CHAPTER 7

Linear Inequalities

What will you learn?

- Inequalities
- Linear Inequalities in One Variable

Why study this chapter?

As a basic knowledge in fields that need to apply the concept of limits. An architect needs to consider the height limit of a structure constructed, an engineer needs to determine the speed and weight limit of a vehicle designed, a financial planner uses the idea of limits to calculate the optimum profit of a company based on its operation costs. Discuss other fields that involve the concept of limits.

Body Mass Index (BMI) is used to determine ideal body weight. A survey carried out by the World Health Organisation in the year 2011 revealed that 44.2% of the population in Malaysia have BMI more than 25.

Based on the table given, what is their body weight classification? What is your body weight classification?

Body Weight Classification	BMI
Underweight	BMI < 18.5
Normal weight	$18.5 \leqslant$ BMI < 25.0
Overweight	$25.0 \leqslant$ BMI < 30.0
Obese	BMI $\geqslant 30.0$

Scan the QR Code to watch the video about healthy lifestyle practices.

http://goo.gl/fPfbq6

Walking through Time

Thomas Harriot

The symbols '>' and '<' were introduced by an English surveyor Thomas Harriot in his book published in the year 1631. The inequality symbol is believed to have originated from the equality symbol '='.

For more information:

http://goo.gl/JooUWU

Word Link

• inequality	• *ketaksamaan*
• linear inequality in one variable	• *ketaksamaan linear dalam satu pemboleh ubah*
• simultaneous linear inequalities	• *ketaksamaan linear serentak*
• converse property	• *sifat akas*
• transitive property	• *sifat transitif*
• additive inverse	• *songsangan terhadap penambahan*
• multiplicative inverse	• *songsangan terhadap pendaraban*

Open the folder downloaded from page vii for the audio of Word Link.

7.1 Inequalities

LEARNING STANDARDS

Compare the values of numbers, describe inequality and hence, form algebraic inequality.

What are inequalities?

In our daily lives, we often make comparisons between two quantities with different values. We compare the quantities in terms of number, price, temperature, size, height, mass and so on.

Which smart phone brand is cheaper?

Which has a larger mass?

By comparison, we found that

- the price of smart phone brand A is cheaper than brand B.
- the mass $(x + 50)$ g is greater than 80 g.

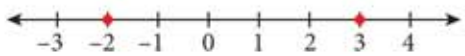
The relationship between two quantities that do not have the same value is known as an **inequality**.

Let's Discuss

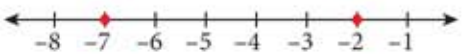
Discuss the relationship between two quantities in real-life situations which involve the usage of 'more than' or 'less than'.

Compare the values of numbers

In chapter 1, we have learned how to compare the value of an integer with another integer based on its position on a number line. In this chapter, we shall write this comparison by using mathematical symbols.
For example:



Observe the position of the pair of numbers –2 and 3 on the number line.
–2 lies to the left of 3,
therefore –2 is less than 3.
The symbol '<' is used to represent 'less than'.
So, '–2 is less than 3' is written as '$-2 < 3$'.



Observe the position of the pair of numbers –7 and –2 on the number line.
–2 lies to the right of –7,
therefore –2 is more than –7.
The symbol '>' is used to represent 'greater than'.
So, '–2 is greater than –7' is written as '$-2 > -7$'.

$-2 < 3$ and $-2 > -7$ are inequalities.

Example 1

Fill in the boxes with the symbol '>' or '<' so that it becomes a true statement. Hence, write an inequality for each statement by using 'is greater than' or 'is less than'.

(a) $-\frac{5}{6}$ ☐ 4 (b) 4^2 ☐ 9

SMART TIPS

Symbol	Meaning
>	greater than
<	less than

Solution

(a) $-\frac{5}{6}$ < 4 (b) 4^2 > 9

$-\frac{5}{6}$ is less than 4. 4^2 is greater than 9.

Self Practice 7.1a

1. Fill in the boxes with the symbol '>' or '<' so that it becomes a true statement. Hence, write an inequality for each statement by using 'is greater than' or 'is less than'.

(a) -6 ☐ 0 (b) $\frac{1}{7}$ ☐ $\frac{1}{4}$ (c) 0.42 ☐ 0.072

(d) 4.5 ☐ $\sqrt{4.5}$ (e) 10 cm ☐ 50 mm (f) 1 200 g ☐ 1.6 kg

Describe inequality and form algebraic inequality

Observe the number line below.

The number line compares 4 with another unknown number, x. We can describe the relationship between 4 and x in an inequality as 'x is greater than 4' and the inequality is written as '$x > 4$'.

