

MATHEMATICS

Secondary ONE

Year 2021



Name: () Class:

Unit 2 Percentages

Textbook 1B: Chapter 8 Percentages

Topical Enduring Understanding

- Fractions, decimals, and percentages are all related and can be used interchangeably
- Percentages are based on 100
- Fractions, decimals, and percentages are all used in everyday life.

Topical Essential Questions

- Can we use the different processes to change between fractions, decimals, and percentages?
- Can we explain some ways in which percentages are used in everyday life?
- What context determines the **equivalent** form for analysis, interpretation or comparison?

Key Points

- What are percentage and percentage change?
- How to use the constant of **proportionality** (y/x) to find percentages?
- How to use percentages greater than 100%?
- How to compare two quantities by percentage?
- Why percentage has useful applications in real life, e.g. profit and loss, discount, Goods and Service Tax, and commission?

Resources

- Textbook: *Think! Mathematics New Syllabus Mathematics 1B (8th edition)* Chapter 8
- Online Resource: Student Learning Space (SLS) (learning.moe.edu.sg) **Percentages** module

Pre-requisite (Primary Mathematics Syllabus, implementation starting with 2013 Primary 1 cohort)

- 1.1 Expressing a part of a whole as a percentage
 - 1.2 Use of %
 - 1.3 Finding a percentage part of a whole
 - 1.4 Finding discount, GST, annual interest
 - 1.5 Solving up to 2-step word problems involving percentage
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Unit Checklist

Cognitive Level	Know, Understand, Demonstrate	Checklist
Level 0 Memorisation	Understand what percentage is	
	Recognise percentages expressed in different forms (fractions, decimals)	
	Compare two quantities by percentage	
Level 1 Procedural tasks without connections	Express percentage in its equivalent forms	
	Express one quantity as a percentage of another	
	Percentages greater than 100%	
Level 2 Procedural tasks with connections	Percentage change: Increase/ Decrease a quantity by a given percentage	
	Reverse percentages	
	Percentage Point	
Level 3 Problem Solving	Problem solving: Application of Percentages in real world contexts	
	• Profit and Loss	
	• Discount	
	• Goods and Service Tax (GST)	
	• Commission	

Assignment

Source: Textbook *Think! Mathematics New Syllabus Mathematics 1B (8th edition)* Chapter 8

	Basic	Immediate	Advanced
Exercise 8A	Q1b, 2b, 3b, 4a, 5a, 6d	Q15, Q17, Q20	Q22, Q23
Exercise 8B	Q4, Q5, Q6, Q9	Q13, Q16, Q18	Q20
Exercise 8C	Q3 Profit & Loss Q6 Discount	Q12 Profit & Loss Q17 Discount Q18 GST Q19 Commission	

Lesson 1 Retrieve & Extend

(I) Pre-Lesson Engagement (estimated duration: 30min)

Resource: SLS Lesson - 2021 S1 Percentages (1) Using %ages

On your own, attempt the SLS lesson and write down the key learning points, guided by the template below:

Percentages are often used to

One visual representation that is commonly associated to percentages is

Give an example a quantity that can be expressed in various equivalent forms (Percentage, Fraction, Decimal)

Under what situation would *Percentages* provide a more realistic and accurate representation for reporting instead of using the quantity (i.e. the actual number).

Percentage Change

With reference to the video clip, write down a **general formula** to calculate the **Percentage Change**.

(II) Equivalent forms: Percentage, Decimal, Fraction, Ratio

- Express a percentage as a fraction and decimal, and vice versa

Activity 1: Complete the following table:

Note: Show the “conversion” working clearly though you may use your calculator to find the answer.

Big Idea

	Percentage [Note] Leave the answer in fraction or decimal. See notes for “Fraction” and “Decimal”	Fraction [Note] Express in its simplest form, and as a mixed number (if applicable)	Decimal [Note] Round off the figure to 3 significant figures if it is non-exact
a	18%		
b	0.25%		
c	$1\frac{1}{3}\%$		
d		$\frac{3}{125}$	
e		$\frac{21}{20}$	
f		$1\frac{14}{15}$	
g			0.0034
h			16.8

Activity 2: Given the scenario, express two quantities in equivalent forms

Source: Textbook p8

There are 15 boys and 25 girls in a class.

Let A and B represent the number of boys and girls in the class respectively.

Complete the following table, that illustrates the **relationship** between A and B

In words	A is% of B	B is% of A
Percentage	$A = \dots \dots \dots \% \times B$	$B = \dots \dots \dots \% \times A$
Fraction	$A = \dots \dots \dots \times B$	$B = \dots \dots \dots \times A$
Decimal	$A = \dots \dots \dots \times B$	$B = \dots \dots \dots \times A$
Ratio	$A : B = \dots \dots \dots : \dots \dots \dots$	$B : A = \dots \dots \dots : \dots \dots \dots$

(III) Expressing one quantity as a percentage of another

- Express one quantity as a percentage of another
- Compare two quantities by percentage

To express one quantity, a , as a percentage of another quantity, b , we write a as a fraction of b before converting the fraction $\frac{a}{b}$ into a percentage.

