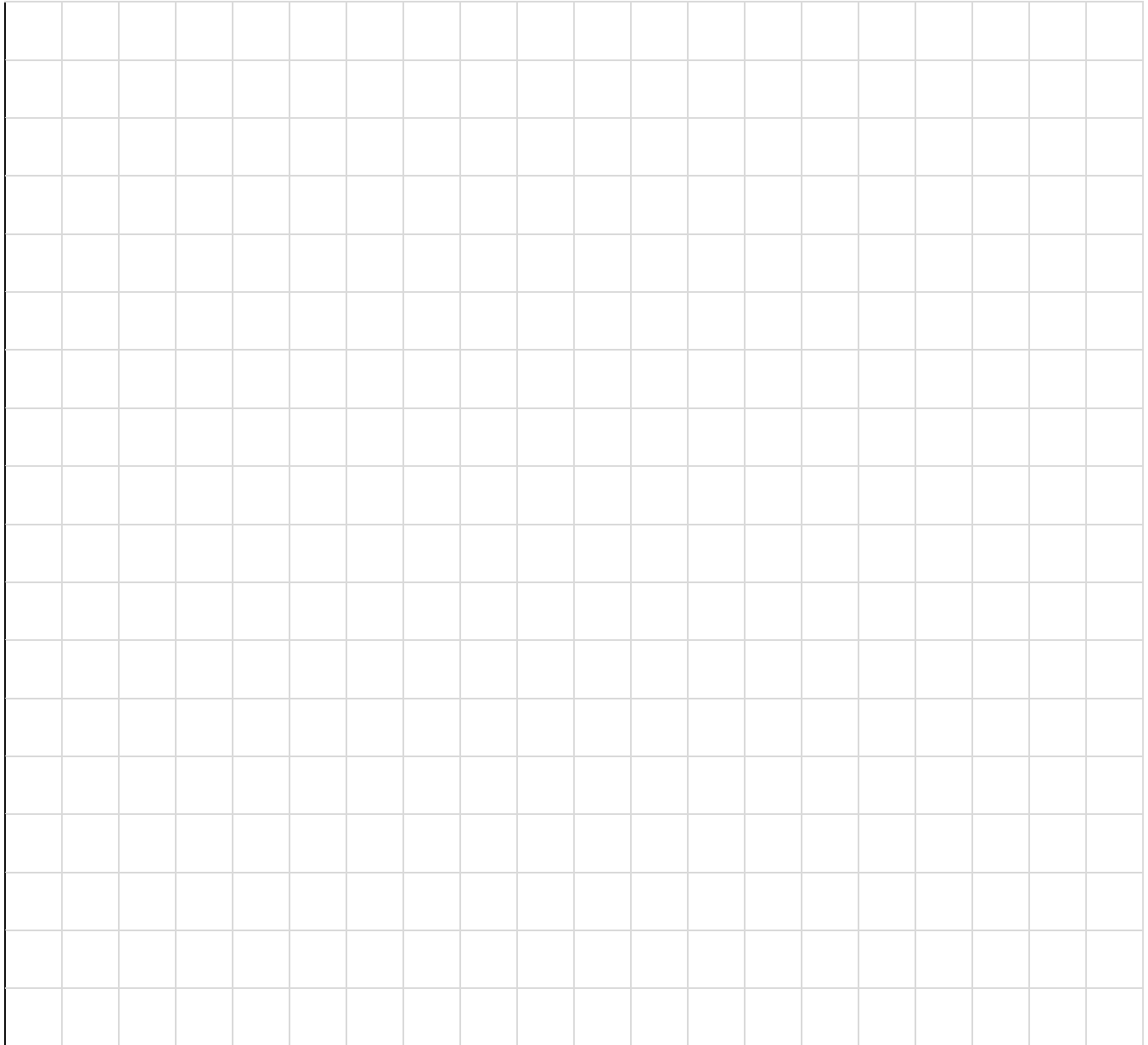
Analysis

Describe the trend and seasonality. Justify your description.

Conclusion

Answer the investigation question.

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What does this data suggest about attendance in this class? Can the results be applied to the whole school or other schools in NZ?

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