

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

A2 GCE

4754/01B

MATHEMATICS (MEI)

**Applications of Advanced Mathematics
(C4) Paper B: Comprehension**

INSERT

WEDNESDAY 18 JUNE 2014: Afternoon

**DURATION: Up to 1 hour
plus your additional time allowance**

MODIFIED ENLARGED

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INSURANCE FOR YOUNG DRIVERS

INTRODUCTION

Most people would regard being able to drive as an essential skill for adults in today's world. Passing the driving test is an important event for many young people; some see it as a passport into adult life. 5

The test is not particularly easy but passing it is often only the start of your worries. For example, you then have to pay for motor insurance and this can be very expensive for young inexperienced drivers. This article looks at why insurance costs are so high, and what you can do about it. 10

INSURANCE: A SIMPLE MODEL

Insurance is about sharing the cost associated with risk. 15

Imagine, for example, that 100 people belong to a racing club; they have regular races using a particular type of vehicle. They provide their own vehicles. On average, 10 people have an accident each year and the cost of repairs per accident is £5000. So, in any year there is a probability of 20

$\frac{1}{10}$ that a particular person will have an accident.

The members of the club agree to share the risk by each paying an annual amount of 25

$\frac{1}{10} \times £5000 = £500$ into a fund to provide enough money to compensate those who have accidents. This simplified example illustrates the idea of

sharing risk which underpins insurance; the £500 payment is called the ‘premium’. 30

Insurance is virtually always run by companies and they add an amount to any premium to cover their own costs, and to allow them a profit margin. They also need to ensure that they have sufficient money to cover a bad run of accidents. These factors are not taken into account in this example. 35

REFINING THE MODEL

In the example above, everyone was assigned an equal probability of an accident of $\frac{1}{10}$ and paid the same premium. In practice, insurance companies try to identify high-risk groups and charge them higher premiums, and low-risk groups who can pay lower premiums. They also vary premiums according to the likely cost of an accident. Thus expensive and fast cars tend to attract higher premiums. 40 45

Imagine that, in the example of the racing club, three distinct groups of people, denoted by A, B and C, can be identified. Table 1 gives the proportion of people in each of these groups, the probabilities of their having an accident in any year and the average cost of an accident. 50

Table 1 Probabilities (per year) and average costs of accidents for different groups

Group	A	B	C
Proportion of people	10%	30%	60%
Probability of an accident	0.4	0.1	0.05
Average cost per accident	£9500	£3000	£1000

So among the 100 people in the club, 10 are in Group A, 30 in Group B and the rest in Group C.

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The average number of accidents per year is 4 for those in Group A, 3 for those in Group B and 3 for those in Group C.

The average cost of these accidents is £38 000 for Group A, £9000 for Group B and £3000 for Group C, making £50 000 in total. So, although only 10% of the people are in Group A, on average they account for 76% of the total accident costs.

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In fact, the average cost per year of the accidents per person in Group A is £3800; in Group B it is £300 and in Group C it is £50.

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Clearly it would not be fair for those in the three groups to pay the same premiums; those in Group A should pay very much more.

INSURANCE FOR CAR DRIVERS

Although the example of the racing club, with just three groups, is very much simpler than a real-life situation, it does highlight the two basic elements involved in calculations of insurance premiums: the probability and the cost of an accident. 70

In the example, the premium was determined by sharing the estimated cost of accidents among a specific group of people. In real motor insurance, it is not possible to define such a closed group, and so premiums are calculated purely on the basis of estimates of the probabilities and costs of accidents. 75 80

In motor insurance, important considerations when estimating the probability of an accident include the driver's age, gender, experience and past record. Those for the cost of an accident include the power of the car (and so its speed) and its value. 85

THE DRIVER'S AGE AND GENDER

The age of the driver is an important factor in determining the risk. Table 2, which is based on data from the Association of British Insurers relating to serious accidents, compares the accident rates of drivers, by age group and by gender. The group with the lowest rate, female drivers aged 60 to 69, has been assigned a value of 1, and all the others are compared to that. Thus a male driver in the 17 to 20 age group is 13.4 times as likely to have a serious accident as a female in the 60 to 69 age group. 90 95

In the rest of this article it is assumed that this general pattern can be applied to all accidents that give rise to insurance claims. 100

Table 2 Relative accident rates for car drivers, classified by age group and by gender (Source ABI)

Age group	17–20	21–29	30–39	40–59	60–69	70+
Male	13.4	4.8	2.9	1.9	1.2	1.4
Female	11.3	4.6	2.8	1.9	1.0	1.2

Table 2 shows that young drivers are much more likely to be involved in accidents than older drivers; figures like these make it inevitable that insurance premiums for young drivers are high. 105
Table 2 also shows that the accident rate for male drivers is higher than that for females for most age groups.

