🎓 MATHS TEACHER HUB

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Percentages - Calculator

(9 – 1) Topic booklet

Higher

These questions have been collated from previous years GCSE Mathematics papers.

You must have: Ruler graduated in centimetres and millimetres, protractor, pair of compasses, pen, HB pencil, eraser.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – there may be more space than you need.
- Diagrams are NOT accurately drawn, unless otherwise indicated.
- You must **show all your working out.**
- If the question is a **1H** question you are not allowed to use a calculator.
- If the question is a **2H** or a **3H** question, you may use a calculator to help you answer.

Information

- The marks for **each** question are shown in brackets
  – use this as a guide as to how much time to spend on each question.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Answer ALL questions
Write your answers in the space provided.
You must write down all the stages in your working.

2 Karen is organising a party for a charity.

She spends
   £100 on food
   £120 on a hall
   £80 on a DJ.

Karen sells 54 tickets for the party.
Each ticket costs £7.50

Work out the percentage profit Karen makes for the charity.

$100 + 120 + 80 = £300$ spends

$54 \times 7.50 = £405$ tickets

$\dfrac{405}{300} = 1.35 = 135\%$

$100\% \longrightarrow 135\%$

$= 35\%$ profit

35 %

(Total for Question 2 is 4 marks)

2 Emily buys a pack of 12 bottles of water.
The pack costs £5.64

Emily sells all 12 bottles for 50p each.

Work out Emily's percentage profit.
Give your answer correct to 1 decimal place.

$12 \times 50p = £6$

$100\% \longrightarrow 106.4\%$

$= 6.4\%$ profit

$\dfrac{6}{5.64} = 1.0638$

$= 1.064$

$= 106.4\%$

6.4 %

(Total for Question 2 is 3 marks)

2 On Saturday, some adults and some children were in a theatre.
The ratio of the number of adults to the number of children was 5 : 2

Each person had a seat in the Circle or had a seat in the Stalls.

$\frac{3}{4}$ of the children had seats in the Stalls.

117 children had seats in the Circle.

There are exactly 2600 seats in the theatre.

On this Saturday, were there people on more than 60% of the seats?
You must show how you get your answer.

$\frac{1}{4}$ = 117 children in the circle

$\qquad$ = 468 children

$\frac{3}{4}$ = 351 children in the stalls

$$A : C$$
$$5 : 2$$
$$1170 : 468 \Big) \times 234$$

1170 Adults

= 468 + 1170 = 1638 seats with people on.

$$\frac{1638}{2600} \times 100 = 63\%$$

$$63\% > 60\%$$

(Total for Question 2 is 5 marks)

2 Katy invests £200 000 in a savings account for 4 years.
The account pays compound interest at a rate of 1.5% per annum.

Calculate the total amount of interest Katy will get at the end of 4 years.

$$200000 \times 1.015^4 = £212272.71$$

$$212272.71 - 200000 = £12272.71$$

£ __12272·71__

(Total for Question 2 is 3 marks)

2 Last year Jo paid £245 for her car insurance.
This year she has to pay £883 for her car insurance.

Work out the percentage increase in the cost of her car insurance.

$$\frac{883}{245} = 3.604081$$

$$= 360.4\%$$

$$100\% \longrightarrow 360.4\%$$

$$= 260.4\% \text{ increase}$$

__260·4__ %

(Total for Question 2 is 3 marks)

3   Andrew invests £4500 in a savings account for 2 years.
The account pays compound interest at a rate of 3.4% per year.

Calculate how much Andrew has in this savings account at the end of the 2 years.

$$4500 \times 1.034^2 = 4811.202$$

£   4811.20

(Total for Question 3 is 2 marks)

4   A company has 25 000 workers.
The number of workers increases at a rate of 6% per year for 3 years.

Calculate the total number of workers at the end of the 3 years.

$$25000 \times 1.06^3 = 29775.4$$

29775

(Total for Question 4 is 4 marks)

4 Jo is going to buy 15 rolls of wallpaper.

Here is some information about the cost of rolls of wallpaper from each of two shops.

Chic Decor
3 rolls for £36

Style Papers
Pack of 5 rolls normal price £70
12% off the normal price

Jo wants to buy the 15 rolls of wallpaper as cheaply as possible.

Should Jo buy the wallpaper from Chic Decor or from Style Papers?
You must show how you get your answer.

