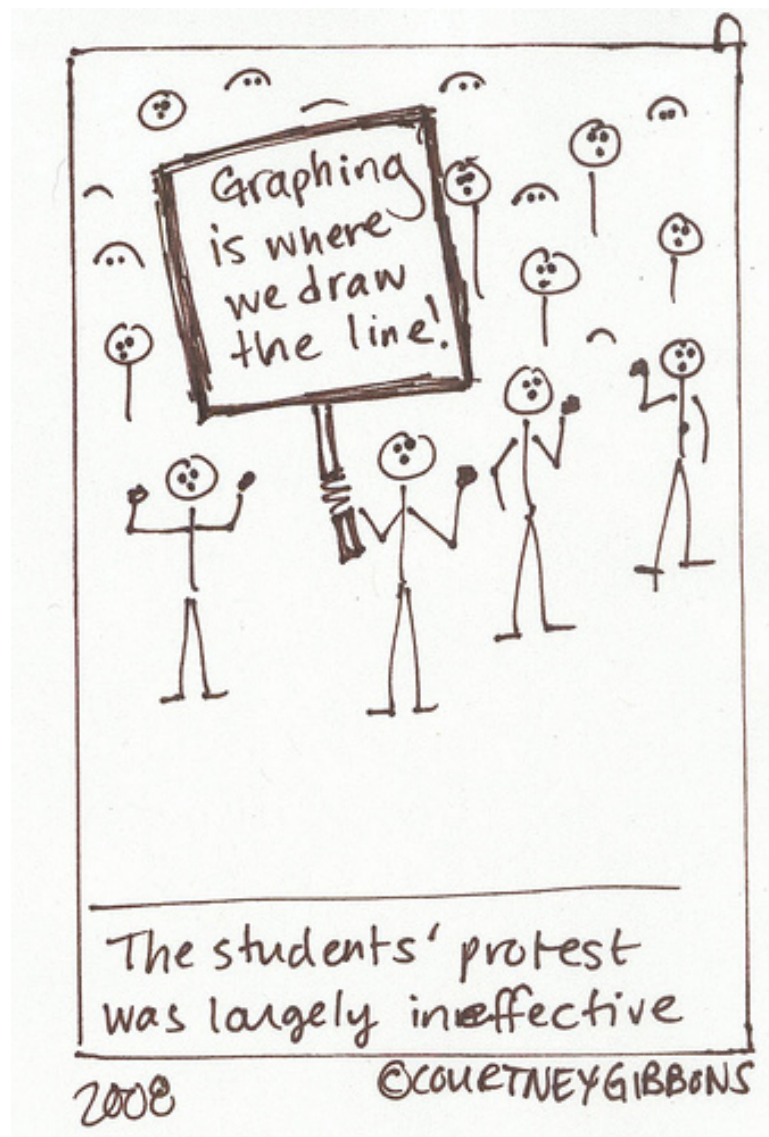


# Unit 2 – Linear Relations

## *Chapter 2 – Relations* *Workbook*

MPM1D



## Chapter 2 Worksheet Checklist

Worksheet	Check ✓
2.1 – Hypotheses and Sources of Data	
2.2 – Sampling Principles Worksheet	
2.3 – Scatter Plots Worksheet	
2.4 – Trend, Interpolation, and Extrapolation Worksheet	
2.5 – Linear and Non-Linear Relations Worksheet	
2.6 – Distance Time Graphs Worksheet #1	
2.6 – Distance Time Graphs Worksheet #2	
Chapter 2 Review Crossword	
Chapter 2 Review	

Mark /10	0-2	3-5	6-8	9-10
<b>Work completion for chapter 3</b>	Little to know homework done throughout chapter.	Some homework completed. Unorganized.	Most homework completed. Work clear and organized.	All homework completed accurately. Great organization of work.

Mark /4	1	2	3	4
<b>In Class Work for Chapter 3</b>	Class time not used well for work completion. Inattentive during lessons. Need to improve at limiting distractions.	Some work completed during class. Sometimes distracted during lessons.	Works well during class. Minimal distractions. Good attention during lessons.	Always uses class time efficiently. Pays attention and contributes to lessons.

**Comments:**

## 2.1 Hypotheses and Sources of Data

MPM1D

1. State the opposite of each hypothesis.

a) Most people's favourite number is 7.

b) Adults spend more time listening to classical music than to rap.

c) In Ontario, more teenagers join soccer teams than hockey teams.

d) Chocolate is not the most popular flavor of ice cream.

2. State a hypothesis about a relationship between each pair of variables. Then, state the opposite of each hypothesis.

a) A student's age and time spent doing homework

hypothesis:

opposite hypothesis:

b) A mother's height and the height of her children

hypothesis:

opposite hypothesis:

c) Temperature and crime rates

hypothesis:

opposite hypothesis:

d) The cost of gasoline and the number of people using public transit

hypothesis:

opposite hypothesis:

**3.** Which of the following data are primary and which are secondary?

a) An office manager hands out a questionnaire to see if employees want to work earlier hours during the summer.

b) A student finds data on internet use in a report published by Statistics Canada.

c) A researcher collects information about how far people travel on public transit by talking to passengers on the buses.

d) A researcher downloads data about the length of rides taken on public transit from a transit authority's Web site.

**4.** Identify each data source as primary or secondary. State one advantage of each source of data.

a) A researcher interviewed 100 students about their study habits.

b) A sporting goods company searched on the Internet for data on how Canadians spend their leisure time.

c) A manufacturer surveyed 1000 recent customers about possible changes to a product.

d) A student found advertisements in out-of-town newspapers at a library to check admission prices at theatres across the country.

5. a) Make a hypothesis about whether the students in your class prefer cats or dogs as pets.

b) Describe how you could test your hypothesis. Explain whether you would use primary or secondary data.

6. Steve prepared the following table using data volunteered by eight male students in his science class.

a) Is Steve using primary or secondary data? Explain.

Name	Eye Colour	Height (cm)
Josanth	brown	167
Fred	green	181
Graham	green	185
Cho	brown	171
Seth	blue	154
Jamal	green	183
Juan	brown	160
Cameron	blue	173

b) Make two hypotheses based on these data.

c) How could you test your hypotheses?

**7.** a) Make a hypothesis about the number of phone calls Canadians make.

b) Describe how you could use primary data to test your hypothesis.

c) Describe how you could use secondary data to test your hypothesis.

d) Which set of data is more likely to give accurate results?

**8.** A coach is selecting students to compete in the high jump for the school's track and field team.

a) Make a hypothesis about a physical characteristic that could help an athlete do well in the high jump.

b) What data would you need to test your hypothesis? Would you use primary or secondary data? Explain why.

**Bonus:** The mean of a list of  $n$  numbers is 6. When the number 17 is added to the list, the mean becomes 7. What is the value of  $n$ ?