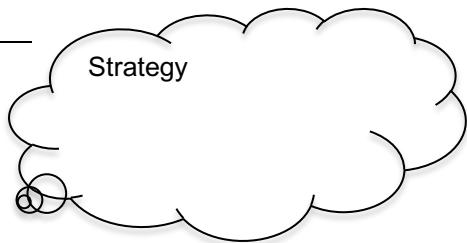
Big Idea

Important note: Both a and b must be of the same unit.

Practice 1 (Tier A)

Source: Textbook p13 Exercise 8A

Show the working clearly though you may use your calculator to find the answer.



12. Express the first quantity as a percentage of the second quantity	
(b) 25 seconds, 3.5 minutes	(c) 1 year, 4 months
(e) 335 cm, 5 m	(g) 60° , 360°

9. Find the value of each of the following	
(a) 0.8% of 4.5 m	(b) $111\frac{4}{5}\%$ of 24 kg

Practice 2 (Tier B)

Source: Discovery Mathematics Textbook 1B

At a hawker centre, there are three drink stalls. On a certain day,

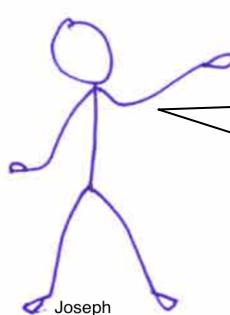
- Stall A sold 175 glasses out of 200 prepared glasses of sugar cane juice.
 - Stall B sold 85% of its 220 prepared glasses of soya bean drink and
 - Stall C sold 180 glasses of herbal tea which is 80% of its prepared glasses of herbal tea.
- (a) Which stall sold the greatest number of glasses of drinks? How many glasses of drinks were sold by this stall?
- (b) Which stall sold the highest percentage of its prepared glasses of drinks? What was the percentage figure?
- (c) Which stall prepared the greatest number of glasses of drinks? What was this figure?

Polya's 4-Step to Problem Solving

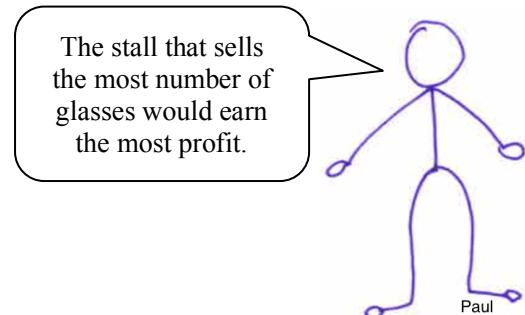
1. Understand the problem
2. Devise a Plan
3. Carry out the plan
4. Look Back

Based on the information given and what's required, how could we organise the given and the required in a table?

Point to Ponder: Do they mean the same thing?



The stall with the highest percentage of drinks sold would earn the most profit.

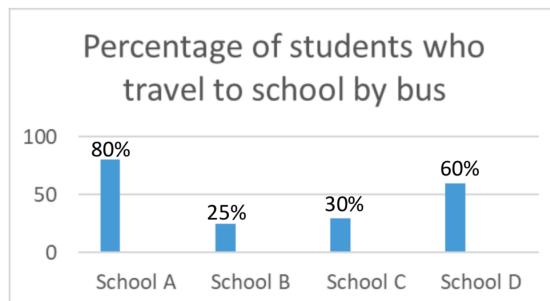


The stall that sells the most number of glasses would earn the most profit.

Practice 3 (Tier B)

Adapted from syllabus guide

The graph below shows the percentages of students travel to school by bus across 4 different schools.



The table below shows the school population of these 4 different schools:

School	A	B	C	D
Total	800	2600	2800	1150

Do you agree with the following students' statements?

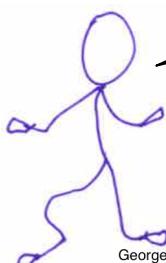
Explain your reasoning (with mathematical calculation when possible).

The bar graphs show that a bigger percentage of School A students travel to school by bus compared to School C.



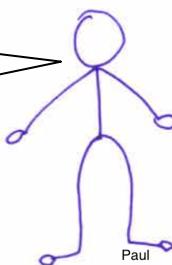
Joseph

The bar graphs show that there are fewer students from school D travel to school by bus compared to School A.



George

Considering only School B and School C, in total, 55% of the students travel to school by bus.



Paul

Point to Ponder: What is the key idea that Practice 3 wants to highlight?

Lesson 2 Percentage Change, Reverse Percentage & Percentage Point

(I) Percentage Change & Reverse Percentage

- Increase/ decrease a quantity by a given percentage (Textbook p15-p18)
- Solve problems involving reverse percentages (Textbook p19-p21)

Calculating Percentage Change:

$$\text{Percentage increase/decrease} = \frac{\text{increase/decrease}}{\text{original value}} \times 100\%$$

$$\text{Increase/Decrease} = \text{Percentage increase/decrease} \times \text{original value}$$

$$\text{New value} = \text{final percentage} \times \text{original value}$$

Practice 1 (Tier A)

Source: Textbook p21 Exercise 8B

1. Find the value of each of the following	
(b) Increase 28 by 125.7%	(d) Decrease 216 by 37½%
2(a) The result of a number, when increased by 15% is 161. Find the number.	2(d) The result of a number, when decreased by 20%, is 192. Find the number.

