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587 Bukit Timah Road  
#03-36 Coronation Shopping Plaza  
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First published 2024

**ISBN 978 981 18 9468 8**

Printed in Singapore

# PREFACE

**Secondary 1 Express 150 Essential Practice Questions (Volume 1B)** is the second of a two-book series specially written for Secondary 1 students to prepare for their various continual assessments and semestral assessments in Mathematics. The materials in this book follow closely to the latest Mathematics syllabus implemented by the Ministry of Education, containing the last 7 units of the Secondary 1 curriculum. These materials are relevant for students in both the 'O' Level and Integrated Programme (IP) tracks and serve to provide a concise yet complete essential collection of practice questions that a student needs to fully comprehend each given topic bounded by the syllabus.

This book has the following features:

- **Key Concepts**

We start each unit with important learning objectives clearly stated to guide students in their understanding of the topics. This is followed by summary of the essential concepts for the topics as a quick revision guide for students to consolidate their learning before attempting the practice questions.

- **Basic Questions, Intermediate Questions and Advanced Questions**

The **Basic Questions** in this section tackles the foundational concepts for each topic. Mastering these questions is vital to ensure proper foundation of the topic is set. When a student gains confidence by completing the Basic Questions, they can move on to **Intermediate Questions** which builds upon their foundation in the topic while introducing another layer of problem solving. To further challenge and stretch the student's thinking skills, they are encouraged to attempt the **Advanced Questions** to ensure full mastery of the topic(s) presented in the question.

- **Problems in Real-World Context (P.R.W.C.) Questions**

Some of the practice questions in this book are problems in Real-World Contexts and are denoted by the following badge:



- **Higher Order Thinking (H.O.T.) Questions**

Some of the practice questions in this book are Higher Order Thinking questions and are denoted by the following badge:



Students will find this book handy when they need to supplement their Mathematics learning with additional practice questions to prepare for their tests and examinations. With thorough practice, students are sure to gain a stronger mastery in the subject and increase their confidence when it comes to Mathematics assessments.

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# UNIT 8: PERCENTAGES

## SUMMARY

### LEARNING OBJECTIVES

- (i) Convert between percentage, decimal and fraction.
- (ii) Express one quantity as a percentage of another.
- (iii) Compare two values in terms of percentage.
- (iv) Describe increase and decrease in values in terms of percentage change.
- (v) Solve problems involving percentage under real-world contexts, i.e., involving profit & loss, discount and Goods and Services Tax (GST).

### ESSENTIAL CONCEPTS

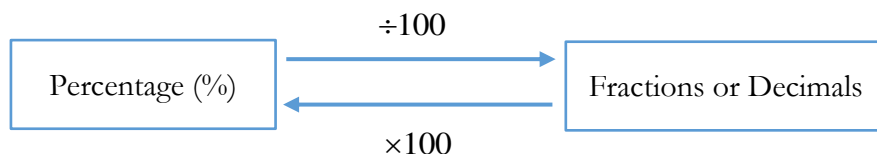
#### (i) Basics of Percentage (Questions 1 – 8)

- (a) **Percentage** is a number expressed as a fraction of 100, denoted by “%”.

In general,

$$x\% = \frac{x}{100}$$

- (b) The following equations show the process of conversion between percentage, decimals and fractions.



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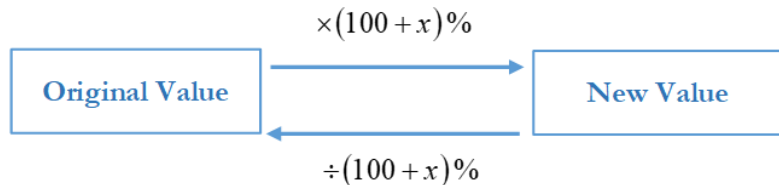
(ii) **Percentage Change and Reverse Percentage (Questions 9 – 14)**

Percentage increase/decrease represents the change of a quantity with respect to its original value.

The following equations show the conversion between original and new value for percentage increase and decrease, respectively.