Answers:

1.
  - a) Most people's favourite number is not 7.
  - b) Adults do not spend more time listening to classical music than rap. (Alternative: Adults spend either less time or as much time listening to classical music as they spend listening to rap.)
  - c) In Ontario, the number of teenagers who join hockey teams is greater than or equal to the number who join soccer teams.
  - d) Chocolate is the most popular flavour of ice cream.
2. Answers will vary. Examples:
  - a) Hypothesis: Time spent doing homework increases as a student's age increases. Opposite: Time spent doing homework does not increase as a student's age increases.
  - b) Hypothesis: Children tend to grow to the same height as their mothers. Opposite: Children do not tend to grow to the same height as their mothers.
  - c) Hypothesis: As temperature increases, the crime rate also increases. Opposite: As temperature increases, the crime rate decreases or remains constant.
  - d) Hypothesis: As the cost of gasoline increases, the number of people using public transit increases. Opposite: As the cost of gasoline increases, the number of people using public transit decreases or stays the same.
3.
  - a) Primary; the office manager gathers the data.
  - b) Secondary; the student uses data gathered by Statistics Canada.
  - c) Primary; the researcher gathers the data.
  - d) Secondary; the researcher uses data gathered by the transit authority.
4. Answers about advantages will vary.
  - a) Primary; data are up-to-date
  - b) Secondary; Internet search is fast and easy
  - c) Primary; getting opinions from customers
  - d) Primary; data are up-to-date
5. Answers will vary. Examples:
  - a) Most students in the class prefer dogs as pets.
  - b) Survey the class. Primary data are best since the population is small and secondary data may not be available.
6.
  - a) Primary; Steve gathered the data himself.
  - b) Answers will vary. Examples: Brown-eyed students are shorter. Blue is the least common eye colour.
  - c) Survey a larger sample.
7. Answers will vary. Examples:
  - a) Females make more phone calls than males.
  - b) Survey 50 females and 50 males.
  - c) Look for data on the Internet or in publications.
  - d) Secondary sources using larger samples are more likely to be accurate.
8. Answers will vary. Examples:
  - a) Taller people perform better at the high jump.
  - b) Heights of the athletes and how high the athletes can jump; primary data for the school team would be easy to collect, but secondary sources could give a larger sample and more accurate results.

## 2.2 – Sampling Principles Worksheet

MPM1D

1. Identify the population in each situation

- a) Generally, girls learn to walk before boys do.
- b) The mean mark on yesterday's test was 72%
- c) As cars age their repair costs increase
- d) Most food stores charge more for cream than for milk.

2. Describe the data required to answer each question. Explain whether you would use a census or a sample to collect each set of data.

- a) Do girls learn to walk before boys do?
- b) Is the mean mark on a test greater than 75%?
- c) Is the mean annual salary of employees in Canada less than \$50 000?
- d) How are a person's height and age related?



f) What is the most common colour among the cars that drive by your school?

3. Describe how you could choose a random sample to determine each of the following:

a) The type of coffee preferred by customers of a local café.

b) Ontario teenagers' favourite magazines.

c) Political parties supported by bilingual Canadians

d) Countries of origin for immigrants to Canada.

4. Identify the type of sample in each situation. Comment on any possible bias in these samples.

a) A career studies class interviews University of Waterloo graduates to learn about career choices for university graduates.

b) A town council randomly selects phone numbers from a town directory to survey citizens' opinions on a new park.

c) Moviegoers leaving a cinema are interviewed to find out how people spend their free time.

d) Every fifth person entering the cafeteria is asked to fill out a questionnaire about the menu.

5. List three ways you could divide the students in your school into groups for selecting a stratified random sample.

i.

ii.

iii.

6. A government agency wants to survey Ontario farmers.

a) Identify the population.

b) Suggest a stratified random sampling technique that the agency could use.

7. A company wants to select 50 of its 325 employees for a survey.

a) Identify the population.

b) Describe a systematic random sampling technique that the company could use.

8. The physical education department wants to survey the members of school teams.

a) Identify the population.

b) Describe a method of randomly selecting 15% of the members of the teams.

9. (Extension Question) This table lists the enrolment at a high school. The school administration wants to interview a random sample of 150 students, stratified by grade. How many students should the administration select from each grade?

Grade	Number of Students
9	330
10	308
11	295
12	283

10. Identify the population for each of the following. Then, describe how you could select an appropriate sample of each population.

a) The popularity of various kinds of music in your school.

b) The popularity of various kinds of music in your community.

c) The effectiveness of a national campaign to convince people between the ages of 18 and 30 not to smoke.

d) The spending habits of senior citizens in Ontario.

e) The quality of printing from various computer printers on sale in Canada.

f) The mean cost of gasoline in your community.

11. Even in the 1920s, polling companies conducted surveys by calling people randomly selected from telephone directories. Explain why using this sampling method in the 1920s would not produce a representative sample of the opinions of everyone in the country.

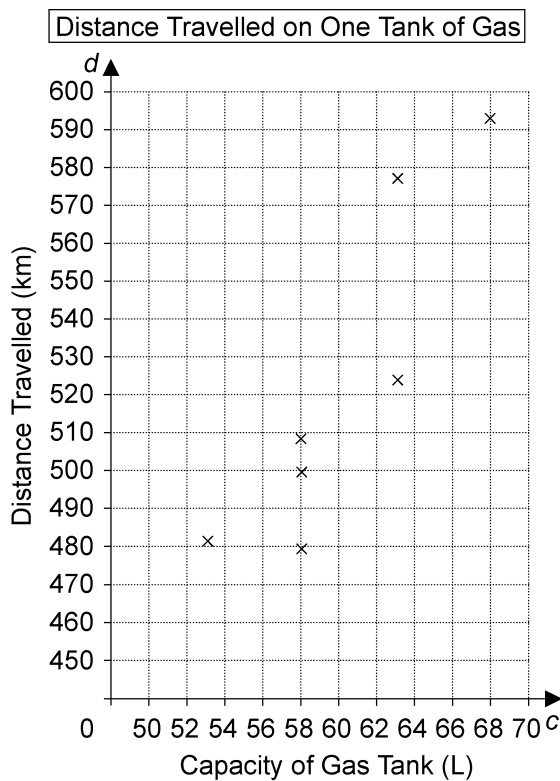
## Answers:

1. a) all children      b) everyone who wrote the test  
c) all cars      d) all food stores
2. a) age when girls and boys learn to walk; sample  
b) test marks; census  
c) salaries of Canadian employees; sample  
d) people's heights and ages; sample  
e) make of car in school parking lot; census  
f) colour of cars driving by the school; sample
3. Answers will vary. Examples:  
a) Survey every fourth customer who comes into the cafe.  
b) Randomly select 1% of the teenagers in every high school across Ontario.  
c) Use a random number generator to select telephone numbers within Canada, and then survey the people who identify themselves as bilingual.  
d) Select households to survey by any random method, and then ask the people surveyed where they were born.
4. a) non-random sample; could be biased since University of Waterloo students may not be representative of all university graduates  
b) simple random sample; could be biased since the sample excludes anyone who does not have a telephone listing  
c) non-random sample; biased because it includes only people who have chosen to spend some of their free time going to a movie
5. by age, by grade, by gender
6. a) all Ontario farmers  
b) Answers will vary. Example: Randomly select 10% of the farmers in each county.
7. a) the company's employees  
b) Randomly select a starting point on an alphabetical list of the employees, and then select every sixth person until you have a total of 50.
8. a) members of the school teams  
b) Answers will vary. Example: Write each team member's name on a slip of paper, and then randomly draw 15% of the slips out of a box.
9. grade 9, 41; grade 10, 38; grade 11, 36; grade 12, 35
10. Answers for sampling methods will vary.  
a) students in the school  
b) all people in the community  
c) all people aged 18 to 30  
d) all senior citizens in Ontario  
e) all computer printers for sale in Canada  
f) gasoline prices at all vendors in the community
11. In the 1920s, many people did not have telephones. Since these people were not included in the surveys, the samples were not representative of the whole population.

