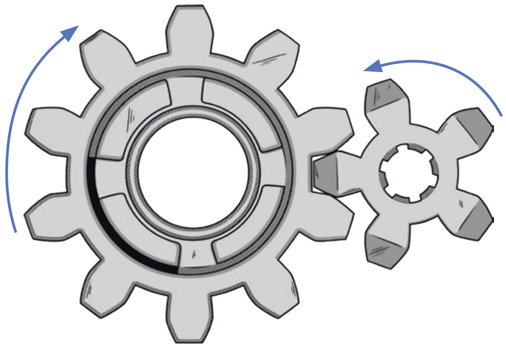
The Mechanic **Gear Ratios**

A gear ratio is a direct measure of the ratio of the rotational speeds of two or more interlocking gears. For example, the picture shows a 10 teeth gear and a 5 teeth gear.



1. Complete the table showing the gear ratios (the ratio of the driver gear to the driven gear). Do not simplify your answers.

Driver Gear	Driven Gear	Ratio
7	21	
10	2	
5		5:15
	5	25:5

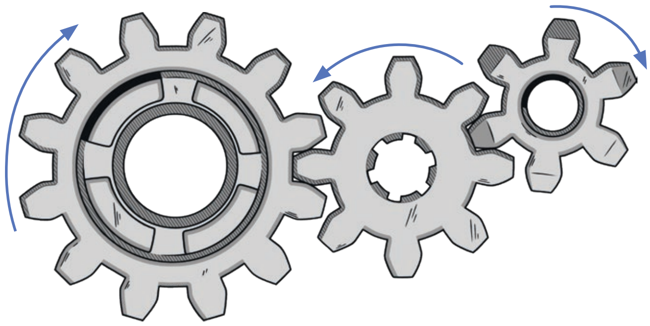
In the example showing a 10 teeth gear with a 5 teeth gear, if the 10 teeth gear is the driver then the ratio is 10:5. This simplifies to 2:1 and is known as a gearing up ratio. If the 5 teeth gear is the driver the ratio still simplifies to 2:1 but this is known as a gearing down ratio.

2. Complete the table to calculate the simplified gear ratio. In each case, state if it is a gearing up or gearing down ratio.

Driver Gear	Driven Gear	Ratio	Simplified Ratio	Gearing Up or Gearing Down?
3	4			
12	2			
5		5:25		
		8:	4:7	

A gear train consists of 2 or more gears. Only the first and last gears are important when calculating the gear ratio. The first is the driver gear and the last is the driven gear.

3. In a gear train, the driver gear has 12 teeth and the driven gear has 6. What would be the effect on the rotation of the gears if an 8 teeth gear was added to the middle of the gear train?

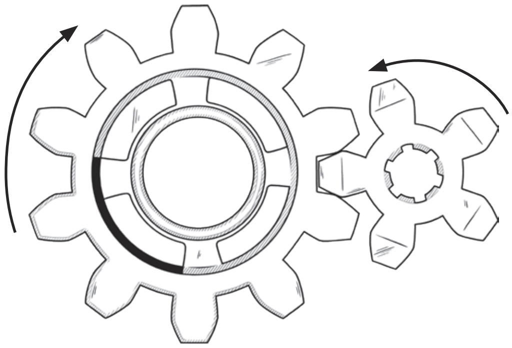


4. Prove that the gear ratio of the train shown in question three is the same as the gear ratio of a gear train where the driver gear has 12 teeth and the driven gear has 6.

   Hint: The intermediate gear ratios of a gear train will multiply together to equal the overall gear ratio.

The Mechanic **Gear Ratios Answers**

A gear ratio is a direct measure of the ratio of the rotational speeds of two or more interlocking gears. For example, the picture shows a 10 teeth gear and a 5 teeth gear.



1. Complete the table showing the gear ratios (the ratio of the driver gear to the driven gear). Do not simplify your answers.