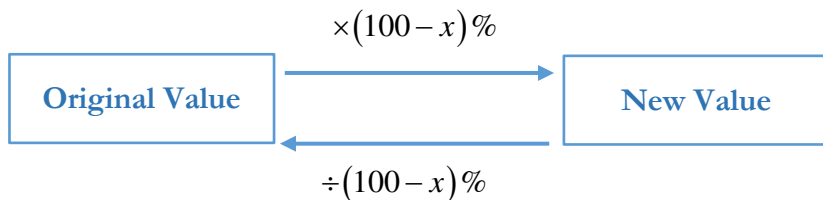
(a) For percentage increase:

$$x\% = \frac{\text{Increment}}{\text{Original Value}} \times 100\%$$



(b) For percentage decrease:

$$x\% = \frac{\text{Decrement}}{\text{Original Value}} \times 100\%$$



(iii) **Applications of Percentage (Questions 15 – 25)**

(a) Profit and Loss

$$\begin{aligned} \text{Profit} &= \text{Selling Price} - \text{Cost Price} \\ \text{Loss} &= \text{Cost Price} - \text{Selling Price} \end{aligned}$$

$$\text{Profit as a Percentage of Cost Price} = \frac{\text{Profit}}{\text{Cost Price}} \times 100\%$$

$$\text{Loss as a Percentage of Cost Price} = \frac{\text{Loss}}{\text{Cost Price}} \times 100\%$$

**(b)** Discount

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

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

**(c)** Goods and Services Tax (GST)

$$\text{Total Amount Payable} = \overset{\text{Selling price}}{\text{Marked Price} - \text{Discount}} + \text{Service Charge} + \text{GST Payable}$$

$$\text{Service Charge} = \text{Service Charge Percentage} \times \overset{\text{Selling price}}{(\text{Marked Price} - \text{Discount})}$$

$$\text{GST Payable} = \text{GST charge percentage} \times (\text{Marked Price} - \text{Discount} + \text{Service Charge})$$



## Basic Questions

1. Express each of the following percentages as a decimal and a fraction (in the lowest term).

(i) 37%

(ii) 291%

(iii) 1.3%

(iv)  $17\frac{5}{8}\%$

(v) 128.64%

(vi) 0.095%

2. Express each of the following fractions as a percentage (Correct your answers to 3 significant figures).

(i)  $\frac{7}{10}$

(ii)  $\frac{4}{15}$

(iii)  $\frac{64}{125}$

(iv)  $7\frac{19}{20}$

(v)  $1\frac{36}{37}$

(vi)  $2\frac{51}{100}$

3. Express each of the following decimals as a percentage.

(i) 0.064

(ii) 0.81

(iii) 5.5

(iv) 13.031

(v) 3.87

(vi) 2.051

4. In a company, there are 115 male employees and 135 female employees. Find

(i) the percentage of male employees in the company,

(ii) the percentage of female employees in the company



**Intermediate Questions**

7. For each pair of the following values, express the first value as a percentage of the second value.
- (i) 136 centimetres, 4 metres
  - (ii) 2700 seconds, 2 hours
  - (iii)  $45^\circ$ ,  $360^\circ$
  - (iv) 2.5 kg, 200 g
  - (v) 4 years, 6 months
  - (vi)  $3\frac{3}{5}$  litres, 50 millilitres
8. (i) The length of a rectangle is increased by 30% and the breadth of the rectangle is increased by 40%. Find the percentage change in its area.
- (ii) The radius of a circle is increased by 20%. Find the percentage change in its perimeter and area, respectively.
- (iii) The base of a triangle is increased by 10% and the perpendicular height from the base is decreased by 10%. Find the percentage change in its area.

9. The breadth of a cuboid is 6 cm. The length of the cuboid is 150% that of its breadth, and the breadth of the cuboid is 150% that of its height.
- Find the length and height of the cuboid.
  - Find the volume of the cuboid.
  - If the length of the cuboid is increased by 50% and the breadth of the cuboid is decreased by 50%, while the height of the cuboid does not change. Find the new length and breadth of the cuboid.
  - Based on your answers in **(iii)**, determine whether the volume of the cuboid is the same as original. If yes, state your reasons by providing detailed workings. If not, find the new volume and the percentage change in the volume of the cuboid.
10. For two real numbers,  $x$  and  $y$ , given that  $x$  is 40% of  $y$ , find
- the value of  $\frac{x}{8y}$ ,
  - $(5x + y)$  as a percentage of  $y$ ,
  - $x^2$  as a percentage of  $y^2$ ,
  - $y^2$  as a percentage of  $x^2$ .


