Qualification Accredited

OCR
Oxford Cambridge and RSA

LEVEL 3 CERTIFICATE

Examiners' report

FREE STANDING MATHEMATICS QUALIFICATION: ADDITIONAL MATHS

6993
For first teaching in 2018

6993/01 Summer 2019 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper 1 series overview

This revised specification is modelled on its predecessor with OCR taking the opportunity to change the layout and font to be helpful to candidates. There are a few extra topics to be covered and there was an indication that some candidates were not prepared for these new topics (logarithms, exponential functions and numerical methods).

There were two questions in this paper (Questions 4(a) and 12(c)) that requested a sketch. In these questions the vast majority plotted the curves (not always correctly), indicating that candidates did not understand the difference between sketching, plotting and drawing as defined in the specification.

Question 1

1 A committee consists of five people. The roles of Chairman, Secretary and Treasurer are to be allocated at random from the committee with no one person taking more than one role.
In how many ways can this allocation of roles be made? **[2]**

A large minority did not appreciate the difference between a permutation and a combination. In this question a permutation of 3 from 5 was required; the response 10 was seen rather too often.

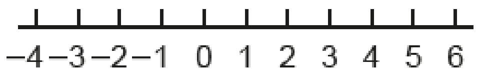
Question 2 (a)

2 **(a)** Solve the inequality $x^2 - x - 12 \leqslant 0$. **[3]**

Very few candidates did not factorise the quadratic function properly and most obtained the correct inequality.

Question 2 (b)

(b) Illustrate your answer to part **(a)** on the number line provided. **[2]**



A number of candidates seemed unaware of the difference between filling in the circles at the ends of the number line and not filling them in. In a few cases this led to an uncertainty as to whether the circles had been filled in or not. There were also a few non-standard presentations of the inequality on the number line.

Question 3

3 Find the equation of the normal to the curve $y = x^3 - 2x^2 + 2x + 4$ at the point (2, 8). **[6]**

This topic seemed to be well known and most candidates achieved the final equation of the normal well. Common errors seen were

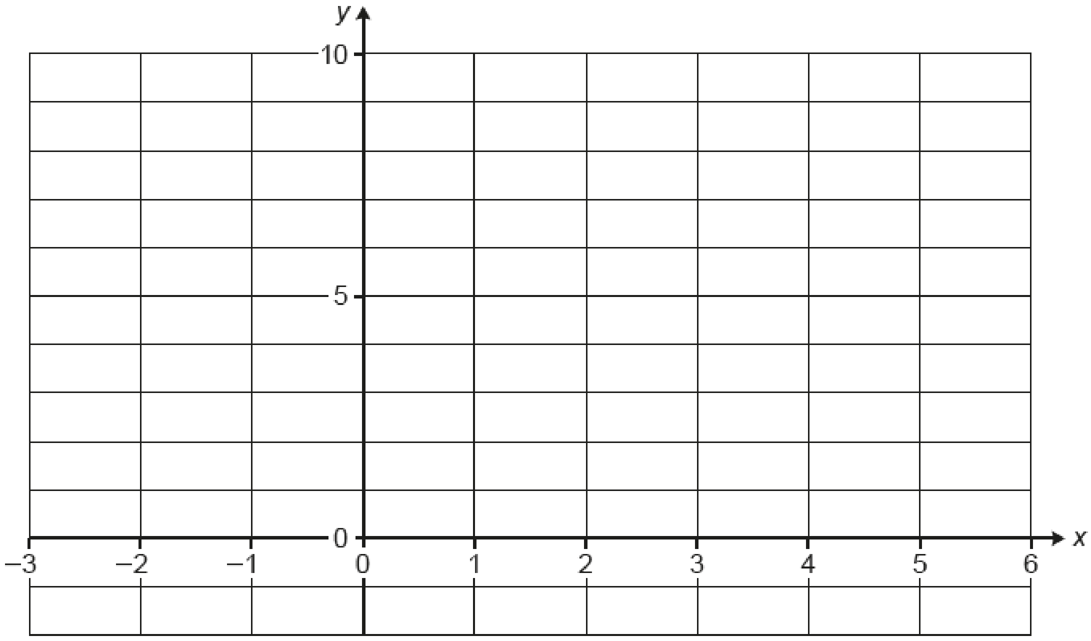
- the gradient was the coefficient of the *x* term in the gradient function (which happened to be 6)
- the gradient was the value of the second derivative (that also in this case happened to be 6)
- writing the gradient as 6*x*.