Driver Gear	Driven Gear	Ratio
7	21	**7:21**
10	2	**10:2**
5	**15**	5:15
25	5	25:5

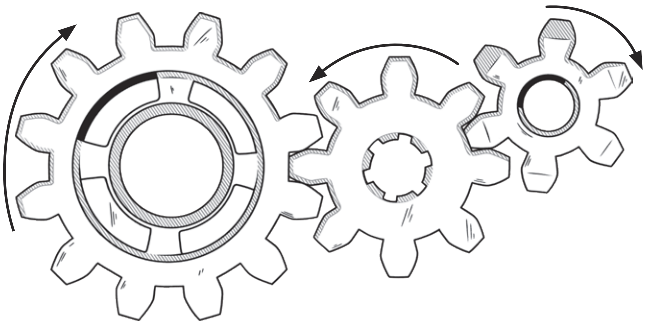
In the example showing a 10 teeth gear with a 5 teeth gear, if the 10 teeth gear is the driver then the ratio is 10:5. This simplifies to 2:1 and is known as a gearing up ratio. If the 5 teeth gear is the driver the ratio still simplifies to 2:1 but this is known as a gearing down ratio.

2. Complete the table to calculate the simplified gear ratio. In each case, state if it is a gearing up or gearing down ratio.

Driver Gear	Driven Gear	Ratio	Simplified Ratio	Gearing Up or Gearing Down?
3	4	**3:4**	**3:4**	**down**
12	2	**12:2**	**6:1**	**up**
5	**25**	5:25	**1:5**	**down**
8	**14**	8:**14**	4:7	**down**

A gear train consists of 2 or more gears. Only the first and last gears are important when calculating the gear ratio. The first is the driver gear and the last is the driven gear.

3. In a gear train, the driver gear has 12 teeth and the driven gear has 6. What would be the effect on the rotation of the gears if an 8 teeth gear was added to the middle of the gear train?



With the 12:6 gear train, the driver gear and driven gear will rotate in opposite directions. With a middle gear added, both the driver and driven gears will rotate in the same direction.

4. Prove that the gear ratio of the train shown in question three is the same as the gear ratio of a gear train where the driver gear has 12 teeth and the driven gear has 6.

   Hint: The intermediate gear ratios of a gear train will multiply together to equal the overall gear ratio.

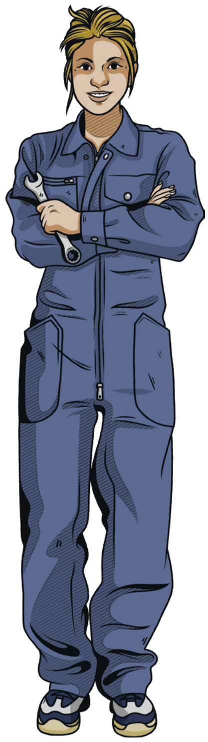
   12:8:6

   12:8 simplifies to 3:2 and 8:6 simplifies to 4:3

   3 × 4 = 12, 2 × 3 = 6

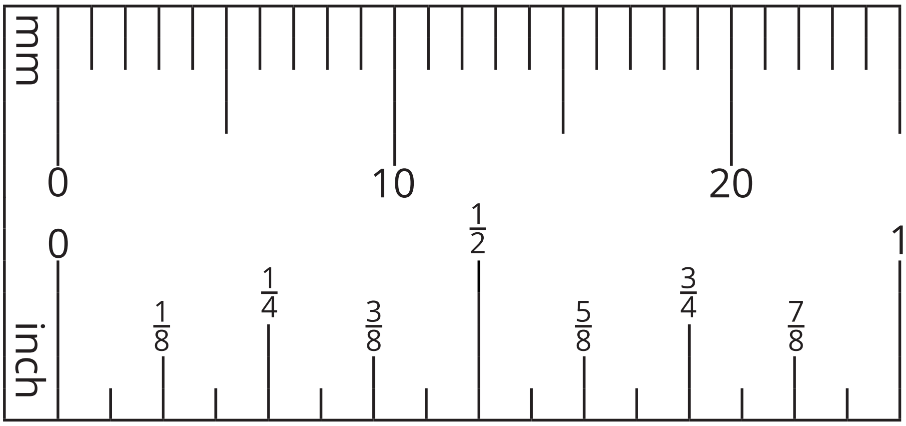
   12:6 or 2:1

The Mechanic **Know Your Socket Sizes: Entry 3**



Mechanics often have to work between SAE (Society of Automotive Engineers) and metric measurements. SAE is measured in inches which are an imperial (old) measurement system. Metric, in the motor vehicle trade, is measured in millimetres.