11. A house costs \$300 000 in the year 2010, and the price increased by 20% over the next 5 years. Then the price further increased by 25% over the next 5 years. Find
- (i) the prices of the house in the year 2015 and the year 2020, respectively,  
(ii) the overall percentage of increase in the house's price from year 2010 to 2020.
12. The value of a machine depreciates by 50% every year after its purchase. If the value of a machine is \$250 000 in the year 2020, and the price was \$2 000 000 on purchase.
- (i) Find the year when the machine was purchased.  
(ii) Find the year when the machine's value depreciates to \$62 500.

13. Amy expected that her monthly income could be increased by 20% this year compared to her monthly income last year, but due to company's financial situation, her salary was cut down by 15%. As a result, Amy's monthly salary was reduced by \$1 680 compared to her expectation.

- (i) Find the monthly income of Amy's in the last year.
- (ii) When financial situation recovers, the company decides to increase Amy's monthly income to her expectation. Find the percentage increase in Amy's monthly income (Correct your answer to 3 significant figures).

14. A store manager first increased the price of their products by 60%, then lowered the price by 20%. A customer bought a specific product at \$160 as a current price.

- (i) Find the original price of the product.
- (ii) Find the overall percentage change in the price of this product compared to its original price.

15. Mrs. Lim bought a house at \$550 000 and spent \$50 000 on the redecoration. She  then leased the house at \$42 000 per year for 10 years. Then Mrs. Lim sold the house at \$700 000.
- (i) Find the total profit of Mrs. Lim as a percentage of her cost (Correct your answer to 3 significant figures).
  - (ii) If Mrs. Lim only lease the house without selling it, find the number of years after which Mrs. Lim will obtain a profit of 5%.



16. A fruit vendor buys 1 000 packs of strawberry from a farmer at \$5 per pack. All other costs including delivery are \$200 in total. Suppose all packs of strawberry are sold.




- (i) Find the selling price per pack of strawberry if the vendor wants to earn a 60% profit on his total cost.
- (ii) During delivery, 17 packs of the strawberry are damaged, thus cannot be sold. Find the new selling price per pack of strawberry if the vendor wants to earn a same percentage of profit on his total cost. Round your answer to the nearest cent.

17. A factory buys raw materials at \$25 000 and pays salary to workers at \$60 000 .



The products are sold to a store at a profit of 15% on the total cost.

- (i) Find the total selling price of the products by the factory.
- (ii) Due to the increasing cost in raw materials, the factory makes a loss of 8% on the total cost, given that the workers' salary and selling price stay the same. Find the new price of raw materials.

- 
18. A stationery vendor bought 500 pencils at a total price of \$300 and sells the pencils at \$1.00 each. Find
- 
- (i) the cost of each pencil,
  - (ii) the profit as a percentage of the cost for each pencil (Correct your answer to 3 significant figures),
  - (iii) the number of pencils he has to sell to avoid making a loss,
  - (iv) total amount of profit if all the pencils are sold,
  - (v) If 27 of the pencils are damaged, which cannot be sold, find the new selling price of each pencil if the vendor intends to keep the same amount of profit. Round your answer to the nearest cent.



## Advanced Questions

19. A storeowner buys a certain number of goods from supplier A at \$6 as a unit price and sell at \$12 as a unit price. The storeowner bears all other costs at \$4 000 in total. Suppose the owner manages to sell all the goods and earns a profit of 20% on the total cost.

(i) Find the number of goods the owner buys from supplier A.

Another supplier B offers a lower unit price at \$4 to the storeowner. The storeowner buys a new number of such goods from supplier B and sell at the unit price \$12. But this time the storeowner only sells 45% of the goods and made a loss of 10% on the total cost. Suppose all other costs are also \$4 000 in total.

(ii) Find the new number of goods the owner buys from supplier B.

20. A book at bookstore A is marked at \$30 but sold at \$24. Another bookstore B  sells this kind of book at \$28 after a percentage discount of 30%. And bookstore B offers a further percentage discount of 20% on the part of purchasing beyond  100 if customers purchase more than 100 books of this kind.
- Find the percentage discounts of the book at bookstore A.
  - Find the marked price of the book at bookstore B.
  - Find the selling price and the overall percentage discount of the book at bookstore B for the part of purchasing beyond 100.
  - A school is planning to buy this kind of book for the students. Find which bookstore, A or B, has a cheaper total price if the school wants to buy 400 such books.
  - Find the minimum number of books one will find it cheaper to buy from bookstore B than bookstore A.