Some people start learning to drive on the road on their 17th birthday, the first possible opportunity, whereas others wait until they are quite a lot older. 110
So while years of driving experience and age are related, the relationship is not a simple one. Table 3 shows the age and gender distribution of those holding full UK driving licences; figures are given in thousands, to the nearest 1000; it does not include those with provisional licences, many of whom are in the 17 to 20 age group. 115

Table 3 Distribution by age and gender of UK licence holders ($\times 1000$) (Source DVLA)

Age group	17–20	21–29	30–39	40–59	60–69	70+
Male	538	2444	3430	8277	3467	2333
Female	482	2200	3037	7109	2726	1499

Table 3 shows that in all age groups male drivers outnumber female drivers. 120

The most striking feature of the figures in Table 2 is the difference in accident rate according to age. An obvious cause is inexperience of driving.

Table 4 gives estimates from the insurance industry of the percentage of accidents to which inexperience contributes, for drivers of certain ages. 125

Table 4 Estimated role of inexperience in accidents (Source ABI)

Age (in years)	18.0	20.5	23.0	27.5	45.0
Male %	36	15	6	2.5	1
Female %	39	18.5	7.5	3.5	1.5

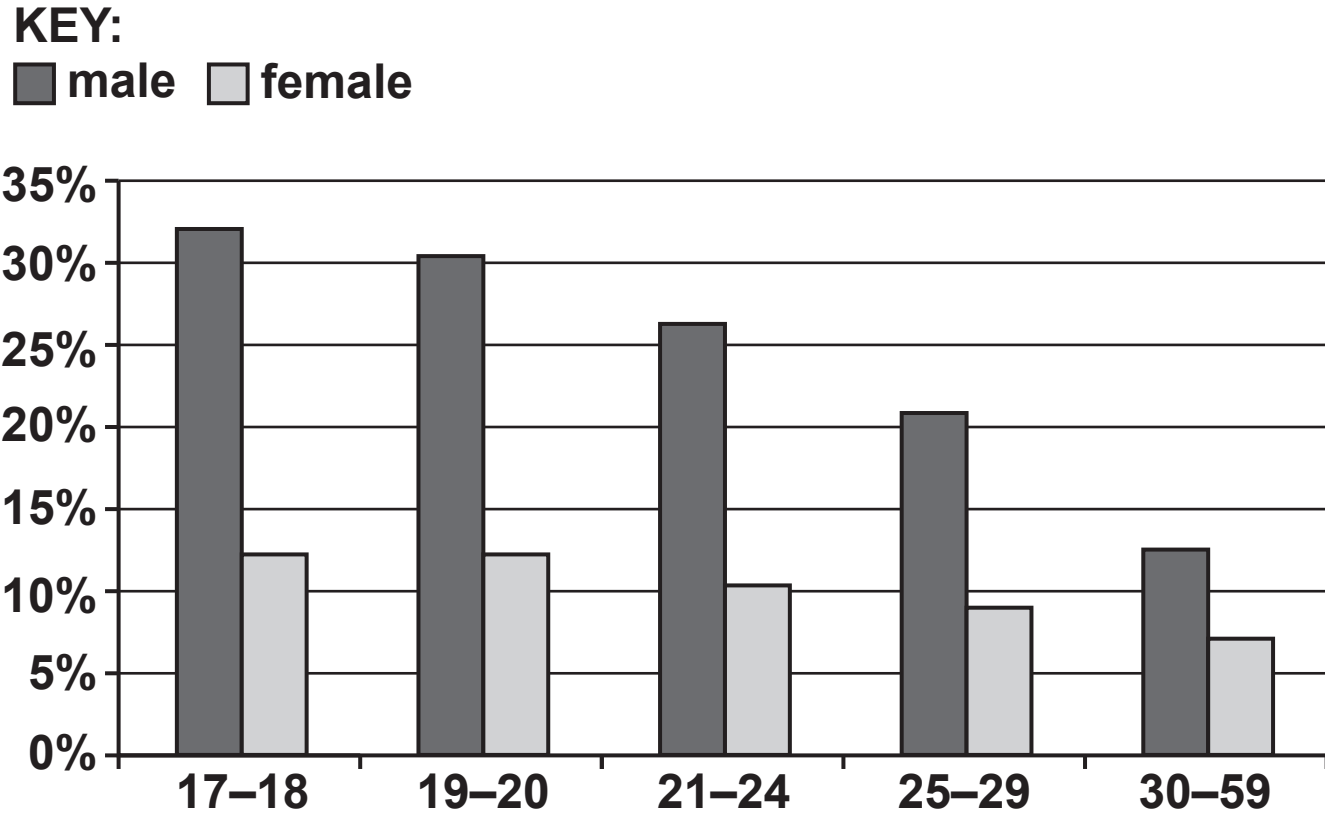
Clearly the role of inexperience goes down with age. A possible mathematical model is that it decays exponentially. 130

