OCR
Oxford Cambridge and RSA

A LEVEL

Examiners' report

MATHEMATICS A

H240

For first teach in 2017

H240/03 Autumn 2020 series

Version 1

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

i	Reports for the Autumn 2020 series will provide a broad commentary about candidate performance, with the aim for them to be useful future teaching tools. As an exception for this series they will not contain any questions from the question paper nor examples of candidate answers.

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.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 3 series overview

H240/03 is the third and final examination component for Mathematics A H240. It is a two hour paper consisting of 100 marks and covers content from the Pure and Mechanics sections of the specification.

Although this examination series was not sat by a standard cohort of candidates, the range of marks were well distributed from single figures up to the nineties.

Section A is on Pure Mathematics and Section B is on Mechanics, with a distinct gradient of difficulty in each section. There was no evidence that this cohort experienced any time issues, although the final question was the least successfully answered on the paper. The final two questions in each section were only successfully completed by the most able candidates.

Although these types of reports traditionally focus on mistakes seen in questions, it should be noted that there were many excellent responses to questions that are traditionally seen as challenging topics.

Candidates who did well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• Used formal mathematical notation and language. • Made efficient use of calculator. • Understood the level of response required for the command words used in the questions. • Read questions carefully and provided the answers that were requested.	• Made careless mistakes in algebraic manipulation. • Used imprecise notation or language. • Did not give sufficient evidence on 'Show that' and 'Determine' questions. • Provided mathematical working that was correct but did not answer the specific question that was asked.

Section A overview

Content from the Pure section of the specification may be assessed on any of the three papers of H240.

The majority of candidates appeared well prepared for the pure content, with method marks being given, but there were a number of places where a more concise use of algebraic notation and language may have led to more of the corresponding accuracy marks being available.

Question 6 included the '**In this question you must show detailed reasoning**' statement, and there were a number of 'Show that' and 'Determine' requests where there were marks given for the quality of the mathematical argument.

Themes in candidate responses in Section A

Question 1

This proved to be a nice introduction to the paper, with the majority of candidates scoring full marks.

However, it is worth noting here that method marks are for an attempt to use a correct formulae. Those candidates that stated the area formulae $\frac{1}{2}ab\sin C$ and then quoted the answer obtained from their calculator scored either the full 2 marks for the correct answer or zero if their stated answer did not round to 15.1 3 sf.

A few candidates attempted to find the height of the triangle first, to use $\frac{1}{2}bh$, with mixed success.

	AfL	For student guidance on calculator use in the examination see the specification, and also a revision poster, available on the qualification web pages.

Question 2

Although the majority of candidates demonstrated a clear understanding of the process of transformation there were very few who scored full marks, with most scoring 2 out of the 3 marks available. Some lost a mark for imprecise language, while others had the order of the transformations in the wrong order.

	AfL	Transformations at A Level require a more formal use of language to describe how to go from the object function to the image function. Translations are best expressed as a single column vector. Informal terms such as 'shift', 'move' or 'along' will not earn accuracy marks. Stretches should be defined by the direction in relation to the axis with the scale factor stated.

Question 3

There were some excellent responses to this question, although some candidates dropped marks for errors in the notation used.

Those candidates that used completing the square in part (a) were generally more successful than those that used calculus. A significant number did not gain the final accuracy mark due to incorrectly stating $x \geq -\frac{9}{2}$ rather than correctly stating the range of the function $\mathrm{f}(x) \geq -\frac{9}{2}$.

Some candidates appeared to misunderstand the concept of range, finding the roots by factorising to $2x(x+3)$ to then incorrectly conclude that $x \geq 3$

	Misconception	A common misconception in functions is with domain and range. For a function $\mathrm{f}(x)$, emphasis needs to be placed on the fact that domain refers to the inputs, the x values, and the range refers to the outputs and must be stated in terms of f or $\mathrm{f}(x)$ (with the use of y condoned but strictly should only be used if defined in the question or by the candidate as $y = \mathrm{f}(x)$).