It is worthy of note that many candidates either felt that they had to find the equation of the tangent in order to proceed to find the equation to the normal or they misread the question and thought they were asked to. A significant number did not proceed beyond finding the equation of the tangent. Candidates were more likely to make calculation errors using $y = mx + c$ rather than $y - y_1 = m(x - x_1)$ to obtain a correct equation for the line.

Question 4 (a)

4 **(a)** On the grid provided, sketch the curve $y = \frac{1}{5} \times 2^x$. **[2]**

4(a)



There is a spare copy of this grid on page 20. If you wish to offer a second attempt then you must cross through the attempt on this grid that you wish to discard.

As stated in the introduction, the vast majority of candidates plotted the curve. There was no penalty for this of course but candidates must have spent a little longer on plotting than if they were able to sketch an exponential function. The features of this curve were

- asymptotic with the negative *x*-axis
- passing through (0, 0.2)
- a steadily increasing gradient.

Question 4 (b)

(b) Solve algebraically the equation $\frac{1}{5} \times 2^x = 3$, giving your answer correct to 3 significant figures. **[3]**

The solution of exponential equations is part of this new topic and many candidates were able to complete this well, although many did not obey the instruction to give the answer to 3 significant figures.

There was some indication that candidates were finding an answer by trial and improvement. None of these candidates were able to find an answer that was correct to 3 significant figures. The wording of the question requires an analytical solution which involved some rearranging and the use of logs.

It was pleasing to see that some candidates were able to use their calculator in using base 2 to find $\log_2 15$.

Question 5

5 In this question you must show detailed reasoning.

Solve the equation $\log_{10} x + \log_{10}(x+2) = 3\log_{10} 2$. **[5]**

This question on a new topic gave a number of candidates' problems. A number cancelled the logarithms, giving $x+(x+2)=6$ (resulting in the correct answer by the wrong method). Of those who obtained the correct quadratic, most combined the left hand side as the log or a product and made the right hand side log 8 before exponentiating.

Of those who combined both sides into one logarithm a number were unable to exponentiate 0.

The quadratic obtained has two roots and many left the answer as these two roots, $x = 2$ and $x = -4$. However, $x = -4$ is not a valid answer so had to be rejected. The process of rejecting this value is important and many candidates did not express themselves clearly. To leave it out indicates that the quadratic equation only has one root which is incorrect. To write it down and then cross it out is ambiguous as the candidate might have thought that it was wrong. The clearest way is to write it down and then state that it needs to be rejected as x has to be positive.

Exemplar 1

$\log_{10}(x) + \log_{10}(x+2) = \log_{10}(2^3)$

$\log_{10}(x(x+2)) = \log_{10}(2^3)$

$\log_{10}(x^2+2x) = \log_{10}(8)$

$x^2+2x = 8$

$x^2+2x-8=0$

$(x+4)(x-2)=0$

$x=-4 \quad x=2$

-4 cannot be a solution, as $\log_{10}(-4)$ is not possible.

$\underline{\underline{x=2}}$

This candidate has stated clearly, with a reason, that the value $x = -4$ should be rejected.

Question 6 (a)

6 Angle θ is such that $\tan\theta = 1.5$.

(a) Find the two values of θ in the range $0° \leqslant \theta \leqslant 360°$. **[2]**

Candidates had no difficulty in using their calculator to find the principal angle but many did not obtain the second value correctly.

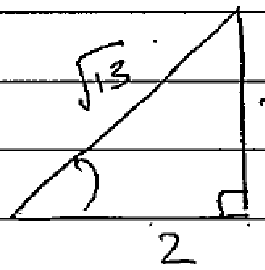
Question 6 (b)

(b) **In this question you must show detailed reasoning.**

Find the **exact** values of $\sin\theta$. **[3]**

This part was poorly answered. There were two clues to indicate what should be done here. The first is the meaning of the statement in the question about detailed reasoning. The second is the fact that the question asked for exact values (i.e. another hint – there is more than one answer to the question, a hint missed by most candidates). Candidates should realise that a calculator answer will not be exact however many decimal places you write down. The answer is irrational and should be written as simply as possible in surd form (another new topic). There were two ways of obtaining the answers for this part. The first was to construct a right angled triangle in which $\tan\theta = 1.5$ – i.e. with sides 2 and 3 (or equivalent). $\sin\theta$ is then obtained easily using Pythagoras to find the third side. The problem with this method is that the use of a triangle in this way disguises the fact that there is a negative answer. The other way to find the answer was to use Pythagoras and the trigonometrical identities to find $\sin\theta$; this results in a value for $\sin^2\theta$ from which candidates were able to see that there were two possible answers.