Chic Decor

15 rolls = 5 × £36

= £180

Style papers

15 rolls = 3 × £70

= £210

£210 × 0.88 = £184.80

Jo should buy the wallpaper from chic Decor.

(Total for Question 4 is 4 marks)

4 Fran asks each of 40 students how many books they bought last year.

The chart below shows information about the number of books bought by each of the 40 students.

Number of students

Number of books
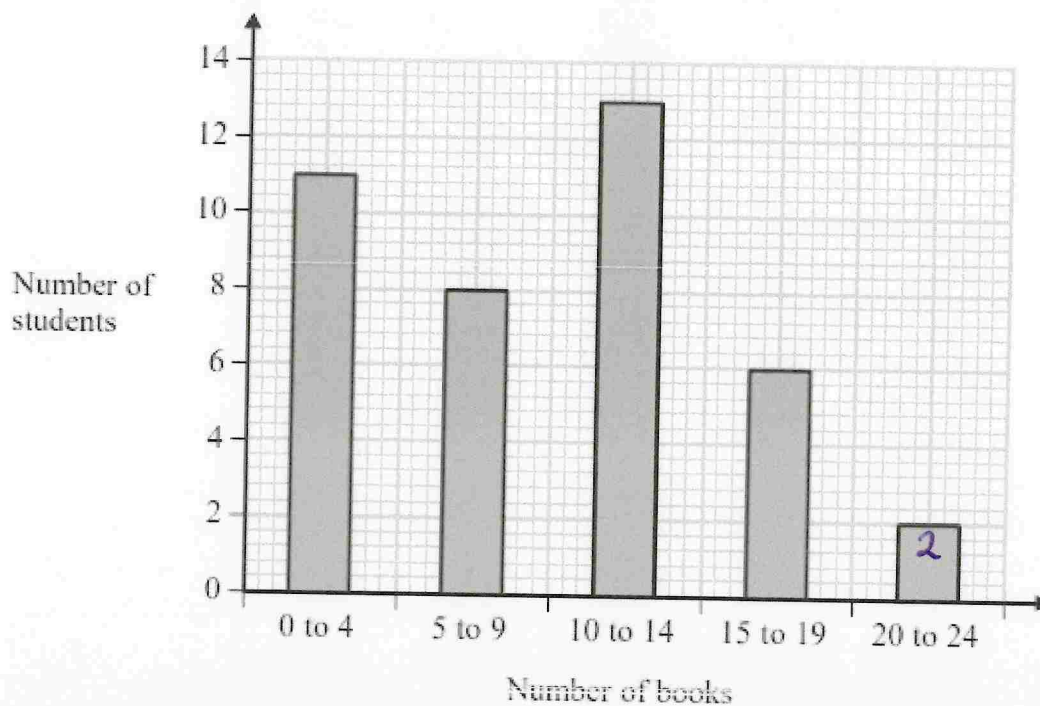
Work out the percentage of these students who bought 20 or more books.

$11 + 8 + 13 + 6 + 2 = 40$ students

$\frac{2}{40} \times 100 = 5\%$

5 %

(2)

(Total for Question 4 is 2 marks)

4   Raya buys a van for £8500 plus VAT at 20%

Raya pays a deposit for the van.
She then pays the rest of the cost in 12 equal payments of £531.25 each month.

Find the ratio of the deposit Raya pays to the total of the 12 equal payments.
Give your answer in its simplest form.

$$8500 \times 1.2 = £10,200$$

$$12 \times £531.25 = £6375$$

$$£10,200 - £6375 = £3825 \text{ deposit}$$

Deposit : 12 payments

3825 : 6375

3 : 5

3:5

(Total for Question 4 is 5 marks)

4   Daniel bakes 420 cakes.
    He bakes only vanilla cakes, banana cakes, lemon cakes and chocolate cakes.

    $\frac{2}{7}$ of the cakes are vanilla cakes.

    35% of the cakes are banana cakes.
    The ratio of the number of lemon cakes to the number of chocolate cakes is 4 : 5

    Work out the number of lemon cakes Daniel bakes.

$$\frac{2}{7} \times 420 = 120 \text{ vanilla cakes}$$

$$0.35 \times 420 = 147 \text{ banana cakes}$$

$$420 - 120 - 147 = 153 \text{ cakes left}$$

L   OOOO
    17 17 17 17   ⎤
                       ⎥ 153
C   OOOOO   ⎦
    17 17 17 17 17

lemon = 4 × 17

68

(Total for Question 4 is 5 marks)

4 Northern Bank has two types of account.
   Both accounts pay compound interest.

Cash savings account
Interest
2.5% per annum

Shares account
Interest
3.5% per annum

Ali invests £2000 in the cash savings account.
Ben invests £1600 in the shares account.