Activity 1:

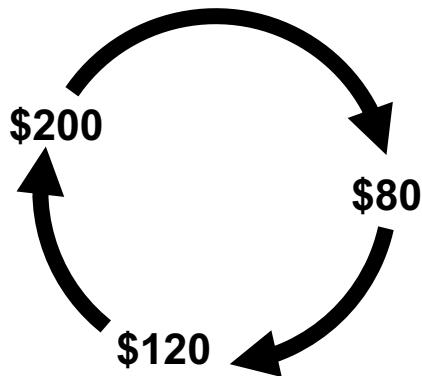
Adapted from syllabus guide

In the following diagram, each arrow shows how one value will give a new value after undergoing a percentage change.

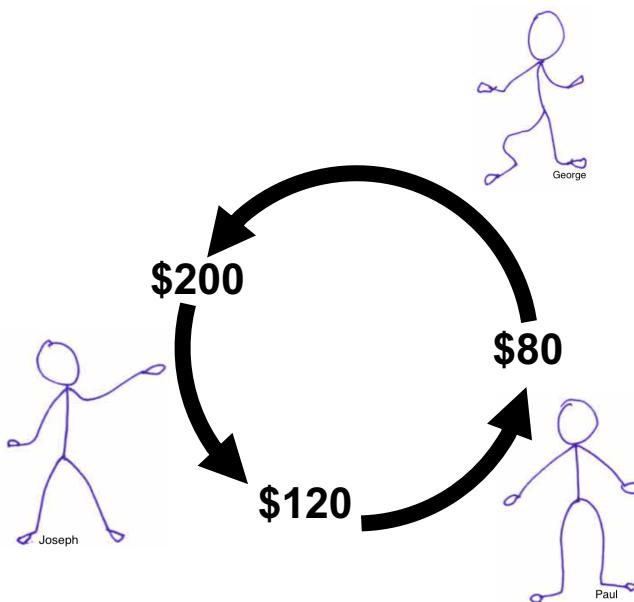
Part A: Describe how one value changes to become the other.
Show the working for your answer.

You may select a statement about percentage change from the following list:

Increase by 40%	Decrease by 60%	Increase by 50%
Decrease by 150%	Increase by $33\frac{1}{3}\%$	Increase by $66\frac{2}{3}\%$



Part B: Now, the directions of the arrows in the diagram are all reversed.
Work out the percentage increase or decrease that would describe the changes.
Come up with your own statement that describes the change.



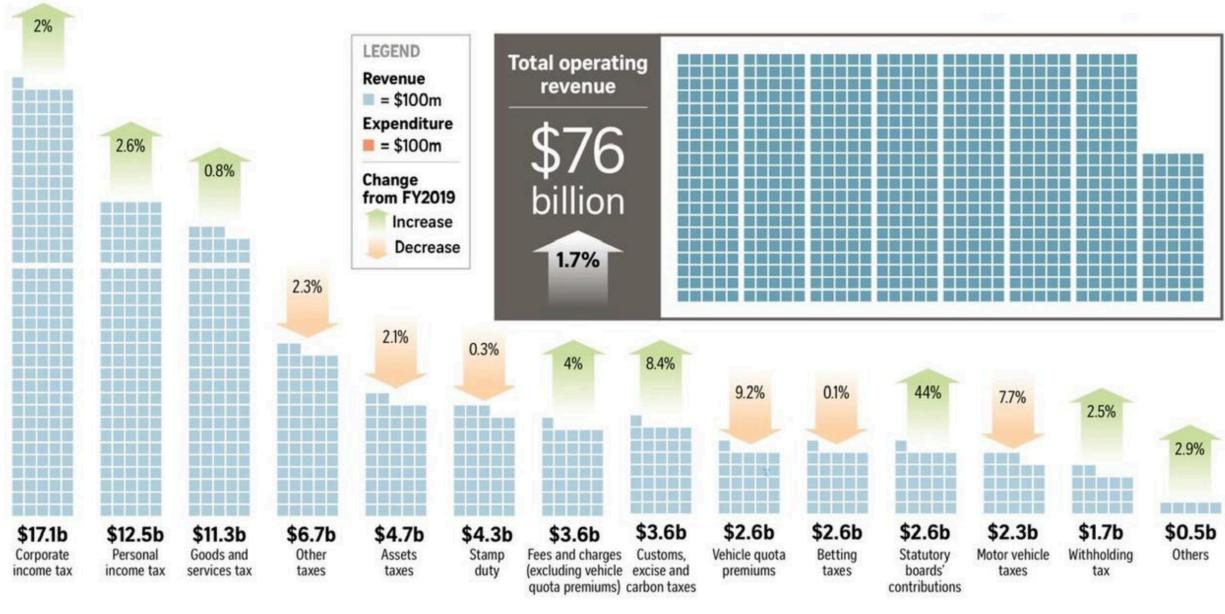
Activity 2: [National Education]

The Singapore Budget 2020 & 2021 (announced in 16 Feb 2021)

Part 1: The pandemic has affected the amount of revenue projected from the various sectors.