Other data show that young drivers are more likely to have accidents at night and this is particularly so for males. One possible explanation for this is lack of experience of driving in the dark; if so, 135

the driving test could be changed so as to include some night-time driving but that might not be easy to implement. Another explanation is that the drivers have been at parties; the worst times for accidents are Friday and Saturday nights. 140

While inexperience is obviously an important consideration, it clearly is not the only cause. Fig. 5 provides another part of the explanation. It shows the estimated percentages of accidents in which excessive speed is a contributory factor. There are large differences between male and female drivers for all the age groups concerned, particularly among the youngest drivers. 145

Fig. 5 Percentage of accidents with excessive speed as a contributory factor
(Source DfT, STATS19)

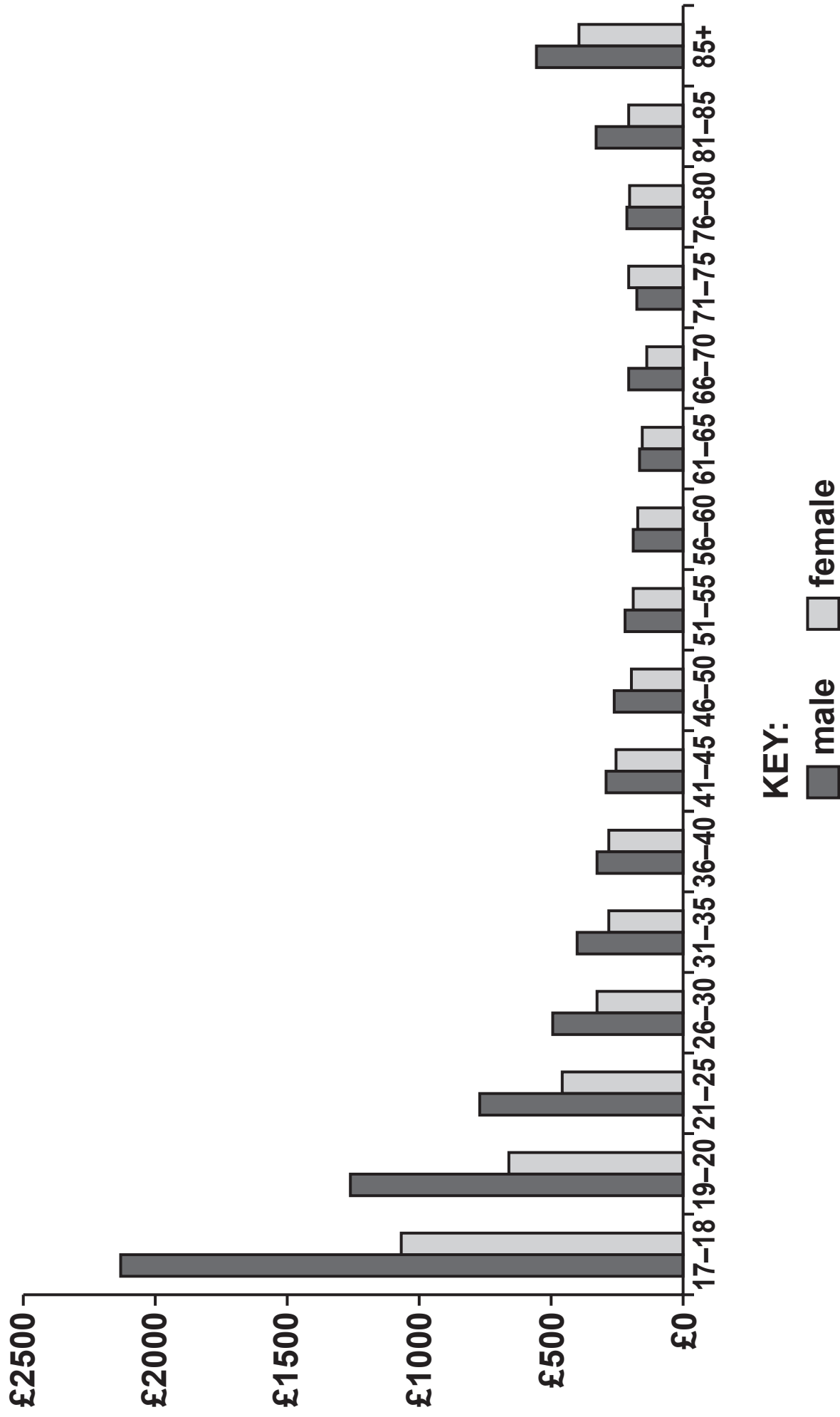


The faster you are driving at the time of an accident, the more serious the accident is likely to be and so the greater the claim on the insurance company. Fig. 6 shows the average costs of claims for different groups of drivers. They are highest for young drivers; for almost all age groups they are higher for males than females.