## 2.3 Scatter Plots Worksheet

MPM1D

1. Classify the variables in each pair as independent or dependent.
  - a) distance travelled and speed
  - b) quality of study and exam mark
  - c) time of year and cost of vacation
  - d) amount of wool needed and number of sweaters
2. This scatter plot shows the capacity of gas tanks and the distance travelled on one tank of gas.



- a) Which is the independent variable?  
Which is the dependent variable?
- b) Describe the relationship between the capacity of the gas tank and the distance travelled.

3. The table shows the heights and arm spans for a group of students:

Height (cm)	Arm Span (cm)
162	160
174	175
162	163
171	168
157	171
175	173
154	153
179	177

- a) Draw a scatter plot of the data.
  - b) Describe the relationship between a person's height and arm span.
  - c) Identify any outliers and explain how they are different from the rest of the data.
4. The table shows the values of some used cars.

Age (years)	Value (\$1000s)
3	36
6	22
4	25
4	29
3	31
2	37
7	21

- a) Identify the independent variable and the dependent variable.
- b) Draw a scatter plot of the data in the table.
- c) Describe the relationship between the age of a car and its value.
- d) Jane bought a 7-year-old car for \$28 000. Did she pay too much? Explain.

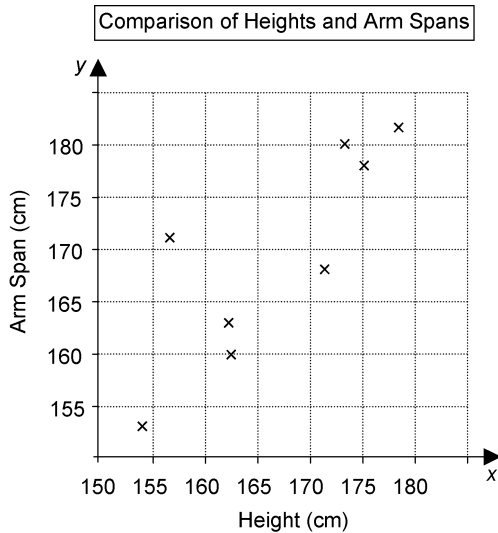




## ANSWERS

1. a) independent: speed; dependent: distance travelled  
b) independent: quality of study; dependent: exam mark  
c) independent: time of year; dependent: cost of vacation  
d) independent: number of sweaters; dependent: amount of wool needed
2. a) independent: capacity of gas tank; dependent: distance travelled  
b) as the capacity of the gas tank increases, so does the distance travelled

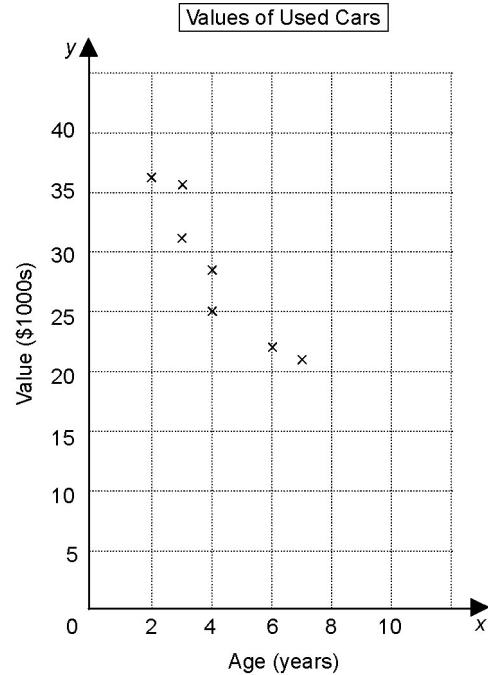
3. a)



- b) A taller person tends to have a longer arm span and a shorter person tends to have a shorter arm span.
- c) There is one outlier. The height 157 cm and arm span 171 does not fit the pattern of the other data. In most cases, height and arm span are almost equal.

4. a) independent: age; dependent: value

b)



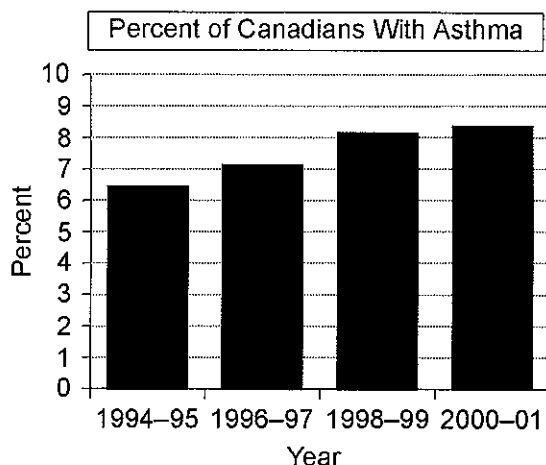
- c) As a car gets older, its value tends to decrease.
- d) Jane paid too much. When I plot the point (7, 28) on the scatter plot, I can see it is an outlier. The value of another 7-year-old car is only \$21 000 and a 4-year-old car has a value of \$29 000.



## 2.4 Trends, Interpolation and Extrapolation Worksheet

MPM1D

1. The graph shows the percent of Canadians with asthma.



**Source:** Statistics Canada, CANSIM, tables 104-0001 and 105-0001 and Catalogue no. 82-221-X.

- a) Did the percent of Canadians with asthma increase or decrease between 1994 and 2001? How do you know?
- b) Describe the trend in the percent of Canadians with asthma.
2. A teacher at an elementary school kept track of the numbers of students who regularly walk to school. The data are displayed in the table.

Year	Number of Students
1980	224
1985	203
1990	176
1995	?
2000	102
2005	85

- a) Make a scatter plot of the data.
- b) Describe the trend in the number of students who regularly walk to school.
- c) Using a line of best fit, predict the number of students who walked to school regularly in 1995. Is this interpolation or extrapolation?

3. The table shows the population of Alberta from 2001 to 2005.

Year	Population (1000s)
2001	3056.7
2002	3116.3
2003	3159.6
2004	3204.8
2005	3256.8

**Source:** Statistics Canada, CANSIM, table (for fee) 051-0001.

- a) Make a scatter plot of the data.
- b) Describe the trend in the population of Alberta.
- c) Using a line of best fit, predict the population of Alberta in 2010. Is this interpolation or extrapolation?



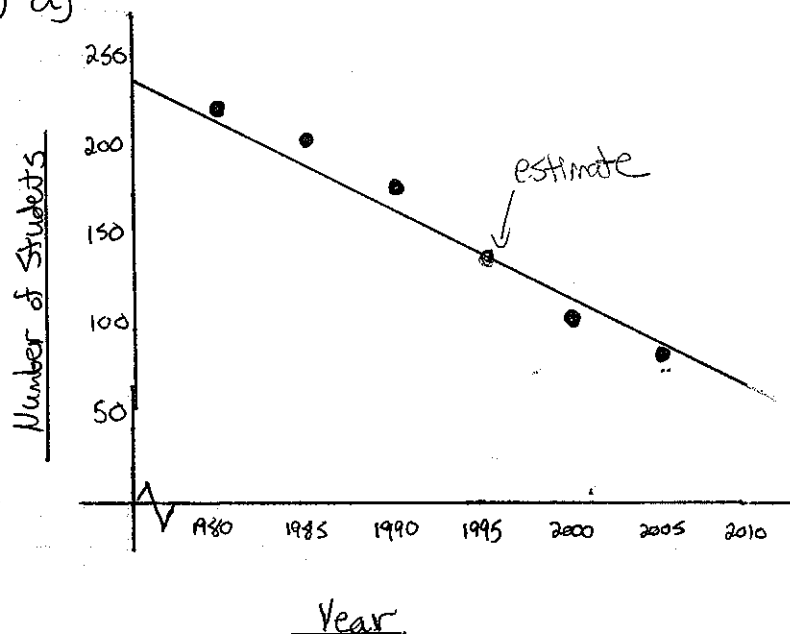


## 2.4 - TRENDS, INTERPOLATION, AND EXTRAPOLATION

\* ANSWERS \*

- ① a) increase  
 b) the number of Canadians with asthma has increased each period from 1994 to 2001