Exemplar 2



$$\tan\theta = \frac{3}{2}$$

$$3^2 + 2^2 = 13$$
$$= \sqrt{13}$$

$$\sin\theta = \frac{opp}{hyp} = \frac{3}{\sqrt{13}}$$

Exemplar 2 highlights the problem with only considering +2 and +3, ignoring the other situation giving $\tan\theta = 1.5$ – i.e. with sides -2 and -3.

Question 7

7 **In this question you must show detailed reasoning.**

The equation $x^3 - 3x + k = 0$, where k is a constant, has a root $x = 2$.

Find the numerical value(s) of the other roots of this equation. **[5]**

There were many ways of achieving the other root(s) to this equation. The vast majority substituted $x = 2$, thus finding that $k = -2$, doing a long division to obtain the quadratic factor and deducing that $x = -1$ is the other (repeated) root.

A few embarked on the long division immediately to get the quadratic factor and noting in passing that the remainder had to be 0 and so k + 2 = 0.

Successive trials using the factor theorem was not a complete method, for a cubic equation has 3 roots and all candidates using this method stopped after finding that $x = -1$was one of them, thus missing the fact that there was a repeated root.

The majority of students gained at least 2 or 3 marks on this question with a significant proportion gaining full marks.

Question 8 (a)

8 Each of five students has a fair coin. They play a game in which each student tosses their coin and when the result of their toss is a head then that student is eliminated from the game. The game continues with the remaining students tossing their coin again. As before, any student who tosses a head is eliminated. The game continues until all the students have been eliminated or there is a single winner.

Calculate the probability that

(a) all students are eliminated after their first toss of the coin, **[2]**

This part was a source of 2 easy marks for all candidates.

Question 8 (b)

(b) exactly two students are eliminated after their first toss and exactly two after their second toss, leaving one winner. **[4]**

The two separate probabilities were often found, but a significant number of candidates added them rather than multiplying them.

Exemplar 3

$5C2 \times (0.5)^2 \times (0.5)^3$

$= 0.3125$

$3C2 \times (0.5)^2 \times (0.5)^1$

$= 0.375$

$0.3125 + 0.375 = 0.6875$

Exemplar 3 shows a typical incorrect solution; the two elimination rounds neatly worked, but then the probabilities added rather than correctly multiplied.

Question 9 (a)

9 The equation $x^3 + 2x^2 - x - 1 = 0$ has two negative roots, α and β, and one positive root, γ.

(a) By considering a change of sign, show that γ lies in the interval [0, 1]. **[2]**

This new topic is an extension of GCSE (6.03). It was therefore surprising to note that a significant number of candidates did not realise that justification of a root in the interval [0,1] is by showing a sign change. Many calculated f(0) and f(1) correctly, others tried values of *x* other than 0 and 1 while a number only tried one of the values of *x*. There is also some work to be done on the notation here as many did not know how to show the substitution, commonly offering 0=-1 and 1=1 as proofs.

Exemplar 4

$x^3+2x^2-x-1=0$

when $x=0$ $\quad 0^3+2(0)^2-0-1=y$

$y=-1<0$ } change of sign between

when $x=1$ $\quad 1^3+2(1)^2-1-1=1>0$ } 0 and 1 so root lies

in interval $0 \leq x \leq 1$ or $[0,1]$

Exemplar 4 shows a clear line of reasoning, substituting $x = 0$ and $x = 1$ into the function $x^3 + 2x^2 - x - 1$ and commenting on the values obtained.

Exemplar 5

$$0^3 + 2(0)^2 - 0 - 1 = -1$$
$$1^3 + 2(1)^2 - 1 - 1 = 1$$

Exemplar 5 shows a sufficient response for this question, the change in sign between $f(0)$ and $f(1)$ clearly shown.