Example 2

In the number line below, describe the relationship between x and 8 as an inequality by using 'is less than'.

Hence, form an algebraic inequality for the relationship.

Solution

x is less than 8.

$x < 8$

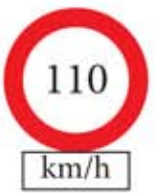
Self Practice 7.1b

1. Based on the number line, describe the relationship between y and 12 as an inequality by using 'is greater than'. Hence, form an algebraic inequality for the relationship.

2. Based on the number line, describe the relationship between 3 and b as an inequality by using 'is less than'. Hence, form an algebraic inequality for the relationship.

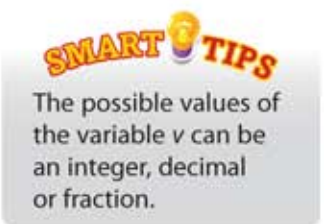
Identify relationship

(a) is greater than or equal to
(b) is less than or equal to

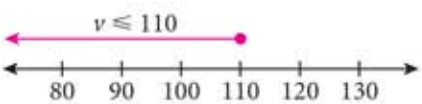


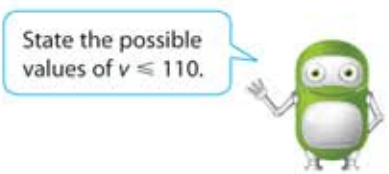
The road sign in the diagram shown can be found along the highway. This road sign reminds drivers that the speed limit of vehicles along the highway must not exceed 110 km/h.

If v represents the speed in km/h, then $v = 110$ and $v < 110$. Both these equality and inequality can be combined by using the symbol '$\leqslant$' and are written as $v \leqslant 110$.



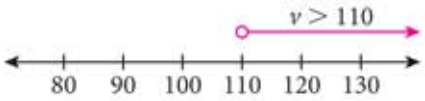
We can use a number line to represent the inequality relationship $v \leqslant 110$ as shown in the diagram below.





How are we going to use the number line to represent the speed of the vehicles that do not follow the speed limit along the highway? What are the risks that would be faced by these irresponsible drivers?

The vehicles that do not follow the road sign have speeds greater than 110 km/h and the speeds can be represented on the number line as shown in the diagram below.



Example 3

Fatimah earns overtime pay when she works at least 9 hours a day.

(a) If t is the number of working hours per day, describe an inequality based on the situation above by using 'is greater than or equal to' or 'is less than or equal to'.

(b) Represent the inequality on a number line and hence form an algebraic inequality for the relationship.

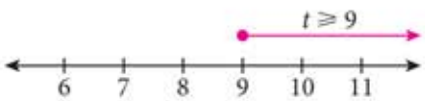
SMART TIPS

Symbol	Meaning
$\geqslant$	greater than or equal to
$\leqslant$	less than or equal to

Solution

(a) t is greater than or equal to 9.

(b)



The algebraic inequality is $t \geqslant 9$.

Scan the QR Code or visit https://youtu.be/xTA_VbuMPME to learn about representing linear inequality on a number line.

Let's Discuss

Fatimah did not earn any overtime pay.

(a) Describe an inequality based on the situation above by using 'is greater than' or 'is less than'.
(b) Represent the inequality on a number line and hence form an algebraic inequality for the relationship.

Self Practice 7.1c

1. Describe an inequality based on each of the following situations by using 'is greater than or equal to' or 'is less than or equal to':

(a) The road sign shows the load of a lorry, m, that is allowed to cross the bridge.

(b) The age, t, to vote is 21 years old.

Represent the inequality on a number line and hence form an algebraic inequality for the relationship.

What are the properties of inequalities?

LEARNING STANDARDS

Make generalisation about inequality related to
(i) the converse and transitive properties, additive and multiplicative inverse,
(ii) basic arithmetic operations.

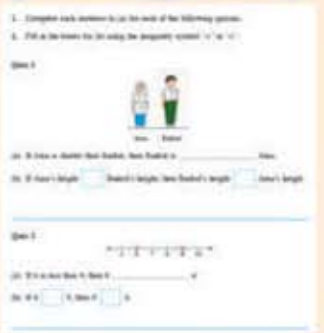
Exploration Activity 1

Pair

Aim: To explore the converse property and the transitive property of inequalities.

Instruction:
- Perform the activity in pairs.
- Open the folder downloaded from page vii.

1. Open the file *converse and transitive properties.pdf* and print the file.
2. Complete the sentence in (a) for each quiz.
3. Fill in the blanks in (b) using the inequality symbol '>' or '<'.