# SUGGESTED ANSWERS



## UNIT 8 PERCENTAGES

1. (i)  $0.37, \frac{37}{100}$   
 (ii)  $2.91, 2\frac{91}{100}$   
 (iii)  $0.013, \frac{13}{1000}$   
 (iv)  $0.17625, \frac{141}{800}$   
 (v)  $1.2864, 1\frac{179}{625}$   
 (vi)  $0.00095, \frac{19}{20000}$
  
2. (i)  $\frac{7}{10} \times 100\% = 70.0\%$  (3 s.f.)  
 (ii)  $\frac{4}{15} \times 100\% = 26.666\%$   
 $= 26.7\%$  (3 s.f.)  
 (iii)  $\frac{64}{125} \times 100\% = 51.2\%$  (3 s.f.)  
 (iv)  $7\frac{19}{20} \times 100\% = 795\%$  (3 s.f.)  
 (v)  $1\frac{36}{37} \times 100\% = 197.29\%$   
 $= 197\%$  (3 s.f.)  
 (vi)  $2\frac{51}{100} \times 100\% = 251\%$  (3 s.f.)
  
3. (i)  $0.064 \times 100\% = 6.4\%$   
 (ii)  $0.81 \times 100\% = 81\%$   
 (iii)  $5.50 \times 100\% = 550\%$   
 (iv)  $13.031 \times 100\% = 1303.1\%$   
 (v)  $3.87 \times 100\% = 387\%$   
 (vi)  $2.051 \times 100\% = 205.1\%$
  
4. Total number of employees  
 $= 115 + 135 = 250$   
 (i) Percentage of male employees  
 $= \frac{115}{250} \times 100\% = 46\%$   
 (ii) Percentage of female employees  
 $= \frac{135}{250} \times 100\%$  or  $100\% - 46\%$   
 $= 54\%$
  
5. (i) Number of boys  
 $= 550 \times 40\% = 550 \times \frac{40}{100} = 220$  boys
  
- (ii) Number of girls  
 $= 550 - 220$  or  $550 \times 60\% = 330$  girls
  
6. Percentage of Mr Ong's income spent on rent  
 $= \frac{3200}{7000} \times 100\% = 45.714\% = 45.7\%$  (3 s.f.)  
 Percentage of Ms Yong's income spent on rent  
 $= \frac{3700}{7600} \times 100\% = 48.68\% = 48.7\%$  (3 s.f.)  
 $\therefore$  Ms Yong spent a higher percentage of her monthly income on rent.
  
7. (i) 136 cm, 4 m = 400 cm  
 $\therefore$  Required percentage  
 $= \frac{136}{400} \times 100\% = 34\%$   
 (ii) 2700 seconds, 2 hours = 120 min  
 $= 7200$  seconds  
 $\therefore$  Required percentage  
 $= \frac{2700}{7200} \times 100\% = 37.5\%$   
 (iii) Required percentage  
 $= \frac{45^\circ}{360^\circ} \times 100\% = 12.5\%$   
 (iv) 2.5 kg = 2500 g, 200 g  
 Required percentage  
 $= \frac{2500}{200} \times 100\% = 1250\%$   
 (v) 4 years = 48 months, 6 months  
 Required percentage  
 $= \frac{48}{6} \times 100\% = 800\%$   
 (vi)  $3\frac{3}{5}$  l = 3600 ml, 50 ml  
 Required percentage  
 $= \frac{3600}{50} \times 100\% = 7200\%$
  
8. (i) Original Area =  $BL$   
 New Area =  $\frac{130}{100}L \times \frac{140}{100}B = \frac{91}{50}LB$   
 Percentage increase  
 $= \frac{\frac{91}{50}LB - LB}{LB} \times 100\%$   
 $= \frac{41}{50} \times 100\%$