Question 9 (b)

(b) Show that $x = \sqrt{\dfrac{x+1}{x+2}}$ is a rearrangement of the equation. **[2]**

Any weakness with the manipulation of algebra was exposed in this part and many did not give the correct steps that led from the original equation to the final equation. Candidates should note that when the answer is given there is no advantage to writing it down at the end of a series of incorrect steps. Candidates who started with the given form and rearranged this to give the original cubic equation generally had more success as there are limited options. Those who started with the original cubic equation had mixed success. Some did not show any factorisation or mention dividing by (x + 2).

Exemplar 6

$$x^3 + 2x^2 - x - 1 = 0 \qquad -(-x-1)$$
$$x^3 + 2x^2 = x + 1$$
$$x^2(x+2) = x+1 \qquad \div\, x+2$$
$$x^2 = \frac{x+1}{x+2} \qquad \sqrt{\ }$$
$$x = \sqrt{\frac{x+1}{x+2}}$$

Exemplar 6 shows a clear algebraic process from original cubic equation to the required rearrangement.

Exemplar 7

$$x^3+2x^2-x-1=0$$

$$x^3+2x^2=x+1 \qquad x=\sqrt{\frac{x+1}{x+2}}$$

$$x^2(x+2)=x+1 \qquad x^2=\frac{x+1}{x+2}$$

$$x^2(x+2)=x+1$$

Exemplar 7 presumably shows a candidate that did not initially spot the route to take, and has approached the problem from both ends. However this solution, taken in its entirety, demonstrates accurate algebraic manipulation with no missing steps between the original cubic equation and the rearranged '$x =$' form.

Exemplar 8

$$x^3+2x^2-x-1=0$$

$$x^3+2x^2=x+1$$

$$x = \sqrt{\frac{x+1}{x+2}}$$

This candidate, for instance was not rewarded for his efforts as there is are significant steps missing.

Exemplar 9

$$x^3+2x^2-x-1=0$$

$$x(x^2+2x-1)-1=0 \qquad x((x+1)^2-1)-1-1=0$$

$$\cancel{x(x^2+2x-1)-1=0} \qquad x((x+1)^2-2)-1=0$$

$$\cancel{x(x^2+2x-1)-1=0} \qquad x=\frac{1}{(x+1)^2+2}$$

$$\cancel{(x)(x+1-\sqrt{2})(x+1+\sqrt{2})-1=0}$$

$$x=\sqrt{\frac{x+1}{x+2}}$$

A common issue, as highlighted in exemplar 9, is where a candidate has got stuck and thought it sufficient to jump to the final rearranged form after a couple of steps.

Question 9 (c)

(c) Using the iterative formula $x_{r+1} = \sqrt{\dfrac{x_r + 1}{x_r + 2}}$ with $x_0 = 0.8$, find γ correct to 3 decimal places, showing the result of each iteration. **[3]**

The major problem in this part was a lack of appreciation of how many decimal places should be used and how many iterations should be carried out to justify the answer of $x = 0.802$ being accurate to 3 decimal places.

The value of x_1 in exact, surd, form was accepted but otherwise this value should have been given and used to at least 4 decimal places. A significant number of candidates chopped this value rather than rounding. Likewise, it was necessary to proceed to find x_3 in order to be confident in the final answer.

It may be that candidates were using special functions on their calculator and were working to more decimal places than they wrote down, but examiners cannot reward work they cannot see. Candidates should write down every iterate they calculate to at least 4 decimal places.

Candidates who were successful often gave the iterates to 8 or 9 decimal places and calculated significantly more iterations than required.

Question 10 (a)

10 You are given that the line $y = 2x + k$ cuts the circle $x^2 + y^2 = 5$ in two points, A and B.

(a) Show that the x-coordinates of A and B satisfy the equation

$$5x^2 + 4kx + (k^2 - 5) = 0.$$ **[2]**

This part was almost universally answered correctly, the only real error being the inability to square a linear term to give a three term quadratic.

Question 10 (b)

(b) Hence find the values of k for which the line is a tangent to the circle. **[2]**

This part was poorly answered with most candidates failing to appreciate that for a chord to be a tangent the roots of the quadratic equation that gave the intersections (the answer to part (a)) had to have coincident roots.

Question 11 (a)

11 John makes wooden toys in his workshop at home. He classifies the toys as small or large.
It takes 5 hours to make a small toy and 8 hours to make a large toy. He works for a maximum of 60 hours each week.
Let x be the number of small toys and y be the number of large toys he makes each week.