From the results of Exploration Activity 1, it is found that
- if a is less than b, then b is greater than a.
  Converse property of inequality: If $a < b$, then $b > a$.
- if a is less than b and b is less than c, then a is less than c.
  Transitive property of inequality: If $a < b < c$, then $a < c$.

Example 4

(a) Write the converse property of inequality
(i) $10 < 24$, (ii) $-4 > -13$.

(b) Write the transitive property of inequality $-5 < -1 < 9$.

Solution

(a) (i) $24 > 10$ (ii) $-13 < -4$
(b) $-5 < 9$

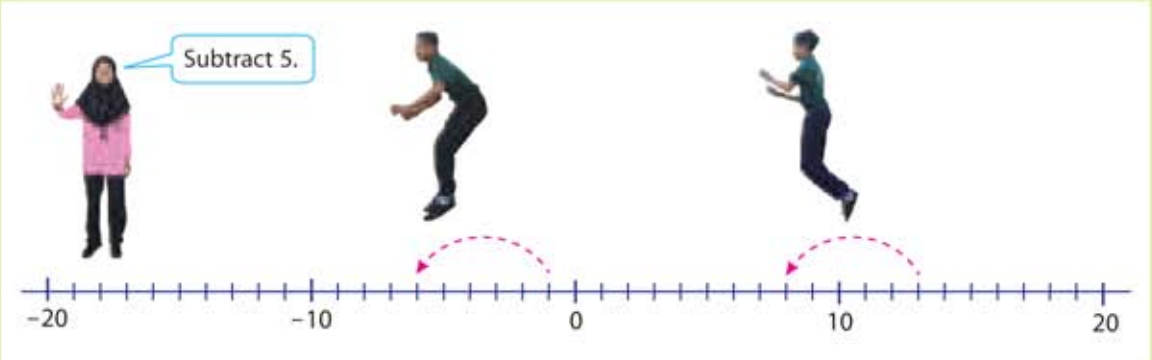
Self Practice 7.1d

1. Write the converse property of each of the following inequalities.
   (a) $5 < 14$ (b) $8 > -8$ (c) $-23 > -32$
   (d) $6.7 > 1.5$ (e) $\frac{1}{13} > \frac{1}{14}$ (f) $-2 > -11.8$
2. Write the transitive property of each of the following inequalities.
   (a) $-2 < 5 < 10$ (b) $-15 < -8 < 0$ (c) $-4.56 < -1.52 < 2.01$
   (d) $-17\frac{2}{9} < 11\frac{1}{5} < 20\frac{1}{3}$ (e) $\frac{1}{20} < \frac{1}{14} < \frac{1}{7}$ (f) $-8 < -4.3 < \frac{1}{9}$

Learning Outside the Classroom

Aim: To make a generalisation about the inequality related to the basic arithmetic operations.

Instruction: Perform the activity in groups of four.



1. Use a rope to represent a number line that shows the integers from −20 to 20.
2. Get two students to participate. Each of them will choose a different positive even number that is less than 20.
3. Then, the students have to stand at the position of each chosen number on the number line.
4. Get another student to write down the inequality to compare both the numbers. Observe the direction of the inequality symbol and determine who has the greater number.
5. The fourth student will give instructions related to basic arithmetic operations (+, −, ×, ÷) for the numbers chosen by both the students.

   Examples of instructions: add 3, subtract −4, multiply by −1, divide by 2
6. Both the students will shift their positions to show the results after performing each of the basic arithmetic operations. Extend the number line on the rope if necessary.
7. Determine whose number is greater after performing each basic operation. Write an inequality to compare the two new numbers.
8. Repeat Steps 3 to 7 with the same original numbers chosen but using a different basic operation.
9. Predict the operation that will retain the direction of the inequality symbol and the operation that will reverse the direction of the inequality symbol.
10. Make a generalisation about the inequality related to the operations.
11. Repeat the steps with two different negative even numbers.

From the results of the activity, we can conclude that:

- The inequality symbol **remains unchanged** when adding or subtracting a positive or negative number to or from both sides of the inequality.

If $a < b$,
then $a + c < b + c$.

If $a < b$,
then $a - c < b - c$.

If $a < b$,
then $a + (-c) < b + (-c)$.

If $a < b$,
then $a - (-c) < b - (-c)$.

SMART TIPS

If $2 < 6$
then $2 + 3 < 6 + 3$
$5 < 9$

If $2 < 6$
then $2 - 3 < 6 - 3$
$-1 < 3$

If $2 < 6$
then $2 + (-3) < 6 + (-3)$
$-1 < 3$

If $2 < 6$
then $2 - (-3) < 6 - (-3)$
$5 < 9$

- (i) The inequality symbol **remains unchanged** when multiplying or dividing both sides of the inequality by a positive number.