In part (b) there were unfortunately a number of vague answers provided starting 'It is …'. Examiners cannot be expected to know what the 'it' is that the candidate is talking about; answers need to be explicit, either in words or as part of an annotated diagram.

Most candidates started part (c) successfully and found the expression for $\mathrm{g}^{-1}(a)$. Some candidates introduced errors, or just wasted some exam time, producing an initial algebraic form for the composite function $\mathrm{fg}(x)$ rather than substituting their numerical answer to $\mathrm{g}(-2)$ into $\mathrm{f}(x)$.

Part (d) included the request to give their final answer in set notation. The 'Determine' request meant that the method mark was for clear and accurate algebraic manipulation into the standard three term quadratic. There is an assumption that candidates would solve quadratic equations by inspection or by using the solve function on their calculator, the command word just signals that the mathematical argument must be evident. The majority of candidates scored these initial 2 marks, but a significant number struggled with giving their result in correct set notation format.

	AfL	Set notation is a new requirement of the 2017 reformed A Level Mathematics criteria. Not all inequality questions will explicitly require final answers to be given in this form but students should be prepared for at least one question in each exam series that will include this request.

Question 4

In part (a) it was seen that a significant number of candidates only showed that the curve had a turning point at $x=1$ using $\frac{\mathrm{d}y}{\mathrm{d}x}=0$ rather than that the curve had a point of inflection at $x=1$ using $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=0$.

Some candidates substituted the values of $x=1$ and $k=6$ to 'verify' that $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=0$ and did not provide sufficient evidence to 'show that $k=6$ '. Where questions ask for candidates to solve a problem to 'show that' a given answer is correct then it is good practice that the working leads to that answer and does not make use of the answer as part of the working.

	AfL	It should be noted that $k=0$ would also give the point of inflection. There was no penalty for not justifying the rejection of this solution on this paper, but for future reference students should be encouraged to always justify any discarded values or expressions (in this case $k \neq 0$ since k is given as a positive constant).

In part (b) the examiners were looking for actual numerical values with an explanation that the change of sign indicates that the *x*-intercept is between those values. Some candidates simply provided a generic explanation of what a change in sign would represent, but no numerical confirmation in the context of this question, which was not sufficient for the request 'Show by calculation …'.

Part (c) was generally done well, although some candidates dropped marks when imprecise notation resulted in subsequent substitution errors. In order to demonstrate that the Newton – Raphson method has indeed been used, it is good practice to write out the iteration formulae, taking care with the x_n and x_{n+1} notation. Candidates that gave their results to the iterations to an accuracy greater than the specified 6 dp were not penalised, but the final accuracy mark required the answer to be quoted to the specified 5 dp.

Part (d) was generally answered well by those that had successfully completed part (c). Most verified their 5 dp answer by checking for the sign change ± 0.000005, although a few investigated smaller interval bounds. Those candidates that did not gain credit either investigated ± 0.00001 or did not explain how their calculations verified the result.

Question 5

Unless explicitly requested, candidates should avoid converting parametric equations into the cartesian form due to the complexity.

	AfL	Complex functions are often defined parametrically because the parametric form is less complex.

In part (a) candidates only needed to determine where $\frac{\mathrm{d}y}{\mathrm{d}t}=0$. Unfortunately, some candidates made errors in the denominator when finding $\frac{\mathrm{d}y}{\mathrm{d}x}$, and while this may not impact the numerical answer obtained, there is a standard principle that answers obtained with wrong working will not gain full credit. The other issue with this question was that the 'exact coordinates of *P*' was needed, those candidates that provided a decimal approximation would not gain full credit (unless the exact value had been seen as part of the working).

The first issue with part (b) was that the limits were given on the diagram as $x=1$ and $x=6$, but the integration was to be done with respect to t; a number of candidates did not spot this. This was a 'Show that' question so the initial method mark was to find $\frac{\mathrm{d}x}{\mathrm{d}t}$ and to show a clear attempt to use this in $\int y\frac{\mathrm{d}x}{\mathrm{d}t}\mathrm{d}t$. The final accuracy mark was to rearrange into the given form.

