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LEVEL 3 CERTIFICATE

Topic Exploration Pack

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QUANTITATIVE PROBLEM SOLVING (MEI)

QUANTITATIVE REASONING (MEI)

Appreciation and Depreciation

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Introduction

Appreciation is the increase in value of an item over a period of time. Items such as houses, land and antiques are likely to increase in value over time. Similarly, depreciation is the decrease in value of an item over a period of time. Items such as cars and televisions are likely to decrease in value over time. Although a 'straight line' method could be used for appreciation or depreciation (similar to simple interest), the more usual way of modelling is to use a percentage rate of appreciation or depreciation per year known as 'reducing balance method' (similar to compound interest). In fact a very common misconception amongst students is to think that items such as cars will decrease in value by a specific number of pounds each year rather than by a specific percentage per year. Some students may not be familiar with the concept of depreciation at all.

Before students start work on this topic, they need to be familiar with working with percentages. In particular, students need to be able to perform calculations involving: forward and reverse percentage increase and decrease; repeated percentage change; and working out a percentage change.

Depreciation is a very important concept for businesses. To give a realistic idea of the financial position of a business, depreciation must always be taken into account. For individuals, the concepts of appreciation and depreciation are equally important. Most purchases will depreciate over time, often very rapidly. A few purchases are likely to appreciate, particularly houses and flats. Other items are more volatile and their value may go up or down. For example, different types of antiques may come into fashion or go out of fashion and consequently appreciate or depreciate.

Example of depreciation showing both straight line and reducing balance methods:

A new car is bought for £12 000. Two models for the depreciation of the car are shown below.

Model A: The car will decrease in value by £1500 each year.

Model B: The car will decrease in value by 20% each year.



The table below shows the value of the car after various numbers of years according to each model.

Years	Model A	Model B
0	£12 000	£12 000
1	£10 500	£9600
2	£9000	£7680
3	£7500	£6144
4	£6000	£4915
5	£4500	£3932
6	£3000	£3146
7	£1500	£2517
8	£0	£2013

It is very clear that the reducing balance method is far more realistic than the straight line model. In fact the percentage rate of depreciation often itself decreases after the first year or two, but for the purposes of the Introduction to Quantitative Reasoning specification a constant percentage rate of depreciation or appreciation is used (and the straight line method is not considered).

In calculating depreciation or appreciation, students should be taught to work out the future value in one go using a 'multiplier', rather than using a step by step method.

For example, in the example above, to work out the value of the car after one year (using Model B), students should simply multiply the original value by 0.8, rather than working out 20% of £12 000 and then taking this away from £12 000.

This enables students to rapidly calculate the value of an asset after any number of years if they know the initial value and the rate of depreciation or appreciation.

There are many websites with information on appreciation and depreciation.

<https://www.tes.co.uk/teaching-resource/Compound-Interest-Depreciation-Appreciation-6432870> is one of a multitude of activities on the TES website. Access to all of the resources on the website is free, although you do need to register.

<http://www.bizhelp24.com/money/depreciation-what-does-it-mean.html> gives an explanation of depreciation from a business point of view, explaining both the straight line and reducing balance methods.

<https://www.moneyadvice.service.org.uk/en/articles/car-depreciation-explained> gives the depreciation rates for various models of car, which may be of interest to some students.



Suggested activities

Activity 1 is a worksheet in which students have to work out the multipliers for increasing or decreasing a quantity by a given percentage. Before doing this activity they need to be taught how to work out these multipliers. This can be done using examples as follows:

E.g.: To increase a quantity by 15%.
Original quantity = 100%.
With the increase the total is $100\% + 15\% = 115\%$
So multiply by 1.15.

If necessary, students should try this out with two or three actual examples to convince themselves that this method gives the correct result.

E.g.: To decrease a quantity by 6.5%.
Original quantity = 100%.
6.5% is taken away so the remaining amount is
 $100\% - 6.5\% = 93.5\%$
So multiply by 0.935.

Again, if necessary, students should attempt two or three actual examples.

Activity 2 requires students to work out appreciation and depreciation over a period of time. It also involves comparison of a model with actual values. For the questions which involve depreciation or appreciation over a period of several years, students should be advised to use a method which finds the final answer in one go, rather than using a step by step method. An example of this is shown below.

E.g.: To find the value which £10 000 appreciates to, over a period of 6 years, at a rate of 7%.
Rather than working out the value after 1 year, then after 2 years and so on, students should do the following calculation:
 $£10\,000 \times 1.07^6 = £15\,007.30$ which gives the result in one step.