If $a < b$,
then $a \times c < b \times c$.

If $a < b$,
then $\frac{a}{c} < \frac{b}{c}$.

SMART TIPS

If $2 < 6$
then $2 \times 3 < 6 \times 3$
$6 < 18$

If $2 < 6$
then $\frac{2}{2} < \frac{6}{2}$
$1 < 3$

(ii) The direction of the inequality symbol is reversed when multiplying or dividing both sides of the inequality by a negative number.

If $a < b$,
then $a \times (-c) > b \times (-c)$.

If $a < b$,
then $\frac{a}{-c} > \frac{b}{-c}$.

SMART TIPS

If $2 < 6$
then $2 \times (-3) > 6 \times (-3)$
$-6 > -18$

If $2 < 6$
then $\frac{2}{-2} > \frac{6}{-2}$
$-1 > -3$

- When both sides of the inequality are multiplied by -1, the direction of the inequality symbol is reversed.

If $a < b$,
then $-a > -b$.

It is known as **additive inverse**.

SMART TIPS

If $2 < 6$
then $2 \times (-1) > 6 \times (-1)$
$-2 > -6$

- When performing reciprocal of both numbers on both sides of the inequality, the direction of the inequality symbol is reversed.

If $a < b$,
then $\frac{1}{a} > \frac{1}{b}$.

It is known as **multiplicative inverse**.

SMART TIPS

If $2 < 6$
then $\frac{1}{2} > \frac{1}{6}$

Self Practice 7.1e

Fill in each box with the symbol '<' or '>'.

1. (a) (i) $-8 \square 16$ (ii) $-8 + 2 \square 16 + 2$ (iii) $-8 - 2 \square 16 - 2$

(b) (i) $8 \square -16$ (ii) $8 + 5 \square -16 + 5$ (iii) $8 - 5 \square -16 - 5$

(c) (i) $-8 \square -16$ (ii) $-8 + 1 \square -16 + 1$ (iii) $-8 - 1 \square -16 - 1$

2. (a) (i) $8 \square 16$ (ii) $8 \times 2 \square 16 \times 2$ (iii) $8 \div 2 \square 16 \div 2$

(b) If $8 < 16$ and $c > 0$, then $8c \square 16c$ and $\frac{8}{c} \square \frac{16}{c}$.

(c) If $16 > 8$ and $c > 0$, then $16c \square 8c$ and $\frac{16}{c} \square \frac{8}{c}$.

3. (a) (i) $6 \square 12$ (ii) $6 \times (-3) \square 12 \times (-3)$ (iii) $6 \div (-3) \square 12 \div (-3)$

(iv) $-6 \square -12$ (v) $\frac{1}{6} \square \frac{1}{12}$

(b) If $6 < 12$ and $d < 0$, then $6d \square 12d$ and $\frac{6}{d} \square \frac{12}{d}$.

(c) If $12 > 6$ and $d < 0$, then $12d \square 6d$ and $\frac{12}{d} \square \frac{6}{d}$.

Mastery Q 7.1

Open the folder downloaded from page vii for extra questions of Mastery Q 7.1.

1. Fill in the boxes with the symbol '>' or '<' so that each of the following statements becomes true.

(a) $(-5)^2 \square (-6)^2$ (b) $0.1 \square \sqrt[3]{0.008}$ (c) $6 + x \square 8 + x$

(d) $m + 3 \square m$ (e) $10 - k \square 8 - k$ (f) $2x + 5 \square 2x - 5$

2.

(a) Based on the number line above, describe the relationship between x and y as an inequality by using 'is greater than'.

(b) Hence, form an algebraic inequality for the relationship.

3. A minimum deposit of RM100 is required to open a bank account.
   (a) Describe an inequality for the minimum deposit required to open a bank account by using 'is greater than or equal to' or 'is less than or equal to'.
   (b) If a is the minimum deposit required to open a bank account, represent the inequality on a number line and form an algebraic inequality for the relationship.

4. Represent the following inequalities on number lines.
   (a) $x > 3$ (b) $x < 15$ (c) $x \geqslant -19$ (d) $-5 \geqslant x$
   (e) $y \leqslant 8.3$ (f) $p \geqslant -5.7$ (g) $x < -\frac{3}{5}$ (h) $7.8 > q$

5. Fill in the boxes with the symbol '>' or '<' so that each of the following statements becomes true.
   (a) If $x < y$, then y ☐ x. (b) If $p < q$ and $q < 0$, then p ☐ 0.
   (c) If $-2 > x$ and $x > y$, then -2 ☐ y. (d) If $x > y$, then $\frac{x}{10}$ ☐ $\frac{y}{10}$.
   (e) If $x > y$, then $(-5)x$ ☐ $(-5)y$. (f) If $u > 0$, then $(-3)u$ ☐ 0.