	Misconception	It was common to see candidates drop the negative sign without switching limits. Some had no explanation, whereas some stated that Area > 0 as their justification. In fact, candidates should recognise that $\int_a^b \mathrm{f}(x)\mathrm{d}x=-\int_b^a \mathrm{f}(x)\mathrm{d}x$ and this is significant in this situation where $\int_3^{0.5}\left(t^3\mathrm{e}^{-2t}\right)\left(-3t^{-2}\right)\mathrm{d}t=\int_{0.5}^{3}\left(t^3\mathrm{e}^{-2t}\right)\left(3t^{-2}\right)\mathrm{d}t$

Part (c) involved using the formula given in part (b) to 'Hence' determine the area. Generally, this was done well, with candidates correctly giving their answer in 'exact' form in terms of e.

Question 6

This was the only '**In this question you must show detailed reasoning**' on this paper. Examiners will be very focused on the individual steps of the calculation on these questions, signified by the '**DR**' notation in the mark scheme.

Part (a) was generally well answered, candidates appeared to be well prepared for this type of question.

A common error was to start the mathematical argument with $\frac{\mathrm{d}y}{\mathrm{d}x}=$ followed by the correct set of differentiated terms with equals sign. Some candidates dropped marks due to careless algebra manipulation.

	AfL	Candidates often attempt to force their algebraic manipulation to result in the given answer, ignoring fundamental rules and changing signs without justification. Method marks may not be given if the working appears random rather than simply including a clear mistake.

In part (b), those candidates that recognised the correct gradients of the tangents at *P* and *Q* generally went on to use their values for the coordinates to find *PQ* and score many of the 5 method marks. However poor algebra manipulation cost accuracy marks.

?	**Misconception**	Candidates appeared comfortable with the horizontal gradient at *Q* being found from $\frac{dy}{dx}=0$ and so using the numerator $4x-4y-9=0$. However, a number of candidates used $\frac{dy}{dx}=1$ rather than $\frac{dy}{dx}=\infty$ for the vertical gradient at *P*. Candidates should recognise a vertical tangent line means that the denominator is zero and so in this question $4x-16y=0$.

A number of candidates solved the quadratic equation generated to find *Q*, but then chose the coordinates $\left(\frac{9}{2},\frac{9}{4}\right)$. Candidates should use all information given in the question, including any sketched curves. In this case, candidates were expected to recognise that the two results for $\frac{dy}{dx}=0$ were valid, but that the diagram indicated which horizontal tangent was to be used. Note that those candidates that used $\left(\frac{9}{2},\frac{9}{4}\right)$ to find their *PQ* with no wrong working would have scored 6 out 8. There was not an explicit mark given for discounting the unwanted quadratic solutions on this question, however it is good practice and may be penalised in other '**DR**' questions.

Section B overview

The Mechanics content is only assessed in section B of this final H240 paper. Mechanics has traditionally proved to be the more challenging strand in A Level Maths, and while this was a small, unusual cohort, it was pleasing to see a good proportion of the questions attempted in this section of the paper.

While this section will naturally focus on Mechanics topics, there is an expectation that candidates are still careful with their written presentation. Careful algebraic notation will be rewarded and better attempts to questions often include an appropriate diagram.

Candidates should read questions carefully and take special notice of explicit or implied (i.e. through inspection of the powers of *t* in expressions) descriptions of acceleration. Question 7 states constant acceleration so '*suvat*' can be used, whereas question 8 has an at^2 term in the equation for v so calculus must be used. Question 9 can be solved using '*suvat*', but the model involves two distinct periods of motion with different values of *a* in each period.

Numerical answers are generally expected to be given to 3 significant figures, unless an 'exact' value is explicitly requested (generally to be subsequently used within the question).

Themes in candidate responses in Section B

Question 7

This was perhaps the best answered question on the paper. Unfortunately, marks were dropped in both parts where candidates gave an answer for velocity when speed was requested or for distance when displacement was requested.

A significant number of candidates attempted this question using calculus; while valid, the responses were more likely to include arithmetic errors.