(a) Write down an inequality giving the time constraint. **[1]**

This was done well by all candidates with almost everyone scoring 1/1.

Question 11 (b)

John knows from experience that

- he needs to make at least 3 large toys each week,
- the number of large toys should be no more than double the number of small toys.

He never leaves any toys unfinished at the end of the week.

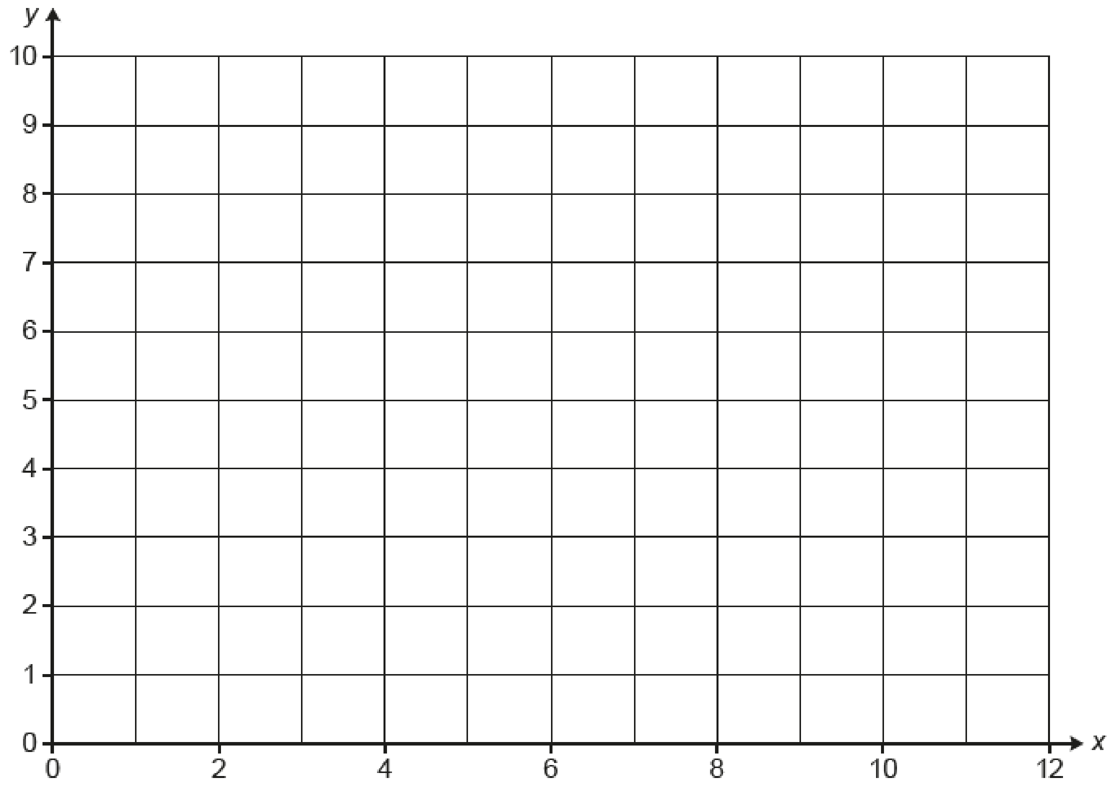
(b) From this information, write down two more inequalities in x and y. **[2]**

This part was also done well by most students. Rare errors were $x \geq 3$ or $y \leq 3$ instead of $y \geq 3$. A rather more common error was to write $x \geq 2y$ or something similar instead of $y \leq 2x$

Question 11 (c)

(c) On the grid provided, illustrate these three inequalities.
Shade the region that is **not** required. **[4]**

11(c)



There is a spare copy of this grid on page 21. If you wish to offer a second attempt then you must cross through the attempt on this grid that you wish to discard.

This graph to show the feasible region has been a standard question for many years and is usually answered well. Even those who quoted the inequalities incorrectly in part (b) drew the correct lines here.

The specification allows for the feasible region to be shaded or left unshaded while the rest of the grid is. However, in this case the question stated specifically that the region not wanted was to be shaded. Almost all candidates did so.

Question 11 (d)

(d) Find the maximum number of toys that John can make in a week and the number of hours he would take to make them. **[2]**

Inevitably, this question was done poorly by those who had not obtained the correct region in part (c) and done well by those who had. Even with a wrong region, candidates could score full marks. Some did not answer the question as required and gave $x = 7$ and $y = 3$ without stating that the total number was 10.