CHAPTER 7

7.2 Linear Inequalities in One Variable

How do you form linear inequalities based on the daily life situations and vice-versa?

LEARNING STANDARDS

Form linear inequalities based on daily life situations, and vice-versa.

Example 5

Construct a linear inequality based on each situation below.

(a) Pak Samad is a *gasing uri* maker in Kelantan. The time, t days, Pak Samad spends in making a *gasing uri* is less than 42 days.

(b) In a fishing competition, the participants can win a prize if the length, l cm, of the fish caught is at least 32 cm.

(c) Madam Chen bakes a cake that has a mass of not more than 2 kg. The mass of the cake, x kg, is received by each neighbour, if Madam Chen cuts the cake into 10 equal slices for her neighbours.

(d) Mr Mohan is a businessman. He intends to donate 3% of the profit earned from his business to a local charity every month. The profit, p, in RM, Mr Mohan has to earn each month if his donation is to exceed RM240 per month.

SMART TIPS

Symbol ⩾
• At least • Not less than • Minimum
Symbol ⩽
• At most • Not more than • Maximum

Solution

(a) $t < 42$ (b) $l \geqslant 32$ (c) $x \leqslant \frac{2}{10}$ (d) $\frac{3}{100}p > 240$

Example 6

Write a situation based on each of the linear inequalities given:

(a) $h \geq 110$ where h is the height of the passenger, in cm, that is allowed to ride the roller coaster.

(b) $T < -5$ where T is the temperature, in °C, of the freezer compartment of a refrigerator.

(c) $m > 4\,600$ where m is Mr Siva's monthly salary, in RM.

Solution

(a) The height of the passenger that is allowed to ride the roller coaster must be at least 110 cm.

(b) The temperature of the freezer compartment of a refrigerator is less than −5°C.

(c) Mr Siva's monthly salary is more than RM4 600.

Self Practice 7.2a

1. Construct a linear inequality based on each of the following situations:

(a) The price, RMx, of a double-storey terrace house is RM450 000 and above.

(b) The passing mark of a Mathematics test is 50. Hajar obtained y marks and she failed the test.

(c) The total number of participants, k, of 5 debating teams if each team cannot have more than 6 people for the competition.

(d) Puan Kalsom has a reward points card that shows one point earned for every RM5 spent. Puan Kalsom spends RMq and is eligible to redeem exclusive prizes.

2. Write a situation based on each of the linear inequalities given:

(a) $n \leq 4$ where n is the number of passengers in a taxi.

(b) $A > 1\,000$ where A is the area of an apartment in m^2.

(c) $4y \geq 60$, where y is the expenditure, in RM, of a customer who patronizes the restaurant.

How do you solve problems involving linear inequalities?

Linear inequality in one variable is an unequal relationship between a number and a variable with power of one.

LEARNING STANDARDS

Solve problems involving linear inequalities in one variable.

For example, the algebraic inequalities such as

$3x < 7$ (The power of the variable x is 1)

and $y - 4 > 5 + 2y$ (The power of the variable y is 1)

are known as **linear inequalities in one variable**.

Solving a linear inequality in x is to find the values of x that satisfy the inequality. The process of solving linear inequalities is similar to the process of solving linear equations. However, we need to consider the direction of the inequality symbol when solving linear inequalities.

Example 7

Solve each of the following inequalities:

(a) $x - 2 \leq 6$ (b) $7x \geq 28$

(c) $-\frac{x}{3} < 9$ (d) $7 - 4x > 15$

Solution

(a) $x - 2 \leq 6$

$x - 2 + 2 \leq 6 + 2$ ← Add 2 to both sides of the inequality.

$x \leq 8$

(b) $7x \geq 28$

$\frac{7x}{7} \geq \frac{28}{7}$ ← Divide both sides of the inequality by 7.

$x \geq 4$

(c) $-\frac{x}{3} < 9$

$-\frac{x}{3} \times (-3) > 9 \times (-3)$ ← Multiply both sides of the inequality by −3 and reverse the inequality symbol.

$x > -27$

(d) $7 - 4x > 15$

$7 - 4x - 7 > 15 - 7$ ← Subtract 7 from both sides of the inequality.

$-4x > 8$

$\frac{-4x}{-4} < \frac{8}{-4}$ ← Divide both sides of the inequality by −4 and reverse the inequality symbol.

