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Free Standing Mathematics Qualification
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Mathematics Advanced Level 6992

(Specification 6992)

Modelling with Calculus

Report on the Examination

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General – Written Component

Although there were some very weak candidates, there were also many excellent entries, some of whom gained the maximum mark of sixty.
In general, algebraic skills are improving but there are still candidates who show very poor algebraic skills.
To solve a quadratic equation, for example, in question 2 part (a), some used the quadratic formula, but could not complete their solutions. It was relatively rare to find candidates using a graphic calculator to solve the quadratic equation; those who did usually obtained the correct solutions quickly.
Some candidates simply keyed the quadratic equation, given in question 1, or the cubic equation, given in question 2, into their calculator and, without using calculus, obtained the maximum / minimum points. This technique was not accepted. As stated in the question, calculus techniques were required.
Generally candidates scored well on questions 1 and 2.

Question 1

Part (a) of this question was found to be a good source of marks by most candidates. In part (b)(i), a significant number plotted the graph (on their rough axes) rather than sketching the graph, as required. In part (b)(ii) only the more able candidates identified the real problem with the model which was that it showed a height of water continuing to rise as time went on.

Question 2

In part (a) most candidates found $\frac{\mathrm{d}v}{\mathrm{d}t}$ correctly and equated this to zero. Relatively few managed to find the solutions correctly. Some candidates successfully used their graphic calculators but most found the solutions incorrectly, often because they quoted the formula for the solution of a quadratic equation incorrectly.

Part (b) was usually answered correctly.

The initial part of part (d), finding when $\frac{\mathrm{d}^2v}{\mathrm{d}t^2} = 0$, was usually completed well but few correctly stated the relevance of this to an investor.

Question 3

In part (a), a significant number of candidates were successful in finding the values of $16 - 2t + 5t^2 - 2t^3$ at the relevant values of t. They then used the trapezium rule to find the correct value of the estimate. In part (a)(ii) many candidates gave correct answers.

The integration in part (b) was answered well.

Part (c) caused problems for candidates; the question expected candidates to divide their previous answer [either that in part (b) or even that in part (a)(i)] by three but many candidates tried to answer with different values inserted into the trapezium rule.

Question 4

This question was answered far better than similar questions in previous years. Most candidates were successful in part (a) using the fact that $\cos 2\pi$ was + 1.

A significant number of candidates were successful in part (b) with most also being successful in part (c). A few left their answer as $\frac{40\pi}{3}$ even though the question asked for the answer to be given to three significant figures.

Question 5

Many candidates made good progress in the question. In part (a), most realised they had to integrate, but a significant proportion did not show $\ln m = -kt + c$ which was a required step. Often incorrect algebraic manipulation was shown as they 'obtained' $m = A\,e^{-kt}$; this was penalised.

However the majority of those who attempted this question were successful in part (a) with most correctly showing that $m = 40\,e^{-kt}$ in part (b).

In part (c), most substituted the given values to obtain $20 = 40e^{-6k}$ but it was rare to see $n\frac{1}{2} = -6k$. Those who did obtain this expression often did not find k to three significant figures.

In part (d) a number of candidates realised that when $t = 18$, there had been three 'half lives'. Those who used a numerical value for k often obtained an answer for the mass of 4.96 rather than exactly 5.

In part (e) many candidates obtained $2 = 40\mathrm{e}^{-0.116t}$ often solving it correctly to find t.

Portfolio

There were some excellent portfolios produced by centres which followed the principle of FSMQ to take data from other subjects and produce relevant mathematical analysis.

Some centres, however, gave out very prescriptive task sheets which did not always enable candidates to produce independent work. Candidates would benefit from more 'open-ended tasks' which allow the candidates to develop their work independently.

Mostly, work was produced at the correct Advanced level but there were still centres producing 'Using and Applying Statistics' portfolios where no extension work was attempted. This resulted in a bare pass mark as there was no Advanced level work. It should also be remembered that to obtain a Grade A for "Using and Applying Statistics" work on significance tests such as t-test, Z test, Mann Whitney test, Wilcoxon signed rank test or the Chi-squared should be attempted. Similarly candidates cannot be awarded a Grade A for 'Modelling with Calculus' unless there is evidence of differential equations and the differentiation/integration of functions such as trigonometry functions, exponential functions etc.

Many centres developing 'Working with Algebraic and Graphical Techniques' portfolios produced excellent reports on the fitting of a function to non-linear data by plotting a linear function. Original data was also used in many cases. However, there were still some

centres where candidates did not seem to fully understand the linearization process and could not explain their methods. Candidates producing portfolios which did not include algebra manipulation, such as equations, logarithms etc. could only achieve a mark in the mid thirties.

Candidates generally indicated when they were checking their work. Checking is an important part of the FSMQ ethos, so should be encouraged. Checking was particularly evident in 'Modelling with Calculus' portfolios where candidates were adept at comparing integration methods with numerical methods.

In Strand 3 there were some excellent conclusions drawn by many candidates. They considered how their initial data and assumptions affected their 'real world' findings and used mathematics to summarise their results. However, a few candidates seemed to 'run out of steam' and provided very brief conclusions.

Centres are to be congratulated on the hard work that was behind many portfolios, working with colleagues from other departments in order to obtain data, and lastly in providing samples promptly for moderators.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics pages of the AQA Website.

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