(a) Work out who will get the most interest by the end of 3 years.
    You must show all your working.

Ali

$$2000 \times 1.025^3 = £2153.78$$

$$= £153.78 \text{ interest}$$

Ben

$$1600 \times 1.035^3 = £1773.95$$

$$= £173.95 \text{ interest}$$

Ben will receive the most interest.

(4)

In the 3rd year the rate of interest for the shares account is changed to 4% per annum.

(b) Does this affect who will get the most interest by the end of 3 years?
    Give a reason for your answer.

Ben will still receive the most interest.

(1)

(Total for Question 4 is 5 marks)

6   A new phone cost £679
    The value of the phone decreases at a rate of 4% per year.

    Work out the value of the phone at the end of 3 years.

$$679 \times 0.96^3 = £600.74$$

£ 600.74

(Total for Question 6 is 3 marks)

6   Last year a family recycled 800 kg of household waste.
    57% of this waste was paper and glass.

                weight of paper recycled : weight of glass recycled = 12 : 7

    Calculate the weight of glass the family recycled.

$$0.57 \times 800\,kg = 456\,kg \text{ of paper and glass}$$

$$456 \div 19 = 24$$

Paper : glass

12 : 7

×24 288 : 168

168 kg

(Total for Question 6 is 3 marks)

6 Ella invests £7000 for 2 years in an account paying compound interest.

In the first year, the rate of interest is 3%
In the second year, the rate of interest is 1.5%

Work out the value of Ella's investment at the end of 2 years.

$$7000 \times 1.03 = £7210$$

$$7210 \times 1.015 = £7318.15$$

£ __7318.15__

(Total for Question 6 is 3 marks)

6   Anil wants to invest £25000 for 3 years in a bank.

Personal Bank	**Secure Bank**
Compound Interest	Compound Interest
2% for each year	4.3% for the first year
	0.9% for each extra year

Which bank will give Anil the most interest at the end of 3 years?
You must show all your working.

Personal bank

25000×1.02^3

$= £26530.20$

Secure bank

$25000 \times 1.043 = 26075$

$26075 \times 1.009^2 = 26546.46$

Anil should invest his money
with secure bank.

(Total for Question 6 is 3 marks)

6   Toby invested £7500 for 2 years in a savings account.
    He was paid 4% per annum compound interest.

    How much money did Toby have in his savings account at the end of 2 years?

$$7500 \times 1.04^2 = 8112$$

£ _____8112_____

(Total for Question 6 is 2 marks)

8   Chanda buys a necklace for £120
    She sells the necklace for £135

    Work out her percentage profit.

$$\frac{135}{120} = 1.125$$

100% ⟶ 112.5%

12.5% increase

$$= 112.5\%$$

_____12.5_____ %

(Total for Question 8 is 3 marks)

8 Tariq buys a laptop.

He gets a discount of 5% off the normal price.
Tariq pays £551 for the laptop.

(a) Work out the normal price of the laptop.

$$\frac{551}{0.95}$$

£ __580__

(2)

Joan invests £6000 in a savings account.
The savings account pays compound interest at a rate of

2.4% for the first year
1.7% for each extra year.

(b) Work out the value of Joan's investment at the end of 3 years.

$$6000 \times 1.024 = 6144$$

$$6144 \times 1.017^2 = 6354.671616$$

£ __6354.67__

(3)

(Total for Question 8 is 5 marks)

8   Ian invested an amount of money at 3% per annum compound interest.
    At the end of 2 years the value of the investment was £2652.25

    (a) Work out the amount of money Ian invested.

$$x \times 1.03^2 = 2652.25$$

$$x = \frac{2652.25}{1.03^2}$$

£ 2500

(3)

Noah has an amount of money to invest for five years.

Saver Account	Investment Account
4% per annum compound interest.	21% interest paid at the end of 5 years.

Noah wants to get the most interest possible.

(b) Which account is best?
    You must show how you got your answer.

£100 investment

Saver Account

$$100 \times 1.04^5$$

$$= £121.67$$

Investment Account

$$100 \times 1.21$$

$$= £121$$

The saver account is slightly better as Noah would get more interest.