$$= \frac{41}{50} \times 100\% = 82\%$$

$\therefore$  Area increased by 82%

(ii) Original perimeter =  $2\pi R$

New perimeter

$$= 2\pi(120\%R) = 2\pi\left(\frac{120}{100}\right)R$$

$$= \frac{12}{5}\pi R$$

Percentage increase in perimeter

$$= \frac{\frac{12}{5}\pi R - 2\pi R}{2\pi R} \times 100\%$$

$$= \frac{\frac{2}{5}\pi R}{2\pi R} \times 100\% = \frac{2}{5} \times 100\%$$

$$= \frac{2}{5}(2) \times 100\% = 20\%$$

Original Area =  $\pi R^2$

New Area =  $\pi(120\%R)^2$

$$= \pi\left(\frac{120}{100}R\right)^2 = \pi\left(\frac{120}{100}\right)^2 R^2$$

$$= \frac{36}{25}\pi R^2$$

Percentage increase in area

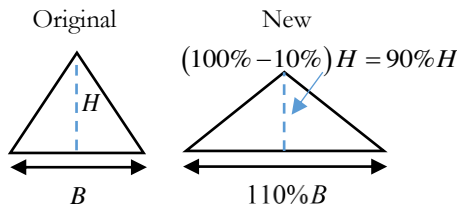
$$= \frac{\frac{36}{25}\pi R^2 - \pi R^2}{\pi R^2} \times 100\%$$

$$= \frac{11}{25}\pi R^2 \times 100\%$$

$$= \frac{11}{25} \times 100\% = 44\%$$

$\therefore$  Perimeter increased by 20% and area increased by 44%.

(iii)



$$\text{Original Area} = \frac{1}{2}BH = 0.5BH$$

$$\text{New Area} = \frac{1}{2}(110\%B)(90\%H)$$

$$= \frac{1}{2}\left(\frac{110}{100}B\right)\left(\frac{90}{100}H\right)$$

$$= \frac{99}{200}BH = 0.495BH$$

Percentage Decrease

$$= \frac{0.5BH - 0.495BH}{0.5BH} \times 100\%$$

$$= \frac{0.005BH}{0.5BH} \times 100\%$$

$$= \frac{1}{100} \times 100\% = 1\%$$

$\therefore$  Area decreased by 1%

9. (i)  $L = 150\% \times B = \frac{150}{100} \times 6 = 9$  cm

$$B = 150\% H$$

$$6 = \frac{150}{100} H$$

$$H = 6 \times \frac{100}{150} = 4$$
 cm

$\therefore$  The length is 9 cm and the height is 4 cm.

(ii) Volume =  $6 \times 9 \times 4 = 216$  cm<sup>3</sup>

(iii) New length,  $L_2 = 150\% L = \frac{150}{100}(9)$

$$= 13.5$$
 cm

New breadth,  $B_2 = (100\% - 50\%) B$

$$= \frac{50}{100}(6) = 3$$
 cm

(iv) The volume of new cuboid

$$= 13.5 \times 3 \times 4 = 162$$
 cm<sup>3</sup>

$\therefore$  The volume is not the same as original.

Percentage decrease

$$= \frac{216 - 162}{216} \times 100\% = 25\%$$

It decreases by 25%.

10. (i)  $x = 40\% y$

$$x = \frac{40}{100} y$$

$$x = \frac{2}{5} y$$

$$\frac{x}{y} = \frac{2}{5}$$





$$\frac{x}{8y} = \frac{2}{5} \times \frac{1}{8}$$

$$\therefore \frac{x}{8y} = \frac{1}{20}$$

$$(ii) \frac{5x+y}{y} \times 100\%; \quad x = \frac{2}{5}y$$

$$= \frac{5\left(\frac{2}{5}y\right) + y}{y} \times 100\%$$

$$= \frac{2y+y}{y} \times 100\%$$

$$= \frac{3y}{y} \times 100\% = 300\%$$

$$(iii) \frac{x^2}{y^2} \times 100\%; \quad x = \frac{2}{5}y$$

$$= \frac{\left(\frac{2}{5}y\right)^2}{y^2} \times 100\%$$

$$= \frac{\left(\frac{2}{5}y\right)\left(\frac{2}{5}y\right)}{y^2} \times 100\%$$

$$= \frac{4}{25}y^2 \times 100\%$$

$$= \frac{4}{25} \times 100\% = 16\%$$

$$(iv) \frac{y^2}{x^2} \times 100\%$$

$$= \frac{y^2}{\left(\frac{2}{5}y\right)^2} \times 100\%$$

$$= \frac{y^2}{\left(\frac{2}{5}\right)^2 y^2} \times 100\%$$

$$= \frac{1}{\left(\frac{2}{5}\right)^2} \times 100\%$$

$$= \frac{25}{4} \times 100\% = 625\%$$

$$11. (i) \text{ Price in 2015} \\ = 300\,000(120\%) \\ = 300\,000\left(\frac{120}{100}\right) = \$360\,000$$