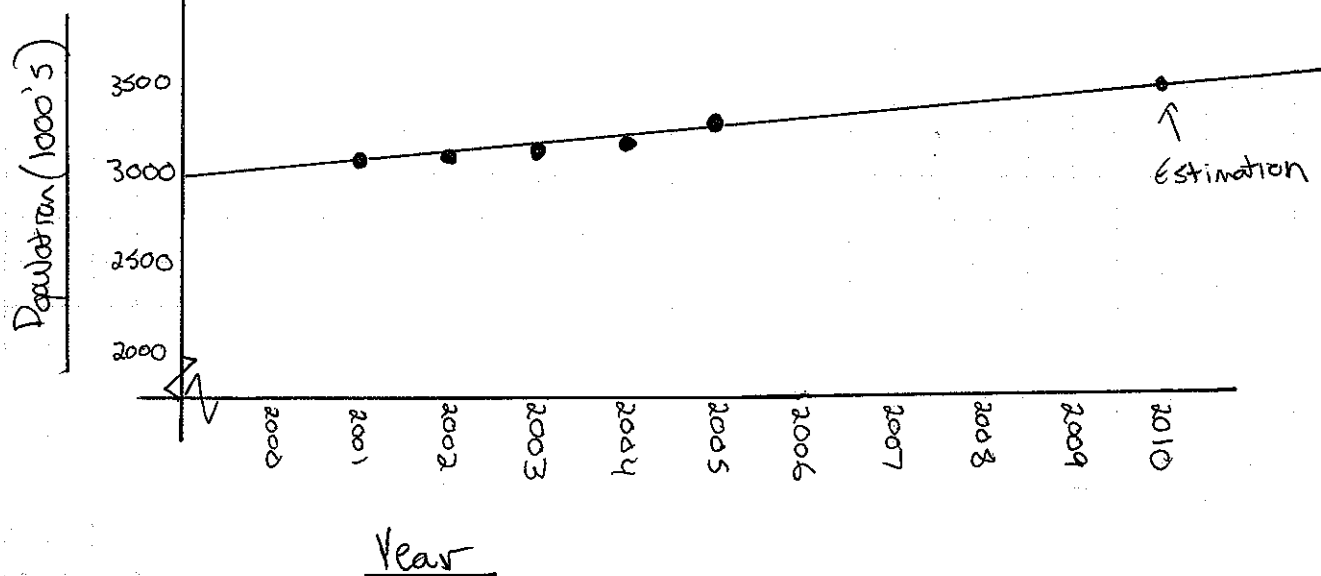
② a)



- b) The # of students who walk to this elementary school has decreased steadily from 1980 to 2005. There is a strong negative correlation.

c) Approximately 135.  
**Interpolation**

③ a)



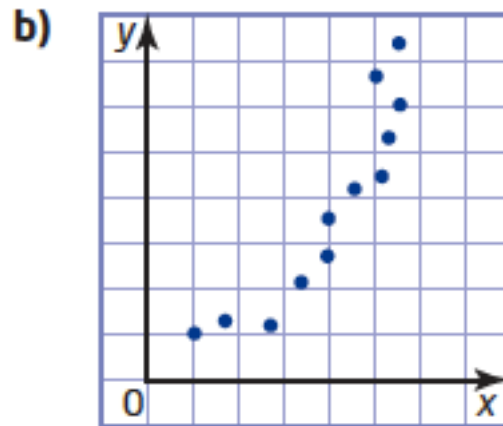
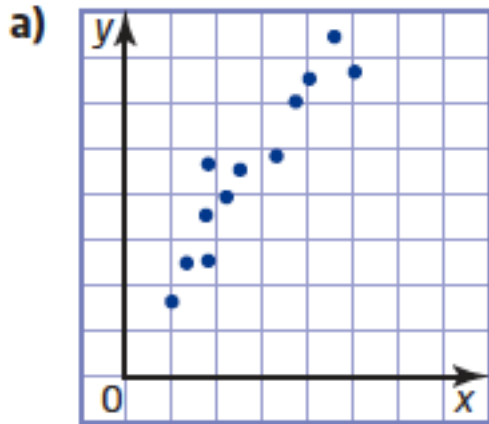
- b) The population of Alberta has shown a steady increase from 2001 - 2005. There is a strong positive correlation.

c) ~~111~~ 3 500 000, Extrapolation.

## 2.5 – Linear and Non-Linear Relations Worksheet

MPM1D

1. Does each graph show a linear relationship? Explain.

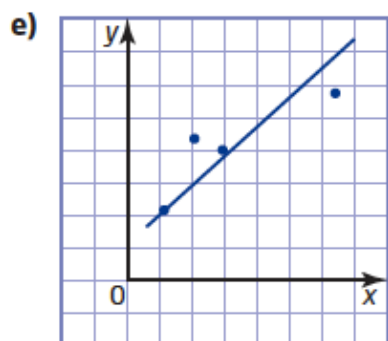
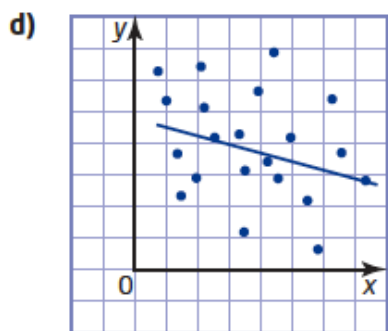
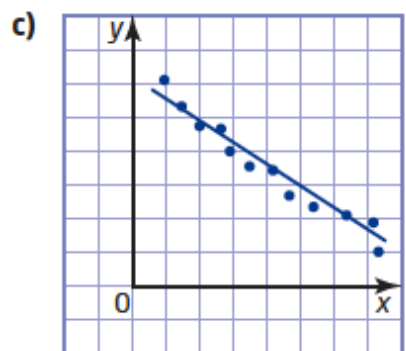
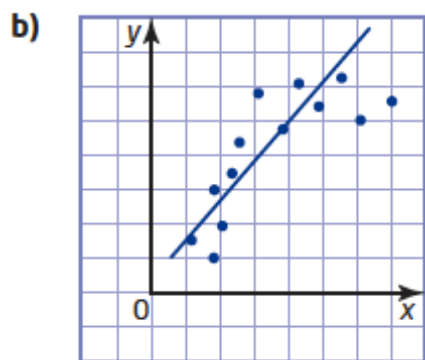
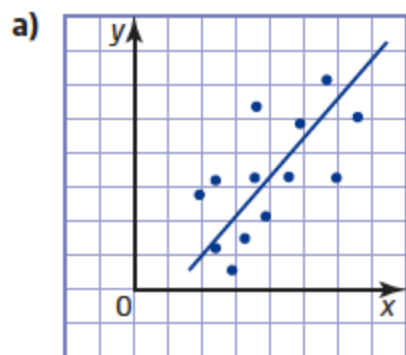


