Qualification Accredited

Oxford Cambridge and RSA

AS LEVEL

Examiners' report

MATHEMATICS A

H230
For first teaching in 2017

H230/02 Summer 2018 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 H230/02 series overview

H230/02 is one of the two examination components for the new revised AS Level examination for GCE Mathematics A. The examination is structured in two sections. Section A : Pure Mathematics (this paper consists of eight questions allocated 50 marks) and Section B : Mechanics (this paper consists of three questions allocated 25 marks). All questions should be answered. Each section has a gradient of difficulty throughout the section and consists of a mix of short and long questions.

Three overarching themes are applied across all content.

1. Mathematical argument, language and proof.
2. Mathematical problem solving.
3. Mathematical modelling.

To do well on this paper candidates need to be comfortable applying their knowledge and understanding to all three of these overarching themes, in both familiar and unfamiliar contexts.

Candidate performance overview

Candidates who did well on this paper generally did the following.

- Performed calculations to an appropriate degree of accuracy, and gave answers to the accuracy requested e.g. in Q1(i) and Q7(ii).
- Demonstrated a competent algebraic technique.
- Readily identified required methods.
- Coped well with unstructured questions e.g. Q5, Q8 and Q9.
- Interpreted modelling situations well.

Candidates who did less well on this paper generally did the following.

- Made careless mistakes in calculations.
- Lacked accuracy in their algebraic work e.g. were prone to sign errors.
- Did not always read the question carefully e.g. Q1(ii).
- Found it difficult to develop a suitable method to solve an unstructured question.
- Found it difficult to apply what they had learnt to unfamiliar situations e.g. Q6.

Teachers and candidates are encouraged to study carefully the requirements we expect from terms such as 'Determine', 'Show that', 'Hence', 'In this question you must show detailed reasoning' etc. These are fully explained in the Specification Document.

The Appendix to the mark scheme gives full details of how the solution methods for quadratic equations were assessed.

We were pleased that the instruction to use g = 9.8 was widely followed.

There was no evidence that time constraints had led to a candidate underperforming.

Section A

Question 1(i)

1 In triangle ABC, $AB = 20$ cm and angle $B = 45°$.

(i) Given that $AC = 16$ cm, find the two possible values for angle C, correct to 1 decimal place. **[4]**

The need to use the sine rule was well recognised, with the required acute angle often appearing. The possibility of a related obtuse angle was seen less often. Many just left one answer. Some thought the third angle in the triangle was what was expected. For full credit the two angles were needed correct to 1 decimal place as requested in the question.

Question 1(ii)

(ii) Given instead that the area of the triangle is $75\sqrt{2}$ cm^2, find BC. **[2]**

Those who understood ½*ab*sin*C* was needed were quite successful. Some did not realise the significance if the word 'instead' and used ½x16x(*BC*)sin62.1º . The manipulation to find *BC* was usually accurate. A small minority attempted to use ½*bh*.

Question 2(i)

2 **(i)** The curve $y = \frac{2}{3+x}$ is translated by four units in the positive x-direction. State the equation of the curve after it has been translated. **[2]**

This was well done. 2/(3 + *x* +4) was seen, and the less satisfactory 2/(3 + *x*) + 4 also. We wanted the answer to be tidied up and '*y* =' was expected.

Question 2(ii)

(ii) Describe fully the single transformation that transforms the curve $y = \frac{2}{3+x}$ to $y = \frac{5}{3+x}$. **[2]**

Many candidates realised this was a stretch, but did not necessarily describe it well. We wanted to see scale **factor** 5/2 and an accurate description of the direction. *y*- stretch was not considered acceptable. A small minority misunderstood the concept and gave a translation of 3 units as their response.

Question 3(i)

3 In each of the following cases choose one of the statements

$$P \Rightarrow Q \qquad P \Leftarrow Q \qquad P \Leftrightarrow Q$$

to describe the relationship between P and Q.

(i) P: $y = 3x^5 - 4x^2 + 12x$

Q: $\frac{dy}{dx} = 15x^4 - 8x + 12$ **[1]**

The most common error was to give $P \Leftrightarrow Q$. $P \rightarrow Q$ was condoned.

Question 3(ii)

(ii) P: $x^5 - 32 = 0$ where x is real

Q: $x = 2$ **[1]**

The most common error was $P \Rightarrow Q$. $P \leftrightarrow Q$ was condoned.

