

Exercise walk-through

# 1.4

## Percentages, ratio and proportional reasoning

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International Baccalaureate · IB Diploma · Mathematics: Analysis and Approaches

# 1.4 Percentages, ratio and proportional reasoning

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Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

**Total: 13 marks**

**KEY WORDS** multiplier

# Objective

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Percentages, ratio and proportional reasoning. Original classroom practice for IB SL; not an official IB paper.

## 1 Key knowledge and worked examples

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### ■ Can we recover the original price?

- A coat is reduced by 20% to ¥240. The discount applies to the original price, not to the sale price.
- This lesson studies **multiplier** : A factor that performs a percentage change in

one multiplication.

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## ■ The method

- A  $p\%$  increase has multiplier  $1+p/100$ ; a decrease has multiplier  $1-p/100$ .
  - Reverse a percentage by dividing by the multiplier.
  - In a ratio, first find the total number of parts.
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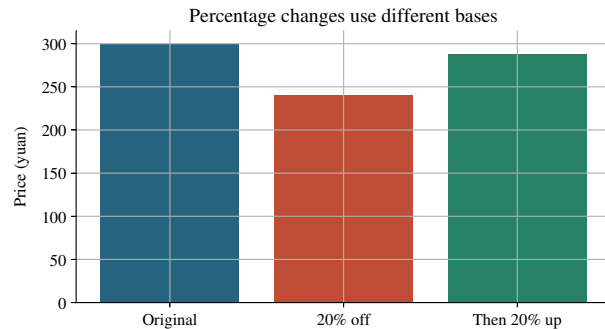
## ■ A worked case

$$P_{\text{new}} = P_{\text{old}} \left( 1 + \frac{r}{100} \right)$$

### **Example:**

Let the original price be  $P$ . The model is sale price  $= 0.8P$ . Hence  $P = 240 / 0.8 = 300$ . A later 20% increase gives  $240 \times 1.2 = 288$ , so the two changes do not cancel.

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■ **Where it goes wrong**

- A percentage uses a stated base.
- Subtracting the percentages loses that base.
- For compound change, multiply the multipliers; do not add the percentages.

**Not true:** A 20% decrease followed by a 20% increase restores the starting price. The 20% increase is taken of a smaller amount:  $100 \times 0.8 \times 1.2 = 96$ , not 100.

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■ **Applying it**

- For direct proportion use  $y=kx$ ; for inverse proportion use  $y=k/x$ .
- Calculate  $k$  from a known pair before using a new value.
- State what you held constant.

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■ **In your course**

- Analysis and Approaches SL, the course first assessed in 2021.
- Paper 1 is non-calculator: keep fractions, surds and  $\pi$  exact and show each step. On calculator papers, still write the expression before its value.

**Key:**

- **Multiplier:** A factor that performs a percentage change in one multiplication.
  - A  $p\%$  increase has multiplier  $1+p/100$ ; a decrease has multiplier  $1-p/100$ .
  - Watch for: A percentage uses a stated base.
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■ **Write from a final price of 192**

- A price of 200 falls by 20 percent and then rises by 20 percent.
- Find the final price. The two changes do not cancel.

## Exercises 2.1-2.3

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**2.1** A price of 80 rises by 15%. Find the new price. Show the relation, substitution and units. [2]

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**2.2** A 25% discount leaves a price of 90. Find the original price. Show the relation, substitution and units. [2]

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**2.3** Share 84 in the ratio 2:5. Find the larger share. Show the relation, substitution and units. [2]

## Exercises 2.1·2.3

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**2.1** A price of 80 rises by 15%. Find the new price. Show the relation, substitution and units. [2]

**2.1** Multiply by 1.15:  $80 \times 1.15 = 92$ .

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**2.2** A 25% discount leaves a price of 90. Find the original price. Show the relation, substitution and units. [2]

**2.2** The sale price is 75% of the original:  $90 / 0.75 = 120$ .

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**2.3** Share 84 in the ratio 2:5. Find the larger share. Show the relation, substitution and units. [2]

**2.3** There are seven ratio parts. The larger share is  $84 \times 5 / 7 = 60$ .

## Exercises 2.4·3.1

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**2.4** Decide whether this claim is true and justify: Multiplier means a factor that performs a percentage change in one multiplication. [2]

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**2.5** A price falls 20% then rises 20%. Why is the final price not the starting price? Choose one answer.

- **A** The second 20% acts on the reduced price, not the original
- **B** The 20% rise is taken of the original price, so it cancels exactly
- **C** Percentage changes always cancel when they are equal and opposite [1]

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**3.1** A price rises 20% then falls 20%. Find the net change and the percentage increase needed to recover the original after that pair. [4]

## Exercises 2.4·3.1

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**2.4** Decide whether this claim is true and justify: Multiplier means a factor that performs a percentage change in one multiplication. [2]

**2.4** True. True: A factor that performs a percentage change in one multiplication.

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**2.5** A price falls 20% then rises 20%. Why is the final price not the starting price? Choose one answer.

- **A** The second 20% acts on the reduced price, not the original
- **B** The 20% rise is taken of the original price, so it cancels exactly
- **C** Percentage changes always cancel when they are equal and opposite [1]

**2.5 A** A 20% decrease multiplies by 0.8 and the later 20% increase multiplies that result by 1.2:  $0.8 \times 1.2 = 0.96$ . Each percentage uses a different base.

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**3.1** A price rises 20% then falls 20%. Find the net change and the percentage increase needed to recover the original after that pair. [4]

**3.1** Factor  $1.2 \times 0.8 = 0.96$ , a 4% fall. Recovery factor  $1/0.96$ , giving 4.1667% increase. Both percentage changes use different bases.