2. Does each set of points have a linear relationship? Justify your answer.

a)  $(-6, -4), (-5, -2), (-4, 0), (-3, 2), (-2, 4), (-1, 6), (0, 8), (1, 10), (2, 12), (3, 14)$

b)  $(0, 0), (1, 1), (2, 4), (3, 9), (4, 16), (5, 25), (6, 36)$

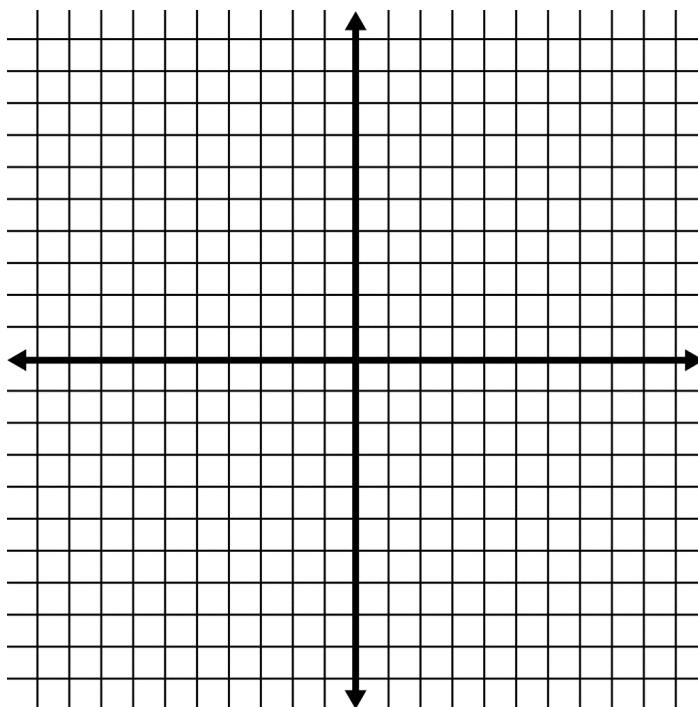
3. State whether each of these lines of best fit is a good model for the data. Justify your answers.



4. Plot each set of points on a grid. If your plot shows a linear relationship, draw a line of best fit. If the relation appears non-linear, sketch a curve of best fit.

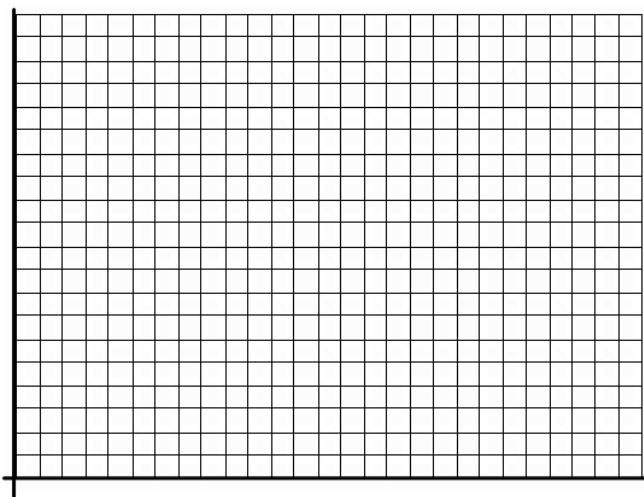
a)

$x$	1	2	7	4	9	3	6	2
$y$	-2	0	12	5	20	3	11	1

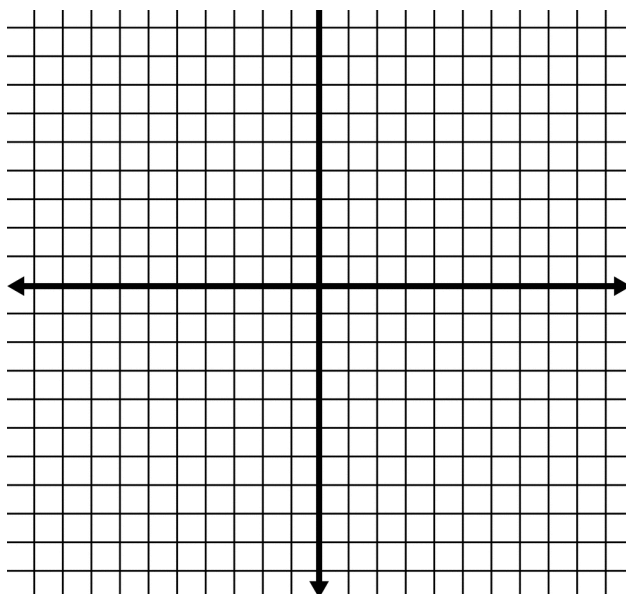


b)

Time (s)	40	32	55	18	66	43	37
Score	7	9.5	6	10	4	6	7.5



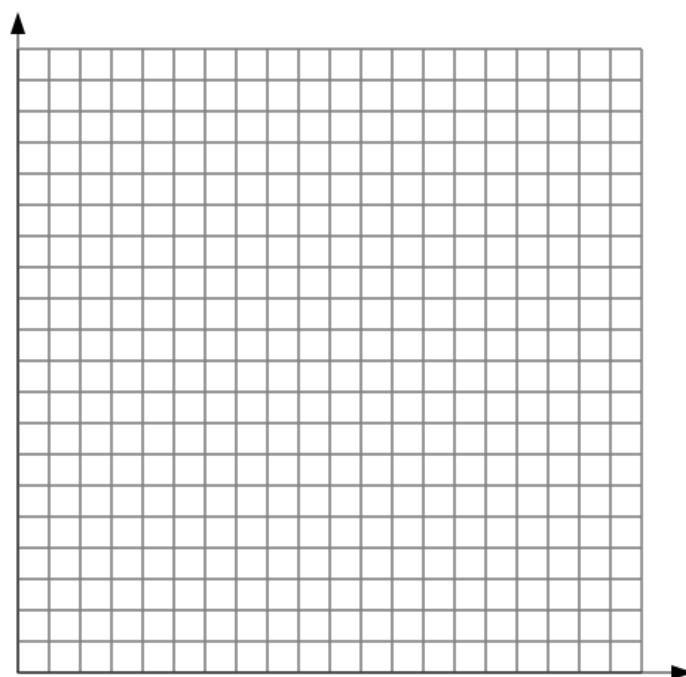
c)  $(-5, 3), (6, 1), (2, 2), (-3, 0), (-1, 2), (9, 10), (8, 4), (0, 1), (7, 5), (-4, 1)$



5. A weather balloon recorded the air temperature at various altitudes.

Altitude (m)	500	800	1000	1500	1700	2100
Temperature ( $^{\circ}\text{C}$ )	16.2	14.5	13.1	11.2	9.8	8.1

a) Make a scatter plot of the data.