Chart 1: Year 2020 Budget (announced in February, before the Covid-19 Pandemic)

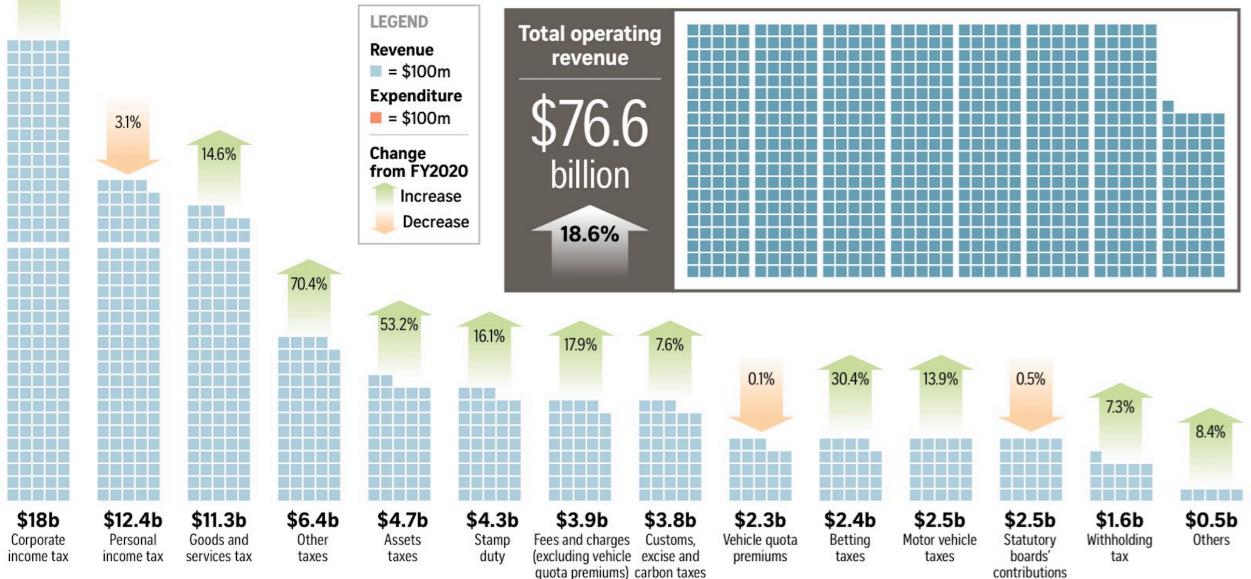
WHERE THE MONEY WILL COME FROM



Source of image: The Straits Times (19 Feb 2020) Budget 2020

Chart 2: Year 2021 Budget (announced on 16 Feb 2021)

WHERE THE MONEY WILL COME FROM



Source of image: The Straits Times (17 Feb 2021) Budget 2021

Table:

ANNEX F-2: FISCAL POSITION IN FY2021

	Actual FY2019	Revised FY2020	Estimated FY2021	Change Over Revised FY2020	
	\$billion	\$billion	\$billion	\$billion	% change
OPERATING REVENUE	74.27	64.61	76.64	12.03	18.6
Corporate Income Tax	16.73	13.74	17.97	4.22	30.7
Personal Income Tax	12.37	12.77	12.37	(0.40)	(3.1)
Withholding Tax	1.64	1.54	1.65	0.11	7.3
Statutory Boards' Contributions ¹	1.80	2.52	2.51	(0.01)	(0.5)
Assets Taxes	4.76	3.09	4.74	1.65	53.2
Customs, Excise and Carbon Taxes	3.26	3.51	3.77	0.27	7.6
Goods and Services Tax	11.16	9.90	11.34	1.45	14.6
Motor Vehicle Taxes	2.42	2.21	2.52	0.31	13.9
Vehicle Quota Premiums	2.87	2.28	2.28	0.00	(0.1)
Betting Taxes	2.62	1.85	2.41	0.56	30.4
Stamp Duty	4.20	3.66	4.25	0.59	16.1
Other Taxes ²	6.68	3.78	6.43	2.66	70.4
Other Fees and Charges	3.41	3.32	3.91	0.59	17.9
Others	0.35	0.45	0.49	0.04	8.4
Less:					
TOTAL EXPENDITURE	75.34	94.06	102.34	8.28	8.8
Operating Expenditure	58.67	77.64	82.46	4.82	6.2
Development Expenditure	16.67	16.41	19.87	3.46	21.1
PRIMARY SURPLUS / DEFICIT³	(1.06)	(29.45)	(25.70)		