Question 11 (e)

The price for which John sells his wooden toys is such that the profit made is £28 for each small toy and £60 for each large toy.

(e) Assuming that at the end of each week he sells all the toys, find the number of each type of toy he should make to maximise his profit and calculate the profit in this case. **[3]**

This part required a little more work to justify that the point required did give the maximum profit. The two ways of doing this were

- to calculate the profit for relevant points in the feasible region and to choose the one with the greatest profit,
- to draw a series of lines on the graph to represent the objective function, P, and to choose the point where P was greatest.

A list of points with their profit is an essential part of the answer if done the first way. Candidates should be careful not to cross out points and their profit if they are to be rejected. To cross something out is to indicate that it is not to be marked.

This question, as with many set in the past, deals with a practical situation involving integer points only. A few ignored the practical context and worked in decimals.

Question 12 (a)

12 The curve C_1 has equation $y = 10x - x^2 + k$ and passes through the point (5, 10).

(a) Show that $k = -15$. **[2]**

This proved an easy starter to the question with almost all candidates earning full marks.

(b) Show that there is a maximum value at the point (5, 10). **[3]**

Question 12 (b)

A significant number of candidates missed a number of steps in this part, thus earning few if no marks. The most popular method for demonstrating a maximum was to show that $\frac{d^2y}{dx^2} < 0$. However, this neither demonstrated that the turning point was when $x = 5$ nor that $y = 10$.

Exemplar 10

$y = -x^2 + 10x - 15.$

$\frac{dy}{dx} = -2x + 10$

$\frac{d^2y}{dx^2} = -2$

↳ negative number so there is a maximum value at (5, 10)

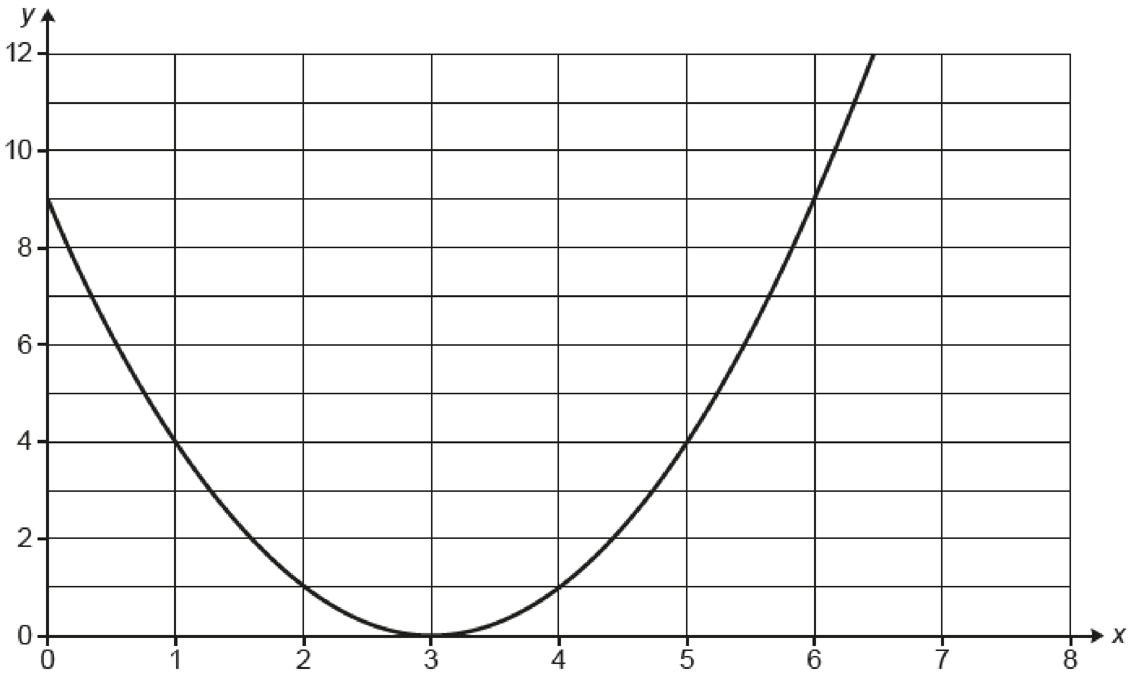
Exemplar 10 shows a typical incomplete solution; the candidate has confirmed that the curve C_1 has a maximum, but does not show that this occurs at the given point $(5,10)$.