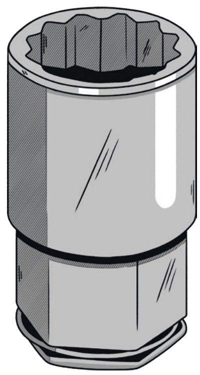
Inches are split into sixteenths not tenths



The table shows the SAE sizes of common sockets. Many garages will have both sets and you may hear a mechanic say, "Pass me a $\frac{5}{16}$ socket." You will need to know that this is an 8mm socket.

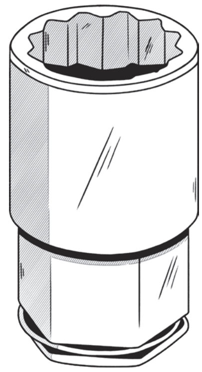
Using the ruler diagram, complete the table converting SAE sizes to millimetres.

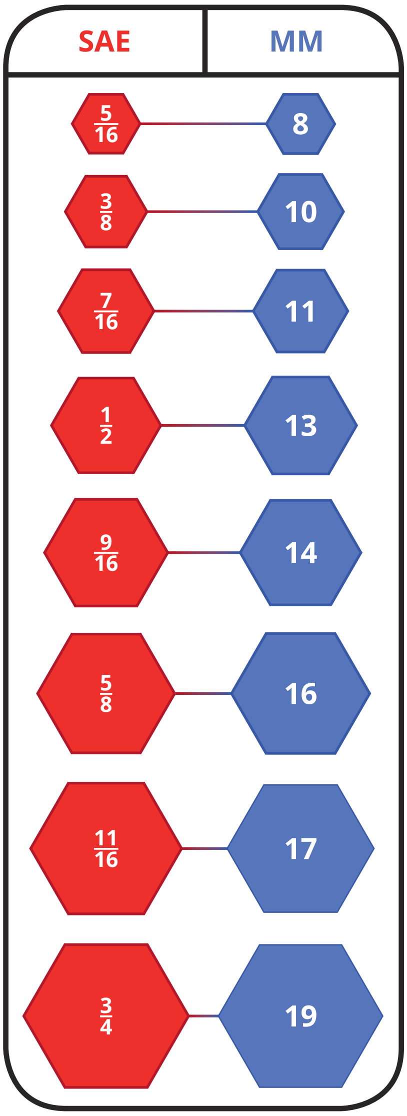
Socket Sizes	
SAE Inches	Nearest metric equivalent (mm)
$\frac{5}{16}$	8
$\frac{3}{8}$	
	11
$\frac{1}{2}$	
	14
$\frac{5}{8}$	
$\frac{11}{16}$	
	19



The Mechanic **Know Your Socket Sizes: Entry 3 Answers**

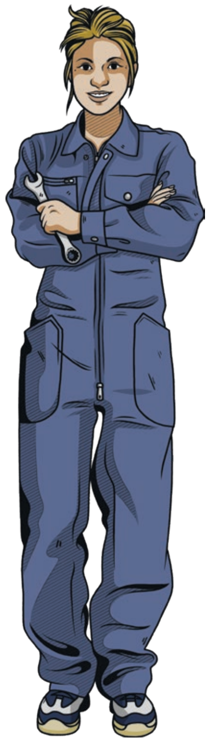
Socket Sizes	
SAE Inches	Nearest metric equivalent (mm)
$\frac{5}{16}$	8
$\frac{3}{8}$	**10**
$\frac{7}{16}$	11
$\frac{1}{2}$	**13**
$\frac{9}{16}$	14
$\frac{5}{8}$	**16**
$\frac{11}{16}$	**17**
$\frac{3}{4}$	19





Here is a quick reference bookmark to help you remember.