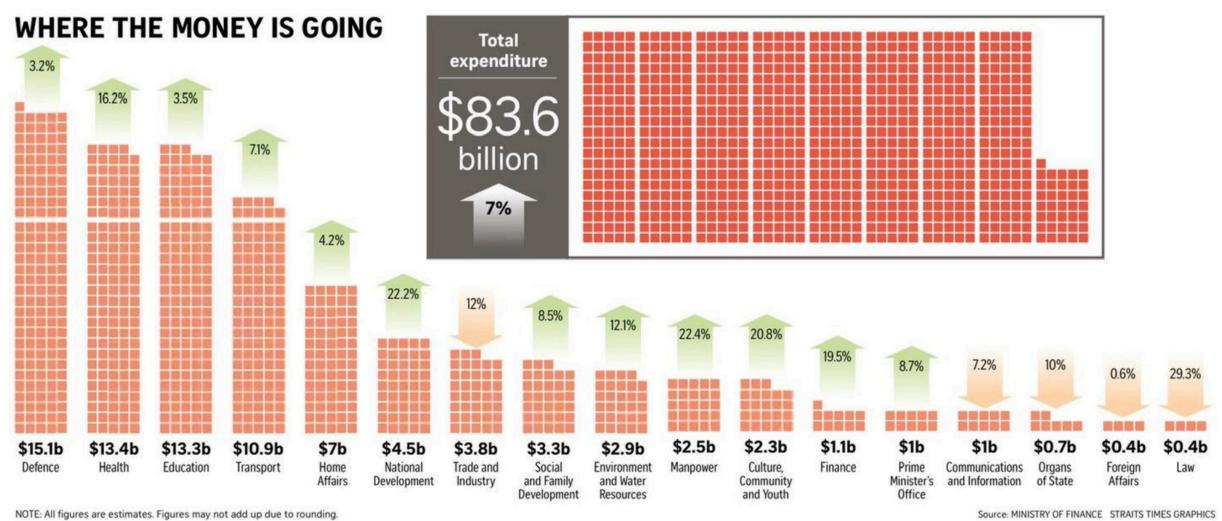
Source of image: MOF Annex F-2: Fiscal Position In Fy2021
 Website for 2021 Budget: <https://www.mof.gov.sg/singaporebudget/budget-speech>

- Q1. With reference to the figures presented in the Table and Chart 1, what is the **percentage change** between the original figure (reported in 2020 Feb) and actual total operating revenue of Year 2020.
- Q2. In both Chart 1 & Chart 2, the amount reflected for GST is \$11.3 billion. However, in Chart 2, it shows there is an increase of 14.6% from the previous year.
- (a) How could this has happened?
 - (b) By comparing the actual and projected figures, calculate the percentage decrease in the amount received through GST in 2020.

Part 2: Owing to the pandemic situation, adjustments were made to the 2020 Budget that was announced in February.

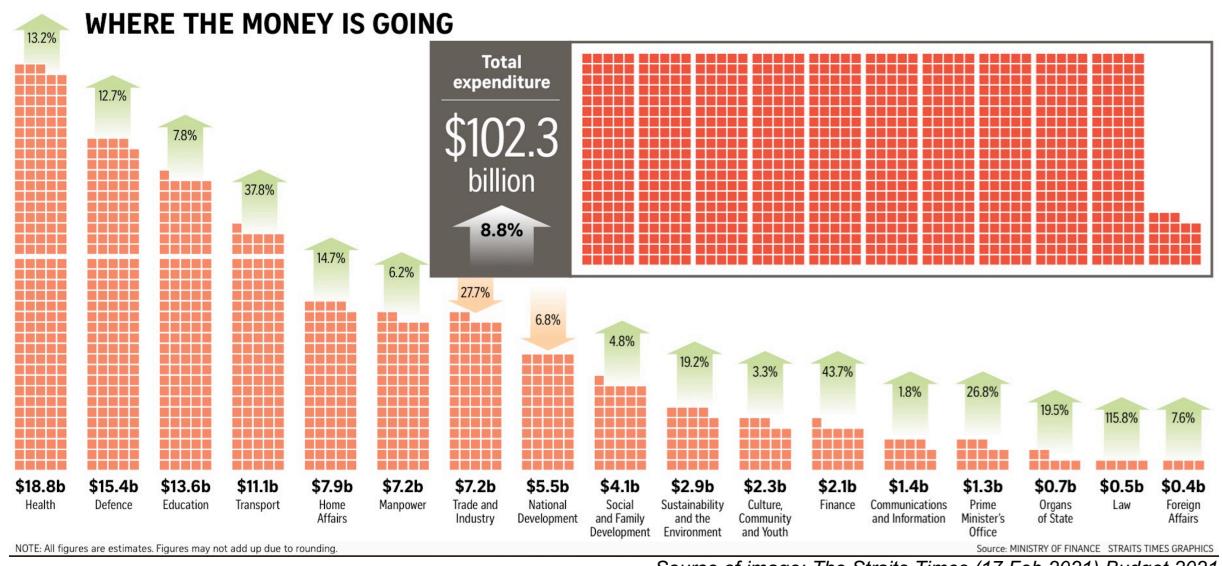
The charts below illustrate the amount of budget received by the various sectors in Year 2020 and Year 2021.

Chart 3: Year 2020 Budget (announced in February, before the Covid-19 Pandemic)



Source of image: *The Straits Times* (19 Feb 2020) Budget 2020

Chart 4: Year 2021 Budget (announced on 16 Feb 2021)



Source of image: *The Straits Times* (17 Feb 2021) Budget 2021

- Q3. In the budget allocated to the Health Ministry, there is an 13.2% increase, compared to what was actually allocated in 2020.
- (a) Calculate the actual amount that went to the Health Ministry in 2020.
 - (b) By comparing the actual and projected figures, calculate the percentage increase on the amount received by the Health Ministry in 2020.
- Q4. Several ministries/ government agencies ss a significant increase in the proportion of the budget allocated this year, when compared to the amount initially allocated in 2020. One of them is the Law Ministry.
- (a) Calculate the actual amount that went to the Law Ministry in 2020?
 - (b) Calculate the percentage of that actually went to the Law Ministry in 2020?
- Q5. The amount allocated to the Ministry of National Development is 6.8% less than what it actually received in 2020.
- (a) How much went to the ministry in 2020?
 - (b) Did the ministry actually receive more or less than what was initially allocated in Feb 2020? By much is this difference?