Question 12 (c)

The curve C_2 with equation $y = (x-3)^2$ has been plotted on the grid provided.

(c) On the same grid, sketch the curve C_1. **[2]**

12(c)



There is a spare copy of this graph on page 22. If you wish to offer a second attempt then you must cross through the attempt on this grid that you wish to discard.

This part was almost universally done correctly. There were at times some wayward parts to the curve at its extremities and some did not pass through the correct points of intersection.

Question 12 (d)

(d) Find the coordinates of the points of intersection of the curves C_1 and C_2. **[2]**

There was little space given here for calculations – writing down the points from the graph was satisfactory.

Question 12 (e)

(e) Find the area between the curves C_1 and C_2. **[5]**

There were two ways to find this answer.

The first was to subtract the equations and to integrate the resulting function. This resulted in a number of errors, the first being that the functions of the curves were equated, meaning that the resulting function to be integrated was actually equal to zero. The second error was at this stage to divide by 2.

The second way was to find the area under both curves separately and then to subtract the two values obtained.

The layout for this working usually left something to be desired, often resulting in candidates making careless algebraic errors..

The SC for an answer with no working gaining full credit reflects that numerical integration functions on a calculator could have been used here; the implication being that candidates obtaining the correct answer had demonstrated an understanding of the underling concept and had made efficient use of their calculator. This would not have been the case if the question had used one of the defined assessment 'command words'.

Exemplar 11

area between curve

$\cancel{\int_2^6 (2x^2 - 16x + 24)\,dx}$

$\cancel{\frac{2x^3}{3} - \frac{16x^2}{2} + 24x}$

$= \left[\frac{2x^3}{3} - 8x^2 + 24x\right]_2^6$

$\left[\frac{2(6)^3}{3} - 8(6)^2 + 24(6)\right] - \cancel{\left[\frac{2(2)^3}{3} - 8(2)^2 + 24(2)\right]}$

$\cancel{= 0 - 21.\dot{3}}$

$\cancel{= -21.\dot{3}}$

$\int_2^6 [(10x - x^2 - 15) - (x^2 - 6x + 9)]\,dx$

$\int_2^6 (16x - 2x^2 - 24)\,dx$

$= \frac{16x^2}{2} - \frac{2x^3}{3} - 24x$

$= \left[8x^2 - \frac{2x^3}{3} - 24x\right]_2^6$

$= 0 - -21.\dot{3}$

$= 21.\dot{3}$

$= \underline{21.3 \text{ unit}^2}$

Exemplar 11 uses the first method; the careful use of brackets in the first line avoids sign errors.

Exemplar 12

$$\int_2^6 (x-3)^2 = \int_2^6 x^2 - 6x + 9$$

$$= \frac{x^3}{3} - \frac{6x^2}{2} + 9x$$

$$= \left[\frac{x^3}{3} - 3x^2 + 9x\right]_2^6 = 18 - 8.\dot{6} = 9.\dot{3}$$

$$\int_2^6 10x - x^2 - 15 = \frac{10x^2}{2} - \frac{x^3}{3} - 15x$$

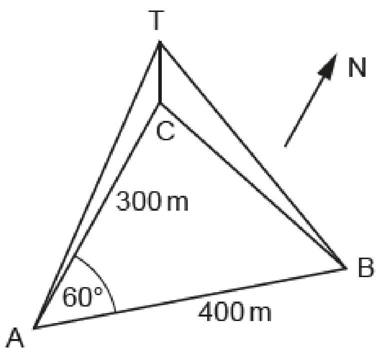
$$= \left[5x^2 - \frac{x^3}{3} - 15x\right]_2^6 = 18 - (-12.\dot{6}) = 30.\dot{6}$$

$$30.\dot{6} - 9.\dot{3} = \underline{\underline{21.\dot{3} \text{ unit}^2}}$$

Exemplar 12 uses the second method; the missing 'dx' was not penalised here, but correct notation should be encouraged.

Question 13 (a)

13 A straight road runs on a bearing of 060° from a point A to a point B, 400 m from A.
A vertical mast, CT, stands at a point C, 300 m due north of A. From the point A the angle of elevation of the top of the mast, T, is 7°. The triangle ABC is on horizontal ground.