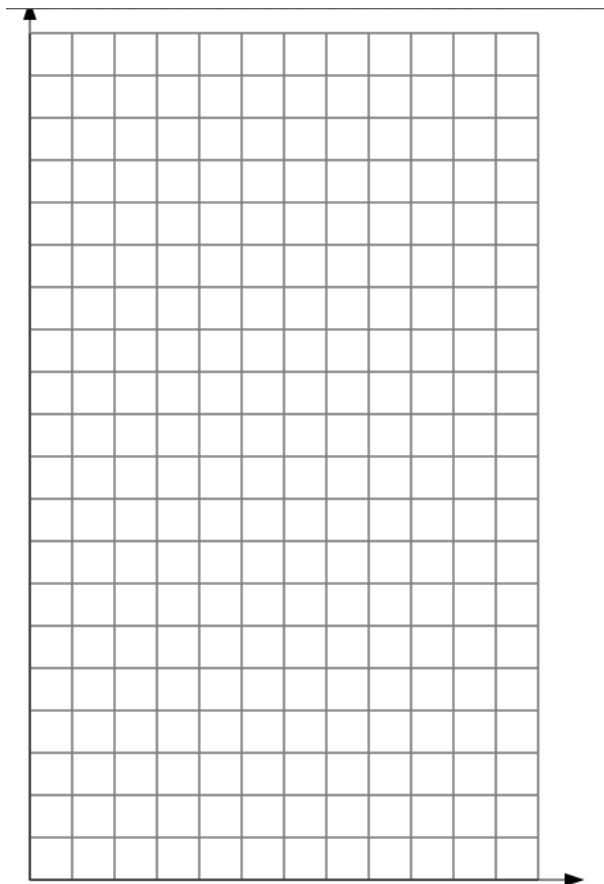


b) Describe the relation and draw a line or curve of best fit.

c) Use your line or curve of best fit to estimate the temperature at an altitude of 600 m. Is this interpolation or extrapolation?

d) Estimate the temperature at 2500 m. Is this interpolation or extrapolation?

6. a) This table lists the speed of a skydiver during the first 4 seconds of free fall. Plot the data on a grid with time from 0 seconds to 12 seconds on the horizontal axis and speed from 0 m/s to 100 m/s on the vertical axis.



Time (s)	0	1	2	3	4
Speed (m/s)	0	6	12	18	23

b) Extrapolate to estimate the skydiver's speed after 12 seconds of free fall.

c) This table gives the skydiver's speed for the next 8 seconds of free fall. Add these data to the graph you made in part a).

Time (s)	5	6	7	8	9	10	11	12
Speed (m/s)	28	33	37	40	42	43	43	43

d) Describe the trend in the enlarged set of data. What causes this trend?

e) Explain why extrapolations can be inaccurate.

7. (Consider each set of data. How can you tell whether the relation between the variables in each pair is linear without graphing the data?)

a)

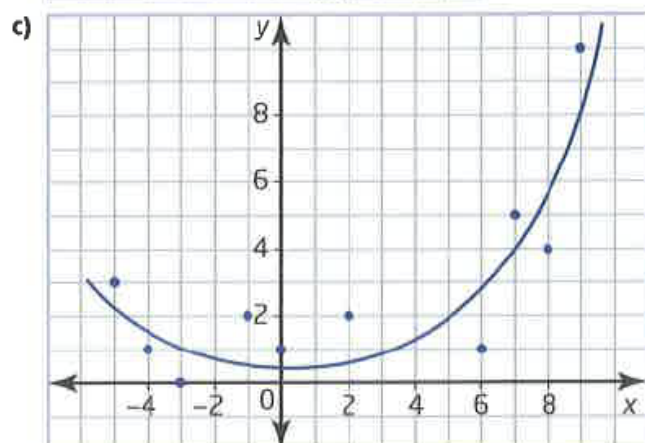
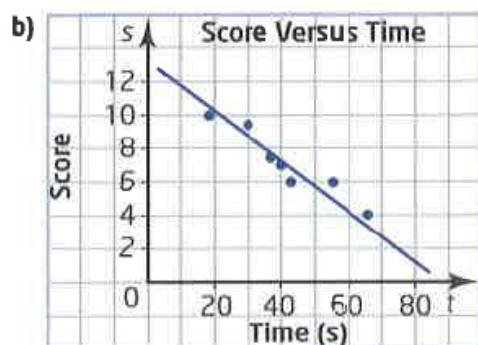
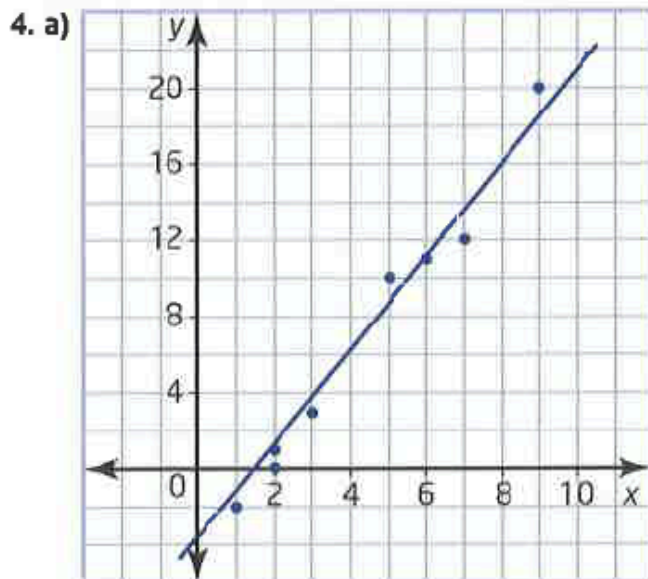
$t$	-2	-1	0	1	2	3	4	5
$d$	-9	-4	1	6	11	16	21	26

b)

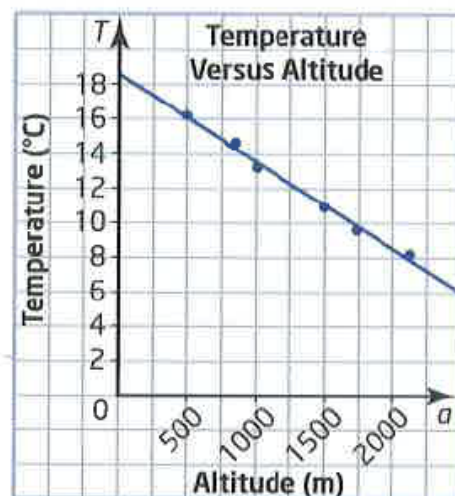
$t$	-3	-2	-1	0	1	2
$h$	5	0	-3	-4	-3	0

## Answers:

1. a) Yes; the points lie close to a straight line.  
b) No; the points lie close to a curve.
2. a) Linear; the points lie on a straight line.  
b) Non-linear; the points lie on a curve.
3. a) Yes; points are reasonably close to a straight line.  
b) No; the points follow a curve.  
c) Yes; the points lie close to a straight line.  
d) No; there is no apparent pattern.  
e) No; there are not enough points to find a good line of best fit.



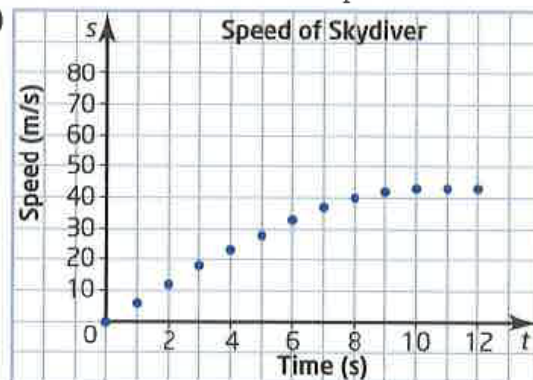
5. a), b)



The temperature decreases linearly as the altitude increases.

c) 15.5°C      d) 6.0°C

6. a), c)



b) about 70 m/s

d) Air resistance increases with speed, so the speed increases only until the air resistance offsets the acceleration due to gravity.

e) The relationship between the variables may change beyond the range of the data.

11. a) Linear; each time  $t$  increases by 1,  $d$  increases by 5.