Practice 2 (Tier B)

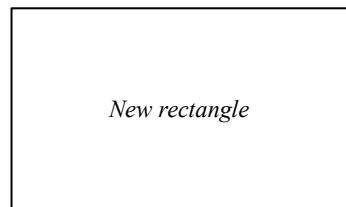
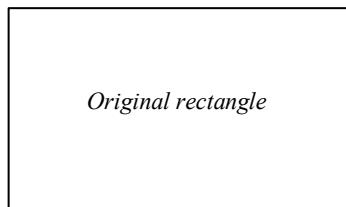
Source: Textbook p18 Practice Now 12

The length of a rectangle is twice that of its breadth.

If the length of the rectangle is increased by 20% while its breadth is decreased by 20%, determine, if any, the percentage change in its perimeter.

Guide...

1. Sketch a rectangle and label the **unknown breadth, x .**
2. With this, what is the length of the rectangle, in terms of x ?
3. Express the new length and breadth of the rectangle in terms of x . Label the rectangle.
4. Now, do the relevant calculation to determine if there is any change in perimeter.



THINK: What would be the denominator to calculate the change if the perimeters of the original and new rectangle are different?

Practice 3 (Tier C)

Source: Discovery Mathematics Textbook 1B

Consider a rectangle of length 50 cm and width 40 cm.

- (a) Find its area.
- (b) Find its area when the length is increased by 10% and the width is decreased by 10%.
- (c) Find its area when the length is decreased by 10% and its width is increased by 10%.
- (d) Compare the results in (a), (b) and (c).

- (e) Find its area when the length is increased by 20% and the width is decreased by 20%
- (f) Find its area when the length is decreased by 20% and its width is increased by 20%.
- (g) Compare all of the above results. What can you conclude?

- (h) Sufen proposed that the new area of $A \text{ cm}^2$ when the length is increased by $x\%$ and the width is decreased by $x\%$ is given by

$$A = 2000 \times \left(1 - \frac{x^2}{100}\right)$$

What is the mistake in the formula?

(II) Percentage Point

Activity 3:

The following articles are related to the raise of Goods and Services Tax in Singapore.

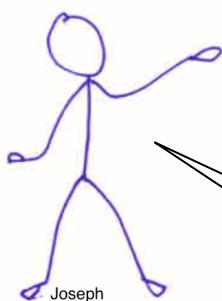
ARTICLE 1: https://www.singaporebudget.gov.sg/data/budget_2007/download/FY2007_Budget_Statement.pdf
Extracted from the budget statement 2007, delivered by Finance Minister

Raising the Goods and Services Tax Rate

5.26 This is why PM announced last year that we will raise the GST rate. Doing this will broaden our tax base, and enable the Government to implement Workfare and other initiatives to strengthen our social cohesion and grow our economy.

5.27 I have decided to raise the GST rate to 7% with effect from 1st July 2007. It is prudent to implement the GST increase now, in one step, while the economy is strong. This is expected to raise additional revenues of \$750 million this year, and \$1.5 billion per year going forward.

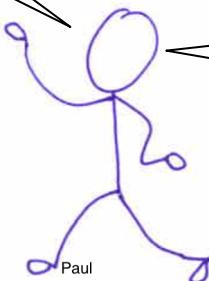
Note: 1.5 billion in number is 1,500,000,000



The increase from 5%
to 7% is an increase of
40% and not 2%!!!

•

How did Joseph
arrive at 40%?



Do you think Joseph is
right to say that the
increase is 40%?

ARTICLE 2:

Source: <https://www.straitstimes.com/singapore/singapore-budget-2018-gst-to-be-raised-from-7-to-9-sometime-between-2021-and-2025>
Extracted from the Straits Times.

Singapore Budget 2018: GST to be raised from 7% to 9% some time between 2021 and 2025

SINGAPORE - The goods and services tax (GST) is set to increase from 7 per cent to 9 per cent some time between 2021 and 2025.

This comes as the Government's spending on healthcare, infrastructure and security has gone up and is expected to increase further in the years to come.

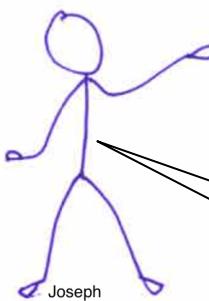
Finance Minister Heng Swee Keat made the announcement in his [Budget statement in Parliament](#) on Monday (Feb 19).

The exact timing will depend on three factors: the state of Singapore's economy, how much the country's expenditures grow, and how buoyant Singapore's existing taxes are. But Mr Heng said he expected that the Government would need to do so earlier rather than later.

Mr Heng said the GST increase is "necessary because even after exploring various options to manage our future expenditures through prudent spending, saving and borrowing for infrastructure, there is still a gap".

He said the 2 percentage point increase will provide the Government with revenue of almost 0.7 per cent of Singapore's gross domestic product per year.