(2)

8. Tamsin buys a house with a value of £150 000
The value of Tamsin's house increases by 4% each year.

Rachel buys a house with a value of £160 000
The value of Rachel's house increases by 1.5% each year.

At the end of 2 years, whose house has the greater value?
You must show how you get your answer.

Tamsin

$150000 \times 1.04^2 = £153015$

Rachel

$160000 \times 1.015^2 = £164836$

After 2 years, Rachel's house has the greater value.

(Total for Question 8 is 4 marks)

9 Some people were asked if they wanted a new television.

70% of the people said yes.
80% of the people who said yes wanted a television with a large screen.

What percentage of the people asked said they wanted a television with a large screen?

Yes   NO
70%   30%
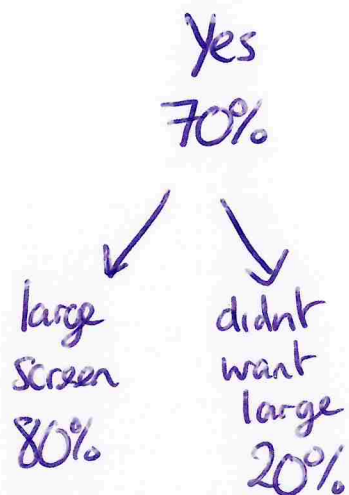
large   didnt
screen   want
80%   large
          20%

80% of the 70%

0.8 × 0.7

= 0.56

56 %

9 Jean invests £12 000 in an account paying compound interest for 2 years.

In the first year the rate of interest is x%
At the end of the first year the value of Jean's investment is £12 336

In the second year the rate of interest is $\frac{x}{2}$%

What is the value of Jean's investment at the end of 2 years?

$$12000 \times x = 12336$$

$$x = \frac{12336}{12000}$$

$$x = 1.028 \quad = 102.8\%$$

$$\text{Interest} = 2.8\%$$

2nd year =

Interest
$= 1.4\%$

$$12336 \times 1.014 = 12508.70$$

£ 12508.70

(Total for Question 9 is 4 marks)

9   Jack bought a new boat for £12 500

The value, £V, of Jack's boat at the end of n years is given by the formula

$$V = 12\,500 \times (0.85)^n$$

(a) At the end of how many years was the value of Jack's boat first less than 50% of the value of the boat when it was new?

① $12500 \times 0.85 = £10625$

② $12500 \times 0.85^2 = £9031.25$

③ $12500 \times 0.85^3 = £7676.56$

④ $12500 \times 0.85^4 = £6525.07$

⑤ $12500 \times 0.85^5 = £5546.31$

$5546 < 6250$

5 years

(2)

A savings account pays interest at a rate of R% per year.
Jack invests £5500 in the account for one year.

At the end of the year, Jack pays tax on the interest at a rate of 40%.
After paying tax, he gets £79.20

(b) Work out the value of R.

$79.20 \div 0.6 = 132$ interest after 1 year.

$5500 \times R = 5632$

$R = \dfrac{5632}{5500}$

$R = 1.024$

$R = 102.4\%$

2.4

(3)

9 Jules buys a washing machine.

20% VAT is added to the price of the washing machine.
Jules then has to pay a total of £600

What is the price of the washing machine with **no** VAT added?

$600 \div 12 = £500$

£ 500

(Total for Question 9 is 2 marks)

9   Ibrar bought a house for £145 000

The value of the house depreciated by 4% in the first year.
The value of the house depreciated by 2.5% in the second year.

Ibrar says,

"4 + 2.5 = 6.5 so in two years the value of my house depreciated by 6.5%"

(a) Is Ibrar right?
You must give a reason for your answer.

4% reduction = 0.96   Ibrar is wrong.
2.5% reduction = 0.975

0.96 × 0.975 = 0.936

The house deprecates by a % of its value at the
end of each year, not its initial value.

(2)

The value of Ibrar's house increases by x% in the third year.
At the end of the third year the value of Ibrar's house is £140 000

(b) Work out the value of x.
Give your answer correct to 3 significant figures.

145000 × 0.96 × 0.975 × x = 140000

135720 × x = 140000

x = $\dfrac{140000}{13572}$

x = 1.0315

x = 103.153 %

3.15%

(3)

10 Robert makes 50 litres of green paint by mixing litres of yellow paint and litres of blue paint in the ratio 2 : 3

Yellow paint is sold in 5 litre tins.
Each tin of yellow paint costs £26

Blue paint is sold in 10 litre tins.
Each tin of blue paint costs £48

Robert sells all the green paint he makes in 10 litre tins.
He sells each tin of green paint for £66.96

Work out Robert's percentage profit on each tin of green paint he sells.