The Mechanic **Know Your Socket Sizes**

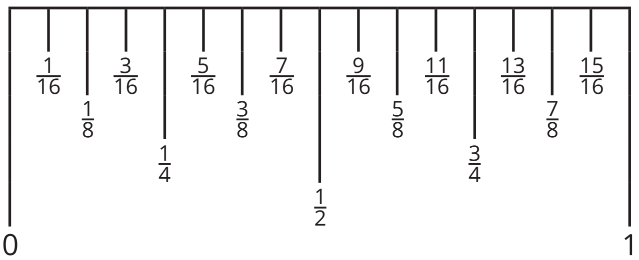


Mechanics often have to work between SAE (Society of Automotive Engineers) and metric measurements. SAE is measured in inches which are an imperial (old) measurement system. Metric, in the motor vehicle trade, is measured in millimetres.

The conversion factor for inches to mm is:

1 inch = 25.4mm

Inches are split into sixteenths not tenths

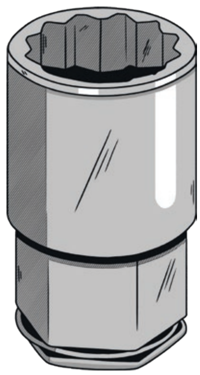


The table shows the SAE sizes of common sockets. Many garages will have both sets and you may hear a mechanic say, “Pass me a $\frac{5}{16}$ socket.” You will need to know that this is an 8mm socket.

Complete the table to convert the SAE sizes to millimetres. Round your answers to the nearest whole number to determine their nearest metric equivalent.

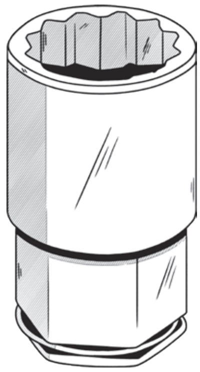
Example: $\frac{5}{16} \times 25.4 = 7.9375$mm. An 8mm socket is the nearest equivalent to $\frac{5}{16}$ inches.

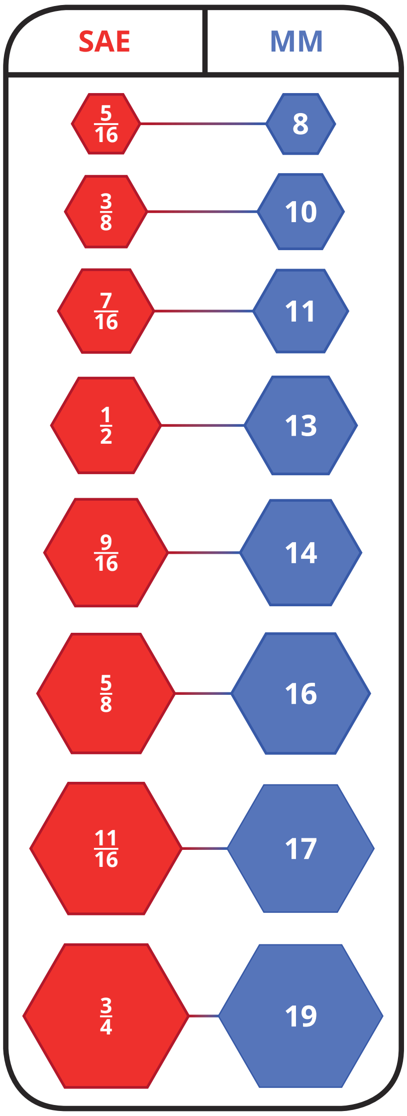
Socket Sizes		
SAE Inches	mm	Nearest metric equivalent (mm)
$\frac{5}{16}$	7.9375	8
$\frac{3}{8}$		
$\frac{7}{16}$		
$\frac{1}{2}$		
$\frac{9}{16}$		
$\frac{5}{8}$		
$\frac{11}{16}$		
$\frac{3}{4}$		



