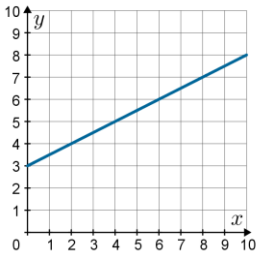
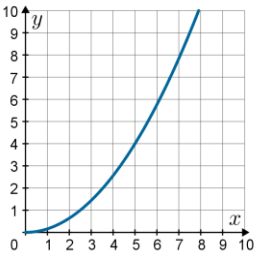
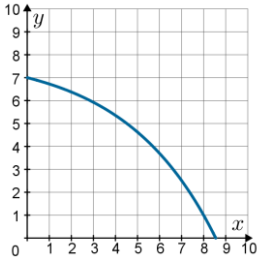
4.2 LINEAR VS. NON-LINEAR

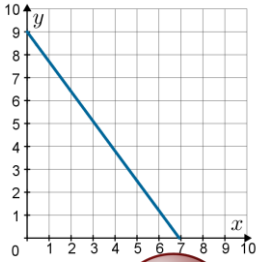
PART A

1) Classify each of the following relations as either linear or non-linear.

a) 

b) 

c) 

d) 

2) What does it mean for a relationship between two variables to be a linear relation?

3) Use the first differences to classify each of the following relations as either linear or non-linear.

a)

Time (s)	Height (m)
0	2
1	8
2	14
3	20
4	26

b)

Number of Years	Population
0	2000
1	3000
2	4500
3	6750
4	10 125

c)

Distance (m)	Speed (m/s)
0	20
5	17
10	14
15	11
20	8

d)

Number of Toppings	Total Cost ($)
1	8.50
2	9.25
3	10.00
4	10.75
5	11.50

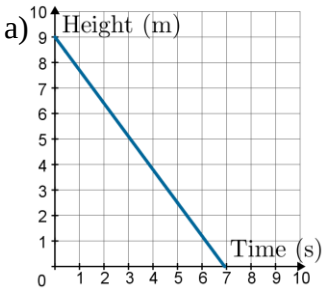
e)

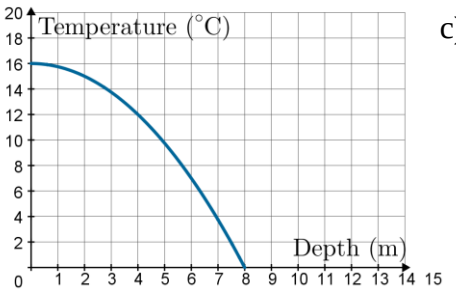
x	y
0	–5
2	–7
4	–1
6	13
8	35

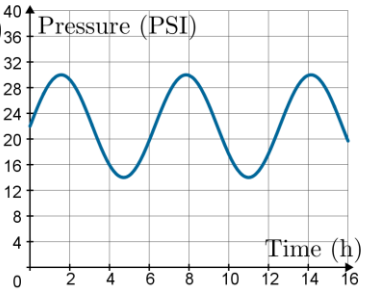
f)

Time (min)	Temperature (°C)
10	4.6
15	1.2
20	–2.2
25	–5.6
30	–9.0

4) Determine the start value (initial value) for each of the following relations.

a) 

b) 

c) 

5) Determine the initial value (start value) for each of the relations in question #3.

6) Determine whether each equation models a linear or non-linear relation.

a) $h = 3t$ b) $T = d^2$ c) $A = 2^t$ d) $y = 5 - 2x$ e) $C = \frac{2}{3}n + 8$

PART B

7) The following diagrams show why 1, 3, 6, 10 and 15 are called *triangular numbers*.

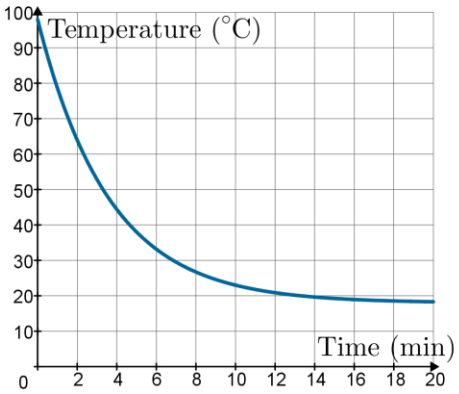
a) Complete the table on the right.
b) Is the relationship between the diagram number and the corresponding value linear? Explain.

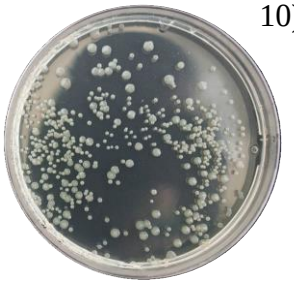
Diagram Number	Value
1	1
2	3
3	
4	
5	
6	
7	

Number of Guests	Total Cost ($)
0	
10	
20	
30	
40	
50	

8) The cost of hosting an event at Rachel's Banquet Centre is made up of a one-time initial fee of $280, plus $45 per guest.
   a) Is the relationship between the number of guests and the total cost linear or non-linear? Explain.
   b) Complete the table of values on the left.
   c) Determine the total cost of hosting an event with 100 guests.
   d) To determine the total cost for 100 guests, can we simply double the total cost for 50 guests? Explain.
   e) Determine the number of guests if the total cost is $3565.