Yellow : Blue
2 : 3
20 : 30

20 litres of Yellow

= 4 tins × £26

= £104

30 litres of Blue

= 3 tins × £48

= £144

Total spends = £248

Green

5 tins × £66·96

= £334·80

$\dfrac{334·80}{248}$ = 1·35

= 135%

100% ⟶ 135%

= 35% profit

35   %

10 Jane bought a new car three years ago.

At the end of the first year the value of the car had decreased by 12.5%
The value of the car then decreased by 10% each year for the next two years.

At the end of the three years, the value of the car was £17010

Work out the value of the car when Jane bought it three years ago.

$$x \times 0.875 \times 0.9^2 = 17010$$

$$x = \frac{17010}{0.875 \times 0.9^2}$$

$$x = 24000$$

£ 24000

(Total for Question 10 is 3 marks)

10 Louise invests £x in Better Investments for 3 years.
    Sadiq invests £x in County Bank for 3 years.

Better Investments	**County Bank**
Compound Interest	Compound Interest
2.5% per annum	2% per annum for the first two years 3.5% per annum for each extra year

At the end of the 3 years, the value of Louise's investment is £344 605

Work out the value of Sadiq's investment at the end of the 3 years.

$$x \times 1.025^3 = 344605$$

$$x = \frac{344605}{1.025^3}$$

$$\underline{\underline{x = 320000}}$$

Sadiq

$$320000 \times 1.02^2 \times 1.035 = 344580.48$$

£ 344580.48

10 Marie invests £8000 in an account for one year.
At the end of the year, interest is added to her account.

Marie pays tax on this interest at a rate of 20%
She pays £28.80 tax.

Work out the percentage interest rate for the account.

$20\% = 28.80$

$10\% = 14.40$

$100\% = 144$ interest gained

$8000 \times x = 8144$

$x = \dfrac{8144}{8000}$

$x = 1.018$

$x = 101.8\%$

1.8 %

(Total for Question 10 is 3 marks)

10 Aaliyah bought a car.

In the first year after she bought the car, its value depreciated at a rate of 23% per annum.
In the second year after she bought the car, its value depreciated at a rate of 19% per annum.

At the end of the second year the car was worth £10 914.75

What was the value of the car when Aaliyah bought it?

$$x \times 0.77 \times 0.81 = 10914.75$$

$$x = \frac{10914.75}{0.77 \times 0.81}$$

$$x = 17500$$

£ 17500

(Total for Question 10 is 3 marks)

10 Naoby invests £6000 for 5 years.
The investment gets compound interest of x% per annum.

At the end of 5 years the investment is worth £8029.35

Work out the value of x.

$$6000 \times x^5 = 8029.35$$

$$x^5 = \frac{8029.35}{6000}$$

$$x = \sqrt[5]{\frac{8029.35}{6000}}$$

$$x = 1.05999$$

$$x = 105.99\%$$

6%

(Total for Question 10 is 3 marks)

10 Katy invests £2000 in a savings account for 3 years.

The account pays compound interest at an annual rate of

$\qquad$ 2.5% for the first year

$\qquad$ x% for the second year

$\qquad$ x% for the third year

There is a total amount of £2124.46 in the savings account at the end of 3 years.

(a) Work out the rate of interest in the second year.

$$£2000 \times 1.025 \times x^2 = £2124.46$$

$$x^2 = \frac{2124.46}{2000 \times 1.025}$$

$$x = \sqrt{1.036321}$$

$$x = 1.017998$$

$$x = 101.7998\%$$

$$1.8\%$$

(4)

Katy goes to work by train.

The cost of her weekly train ticket increases by 12.5% to £225

(b) Work out the cost of her weekly train ticket before this increase.

$$\frac{225}{1.125} = 200$$

£ 200

(2)

(Total for Question 10 is 6 marks)

10 The population of a city increased by 5.2% for the year 2014

At the beginning of 2015 the population of the city was 1 560 000

Lin assumes that the population will continue to increase at a constant rate of 5.2% each year.