Question 3(iii)

(iii) P: $\ln y < 0$

Q: $y < 1$ **[1]**

The most common error was $P \Leftrightarrow Q$. $P \Leftarrow Q$ was also seen, perhaps because candidates thought each statement would be used once in this question. Note this was not the case and is not inevitable. $P \rightarrow Q$ was condoned. This part was found to be the most difficult.

Question 4(i)

4 (i) Express $4x^2 - 12x + 11$ in the form $a(x+b)^2 + c$. **[3]**

This was done very well. Candidates seemed to be very familiar with completing the square. The most common simple numerical error was to have c = 8.75. $(2x - 3)^2 + 2$ was seen occasionally.

Question 4(ii)

(ii) State the number of real roots of the equation $4x^2 - 12x + 11 = 0$. **[1]**

Many candidates did this by evaluating the discriminant rather than using the result they had just obtained. 'State' indicates neither working nor justification is required (cf Specification Document).

Question 4(iii)

(iii) Explain fully how the value of r is related to the number of real roots of the equation $p(x+q)^2 + r = 0$ where p, q and r are real constants and $p > 0$. **[2]**

This part proved less successful. Many candidates were not able to start an argument. Some attempted to evaluate $b^2 - 4ac$ but this was rarely done accurately. Those who recognised how to use the given form of the equation made the most progress, occasionally confusing the $r > 0$ and $r < 0$ cases.

Question 5

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

The line $x + 5y = k$ is a tangent to the curve $x^2 - 4y = 10$. Find the value of the constant k. **[5]**

The instruction requesting detailed reasoning did not prove to be an issue in this question. The two methods outlined in the mark scheme were both seen fairly often, with perhaps the 'substitution' route more popular. This required accurate algebraic work for complete success, but sign errors in the working were quite common and some petered out at the '$b^2 - 4ac$' stage. In the 'gradient' approach, candidates who worked from $y = x^2/4 - 10$ or $y = -x/5 + k$ to the correct value were not given full credit.

Question 6(i)

6 A pan of water is heated until it reaches 100 °C. Once the water reaches 100 °C, the heat is switched off and the temperature T °C of the water decreases. The temperature of the water is modelled by the equation

$$T = 25 + ae^{-kt},$$

where t denotes the time, in minutes, after the heat is switched off and a and k are positive constants.

(i) Write down the value of a. **[1]**

The correct value of a was frequent, but so too was $a = 100$.

Question 6(ii)

(ii) Explain what the value of 25 represents in the equation $T = 25 + ae^{-kt}$. **[1]**

All the options on the mark scheme appeared. Some candidates did not realise that an explanation in the context of the model was needed and tried to give a geometrical interpretation.

Question 6(iii)

When the heat is switched off, the initial rate of decrease of the temperature of the water is 15 °C per minute.

(iii) Calculate the value of k. **[3]**

This was not well understood, with very few candidates using the fact that the gradient of e^{kx}.is equal to ke^{kx}. It was very common to see attempts to solve $85 = 25 + ae^{-kt}$, with the value of a from (i) and $t = 1$.

Question 6(iv)

(iv) Find the time taken for the temperature of the water to drop from 100 °C to 45 °C. **[3]**

Inevitably those who did not obtain a value of *a* and/or *k* were unable to make progress in this part. Those who had incorrect values seemed to understand the method. A few set $T = 55$. Because of the difficulties encountered in (iii) very few correct answers were seen. Note that here units were expected to be mentioned (cf AO3.2a) and candidates need to be aware that these are important, particularly in modelling questions.

Question 6(v)

(v) A second pan of water is heated, but the heat is turned off when the water is at a temperature of less than 100 °C. Suggest how the equation for the temperature as the water cools would be modified by this. **[1]**

A fair number of candidates made no response to this part, but where suggestions were seen the idea was understood.

Question 7(i)

7 (i) Show that the equation

$$2\sin x\tan x = \cos x + 5$$

can be expressed in the form

$$3\cos^2 x + 5\cos x - 2 = 0.$$ **[3]**

This question was done well by many. Because the answer aimed for was given, examiners paid close attention to the written detail and expected fully accurate working for the answer mark. Removing the denominator sometimes led to error, with $\cos^2 x + 5$ appearing on the RHS, and less regularly 2sin*x*cos*x*sin*x* on the LHS.

