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LEVEL 3 CERTIFICATE
Topic Exploration Pack

H866/H867

QUANTITATIVE PROBLEM SOLVING (MEI)
QUANTITATIVE REASONING (MEI)
Costing

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MEI
Innovators in
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Oxford Cambridge and RSA

Contents

This Topic Exploration Pack should accompany the OCR 'Costing' learner activities, which you can download from the OCR website.

This activity offers an opportunity for maths skills development.

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Introduction

The ability to cost a financial decision is very important for everyday life. There are many types of financial decisions which have to be made, whether simple day to day decisions, such as whether or not to buy a particular item of clothing, or much longer term decisions such as whether to buy or rent a home. Students will come across these in their adult life and they should be given adequate skills to deal with them.

During this topic, students will need to be or become familiar with a number of terms involved in financial decision making. These include income, expenditure, budget, profit, loss, investment, tax, revenue, inflation, APR and AER. Although some of these terms may already be known by students, such as income and expenditure, others such as revenue and APR are less likely to be known. Many of these terms are linked to percentages and thus a good knowledge of percentages and percentage change will be required. In particular the technicalities of APR and AER may come as a surprise to many students, who would expect that there is only one thing that an interest rate of 5% can mean.

For more information see http://www.money.co.uk/article/1004102-what-are-aer-and-gross-interest-rates.htm and http://www.learnmoney.co.uk/banking/bank-46.html.

Students will probably not be familiar with 'Demand curves' and it is important that they use the conventional approach of having demand on the horizontal axis and price on the vertical axis. Of course the simplest type of demand curve is in fact a straight line and in Activity 2 there is both a straight line and curved model.

Spreadsheets are an essential tool in modelling financial problem solving. Therefore, in learning about this topic, students should be given experience of using spreadsheets for this purpose. Although spreadsheets obviously cannot be used in an examination situation, exam questions can require candidates to write down a spreadsheet formula and also to fill in a spreadsheet table in the printed answer book. If students do not already have access to a spreadsheet package, 'Gnumeric' can be downloaded free of charge and contains all the formulae and facilities that are expected from commercial software.

There are several different resources for managing finance here:

http://www.bbc.co.uk/education/topics/zt4cwmn

Suggested Activities

Activity 1 is a simple budgeting exercise. For students who want more information on building costs there are many websites such as:

http://www.ourproperty.co.uk/guides/building_an_extension__what_to_consider.html
or
http://www.jewson.co.uk/working-with-you/for-self-builders/preliminary-planning/calculators/build-cost-calculator/
where one can do detailed costings.

Activity 2 is much more complex and asks students to choose the best of three different options for purchasing a car. A spreadsheet should be used for this activity. To do this activity, students will need to be able to calculate compound interest. They will also need to find the conversion factor between litres and gallons. It is recommended that students set up their own spreadsheet, but teachers can use the given one as a guide.

There is a very good guide to various options for purchasing a car here http://www.whatcar.com/car-advice/buying/car-finance-explained/3485458 .

Activity 3 requires students to use a spreadsheet to model a relationship between demand and price. They need to know how to find the equation of a straight line, given two points on the line. An exponential model is then suggested, and students will also need to be familiar with this topic. There are many websites with more information on demand curves such as here
http://www.tutor2u.net/business/gcse/finance_demand.html .

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Activity 1

Vanya is considering having a loft extension for her house. She has a total budget of £15,000. She decides to employ her own architect and then get the work done by individual contractors. She estimates the minimum and maximum costs for each part of the project to be as below. By choosing cheaper or more expensive materials she will be able to make the costs closer to the minimums or maximums.

Type of expenditure	Minimum	Maximum
Architect and other fees	£ 2,000	£ 3,500
Builder - labour	£ 4,000	£ 9,000
Roofing	£ 1,200	£ 2,400
Plastering	£ 800	£ 1,400
Electrics	£ 1,200	£ 2,000
Plumbing	£ 600	£ 900
Windows and doors	£ 1,200	£ 2,600
Decorating	£ 300	£ 800
Insulation	£ 400	£ 1,200

1. Show that Vanya may have enough money in her budget to carry out her project, but cannot be sure that she will have enough.

Vanya decides to go ahead with the project and after 1 month, the expenditure so far is shown below, together with the estimated remaining costs.

Type of expenditure	Cost so far	Remaining
Architect and other fees	£ 2,000	£ -
Builder - labour	£ 4,000	£ 2,000
Roofing	£ 1,600	£ -
Plastering	£ -	£ 1,000
Electrics	£ -	£ 1,500
Plumbing	£ -	£ 750
Windows and doors	£ 1,500	£ 200
Decorating	£ -	£ 500
Insulation	£ -	£ 600

2. Show that if the estimated costs are all correct, Vanya will not have enough money to complete the project.

3. Vanya decides to try to reduce the remaining costs to the minimum given in the first table, other than 'Builder – labour' and 'Windows and doors' as these last two have already been started. Will she now have enough in her budget to complete the project?