Price in 2020

$$= \$360\,000\left(\frac{125}{100}\right) = \$450\,000$$

$$(ii) \text{ Percentage increase} \\ = \frac{\$450\,000 - \$300\,000}{\$300\,000} \times 100\% \\ = \frac{1}{2} \times 100\% = 50\%$$

$$12. (i) \begin{array}{ccc} \$2000\,000 & \xrightarrow{\times 50\%} & \$1000\,000 \\ 2017 & & 2018 \\ & \searrow \times 50\% & \end{array}$$

$$\begin{array}{ccc} \$500\,000 & \longrightarrow & \$250\,000 \\ 2019 & \times 50\% & 2020 \end{array}$$

$\therefore$  The machine was purchased in 2017.

$$(ii) \begin{array}{ccc} \$250\,000 & \xrightarrow{\times 50\%} & \$125\,000 \\ 2020 & & 2021 \\ & \searrow \times 50\% & \end{array}$$

$$\$62\,500 \\ 2022$$

$\therefore$  The machine's value depreciates to \$62 500 in 2022.

13. (i) Let  $x$  be the monthly income last year.

$$\begin{array}{ccc} \text{Last year} & & \text{Expectation} \\ x & \xrightarrow{\times 120\%} & \frac{120}{100}x \\ \downarrow \times (100\% - 15\%) & & \end{array}$$

This year (Actual income)

$$x(85\%) = \frac{85}{100}x$$

$$\Rightarrow \frac{120}{100}x - \frac{85}{100}x = \$1680$$

$$\frac{7}{20}x = 1680$$

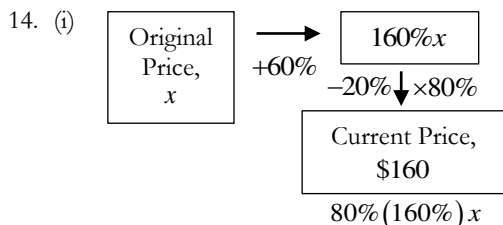
$$x = \frac{1680}{\left(\frac{7}{20}\right)} = \$4800$$

$\therefore$  Amy's monthly income last year was \$4800.

$$(ii) \text{ Percentage increase} \\ = \frac{\frac{120}{100}x - \frac{85}{100}x}{\frac{85}{100}x} \times 100\%$$



$$\begin{aligned} &= \frac{7}{20}x \\ &= \frac{17}{20} \times 100\% = 41.17\% \\ &= 41.2\% \text{ (3 s.f.)} \end{aligned}$$



Let original price be  $x$

$$\therefore 80\%(160\%x) = 160$$

$$0.8(1.6x) = 160$$

$$x = \frac{160}{0.8(1.6)} = \$125$$

$\therefore$  Original price was \$125.

- (ii) Overall percentage increase  
 $= \frac{\$160 - \$125}{\$125} \times 100\% = 28\%$   
 $\therefore$  It increases by 28%.

15. (i) Total cost  
 $= \$550\,000 + \$50\,000$   
 $= \$600\,000$   
 Total Revenue (Amount Received)  
 $= \text{Total Rent} + \text{Buying Price}$   
 $= \$42\,000 + \$700\,000$   
 $= \$1120\,000$   
 Total Profit  
 $= \$1120\,000 - \$600\,000$   
 $= 520\,000$   
 Percentage Profit  
 $= \frac{520\,000}{600\,000} \times 100\% = 86\frac{2}{3}\%$   
 $= 86.666\% = 86.7\% \text{ (3 s.f.)}$

- (ii) Total cost = \$600 000  
 Total Revenue  
 $= \$600\,000(105\%) = \$630\,000$   
 Let the number of years be  $x$ .  
 $\$42\,000x = \$630\,000$   
 $x = \frac{630\,000}{42\,000} = 15$   
 $\therefore$  After 15 years.

16. (i) Total cost =  $1000 \times \$5 + \$200$   
 $= \$5200$   
 Let selling price per pack by vendor be  $x$ .  
 Total revenue =  $1000x$   
 $5200(160\%) = 1000x$   
 $x = \frac{5200(1.60)}{1000} = \$8.32$

$\therefore$  The selling price per pack is \$8.32.