9) A hard-boiled egg that has a temperature of 98 °C is placed under running water. The graph on the right shows the temperature of the egg once it is placed in the water.
   a) Describe how the temperature of the egg is changing over time.
   b) Is the relationship between the temperature of the egg and time linear or non-linear?
   c) Based on the graph, what do you think the temperature of the running water is?



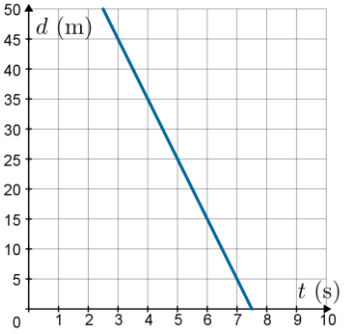


10) As part of a science project, Antwan grew a colony of bacteria in a petri dish. He estimated that the area covered by the bacteria doubled every day. The bacteria initially covered an area of 1 cm^2.
   a) Is the relationship between the number of days and the area covered by bacteria linear or non-linear?
   b) Create a graph to display the area covered by bacteria over the first six days.

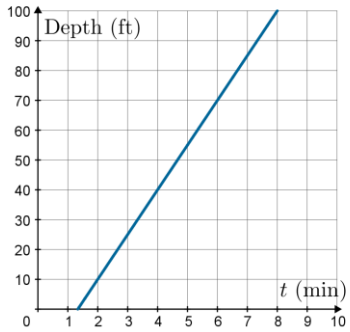
PART C

11) Determine the initial value for each of the following linear relations.

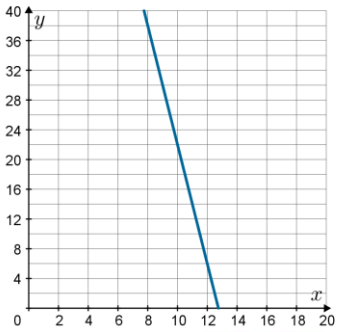
a)



b)



c)



12) Sometimes a relation may appear to be linear, but isn't completely linear. For example, consider the number of cups stacked, as shown on the right, versus the total height of the stack. Explain why this relationship is not perfectly linear. Could a change be made to create a true linear relation?

ANSWERS

1) a) linear b) non-linear c) non-linear d) linear

2) A relationship between two variables is a linear relation if the dependent variable always changes by the same amount for any fixed change in the independent variable. That is, the relationship has a constant rate of change. The first differences of a linear relation are equal and the graph of a linear relation is a straight line.

3) a) linear b) non-linear c) linear d) linear e) non-linear f) linear

4) a) 9 m b) 16 °C c) 22 PSI

5) a) 2 m b) 2000 c) 20 m/s d) $7.75 e) −5 f) 11.4

6) a) linear b) non-linear c) non-linear d) linear e) linear

7) a)

Diagram Number	Value
1	1
2	3
3	6
4	10
5	15
6	21
7	28

b) No, since the value increases by a different amount with each successive diagram. That is, the first differences are not equal.

8) a) Linear, since the total cost increases by the same amount ($45) for each additional guest.

b)

Number of Guests	Total Cost ($)
0	280
10	730
20	1180
30	1630
40	2080
50	2530

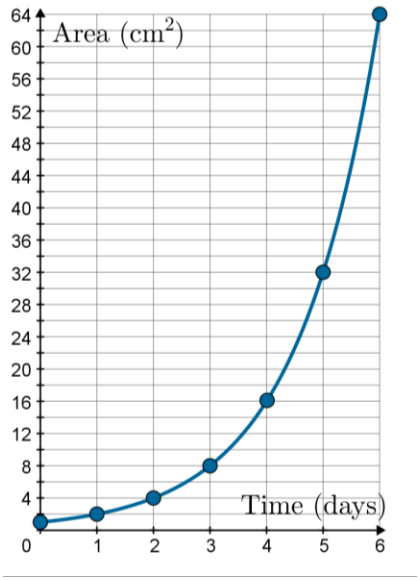
c) $4780

d) No. If we doubled the total cost for 50 guests, we'd also be doubling the one-time initial fee.

e) 73

9) a) As the temperature of the egg decreases over time, the rate at which it is cooling also decreases. b) non-linear c) 18 °C

10) a) non-linear b)



11) a) 75 m b) −20 ft c) 102

12) Following the first cup, the height of the stack would increase by the same amount for each additional cup. The difference between the stack heights for 0 cups and 1 cup, however, would not be the same value. If each cup was inverted (flipped) before stacking, the relation would be linear.