Activity 3 is more difficult as it requires students to work out interest rates required for a given change over a period. An example of this is shown below.

E.g.: An area of land, initially costing £4500 appreciates to a value of £11 915 over a period of 5 years. Find the average annual percentage growth.
Suppose that the multiplying factor is m
 $11915 = 4500 \times m^5$
 $m = \sqrt[5]{11915/4500} = 1.215$
So average annual growth = 21.5%

This activity also requires students to find the time it would take for a sum to appreciate or depreciate to a certain value using trial and improvement (although of course using logarithms would be allowed).



Activity 1

Complete the table (the first row has been done for you).

To	Multiply by
Increase by 12%	1.12
Increase by 25%	
Decrease by 15%	
	1.06
	0.92
Increase by 4.5%	
Decrease by 7.2%	
	0.875
	1.093
Add 4% to a quantity	
Take 17% from a quantity	
Increase by 10%	
Increase by 1%	
Decrease by 10%	
Decrease by 1%	
	0.5
	2.0

Answer: (NB. Answer text is both bold and in red below for clarity.)

To	Multiply by
Increase by 12%	1.12
Increase by 25%	1.25
Decrease by 15%	0.85
Increase by 6%	1.06
Decrease by 8%	0.92
Increase by 4.5%	1.045
Decrease by 7.2%	0.928
Decrease by 12.5%	0.875
Increase by 9.3%	1.093
Add 4% to a quantity	1.04
Take 17% from a quantity	0.83
Increase by 10%	1.1
Increase by 1%	1.01
Decrease by 10%	0.9
Decrease by 1%	0.99
Decrease by 50% or halve	0.5
Increase by 100% or double	2.0



Activity 2

1. A flat is valued at £85 000. It is expected to increase in value by 6% each year. Find the expected value of the flat after a year.

Answer: Expected value $£85000 \times 1.06 = £90100$

2. A new van costs £18 000. It depreciates by 20% per year. Find its value after 1 year.

Answer: Value $£18\,000 \times 0.8 = £14\,400$

3. A woman invests £5000 in a bank account which pays 4% interest per year. Find the value of the investment in 5 years' time

Answer: Value = $£5000 \times 1.04^5 = £6083.26$

4. The value of the machinery in a manufacturing plant depreciates at a rate of 8% per year. If the original value of the machinery is £65 000, find its value 10 years later.

Answer: Value = $£65\,000 \times 0.9210 = £28\,235.25$

5. A new car costs £15 780. It is expected to depreciate by 20% per year for the first two years, then by 12% per year thereafter.

Find the value of the car after:

- (a) 2 years,
 (b) 6 years.

Answer:

Value after 2 years = $15\,780 \times 0.8^2 = £10\,099.20$

Value after 6 years = $£10\,099.20 \times 0.88^4 = £6056.44$

6. A house was bought for £165 000. Two models are suggested for its appreciation.

- Model A is that the value increases at a rate of 4% per year.
- Model B is that the value increases by £8000 per year.

- a) Find the expected value of the house in each of the following 5 years under each model.

Answer:

	Year 1	Year 2	Year 3	Year 4	Year 5
Model A	£171 600	£178 464	£185 603	£193 027	£200 748
Model B	£173 000	£181 000	£189 000	£197 000	£205 000

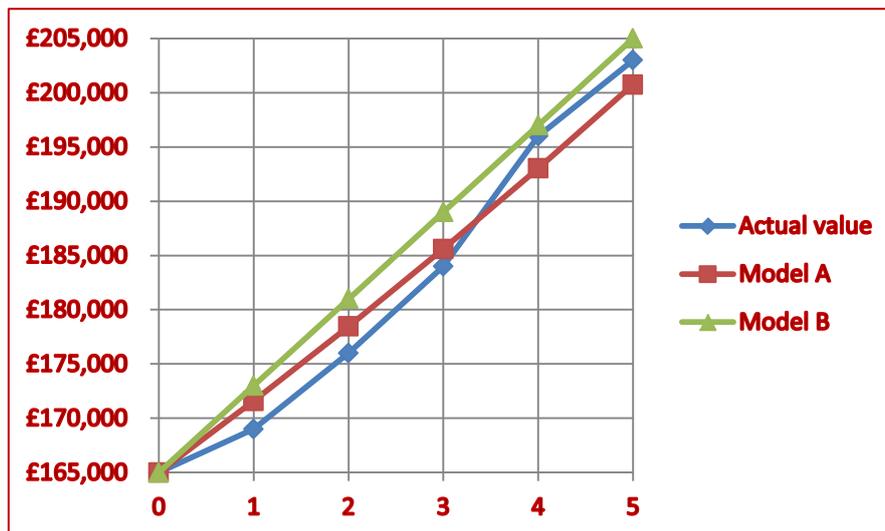


The house was actually valued for each of the next five years (to the nearest thousand pounds) as follows:

Years after start	Value
0	£165 000
1	£169 000
2	£176 000
3	£184 000
4	£196 000
5	£203 000

- b) Draw a single graph to compare the expected values under each of the two models with the actual valuations.