The Mechanic **Know Your Socket Sizes Answers**

Socket Sizes		
SAE Inches	mm	Nearest metric equivalent (mm)
$\frac{5}{16}$	7.9375	8
$\frac{3}{8}$	**9.525**	**10**
$\frac{7}{16}$	**11.1125**	**11**
$\frac{1}{2}$	**12.7**	**13**
$\frac{9}{16}$	**14.2875**	**14**
$\frac{5}{8}$	**15.875**	**16**
$\frac{11}{16}$	**17.4625**	**17**
$\frac{3}{4}$	**19.05**	**19**

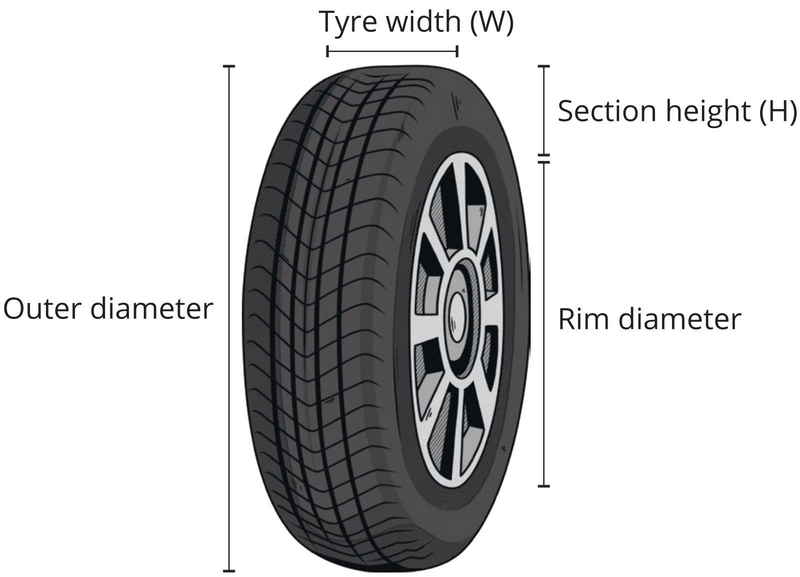




Here is a quick reference bookmark to help you remember.

The Mechanic **Replacement Tyres and Sizes**

Before doing this worksheet, please complete **Understanding Tyre Sizes** first.



Before considering changing tyres, you need to calculate the outer diameter. The diameter is the overall height of the whole wheel and tyre.

Recap

The section height (H mm) for a tyre with aspect ratio R and tyre width W can be calculated by:

$H = R \times W \div 100$

1. Calculate the section height of these common tyre sizes:

   a. 195/60/R15

   ---

   b. 275/40/R20

   ---

2. Convert the rim diameters to millimetres.

   Recap: 25.4mm = 1 inch.

   a. 195/60/R15

   ---

   b. 275/40/R20

   ---

3. The outer diameter (O mm) can be calculated by:

   2 × Section Height (H mm) + Rim Diameter (R mm)

   $O = 2H + R$

   Calculate the outer diameters.

   a. 195/60/R15

   ____

   b. 275/40/R20

   ____

4. When changing tyres, the outer diameters should have a maximum height difference of 2.5%.

   a. Prove that 275/40/R20 tyres cannot be replaced with 195/60/R15.

   ____

   ____

   ____

   b. Can 205/55/R16 tyres be replaced with 215/55/R16? You must show your working.