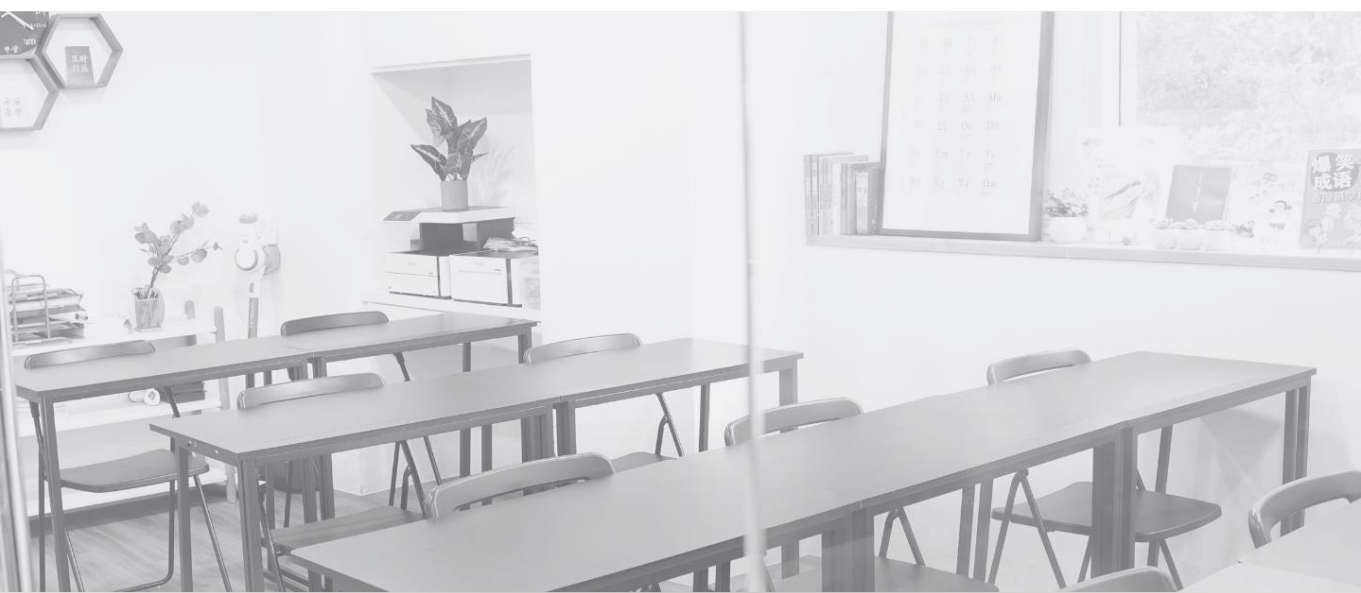
- (ii)  $5200(160\%) = (1000 - 17)x$   
 $x = \frac{5200(1.60)}{1000 - 17} = 8.463 = 8.46 \text{ (3 s.f.)}$

17. (i) Total cost = Cost of Materials + Salary to workers  
 $= \$25\,000 + \$60\,000 = \$85\,000$   
 Total Selling Price  
 $= \$85\,000 \times 115\% = \$85\,000 \times 1.15$   
 $= \$97\,750$   
 $\therefore$  Total selling price is \$97 750.
- (ii) Let the new price of raw materials be  $\$x$ .

Total cost =  $\$x + \$60\,000$   
 Selling price = \$97 750  
 $\frac{(x + 60\,000) - 97\,750}{x + 60\,000} \times 100\% = 8\%$   
 $\frac{x - 37\,750}{x + 60\,000} = \frac{8\%}{100\%}$   
 $x - 37\,750 = 0.08(x + 60\,000)$   
 $x - 37\,750 = 0.08x + 4800$   
 $x - 0.08x = 4800 + 37\,750$   
 $0.92x = 42\,550$   
 $x = \frac{42\,550}{0.92} = \$46\,250$   
 $\therefore$  New price of raw materials is \$46 250.

18. (i) The cost of a pencil  
 $= \frac{\$300}{500} = \$0.60$
- (ii) The profit percentage  
 $= \frac{\$1.00 - \$0.60}{\$0.60} \times 100\% = 66.6\%$
- (iii) The revenue to breakeven is \$300  
 The number of pencil =  $\frac{\$300}{\$1.00} = 300$   
 $\therefore$  He has to sell 300 or more to avoid making a loss.





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## 1-1 Private Tuition Classes

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