Question 7(ii)

(ii) Hence solve the equation

$$2\sin 2\theta\tan 2\theta = \cos 2\theta + 5,$$

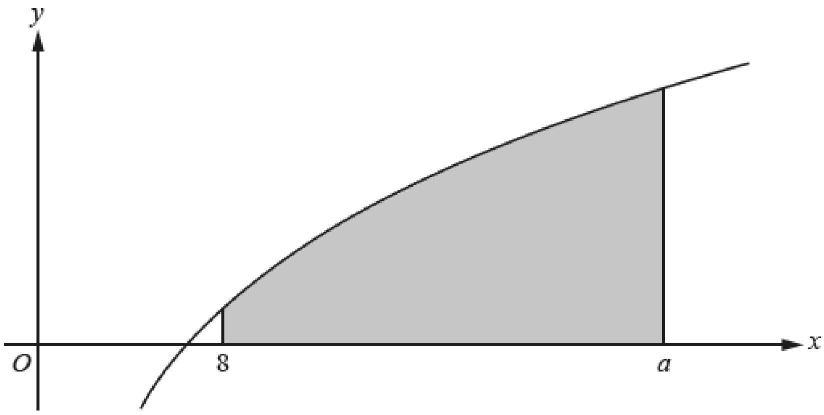
giving all values of θ between 0° and 180°, correct to 1 decimal place. **[5]**

This part starts with the word 'Hence' and what we expect from this is clear in the Specification Document. Most did start by solving a quadratic, not always producing two angles in the end. To gain full credit the two angles had to be given correct to 1 decimal place as requested. 144.8° was not uncommon. Some did not grasp the significance of 2θ and left the answer as 70.5°.

Question 8

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

The diagram shows part of the graph of $y = 2x^{\frac{1}{3}} - \frac{7}{x^{\frac{1}{3}}}$. The shaded region is enclosed by the curve, the x-axis and the lines $x = 8$ and $x = a$, where $a > 8$.



Given that the area of the shaded region is 45 square units, find the value of a. **[9]**

There were some encouraging attempts at this question, with the integration done accurately. Sign errors sometimes lead to the wrong quadratic, but many realised there was a 'hidden' quadratic. This question asked for detailed reasoning so we expected to see some working to show how the quadratic solutions were obtained, either factors or some working with the formula or completing the square. A few candidates found $F(8) - F(a)$ when integrating from 8 to a and some integrated from a to 8 from the start. Those who obtained $a = 27$ from their calculator with no justification/detailed reasoning scored zero, although if they checked by showing the integral from 8 to 27 was equal to 45, then the first three marks were possible. There was a significant minority of candidates that attempted to differentiate rather than integrate to find the area under the curve.

Section B

Question 9

9 In this question the horizontal unit vectors **i** and **j** are in the directions east and north respectively.

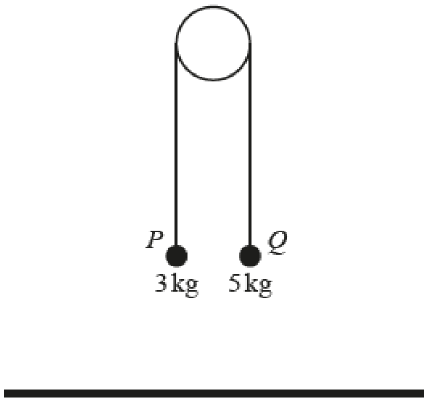
A model ship of mass 2 kg is moving so that its acceleration vector $\mathbf{a}$ m s^{-2} at time t seconds is given by $\mathbf{a} = 3(2t - 5)\mathbf{i} + 4\mathbf{j}$. When $t = T$, the magnitude of the horizontal force acting on the ship is 10 N.

Find the possible values of T. **[4]**

This question proved to be challenging for the majority of candidates. The need to find the magnitude of the acceleration was not well understood. For those who did use it, algebraic and numerical errors sometimes marred the solution. (±)10 = 2(3(2t – 5)**i** + 4**j**) was common, even when the correct methods then followed, but in many cases equations like 10 = 12t – 30 were used. A number of candidates ignored the mass and **F** = **a** pursued.

Question 10(i)

10 Particles P and Q, of masses 3 kg and 5 kg respectively, are attached to the ends of a light inextensible string. The string passes over a smooth fixed pulley. The system is held at rest with the string taut. The hanging parts of the string are vertical and P and Q are above a horizontal plane (see diagram).