Answers to Activity 1

1. Using spreadsheet:

Type of expenditure	Minimum	Maximum
Architect and other fees	£ 2,000	£ 3,500
Builder - labour	£ 4,000	£ 9,000
Roofing	£ 1,200	£ 2,400
Plastering	£ 800	£ 1,400
Electrics	£ 1,200	£ 2,000
Plumbing	£ 600	£ 900
Windows and doors	£ 1,200	£ 2,600
Decorating	£ 300	£ 800
Insulation	£ 400	£ 1,200
Total	**£ 11,700**	**£ 23,800**

So if costs are minimum she will have some money to spare, but if maximum she will be over £8000 short.

2. Using spreadsheet:

Type of expenditure	Cost so far	Remaining
Architect and other fees	£ 2,000	£ -
Builder - labour	£ 4,000	£ 2,000
Roofing	£ 1,600	£ -
Plastering	£ -	£ 1,000
Electrics	£ -	£ 1,500
Plumbing	£ -	£ 750
Windows and doors	£ 1,500	£ 200
Decorating	£ -	£ 500
Insulation	£ -	£ 600
Total	**£ 9,100**	**£ 6,550**

So if the remaining costs are as expected, the total cost will be £9100 + £6550 = £15650, which is £650 more than her budget.

3. Using spreadsheet:

Type of expenditure	Cost so far	Using Minimums
Architect and other fees	£ 2,000	£ -
Builder - labour	£ 4,000	£ 2,000
Roofing	£ 1,600	£ -
Plastering	£ -	£ 800
Electrics	£ -	£ 1,200
Plumbing	£ -	£ 600
Windows and doors	£ 1,500	£ 200
Decorating	£ -	£ 300
Insulation	£ -	£ 400
Total	**£ 9,100**	**£ 5,500**

So using minimums, the total cost will be £9100 + £5500 = £14600, which is £400 below her budget.

Activity 2

Marta is considering buying a car. She has decided on a particular model of car and has several options for buying it. Marta has £4000 available to put towards the cost of the car. She also wants to consider the cost of running the car according to the different options for purchase.

Option 1: Buy for cash at a cost of £8995. To do this, she will have to get a loan for the remaining £4995. She has explored various options and can get a five year loan with monthly repayments of £115.50.

Option 2: Use a manufacturer scheme where she puts down a deposit of £4000 and then pays £145 per month for the next four years.

Option 3: Use a dealer scheme where she pays £160 per month for 4 years and then she makes a final payment of £4400. At the end of the 4 years, she can alternatively return the car to the dealer and pay nothing more. If she does more than 8000 miles per year with this option, she has to pay and additional charge of 10 pence per mile. If she chooses this option, she can invest her £4000 at an interest rate of 3% per annum.

In addition to the cost of buying the car, she has several other costs to take into account:

- **Vehicle excise duty**: This car's emissions are 105g/km CO_2 which currently attracts an annual charge of £20.

- **Insurance**: The cheapest insurance quote is £650 for the first year. However for the next three years this is expected to decrease by £65 each year due to a no-claim bonus (providing that Marta has no accidents).

- **Servicing**: This will cost £130 per year, assuming there are no mechanical problems. However, with option 3, the servicing costs are included in the £160 per month payments.

- **Fuel:** Marta expects to do 6000 miles per year. The fuel consumption quoted by the manufacturer for urban motoring is 57.7 miles per gallon but she expects to get 54 mpg as one does not usually get figures as good as those quoted by manufacturers. She will use a fuel cost of £1.23 per litre

1. Find the monthly cost of fuel.

2. Find the total monthly cost of buying and running the car under Options 1 and 2.

3. Find the total monthly cost of buying and running the car under Option 3 including the interest gained on the £4000.

4. Discuss the advantages of each of the three options.

Answers to Activity 2

1.   1 gallon = 4.546litres so £1.23 per litre = £5.59 per gallon

6000 miles per year = 500 miles per month, and averaging 54 miles per gallon she will need 500/54 = 9.26 gallons per month.

Monthly fuel cost = £5.59 × 9.26 = £51.76

2.