(a) Use Lin's assumption to estimate the population of the city at the beginning of 2017
Give your answer correct to 3 significant figures.

$$1560000 \times 1.052^{2} = 1730000$$

1730000

(3)

(b) (i) Use Lin's assumption to work out the year in which the population of the city will reach 2 000 000

$$1560000 \times 1.052^{5} = 2010033$$

Five years

year 2015 + 5 years   2019

(ii) If Lin's assumption about the rate of increase of the population is too low, how might this affect your answer to (b)(i)?

The population may reach 2000000 sooner than 2020

(3)

(Total for Question 10 is 6 marks)

11 In 2003, Jerry bought a house.

In 2007, Jerry sold the house to Mia.
He made a profit of 20%

In 2012, Mia sold the house for £162 000
She made a loss of 10%

Work out how much Jerry paid for the house in 2003

$$x \times 1.2 \times 0.9 = 162000$$

$$x = \frac{162000}{1.2 \times 0.9} = 150000$$

£ 150000

(Total for Question 11 is 3 marks)

13 Sakira invested £3550 in a savings account for 3 years.

She was paid 2.6% per annum compound interest for each of the first 2 years.
She was paid $R\%$ interest for the third year.

Sakira had £3819.21 in her savings account at the end of the 3 years.

Work out the value of R.
Give your answer correct to 1 decimal place.

$$3550 \times 1.026^2 \times R = 3819.21$$

$$R = \frac{3819.21}{3550 \times 1.026^2}$$

$$R = 1.021998984$$

$$R = 102.1998984\%$$

$$100\% \rightarrow 102.19$$

$$= 2.2\%$$

$$R = 2.2\%$$

(Total for Question 13 is 3 marks)

13 At the beginning of 2009, Mr Veale bought a company.
The value of the company was £50 000

Each year the value of the company increased by 2%.

(a) Calculate the value of the company at the beginning of 2017
Give your answer correct to the nearest £100

$$50000 \times 1.02^8 = 58582.96905$$

$$= 58600$$

£ _____58600_____

(2)

At the beginning of 2009 the value of a different company was £250 000
In 6 years the value of this company increased to £325 000

This is equivalent to an increase of x% each year.

(b) Find the value of x.
Give your answer correct to 2 significant figures.

$$250000 \times x^6 = 325000$$

$$x^6 = \frac{325000}{250000}$$

$$x = \sqrt[6]{\frac{325000}{250000}}$$

$$x = 1.044697508$$

$$x = 104.469\%$$

4.5%

(3)

(Total for Question 13 is 5 marks)

14 At the start of 2022 Kim invested some money in a savings account.
The account paid 3.5% compound interest each year.

At the end of 2022
interest was added to the account then Kim took £750 from the account.

At the end of 2023
interest was added to the account then Kim took £1000 from the account.

There was then £2937.14 in the account.

Work out how much money Kim invested at the start of 2022
You must show all your working.

$$(x \times 1.035) - 750$$

$$(x \ 1.035) - 1000 = 2937.14$$

$$\frac{2937.14 + 1000}{1.035} = 3804$$

$$\frac{3804 + 750}{1.035} = 4400$$

£ 4400

(Total for Question 14 is 4 marks)

15 In a shop, all normal prices are reduced by 20% to give the sale price.

The sale price of a TV set is then reduced by 30%.

Mary says,

"30 + 20 = 50, so this means that the normal price of the TV set has been reduced by 50%."

Is Mary right?
You must give a reason for your answer.

Mary is wrong, 30% reduction is from 80%

$$0.8 \times 0.7 = 0.56$$

There is a 44% reduction, not 50%

(Total for Question 15 is 2 marks)

20 The profit made by a shop increases each year.

The profit made by the shop in year n is $£P_n$

Given that the profit made by the shop in the next year is $£P_{n+1}$ then

$$P_{n+1} = aP_n + 800 \text{ where } a \text{ is a constant.}$$

The table shows the profit made by the shop in 2018 and in 2019

Year	2018	2019
Profit	£24 000	£29 600

Work out the profit predicted to be made by the shop in 2021

$$P_{2019} = aP_{2018} + 800$$

$$29600 = a(24000) + 800$$

$$28800 = 24000a$$

$$\frac{28800}{24000} = a$$

$$1.2 = a$$

$$P_{2020} = 1.2(29600) + 800$$

$$= 36320$$

$$P_{2021} = 1.2(36320) + 800$$

$$= 44384$$

£ 44384

(Total for Question 20 is 4 marks)