$x < -2$

SMART TIPS

To solve linear inequalities that involve multiplication or division, we need to multiply or divide both sides of the inequality with an appropriate number so that the coefficient of the variable becomes 1.

Let's Discuss

What are the possible solutions for each of the following inequalities if x is an integer?

(a) $x \geq 3$

(b) $x \leq -5$

SMART TIPS

Linear inequality in one variable has more than one possible solution.

MATHEMATICS APPLICATION

In conjunction with a reading campaign, a stall is having a book sales promotion by selling every book at a price of RM12.50. Ghani spends not more than RM80 to buy some books from the stall. Calculate the maximum number of books that Ghani can buy.

Scan the QR Code or visit https://youtu.be/BoCl6rCvoDQ to learn about solving inequality on a number line.

Solution

Understanding the problem

- The price of a book is RM12.50.
- Ghani spends not more than RM80 to buy books.
- Calculate the maximum number of books that can be bought.

Devising a plan

- Write a linear inequality in one variable to represent the situation given.
- Solve the inequality and interpret the solutions.

Implementing the strategy

Let n be the number of books,
then the total expenditure is $12.5n$.

So, $12.5n \leqslant 80$

$$\frac{12.5n}{12.5} \leqslant \frac{80}{12.5}$$

$$n \leqslant 6.4$$

Since n is the number of books, then n must be a whole number.

Therefore, the maximum number of books that Ghani can buy is 6.

Doing reflection

When $n = 6$, $12.5n = 12.5 \times 6$
$= 75\ (< 80)$

When $n = 7$, $12.5n = 12.5 \times 7$
$= 87.5\ (> 80)$

Thus, the maximum number of books that can be bought is 6, which is correct.

Self Practice 7.2b

1. Solve each of the following inequalities:

(a) $x + 3 \geqslant 10$ (b) $-2x < 18$ (c) $-7 > \frac{x}{3}$ (d) $16 - 5x \leqslant -4$

2. Fatimah is working part-time as a canned drink seller. She is paid 10 sen for every canned drink sold. She wants to earn at least RM20 per hour. Calculate the number of canned drinks that she needs to sell in an hour in order to achieve her target.

3. Sadiah has RM120 in her savings account and she saves RM40 per month. What is the minimum number of months that Sadiah has to save her money so that her savings can exceed RM500? (Give your answer to the nearest whole number.)

4. A car rental company offers two types of rental packages:

Package A	The basic rental payment is RM40 and an extra payment of RM8 for every rental hour.
Package B	No basic rental payment but RM15 for every rental hour.

What is the maximum time, in hours, of the car rental such that package B will be cheaper? (Give your answer to the nearest whole number.)

How do you solve simultaneous linear inequalities?

LEARNING STANDARDS

Solve simultaneous linear inequalities in one variable.

Based on the World Health Report, the daily consumption of sugar is between 25 g and 37.5 g.

If m gram represents the quantity of daily sugar consumption, then we can write

$$m > 25 \text{ and } m < 37.5$$

The two inequalities are simultaneous linear inequalities in one variable. Therefore, the amount of sugar, in grams, an individual consumes, can be any values between 25 and 37.5, such as 27, 32 and 34.8.

These values are the common values of the simultaneous linear inequalities. The solutions of simultaneous linear inequalities in one variable are the common values of the simultaneous linear inequalities.

Example 8

Solve the following simultaneous linear inequalities:

(a) $2x + 5 < 11$ and $3x - 10 < 5$ (b) $8x + 5 \geqslant 5x - 13$ and $3x - 4 > 9x + 20$

Solution

(a) $2x + 5 < 11$

$2x < 11 - 5$

$2x < 6$

$x < 3$

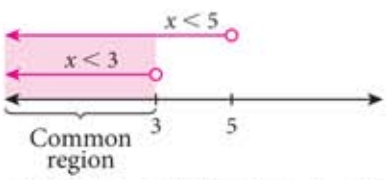
$3x - 10 < 5$

$3x < 5 + 10$

$3x < 15$

$x < 5$

Simplify each linear inequality to the simplest form.

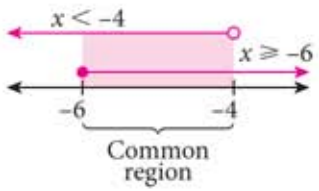


Determine the common values of both the inequalities by using a number line.

Since x needs to satisfy $x < 3$ and $x < 5$, we find the common region of both solutions. The solution is $x < 3$.

(b) $8x + 5 \geqslant 5x - 13$
$8x \geqslant 5x - 18$
$3x \geqslant -18$
$x \geqslant -6$

$3x - 4 > 9x + 20$
$3x > 9x + 24$
$-6x > 24$
$x < -4$



The solution is $-6 \leqslant x < -4$.