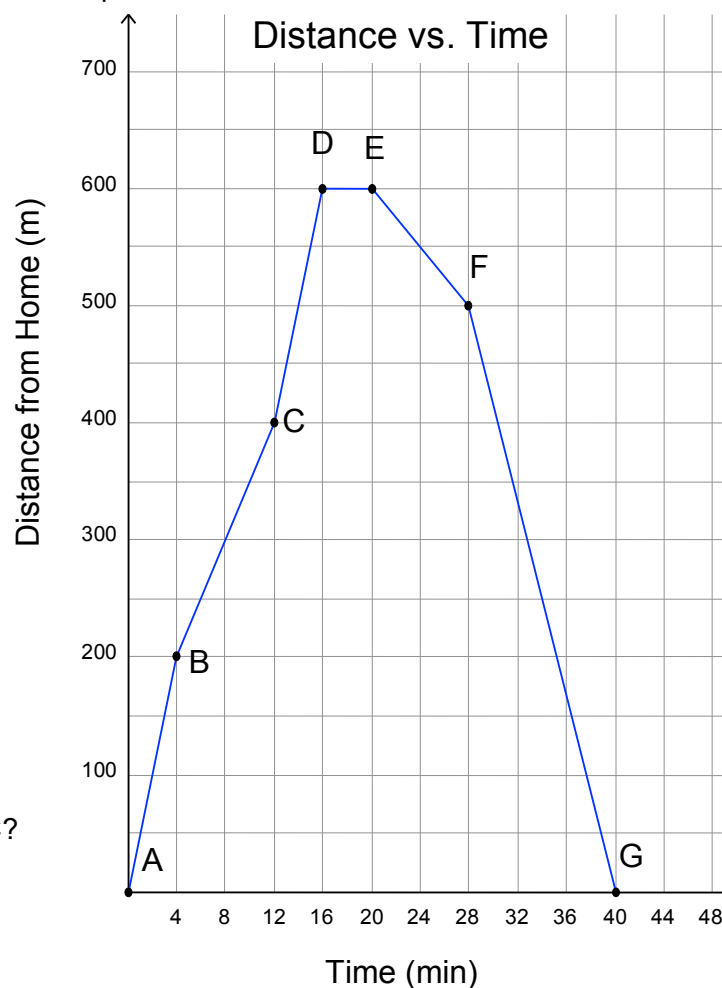
b) Non-linear;  $h$  does not change by a constant amount each time  $t$  increases by 1.

## 2.6 Distance Time Graphs Worksheet #1

### 1) The Corner Store

At 11 o'clock, Micha's mother sends him to the corner store for milk and tells him to be back in 30 minutes. Examine the graph and answer the questions on a separate sheet.

- How long did it take Micha to reach the store?
- How long did Micha stay at the store?
- How long did it take Micha to get home from the store?
- How can you use the graph to tell which direction Micha is travelling?
- How far did Micha travel in the segment BC?
- How long did it take Micha to travel segment BC?
- What was Micha's speed (in m/min) during segment BC?
- Calculate Micha's speed during segment EF.
- How could you tell (without calculations) that Micha was travelling faster during BC than EF?
- When is Micha travelling the fastest? Explain.
- When is Micha travelling the slowest? Explain.
- Did Micha make it home in 30 minutes? How do you know?



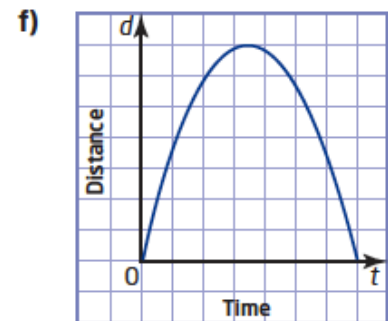
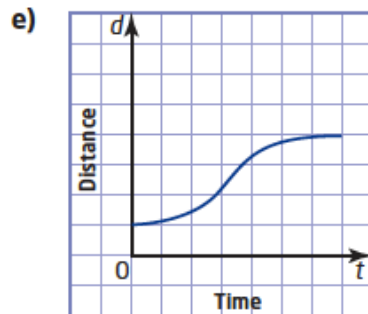
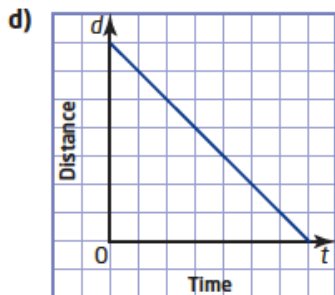
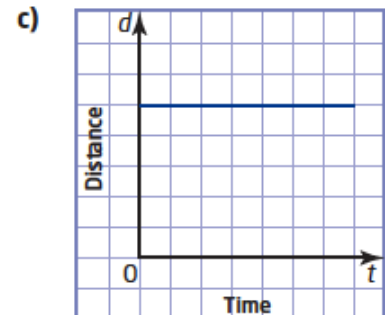
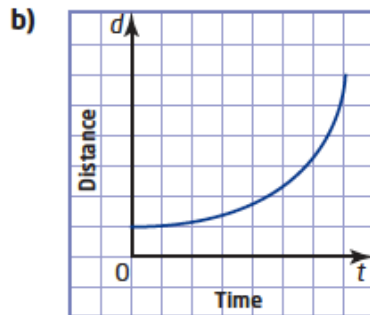
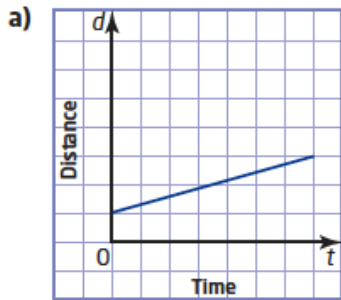
## **Answers**

- 1) 16 minutes
- 2) 4 minutes
- 3) 20 minutes
- 4) rising line = away from home; falling line = towards home
- 5) 200 m
- 6) 8 minutes
- 7) 25 m/min
- 8) 12.5 m/min
- 9) The line is steeper
- 10) AB and CD
- 11) DE; he is not moving
- 12) No, it took 40 minutes

## 2.6 Distance Time Graphs Worksheet #2

MPM1D

1. Describe the motion shown in each distance-time graph. Write a few sentences describing a situation that could be represented by each graph.



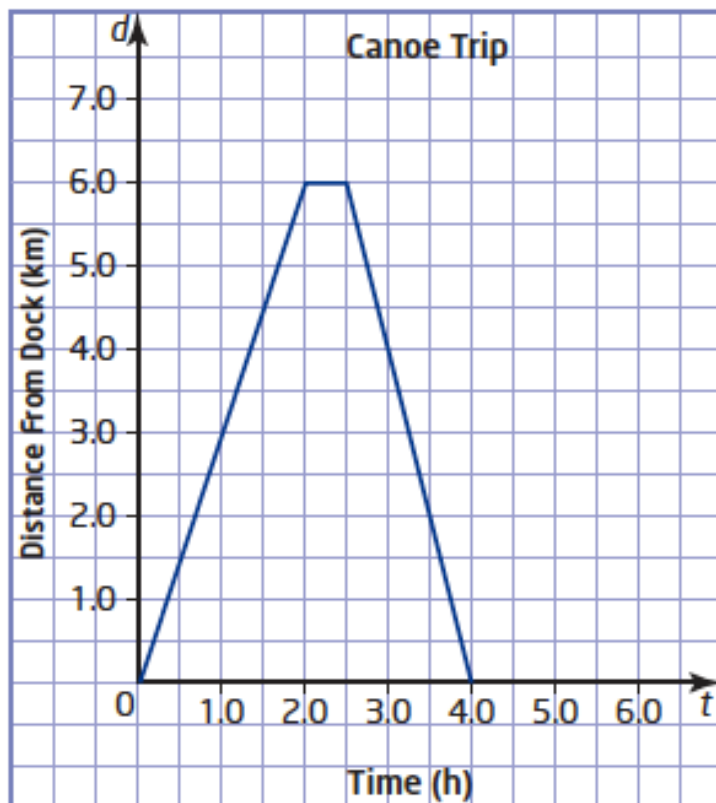
2. Which of the graphs in question 1 show linear relations between distance and time? Justify your answer.