(a) Find the height of the mast. **[2]**

The vast majority of candidates understood this question and used the tangent ratio to find the height of the tower successfully. Some candidates used the sine rule to calculate the answer and were also successful. Generally this was well done and provided a nice start to Q13.

Question 13 (b)

(b) Find the angle of elevation of the top of the mast from point B. **[5]**

In this part of the question, the vast majority of candidates were successful in gaining the first 3 marks to find CB using the cosine rule. A small group of candidates misquoted the cosine rule. This is a formula that is not given on the exam paper and so it (and the sine rule) should be learnt. Most candidates followed this by using the tangent correctly. A proportion of candidates gave themselves extra work by finding TB by Pythagoras and then used this with CB to find the angle successfully.

This question allowed most candidates to attain some marks and again rewarded those who understood the different steps but also took care not to round unnecessarily.

Question 13 (c)

(c) Find the bearing of the base of the mast from point B. **[5]**

This question was similar to part (b) in that the vast majority of candidates were successful at using the sine or cosine rule to find either angle B or C. Finding the correct bearing exposed a lack of understanding in a significant proportion of candidates with many either finding an incorrect answer or just not attempting this part of the question.

Question 14 (a)

14 Speed bumps are designed to encourage drivers to drive slowly. On a particular road, the bumps put onto the road are designed to give minimum discomfort and damage at a speed of $9\,\text{ms}^{-1}$. Paul is driving along the road at a speed of $14\,\text{ms}^{-1}$ when he sees the warning sign, he is 50 m before the first bump. He immediately slows down with uniform deceleration so that when he reaches the first bump he is travelling at a speed of $9\,\text{ms}^{-1}$.

(a) Calculate the uniform deceleration **and** the time taken for Paul to reach the first bump. **[3]**

Although not explicitly in the specification, the majority of candidates used $v^2 = u^2 + 2as$ for this first part. Given that it was deceleration that was involved rather than acceleration, some careful substitution was necessary. Many candidates simply interchanged *u* and *v* which was not acceptable.

Question 14 (b)

Immediately after the bump he accelerates such that at t seconds after leaving the bump his speed, $v\,\text{ms}^{-1}$, is given by $v = \frac{1}{100}(15t^2 - t^3) + 9$.

(b) Show that he reaches his original speed of $14\,\text{ms}^{-1}$ in 10 seconds. **[1]**

The substitution of t = 10 to give v = 14 usually provided an easy mark. Some candidates substituted v = 14 with the intention of showing that t = 10. While an acceptable process, solving the subsequent cubic equation in t caused rather more work than the one mark justified.

Question 14 (c)

(c) Find the distance travelled from the speed bump by the time he reaches this speed. **[4]**

The use of suvat formulae here was inappropriate and many candidates did not score on this part as a result. The fact that the equation for v was a cubic in t rather than linear should have been a clue.

Question 14 (d)

(d) Find the maximum acceleration in this period. **[3]**

The question asked for a maximum value for a. It was therefore necessary, either to rewrite the equation for a *in* the form of completing the square or by differentiating the equation for a. This proved to be beyond most candidates, although many of the more able candidates did well. However, the negative coefficient of t^2 caused real difficulties for those attempting to complete the square.

Question 14 (e)

(e) If all drivers decelerate and accelerate in the same way as Paul, suggest a maximum distance between bumps to ensure that drivers do not exceed a speed of $14\,\text{ms}^{-1}$ when driving down the road. **[1]**

There were few correct responses to this part.

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For further details of this qualification please visit the subject webpage.

Review of results

If any of your students' results are not as expected, you may wish to consider one of our review of results services. For full information about the options available visit the OCR website. If university places are at stake you may wish to consider priority service 2 reviews of marking which have an earlier deadline to ensure your reviews are processed in time for university applications.

CPD Training

Attend one of our popular CPD courses to hear exam feedback directly from a senior assessor or drop in to an online Q&A session.

Please find details for all our courses on the relevant subject page on our website.

www.ocr.org.uk

The small print

OCR Resources: *the small print*

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Please get in touch if you want to discuss the accessibility of resources we offer to support delivery of our qualifications: resources.feedback@ocr.org.uk

Looking for a resource?

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OCR Customer Support Centre

General qualifications

Telephone 01223 553998
Facsimile 01223 552627
Email general.qualifications@ocr.org.uk

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