   ____

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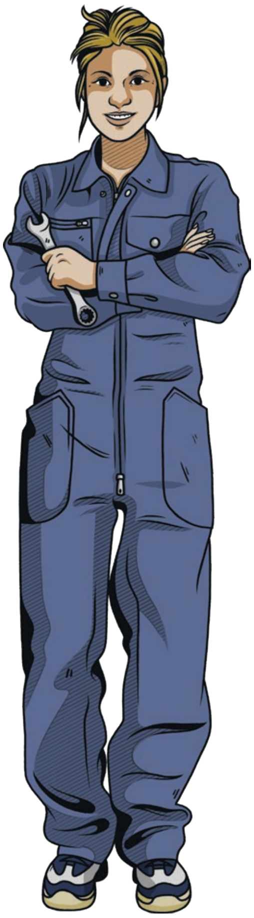
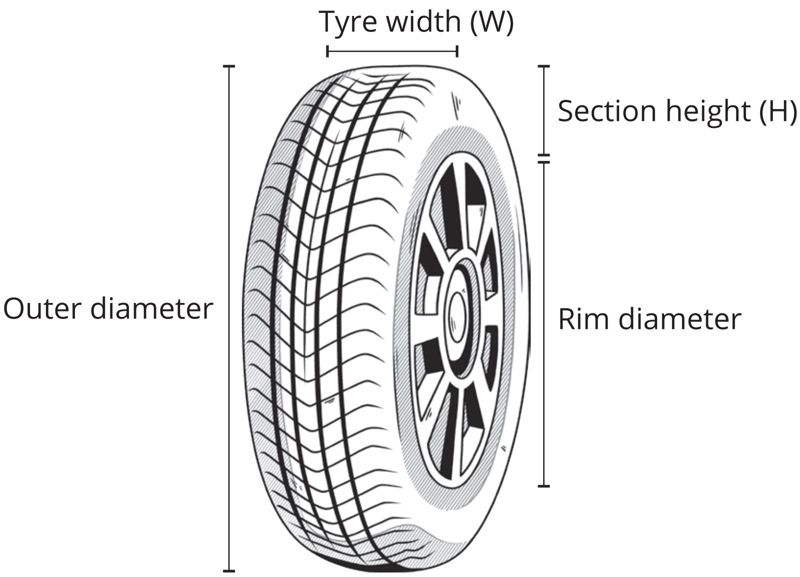


The Mechanic **Replacement Tyres and Sizes Answers**

Before doing this worksheet, please complete **Understanding Tyre Sizes** first.



Before considering changing tyres, you need to calculate the outer diameter. The diameter is the overall height of the whole wheel and tyre.

Recap

The section height (H mm) for a tyre with aspect ratio R and tyre width W can be calculated by:

$H = R \times W \div 100$

1. Calculate the section height of these common tyre sizes:

   a. 195/60/R15

      60 × 195 ÷ 100 = 117mm

   b. 275/40/R20

      40 × 275 ÷ 100 = 110mm

2. Convert the rim diameters to millimetres.

   Recap: 25.4mm = 1 inch.

   a. 195/60/R15

      15 × 25.4 = 381mm

   b. 275/40/R20

      20 × 25.4 = 508mm

3. The outer diameter (O mm) can be calculated by:

   2 × Section Height (H mm) + Rim Diameter (R mm)

   O = 2H + R

   Calculate the outer diameters.

   a. 195/60/R15

      2 × 117 + 381 = 615mm

   b. 275/40/R20

      2 × 110 + 508 = 728mm

4. When changing tyres, the outer diameters should have a maximum height difference of 2.5%.

   a. Prove that 275/40/R20 tyres cannot be replaced with 195/60/R15.

      728 − 615 = 113mm

      113 ÷ 728 × 100 = 15.52% difference.

      This is greater than 2.5%

   b. Can 205/55/R16 tyres be replaced with 215/55/R16? You must show your working.

      205/55/R16

      Section height = 55 × 205 ÷ 100 = 112.75mm

      Rim diameter in mm = 16 × 25.4 = 406.4mm

      Outer diameter = 2 × 112.75 + 406.4 = 631.9mm

      215/55/R16

      Section height = 55 × 215 ÷ 100 = 118.25mm

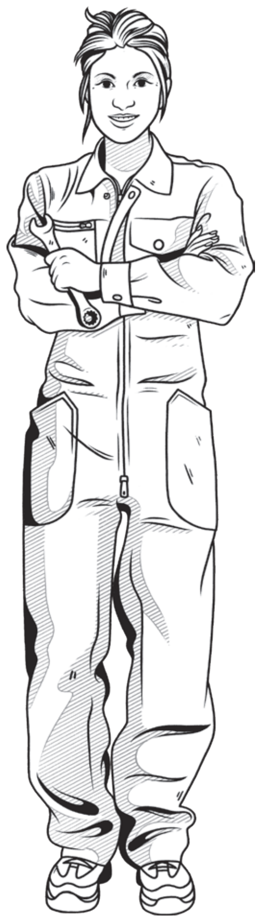
      Rim diameter in mm = 16 × 25.4 = 406.4mm

      Outer diameter = 2 × 118.25 + 406.4 = 642.9mm

      Difference = 642.9 – 631.9 = 11

      Percentage difference = 11 ÷ 631.9 × 100 = 1.74%

      This is less than 2.5% so yes, you can replace them with the new tyres.