3. A canoeist starts from a dock and paddles to the end of a lake and back. This graph shows the canoeist's distance from the dock during this trip.

a) How long did this trip take?

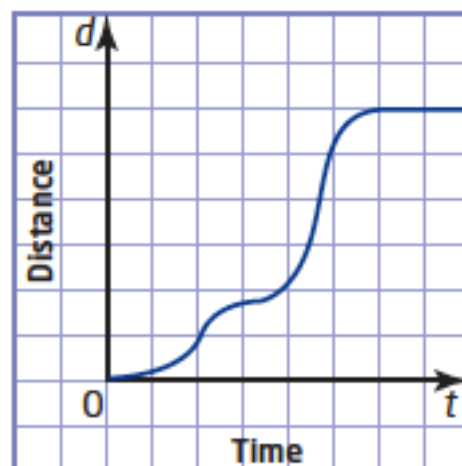
b) How far is it to the end of the lake?

c) What does the flat portion of the graph represent?



d) Was the canoeist travelling faster on the way out or on the way back?

4. This graph shows how far a cyclist has travelled from her starting point. Describe the cyclist's motion in a few sentences.

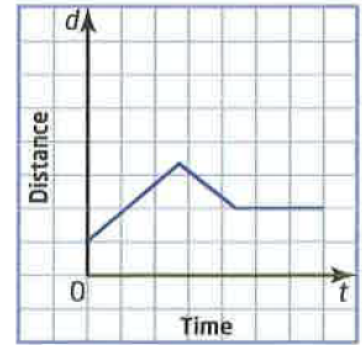


5. a) You are holding a rangefinder pointed at a nearby wall. Describe how you would move in order to match this graph.

b) How would the distance-time graph change if you walked faster?

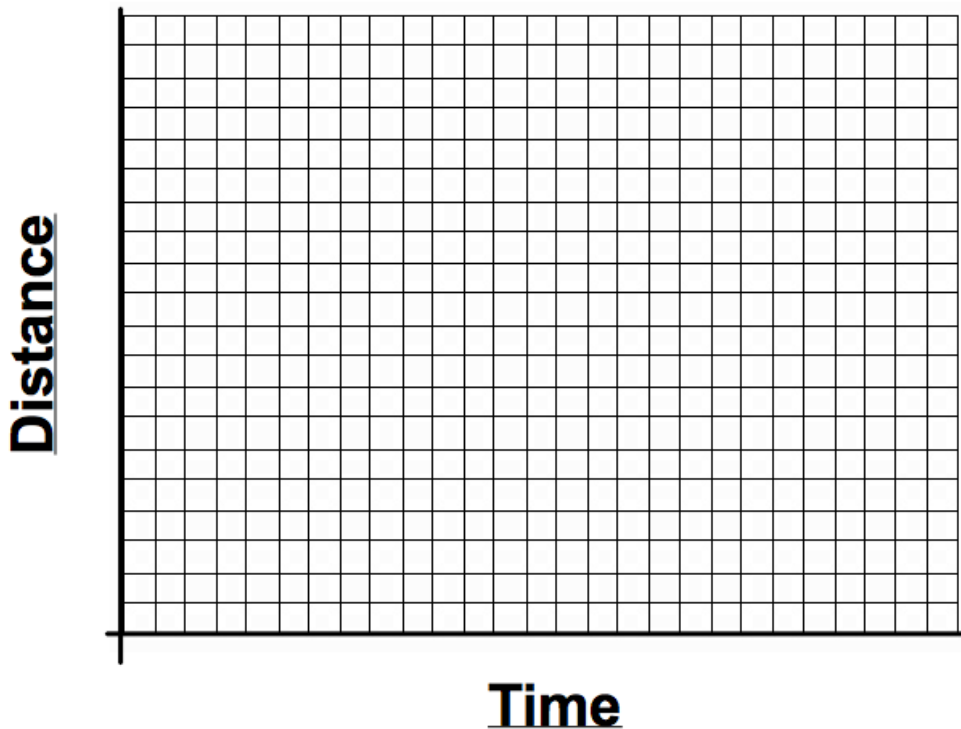
c) How would the graph change if you walked slower?

d) How would the graph change if you stopped sooner?



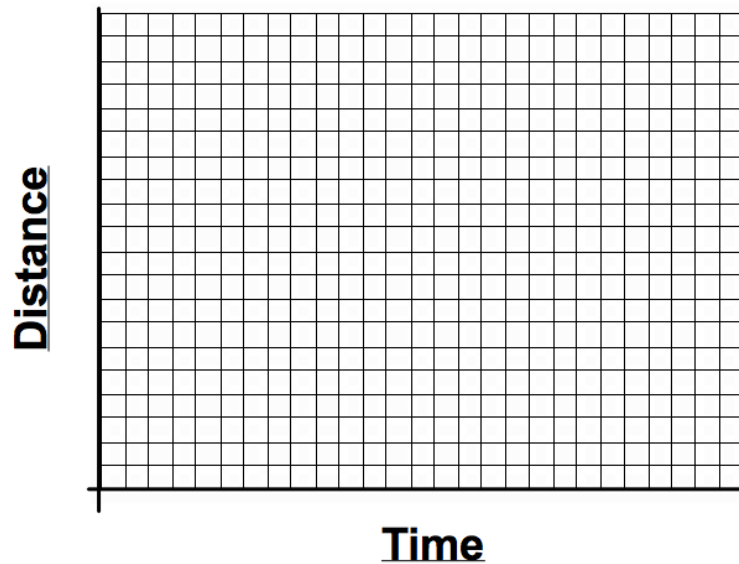
6. Draw a distance-time graph for this situation:

A student leaves home, walking at a steady pace. He slows down, then stops for a few seconds to mail a letter. He turns around and runs home at a constant speed.





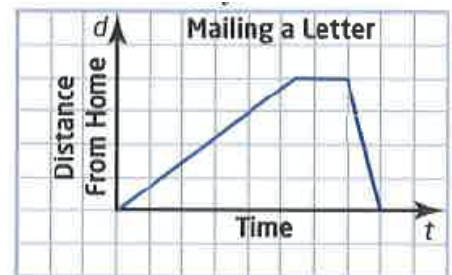
7. Sketch a distance-time graph for a car that slowly speeds up after stopping at a traffic light.



## Answers

1.
  - a) moving away at constant speed
  - b) moving away with increasing speed
  - c) no movement
  - d) moving closer at constant speed
  - e) moving away at increasing speed, then slowing down and stopping
  - f) moving away at decreasing speed, stopping for a moment, then coming back with increasing speed
2. Graphs a, c, d; the points lie on a line.
3.
  - a) 4 h
  - b) 6 km
  - c) stopping at the end of the lake
  - d) on the way back
4. After starting out, the cyclist increases her speed, then slows down. Then she travels a bit faster than before, then slows down and stops.
5.
  - a) Move away from the wall at a constant speed, then walk back toward the wall at the same speed, but stop before you reach your starting position.
  - b) The sloped line segments would be steeper.
  - c) The sloped line segments would be less steep.
  - d) The middle segment would be shorter and the horizontal segment would be higher.

6.



7.