Option 1	Cost for 5 years	
Cost of car	£4000 + £115.50 x 60	£ 10,930.00
Vehicle excise duty	5 years at £20	£ 100.00
Insurance	£650+£585+£520+£455+£455	£ 2,665.00
Servicing	5 years at £130	£ 650.00
Fuel	60 months at £51.76	£ 3,105.60
	Total	£ 17,450.60
	Monthly	**£ 290.84**

Option 2	Cost for 5 years	
Cost of car	£4000 + £145 x 48	£ 10,960.00
Vehicle excise duty	5 years at £20	£ 100.00
Insurance	£650+£585+£520+£455+£455	£ 2,665.00
Servicing	5 years at £130	£ 650.00
Fuel	60 months at £51.76	£ 3,105.60
	Total	£ 17,480.60
	Monthly	**£ 291.34**

3.

Option 3	Cost for 5 years	
Cost of car	£4400 + £160 x 48	£ 12,080.00
Vehicle excise duty	5 years at £20	£ 100.00
Insurance	£650+£585+£520+£455+£455	£ 2,665.00
Servicing	Included	£ -
Fuel	60 months at £51.76	£ 3,105.60
Interest	On £4000 for 4 years at 3%	-£ 502.04
	Total	£ 17,448.56
	Monthly	**£ 290.81**

4. Although **Option 1** is the most expensive, it has the advantage that the repayments are only £115.50 per month, which is considerably cheaper than the other two options. So if Marta is not that well off, this one might be best.

Option 2 is the cheapest so on financial grounds alone, this one is the best.

The main advantage of **Option 3** is that Marta can return the car after 4 years, and she will still have £4000 plus interest (total £4502.04) to put towards another car. However, with this option, if Marta does a lot more miles than she expects, she will have to pay an extra mileage charge.

Activity 3

Andrew runs a bakery and he has decided to make a new type of cupcake. As a result of market research, he believes that he can sell 80 cupcakes per day at a price of £1.00, or 40 cakes per day at a price of £2.00. He initially models the relationship between the number of cupcakes which he can sell and their price as a straight line.

1. Find an equation for price (p) in terms of numbers sold (x).

2. Set up a spreadsheet model (as shown here) to show the relationship between numbers sold and price, using your formula found in question 1 to complete the blank cells.

Number of cakes	Price (pence)
10	
20	
30	
40	200
50	
60	
70	
80	100
90	
100	

3. Use your spreadsheet to produce a demand curve.

4. Each cupcake costs 38 pence to make. Use your spreadsheet to find the maximum profit that Andrew could make each day.

An alternative model for price is $p = 400 \times 2^{-0.025x}$

5. Show that this model fits the results of the original market research.

6. Use a new worksheet in your spreadsheet to find the price for between 10 and 100 cupcakes sold, and so produce a demand curve for this new model.

7. Use your spreadsheet to find the maximum profit according to this new model.

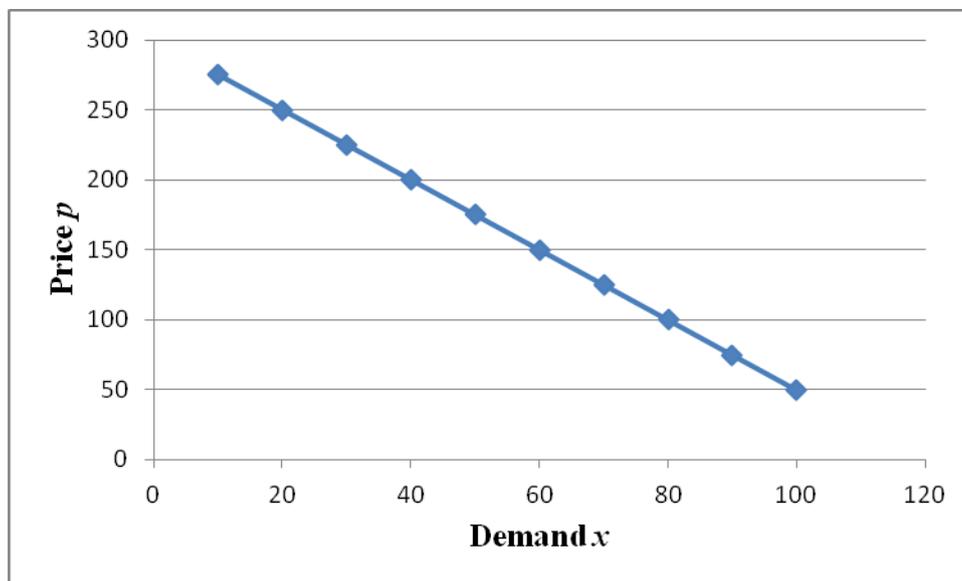8. Discuss which of the two models is more appropriate.

Answers to Activity 3

1. $p = 300 - 2.5x$

2.

Number of cakes	Price (pence)
10	275
20	250
30	225
40	200
50	175
60	150
70	125
80	100
90	75
100	50

3.