GST is a broad-based consumption tax levied on nearly all goods and services in Singapore.



2 percentage point increase.
What does that mean?
How is it different from 2% increase?

Lesson 3 Percentage in Real-World Contexts

Percentages are found in everyday life. They are commonly used to report figures and describe magnitudes. They can be found in newspaper articles, reports and receipts. They are also commonly used in discounts, commission and taxes.

(I) Profit and Loss

Refer to **Textbook** Chapter 8.3 Percentage in real-world contexts (A) Profit and Loss
Read the Examples 12, 13 and 14 (pages 23-24)

Profit (or Gain)	Selling Price – Cost Price > 0	Express Profit or Loss as a percentage of the cost price:
Loss	Selling Price – Cost Price < 0	$\frac{\text{Profit or Loss}}{\text{Cost Price}} \times 100\%$ Answer is in %

Practice 1 (Tier A)

Source: Textbook p30 Exercise 8C Q2

The profit on a refrigerator is 35% of the cost price.

If the profit is \$280, find (i) the cost price (ii) the selling price, of the refrigerator.

Think: What would you associate 100% with?

There is more than one way to attempt this question.

Describe at least 2 ways to solve the problem.

(II) Discount

Refer to **Textbook** Chapter 8.3 Percentage in real-world contexts (B) Discount
Read the Examples 18 and 19 (pages 25-26)

Note: Discount can be described as a value or in percentage.

$$\text{Discount} = \text{Marked Price} - \text{Sale Price}$$

$$\text{Percentage Discount} = \frac{\text{Discount}}{\text{Marked Price}} \times 100\%$$

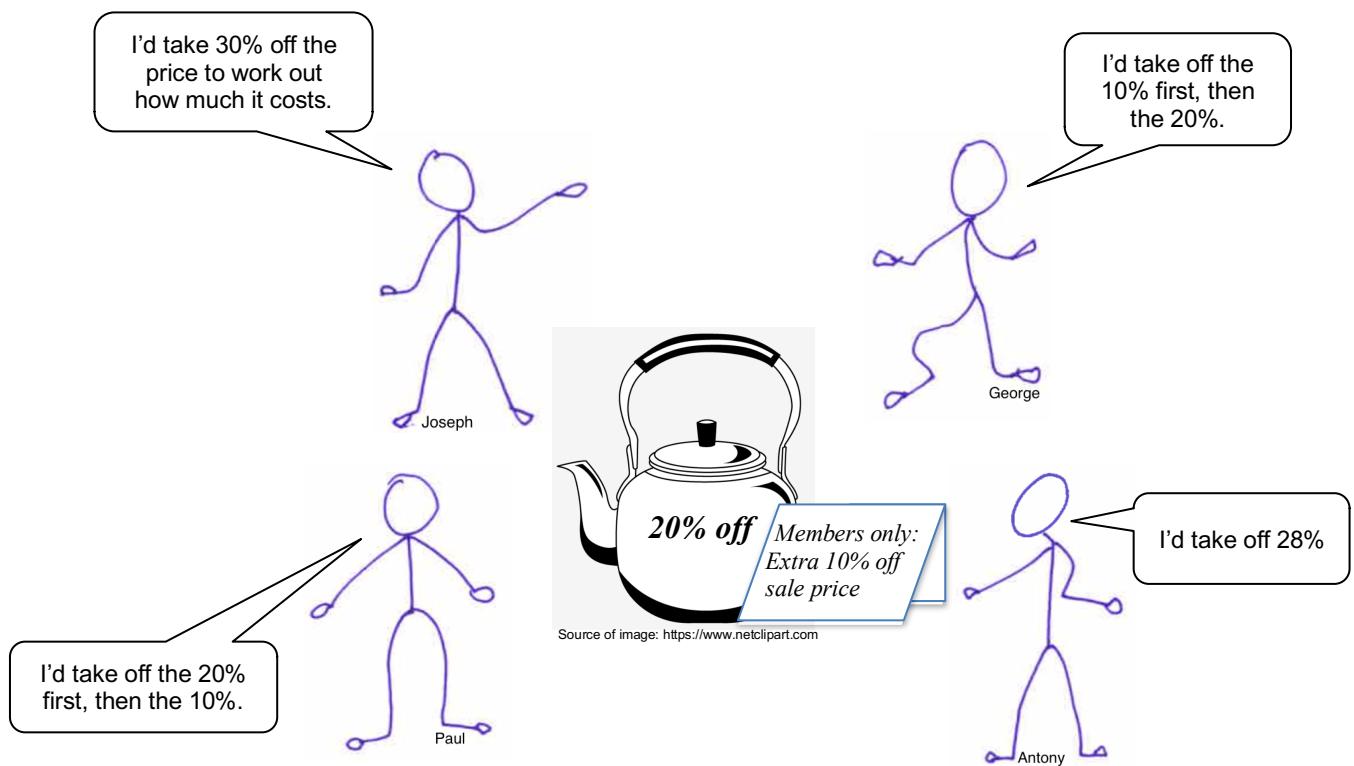
Activity 1:

Source: Concept Cartoon in Mathematics Education

Read the following.

Do you agree with what each of the shopper says?

Who is right? Name one assumption made in this scenario.