Career in Mathematics

Actuaries use inequalities to determine the amount of premium that a client needs to pay in an insurance policy. They also use inequalities to predict the total amount of money that needs to be paid when clients make an insurance claim.

Self Practice 7.2c

1. Solve the following simultaneous linear inequalities:

(a) $x + 2 > 4$ and $4x > 20$
(b) $x - 3 \leqslant -6$ and $3x - 4 \leqslant 5$
(c) $2x + 3 > 0$ and $9x - 2 \leqslant 16$
(d) $5x - 3 < 2$ and $4x + 6 \geqslant x + 3$
(e) $5x - 7 < 13$ and $7x + 4 < 16$
(f) $6x + 5 > 3x + 14$ and $13x - 4 \geqslant 9x$

Mastery Q 7.2

Open the folder downloaded from page vii for extra questions of Mastery Q 7.2.

1. The manager of a clothing store has set some goals for his sales staff. Construct a linear inequality based on each of the following situations:

(a) The minimum total monthly sales in RM, x, is 18 000.
(b) At the end of the month, the total time, t, spent in counting the inventory of the store is at most 8 hours.
(c) The total daily sales, h, must be more than RM700.

2. Write a situation based on each of the linear inequalities given:

(a) $x \leqslant 30$ where x is the speed of the vehicle, in km/h, when approaching the school area.
(b) $m > 1\,100$ where m is the mass of a car in kg.
(c) $y < 900$ where y is the parents' salary, in RM, of a student who qualifies to apply for a scholarship.

3. If Mr Tan keeps a daily balance of at least RM1 200 in his current account, the bank will not impose any service charge to his current account:

(a) Represent the situation on a number line.
(b) If x represents Mr Tan's daily balance, write an inequality that represents the possible values of x when the bank does not impose any service charge to his current account.

4. The salt content in a packet of instant noodles is not more than 800 mg. It is recommended that the maximum daily intake of salt in food is 2 300 mg. Find the maximum packets of instant noodles that can be consumed such that the total salt intake is less than 2 300 mg.

5. Ghanesh has received a restaurant coupon.

(a) Ghanesh buys a set meal which costs RM10.50. If m is the price of the second set meal, construct a linear inequality to represent the values of m such that Ghanesh can use the coupon.

(b) Represent the inequality by using a number line.

6. The maximum capacity of a lift is 960 kg. Assuming that the mass of each boy is 45 kg, find the possible maximum number of boys that could take the lift at any time.

7. Madam Chong's mass is 72 kg. After participating in a fitness programme, her mass decreases at a rate of 3 kg per month. Find the minimum number of months that Madam Chong has to participate in the programme so that her mass becomes less than 52 kg. (Give your answer to the nearest whole number.)

8. Solve the following simultaneous linear inequalities:

(a) $10 - 3x > 8 - 2x$ and $14 - 2x < 9 - 8x$

(b) $\frac{x}{2} - 1 < 3$ and $\frac{3x}{5} - 2 \leqslant x$

(c) $\frac{x}{9} < \frac{2}{3}$ and $\frac{5 - 2x}{7} \geqslant 1$

SUMMARY

LINEAR INEQUALITIES

Inequality involving addition

If $a < b$, then $a + c < b + c$.

Inequality involving subtraction

If $a < b$, then $a - c < b - c$.

Inequality involving multiplication

- If $a < b$, then $a \times c < b \times c$.
- If $a < b$, then $a \times (-c) > b \times (-c)$.

Inequality involving division

- If $a < b$, then $\frac{a}{c} < \frac{b}{c}$.
- If $a < b$, then $\frac{a}{-c} > \frac{b}{-c}$.

At the end of this chapter, I can...	Very good	Work harder
compare the values of numbers, describe inequality and hence, form algebraic inequality.		
make generalisation about inequality related to the converse and transitive properties, additive and multiplicative inverse, and basic arithmetic operations.		
form linear inequalities based on daily life situations, and vice-versa.		
solve problems involving linear inequalities in one variable.		
solve simultaneous linear inequalities in one variable.		

Test Yourself

1. Given that $p < q$. Compare the values of the following pairs of numbers by using the symbol '$<$' or '$>$'.

(a) $p + 5$ ☐ $q + 5$ (b) $\frac{1}{3}p$ ☐ $\frac{1}{3}q$ (c) $-p$ ☐ $-q$

2. Stella is x years old whereas her son is 18 years old. Construct an inequality that shows the relationship between their ages

(a) in the current year, (b) after 3 years, (c) 5 years ago.