Answer:



- c) Explain which model you think is better over this 5 year period.

Answer: Model A is slightly better because the actual value is closer to Model A than to Model B for most of the graph. (Also allow there is not much difference between the models.)

- d) Explain which of the two models you think would be better in the long term, assuming that house prices continue to appreciate.

Answer: Model A would be better because as the value increases more and more, it is to be expected that the change in value would also increase more and more rather than remaining constant.



Activity 3

1. A car, originally valued at £7240, depreciates in value to £5795 over a period of 1 year. Find the annual percentage rate of depreciation.

Answer:

Suppose that the multiplying factor is m

$$5795 = 7240 \times m$$

$$m = 5795 / 7240 = 0.800$$

So annual depreciation = 20%

2. A painting cost £420. A year later its value is £460. Find the annual percentage rate of appreciation.

Answer:

$$460 = 420 \times m$$

$$m = (460 / 420) = 1.09523$$

So annual appreciation = 9.5%

3. A boat was purchased for £23 500 in 2006. Ten years later in 2016, it was valued at £14 100. Find the average annual percentage rate of depreciation.

Answer:

$$14100 = 23500 \times m^{10}$$

$$m = \sqrt[10]{14100 / 23500} = 0.9502$$

So annual appreciation = 5.0%

4. An apartment was bought for £185 500 in January 2010. In January 2015, it was valued at £217 600. Work out the average annual percentage rate of appreciation.

Answer:

$$217600 = 185500 \times m^5$$

$$m = \sqrt[5]{217600 / 185500} = 1.0324$$

So annual appreciation = 3.2%

5. Mark bought a computer for £725. Three years later, he sold it for £120. Find the average annual percentage rate of depreciation.

Answer:

$$120 = 725 \times m^3$$

$$m = \sqrt[3]{120 / 725} = 0.5491$$

So annual depreciation = 45.1%



6. Maya invests £1000 in a bank account. Twenty years later her investment has increased in value to £1540. Calculate the average annual percentage rate of appreciation.

Answer:

$$1540 = 1000 \times m^{20}$$

$$m = \sqrt[20]{1540/1000} = 1.0218$$

So annual appreciation = 2.18%

7.

- a) On a particular date in 1996, the price of gold was \$400 per ounce. On the same date in 2011 it was \$1400 per ounce. Find the average annual percentage rate of appreciation.

Answer:

$$1400 = 400 \times m^{15}$$

$$m = \sqrt[15]{(1400/400)} = 1.0871$$

So annual appreciation = 8.71%

- b) On a particular date in 1996, the price of gold was \$400 per ounce. On the same date in 2011 it was \$1400 per ounce. Find the average annual percentage rate of appreciation.

Answer:

$$1210 = 400 \times m^3$$

$$m = \sqrt[3]{(1210/400)} = 1.0475$$

So annual appreciation = 4.75%

8. A van was bought for £8500 and sold a number of years later for £6300. If the average annual percentage rate of depreciation was 9.5%, work out how many years later the van was sold.

Answer:

By trial and error:

$$£8500 \times 0.9053 = £6300.35$$

So 3 years later

9. A rare stamp was bought for £400 in 2005. A few years later it was valued at £1000. The average annual percentage rate of appreciation was 16.5%. In which year was the valuation carried out?

Answer:

By trial and error:

$$£400 \times 1.165^6 = £1000.04$$

So 6 years later in 2011



10. A motorbike was bought for £3750. During the first year after it was bought it depreciated by 25%.

- a) Find the value of the motorbike after 1 year

Answer:

$$\text{Value} = £3750 \times 0.75 = £2812.50$$

For the following four years it depreciated at a rate of 12% per year.

- b) Work out the value of the motorbike after 5 years.

Answer:

$$\text{Value} = £2812.50 \times 0.88^4 + £1686.64$$

- c) Calculate the average annual percentage rate of depreciation over the whole of the 5 year period

Answer:

$$1686.64 = 3750 \times m^5$$

$$m^5 \sqrt[5]{(16.864/3750)} = 0.8523$$

So annual depreciation = 14.8%



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