The Mechanic **Services, Bills and Ordering Supplies**

1. The table shows the cost of car servicing with and without an MOT and the savings available on that package.

	Cost (£)	Including MOT (£)	Savings (£)
Interim Service	70	94	28.25
Full Service	140	159	
Major Service		210	41.25

   a. Calculate the standard fixed cost of an MOT.

   b. Fill in the gaps to complete the table.

   c. A customer chooses a major service including an MOT. Find the percentage saved compared to paying for a major service and MOT separately.

2. a. The owner of the garage wants to know which engine oil is the best buy. Work out which oil provides the best value for money. You must show your working.

Go Oil
£34.99 - 20 litres

Supreme Oil
5000ml - £9.25

Super Oil
£108 - 60 litres

b. Explain why the garage might not choose to use the best buy.

3. a. Super Oil has a special offer on their 60 litres drums which usually cost £108 each.

Super Oil
60 litres - £108
Buy 2 get 1 free!

The owner of the garage decides to buy 1800 litres of the oil.
Calculate the cost of this purchase.

b. The owner has allocated £2500 for the purchase of the oil. She forgot to add VAT at 20% to the cost. Has she allocated enough? Give a reason for your decision.

c. How many drums can she get for £2500?

d. Calculate her change from £2500.

The Mechanic **Services, Bills and Ordering Supplies Answers**

1. The table shows the cost of car servicing with and without an MOT and the savings available on that package.

	Cost (£)	Including MOT (£)	Savings (£)
Interim Service	70	94	28.25
Full Service	140	159	**33.25**
Major Service	**199**	210	41.25

a. Calculate the standard fixed cost of an MOT.

94 − 70 + 28.25 = £52.25

b. Fill in the gaps to complete the table.

c. A customer chooses a major service including an MOT. Find the percentage saved compared to paying for a major service and MOT separately.

$$\mathbf{\frac{41.25}{199 + 52.25} \times 100 = 16.4\%}$$

2. a. The owner of the garage wants to know which engine oil is the best buy. Work out which oil provides the best value for money. You must show your working.

Go Oil
£34.99 - 20 litres

Supreme Oil
5000ml - £9.25

Super Oil
£108 - 60 litres

34.99 ÷ 20 = £1.75 per litre (rounded to the nearest penny).

5000ml = 5 litres.

9.25 ÷ 5 = £1.85 per litre.

108 ÷ 60 = £1.80 per litre.

'Go Oil' is the best value for money.

b. Explain why the garage might not choose to use the best buy.

It might not be the best quality.

They might want one particular size.

Customers might prefer one particular brand.

3. a. Super Oil has a special offer on their 60 litres drums which usually cost £108 each.

Super Oil
60 litres - £108
Buy 2 get 1 free!

The owner of the garage decides to buy 1800 litres of the oil.
Calculate the cost of this purchase.

$\frac{2}{3} \times 1800 = 1200$ **litres to pay for.**

$\frac{1200}{60} = 20$ **drums**

$20 \times 108 = £2160$

Alternative method

$\frac{1800}{60} = 30$ **drums**

$\frac{2}{3} \times 30 = 20$ **drums to pay for.**

$20 \times 108 = £2160$

b. The owner has allocated £2500 for the purchase of the oil. She forgot to add VAT at 20% to the cost. Has she allocated enough? Give a reason for your decision.

$2160 \times 1.2 = £2592$.

She does not have enough money. She is £92 short.

c. How many drums can she get for £2500?

$108 \times 1.2 = £129.60$

$\frac{2500}{129.60} = 19.29...$

19 drums bought.