4.

Number of cakes	Price (pence)	Income	Expenditure	Profit
10	275	2750	380	2370
20	250	5000	760	4240
30	225	6750	1140	5610
40	200	8000	1520	6480
50	175	8750	1900	6850
60	150	9000	2280	6720
70	125	8750	2660	6090
80	100	8000	3040	4960
90	75	6750	3420	3330
100	50	5000	3800	1200
50	175	8750	1900	6850
51	172.5	8797.5	1938	6859.5
52	170	8840	1976	6864
53	167.5	8877.5	2014	6863.5
54	165	8910	2052	6858
55	162.5	8937.5	2090	6847.5

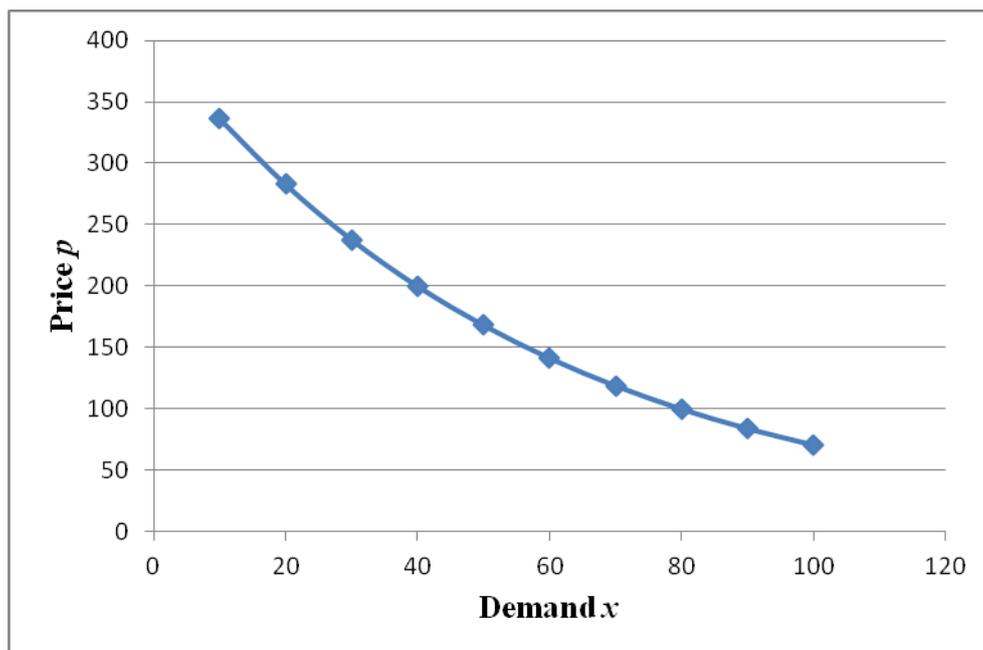Maximum profit is £6864 when 52 cakes are sold.

5.

$$\text{When } x = 40, \ p = 400 \times 2^{-0.025 \times 40} = 400 \times 2^{-1} = 200$$

$$\text{When } x = 80, \ p = 400 \times 2^{-0.025 \times 80} = 400 \times 2^{-2} = 100$$

6.

Number of cakes	Price (pence)
10	336.3585661
20	282.8427125
30	237.841423
40	200
50	168.1792831
60	141.4213562
70	118.9207115
80	100
90	84.08964153
100	70.71067812

7.

Number of cakes	Price (pence)	Income	Expenditure	Profit
10	336.3585661	3363.585661	380	2983.586
20	282.8427125	5656.854249	760	4896.854
30	237.841423	7135.24269	1140	5995.243
40	200	8000	1520	6480
50	168.1792831	8408.964153	1900	6508.964
60	141.4213562	8485.281374	2280	6205.281
70	118.9207115	8324.449805	2660	5664.45
80	100	8000	3040	4960
90	84.08964153	7568.067737	3420	4148.068
100	70.71067812	7071.067812	3800	3271.068
45	183.4008086	8253.036389	1710	6543.036
46	180.2500925	8291.504256	1748	6543.504
47	177.1535038	8326.21468	1786	6540.215
48	174.1101127	8357.285408	1824	6533.285
49	171.1190051	8384.831252	1862	6522.831
50	168.1792831	8408.964153	1900	6508.964

Maximum profit is £6543.50 when 46 cakes are sold.

8. The initial model is simpler, but as the number of cupcakes sold increases beyond 120, the price becomes negative, which does not make sense. The alternative model gives a positive price for any number of cupcakes. Even with 200 cupcakes sold for example, the model gives a price of 12.5 pence. This is well below the cost of making the cupcakes, but still positive so more reasonable.

OCR customer contact centre

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