3. Zain bought x pieces of *Hari Raya* greeting cards at a price of RM1.20 each. He paid RM20 and received a balance of more than RM5. Construct an inequality based on the information given.

4. Mr Koh has three pieces of RM50 notes, two pieces of RM10 notes and n pieces of RM1 notes in his wallet.

(a) Express, in terms of n, the total amount of money in Mr Koh's wallet.

(b) If the total amount of money is less than RM178, find the possible values of n such that $n > 0$.

Self Mastery

5. Solve the following inequalities:

(a) $3x + 7 < 19$ (b) $15x - 6 < 8x + 8$

6. Yoke Ling has four metal balls. Each ball has the same mass. Diagram (a) and Diagram (b) show the positions of the balances when Yoke Ling weighs one metal ball and four metal balls respectively.

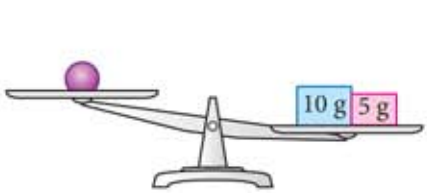


Diagram (a)

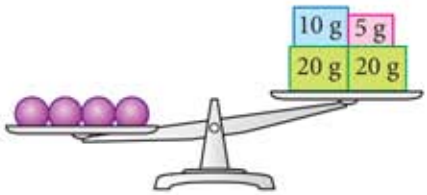


Diagram (b)

Yoke Ling's friends said that the mass of one metal ball could be 12 g, 13 g, 14 g or 15 g. Which of the given mass could be the mass of one metal ball?

Challenge Yourself

7. The Youth and Sports Complex in a district provides badminton court facilities. The management of the complex charges an annual membership fee of RM50. The rental rate per hour of the badminton court for a member and a non-member is shown in the table. When a person enrols as a new member, what is the minimum number of hours for the court rental in a year so that the total cost paid by the member would be more affordable compared to a non-member?

Rental rate per hour	
Non-member	RM15
Member	RM12

8. The mass of a metal sphere is 15 g and the mass of a box is 200 g. Chan puts n metal spheres into the box. If the total mass of the box and the metal spheres is more than 290 g,

(a) form a linear inequality based on the situation above.

(b) find the smallest value of n.

9. Umang is offered a job as a mobile phone sales agent by two companies.
Satria Company offers wages with a fixed rate of RM50 per day and an extra commission of 3% from her total sales.
Perdana Company offers wages with a fixed rate of RM35 per day and an extra commission of 5% from her total sales.
Calculate the minimum total sales, to the nearest RM, that Umang needs to obtain such that Perdana company is a better choice.

10. Solve the following simultaneous linear inequalities:

(a) $4 - 3x \geqslant -5$ and $3x + 1 \geqslant -11$

(b) $\frac{3x}{2} - 1 > 3$ and $3 - x \leqslant 7$

(c) $\frac{2x - 5}{3} \leqslant 3$ and $\frac{5 - x}{2} \leqslant 1$

(d) $\frac{x - 4}{3} \geqslant 2 - x$ and $\frac{3x - 1}{4} < 2$

ASSIGNMENT

Haze is a phenomenon that happens when small particles exist in large quantities in the air. These could block the sunlight from reaching the Earth, hence impairing visibility.

Write a report in the form of an essay about the haze phenomenon that includes the following.

- The causes of haze.
- The effects of haze.
- How does the Air Pollution Index (API) act as a guide to identify the quality of the air?
- The level of haze that occurred in your area and the preventive measures taken following that incident.

Scan the QR Code and visit http://apims.doe.gov.my/v2/ to help you in preparing the report.

Exploring MATHEMATICS

In an amusement park, fixed revenue is generated from advertising sponsors whereas fixed expenses incurred is the maintenance cost of the machines. Besides that, variable revenue is the number of visitors who visit the amusement park whereas variable expenses is the employees' wages. An operations manager needs to estimate the operating expenses and revenues to ensure that the amusement park obtains a profit.

The table below shows the daily expenses and revenues estimated by the operations manager of an amusement park which offers 12 rides. Copy and complete the information in the table below.

Daily expenses	
Total variable operating cost per visitor	RM30
Total fixed cost (RM10 000 + RM2 500 per ride)	
Daily revenues	
Admission ticket per visitor	RM76
Food per visitor	RM50
Souvenirs per visitor	RM30
Parking per visitor	RM5
Total variable revenues per visitor	
Fixed revenue from sponsors	RM8 000

Construct and solve the inequalities to determine the minimum number of visitors needed to visit the amusement park per day in order to obtain a profit.
Interpret your solutions.