1 free for every 2 bought.

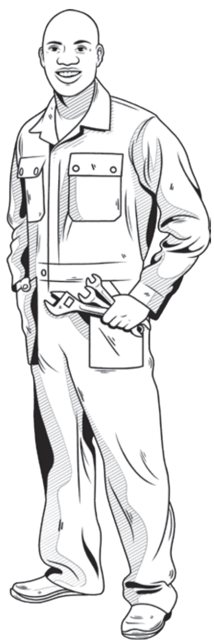
$\frac{19}{2} = 9.5$

19 + 9 drums free = 28

d. Calculate her change from £2500.

$129.60 \times 19 = £2462.40$

$2500 - 2462.40 = £37.60$



The Mechanic **Understanding Tyre Sizes**

A typical tyre size in the UK is 195/65/R15.

What do these numbers mean?

What units are they measured in?

195 is in millimetres and is the width of the tyre.

65 is the aspect ratio as a percentage (explained in question 3).

15 is the diameter of the inner rim of the tyre.

R stands for radial construction.

1. How can you tell that R15 is not measured in millimetres?

   ____

   ____

   The diameter of the inner rim of the tyre is measured in inches. There are 25.4mm to 1 inch.

2. a. Fill in the gaps to compare the width of the tyres with the diameter of the inner rims, rounding your answers to one decimal place.

Width of the tyre, (mm)	Width of the tyre, (inches)	Diameter of the inner rim, (mm)	Diameter of the inner rim, (inches)
195			15
225			18
165			14

   b. What do you notice about the width of the tyre compared to the diameter of the inner rim of the same tyre?

   ____

   ____

3. The aspect ratio, which is given as a percentage, is calculated by:

   Aspect Ratio (%) = Section Height (H) ÷ Tyre Width (W) × 100

   Prove that the aspect ratio of a 195/65/R15 tyre, with a section height of 126.75mm, is 65%.

4. The Section Height can be calculated by:

   Section Height (H) = Aspect Ratio × Tyre Width (W) ÷ 100

   Calculate the Section Height of these common tyre sizes.

   a. 225/40/R18

   b. 205/55/R16

   c. 185/65/R15

   d. 175/65/R14

The Mechanic **Understanding Tyre Sizes Answers**

A typical tyre size in the UK is 195/65/R15.

What do these numbers mean?

What units are they measured in?

195 is in millimetres and is the width of the tyre.

65 is the aspect ratio as a percentage (explained in question 3).

15 is the diameter of the inner rim of the tyre.

R stands for radial construction.

1. How can you tell that R15 is not measured in millimetres?

   A 15mm diameter of the inner rim width is too small compared to the diameter of the tyre.

   The diameter of the inner rim of the tyre is measured in inches. There are 25.4mm to 1 inch.

2. a. Fill in the gaps to compare the width of the tyres with the diameter of the inner rims, rounding your answers to one decimal place.

Width of the tyre, (mm)	Width of the tyre, (inches)	Diameter of the inner rim, (mm)	Diameter of the inner rim, (inches)
195	**7.7**	**381**	15
225	**8.9**	**457.2**	18
165	**6.5**	**355.6**	14

   b. What do you notice about the width of the tyre compared to the diameter of the inner rim of the same tyre?

   It is approximately half the length.

3. The aspect ratio, which is given as a percentage, is calculated by:

   Aspect Ratio (%) = Section Height (H) ÷ Tyre Width (W) × 100

   Prove that the aspect ratio of a 195/65/R15 tyre, with a section height of 126.75mm, is 65%.

   126.75 ÷ 195 × 100 = 65

4. The Section Height can be calculated by:

   Section Height (H) = Aspect Ratio × Tyre Width (W) ÷ 100

   Calculate the Section Height of these common tyre sizes.

   a. 225/40/R18

   40 × 225 ÷ 100 = 90mm

   b. 205/55/R16

   55 × 205 ÷ 100 = 112.75mm

   c. 185/65/R15

   65 × 185 ÷ 100 = 120.25mm

   d. 175/65/R14

   65 × 175 ÷ 100 = 113.75mm