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Fig. 6 Average costs of claims for different groups (Data source DfT, 2009)



REDUCING INSURANCE COSTS

The two major considerations when an insurance premium is being calculated are the probability of an accident and the average cost if it happens. Both of these are highest for young drivers and higher for males than females. 160

So what can young drivers do to reduce their insurance premiums?

Probability of an accident

When you are first insured, a company has no information about how careful a driver you will be, and so it is assumed that you will be as likely to have an accident as anyone else in your situation. It is up to you to prove otherwise. If you avoid accidents, the insurance company will usually reduce your future premiums. 165
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Nearly all insurance companies reduce the premium of a driver who does not make any claims. This reduction is called a 'no-claims discount.' Reductions vary from one insurance company to another but typical values are shown in Table 7. A good no-claims discount saves a lot of money. A no-claims discount has to be earned by claim-free driving and so is never given to a new driver. 175
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Table 7 Typical no-claims discounts

Years of claim-free driving	% discount from the full premium
1	30%
2	40%
3	50%
4	60%
5+	65%

Most insurance companies have a maximum no-claims discount of 65%. One way of interpreting this practice is that the figure arrived at by applying the maximum no-claims discount is actually the basic cost of the insurance, and that drivers who have not earned the so-called discount are actually paying a surcharge. 185

If you are a very careful young driver it may seem unfair that you have to pay the same insurance premium as others who are reckless; you are paying extra for their bad driving. One way to prove that you really are a good driver is to make use of ‘telematics technology’. A small device is fitted to your car and transmits information to your insurance company, typically covering five aspects of your driving: cornering, swerving, braking, speed and acceleration. Feedback is provided in the form of advice on how to improve your driving and so reduce your insurance premium. 190 195

There is no discount for not breaking the law but if you are convicted for an offence like speeding or using your mobile phone while driving, an insurance company will see this as evidence of bad driving and so will probably increase your premium. Convictions result in points on your licence on a scale of 0 (a clean licence) to 12 (the level at which you are normally disqualified from driving).

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Another risk factor is the number of passengers in the car. The figures in Table 8 show that the percentage of serious accidents increases very greatly with the number of passengers drivers are carrying in their cars. Among the possible explanations are that drivers are distracted or that they try to show off.

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Table 8 Serious accidents classified according to the number of passengers in the car

Number of passengers	0	1	2	3+
% of serious accidents	14	20	26	40

The data in this article show that young female drivers have a lower probability of accidents than young male drivers; so you would expect lower premiums for females. Until recently that was the case, but a ruling of the European Court of Justice has now made this illegal.

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Cost of an accident

The cost of an accident is obviously likely to increase with the value of the car. Not only will an expensive car be more expensive to repair, but it is likely to be more powerful and so able to go faster. 225

Insurance companies place cars in bands between 1 and 50 with the most expensive in the groups with the highest numbers. The lower the band of car you have, the cheaper the premium. Table 9 lists the insurance groups for a few new cars at the time of writing this article. 230

Table 9 Insurance groups for some new cars

Car	Insurance group
Skoda Citigo 5 1.0	1
Peugeot 107 Access 1.0	3
Fiat 500 1.2 Pop	5
Nissan NOTE 1.4 Acenta	10
Volvo S40 D2 ES	20
Renault Clio Sport 200	30
Chrysler 300C Executive	40
Jaguar XKR 5.0 Coupé	50

CALCULATING INSURANCE PREMIUMS

Each insurance company has its own way of calculating a driver's premium. That is why the premium varies from one company to another. A company has to strike a balance between two different demands. **235**

The premium must be low enough to be attractive to customers. **240**

It must be high enough to ensure the company does not make a long-term loss.

In addition insurance companies offer benefits, such as a reduced premium in exchange for agreement to pay the first £200 (say) of any claim, so the premium is not the only consideration when choosing between companies. **245**

Devising companies' procedures or formulae involves very skilled mathematical work; it is carried out by actuaries. This article has highlighted some of the factors involved; mathematical models are needed for all of them and the interaction between them has to be understood. All actuaries have a mathematical background and many of them earn high salaries. **250**
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