(i) Find the tension in the string immediately after the particles are released. **[4]**

Whilst this standard situation was generally well understood, it was not uncommon to see attempts which assumed the acceleration after release was g or 0. Those who produced initial appropriate equations generally produced fully accurate solutions, although sign errors were sometimes seen.

Question 10(ii)

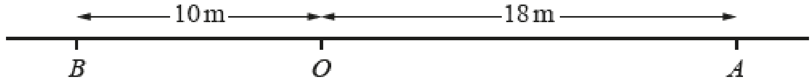
After descending 2.5 m, Q strikes the plane and is immediately brought to rest. It is given that P does not reach the pulley in the subsequent motion.

(ii) Find the distance travelled by P between the instant when Q strikes the plane and the instant when the string becomes taut again. **[4]**

We expected to see an acceleration other than g or 0 used for the descent of *Q*. Some candidates used $v = 0$ for this phase rather than $u = 0$, presumably because '*Q* strikes the plane and is immediately brought to rest'. Those who now looked at the next phase of the motion sometimes did not realise that it was motion under gravity. Some good attempts omitted to double 0.625.

Question 11(i)(a)

11



A particle P is moving along a straight line with constant acceleration. Initially the particle is at O. After 9 s, P is at a point A, where $OA = 18$ m (see diagram) and the velocity of P at A is $8\,\text{m s}^{-1}$ in the direction $\overrightarrow{OA}$.

(i) **(a)** Show that the initial speed of P is $4\,\text{m s}^{-1}$. **[2]**

To gain full credit in this part examiners expected to see $u = -4$ in the working as well as 4 appearing. Whilst $s = \frac{1}{2}(u + v)t$ was widely used, sign fudging was seen. Explanations clearly distinguishing between velocity and speed were unusual.

Question 11(i)(b)

(b) Find the acceleration of P. **[2]**

Once again the necessary methods were widely used, with $v = u + at$ the equation used most. This was often done with $u = 4$, candidates not realising the importance of the minus sign. Those who used the equation $s = vt - \frac{1}{2}at^2$ avoided this consideration here.

Question 11(ii)

B is a point on the line such that $OB = 10$ m, as shown in the diagram.

(ii) Show that P is never at point B. **[4]**

This part proved to be a challenge and, although there are various ways of solving the problem, candidates did not always make their intentions easy to follow. Were they considering the motion from *O* or B? Some even appeared to be considering A. Those trying $s = ut + \frac{1}{2}at^2$ once again had sign difficulties, with $u = 4$ and/or $s = 10$ used quite widely.

Question 11(iii)

A second particle Q moves along the same straight line, but has variable acceleration. Initially Q is at O, and the displacement of Q from O at time t seconds is given by

$$x = at^3 + bt^2 + ct,$$

where a, b and c are constants.

It is given that

- the velocity and acceleration of Q at the point O are the same as those of P at O,
- Q reaches the point A when $t = 6$.

(iii) Find the velocity of Q at A. **[5]**

Few fully correct solutions were seen to this part. Many just earned one mark for differentiating the given displacement equation, seemingly not understanding that $t = 0$ needed to be used in the work to find b and c (not $t = 6$) and then $t = 6$ needed to obtain a. A number of candidates attempted to solve this part using the constant acceleration formulae.

Supporting you

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.

activeresults

Active Results offers a unique perspective on results data and greater opportunities to understand students' performance.

It allows you to:

- Review reports on the **performance of individual candidates**, cohorts of students and whole centres
- **Analyse results** at question and/or topic level
- **Compare your centre** with OCR national averages or similar OCR centres.
- Identify areas of the curriculum where students excel or struggle and help **pinpoint strengths and weaknesses** of students and teaching departments.

http://www.ocr.org.uk/administration/support-and-tools/active-results/

CPD Hub
Your route to OCR's teacher 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.

https://www.cpdhub.ocr.org.uk

The small print

We'd like to know your view on the resources we produce. By clicking on the 'Like' or 'Dislike' button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

Whether you already offer OCR qualifications, are new to OCR, or are considering switching from your current provider/awarding organisation, you can request more information by completing the Expression of Interest form which can be found here: www.ocr.org.uk/expression-of-interest

Looking for a resource?

There is now a quick and easy search tool to help find **free** resources for your qualification:

www.ocr.org.uk/i-want-to/find-resources/

www.ocr.org.uk

OCR Customer Contact Centre

General qualifications

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