Practice 2 (Tier B)

Source: Textbook p30 Exercise 8C Q16

An air conditioner is sold for \$700 after a discount of 12.5%.

- (i) Find the marked price of the air conditioner.
- (ii) If a 10% discount is given on the marked price of the air conditioner before it is sold at a further discount of 2.5%, would the sale price still be \$700?

Think:

- *For (i), what would you associate 100% with?*
- *For the conclusion you made in (ii), can it be generalised and remains true in all for all scenarios?*

(III) Goods and Services Tax (GST)

GST is a tax on consumption. The tax is paid when money is spent on goods or services, including imports.

Find out more about the Singapore Tax System, GST and how it works at the IRAS website
Read HERE (1): <https://www.iras.gov.sg/irashome/About-Us/Taxes-in-Singapore/The-Singapore-Tax-System/>
Read HERE (2): <https://www.iras.gov.sg/IRASHome/GST/Non-GST-registered-businesses/Learning-the-basics/How-GST-Works/>

Refer to **Textbook** Chapter 8.3 Percentage in real-world contexts (C) GST.

Read the Examples 20 and 21 (pages 27-28)

Practice 3 (Tier A)

Source: Textbook p30 Exercise 8C Q8

The microwave oven costs \$270 before GST. Assuming that GST is at 7%, find the total amount of money that Ethan has to pay for the microwave oven.

Think:

- *At present, in Singapore, GST is 7%. Some countries charge GST, too. Do they charge the same amount?*
- *What are the considerations to decide on this figure? (Search local newspaper reports on this to find out more)*

Practice 4 (Tier C)

Source: Textbook p31 Exercise 8C Q21

Devi orders one bowl of ramen at a Japanese Restaurant, which offers an 18% discount. There is a service charge of 10% and GST at 7%. Given that she pays a total of \$10.13, find the marked price of the ramen.

Think:

- *Is GST imposed on the cost of the bowl of ramen only?*
- *Do all restaurants charge service charge?*
- *Get a recipient from a restaurant and analyse how the charges are computed.*

(IV) Commission

Commission is the payment an agent receives for selling or buying something on behalf of another party

Refer to **Textbook** Chapter 8.3 Percentage in real-world contexts (D) Commission.
Read the Example 22 (page 29)

Activity 2:

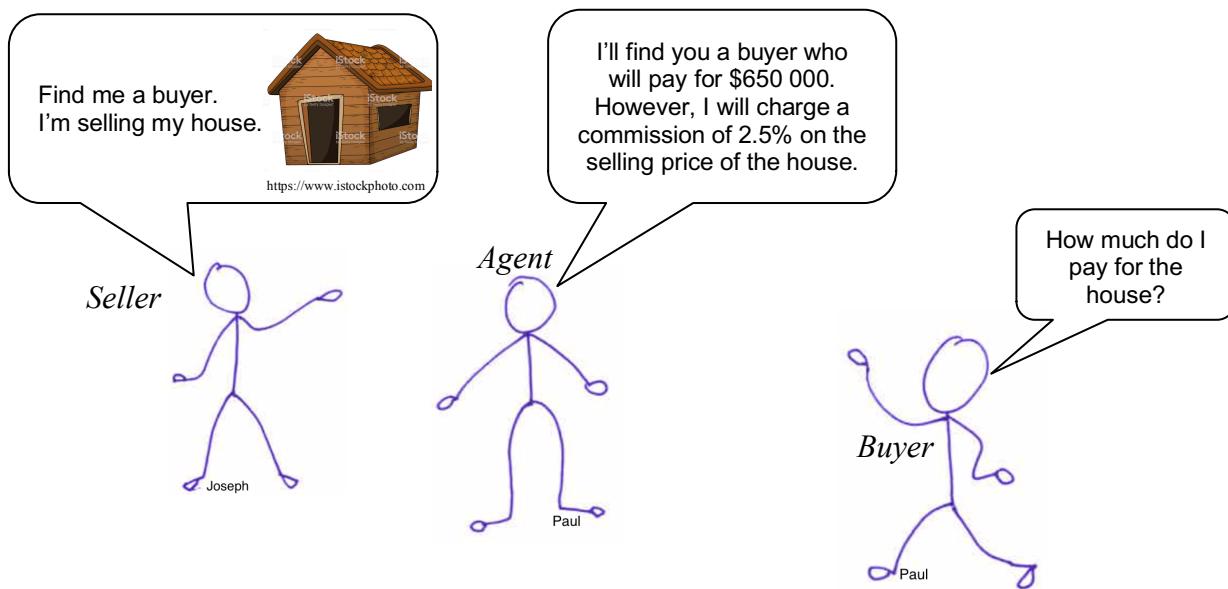
Source: Textbook p30 Exercise 8C Q10

A property agent charges a commission of 2.5% on the selling price of a house.

- Given that the agent sells a house for \$650 000, find the amount of commission he receives
- On another occasion, he receives a commission of \$12 000. Find the selling price of the house.

An illustration of (a).

Let's try to understand the **relationship** between the buyer, seller and the agent.



Practice 5 (Tier A)

A salesman is paid a basic salary of \$520 per month plus a commission of 25% of total sales made during the month. If the product he sold for a particular month is \$5264, what is his total income for that month?