	AfL	Candidates should be aware of the risk of using answers from one part as the starting value for a subsequent part. In Question 7 (b) the answer could be found by $\mathbf{s} = \frac{1}{2}(\mathbf{u} + \mathbf{v})t$ using the value for $\mathbf{v}$ found as part of the working in part (a). However, there is a risk of carrying over an error; where an answer can be found that is independent of previous work then it is generally safer to take that approach. Questions will often explicitly flag the requirement to use the previous work by starting with 'Hence …' or will set up the initial part with 'Show that …' with the result given to minimise the risk of working with wrong values.

Question 8

This question was also completed well, although a significant number attempted to use the '*suvat*' equations.

Part (a) was answered correctly on almost 100% of the scripts.

Part (b) was also answered well. Unfortunately, some candidates ignored the negative sign needed for deceleration, which meant only 3 out of the 4 marks were available.

Part (c) was a 'Find' question, so an answer obtained directly from the calculator was expected, although some candidates did show a fully integrated expression first. Some candidates dropped marks when they used the incorrect limits and some attempted to use '*suvat*', even if they had used calculus in the earlier parts.

Question 9

In this question the angle θ was defined as $\cos\theta = \frac{4}{5}$. Candidates should resist the temptation to calculate the decimal approximation for θ and instead use their knowledge of Pythagoras Triples to state the exact values for $\sin\theta$ (and $\tan\theta$ if required). The exact values have been chosen to make the arithmetic easier. Similarly, some questions will use the values of θ that candidates are expected to know the exact values for, and these should be used rather than the decimal approximation.

	AfL	H240 specification reference 1.05f Understand and be able to use the sine, cosine and tangent functions, their graphs, symmetries and periodicities *Includes knowing and being able to use exact values of* $\sin\theta$ *and* $\cos\theta$ *for* $\theta = 0°, 30°, 45°, 60°, 90°, 180°$ *and multiples thereof and exact values of* $\tan\theta$ *for* $\theta = 0°, 30°, 45°, 60°, 180°$ *and multiples thereof.*

If the examiner wants the decimal approximations to be used, then the angle θ will simply be defined as a numerical value.

Most candidates showed sufficient working using for part (a).

There was evidence that most candidates understood how to obtain the given answer in part (b), but some responses did not fully justify their working. A few students used mass rather than weight and did not include g in their equations.

Part (c) was attempted by all candidates but one or more of the following mistakes were made:

- Assumed $a = 0$.
- Used $R = 2g$ rather than using components.
- Sine/Cosine confusion when stating the components of any force.
- Rounding errors with calculated values of θ rather than using $\cos\theta = \frac{4}{5}$ and $\sin\theta = \frac{3}{5}$.
- Incorrect directions used leading to sign errors.
- Under-specifying the final answer given to less than 3 sf.

Although a fairly standard question, part (d) is traditionally expected to be a challenge for most candidates. For this reason, it was pleasing to see the number of fully correct answers. Common mistakes included:

- Tension was still applied.
- Incorrect acceleration; either the same $a = 0.48$, or $a > 0$, or even $a = 9.8$.
- Distance = speed × time used rather than '*suvat*'.

Question 10

A significant number of candidates did not follow the instruction to take moments about point A in part (a). It was also common to see candidates use mass rather than weight or miss some of the terms. Mixing sine and cosine was also common.

In part (b) (i) it was mathematically easier to work with vertical and horizontal components of the force exerted on the rod at A rather than components parallel and perpendicular to the rod. Candidates that picked up marks on this question generally provided an annotated sketch with some degree of success.

Part (b) (ii) was generally answered well by those that attempted it from their work on part (b) (i). However, of those, a few did not score both marks due to not clearly indicating what their angle was measured from (below the horizontal or measured from the downward vertical).

Question 11

Some candidates struggled with the algebraic format of this question. Those that set out their '*suvat*' equations clearly distinguishing horizontal and vertical components were more success.

Of those candidates that made a good attempt at part (a), a few dropped marks by only calculating the horizontal distance travelled to get to the maximum height – a valid method but which was only $\frac{1}{2}OC$.

Some otherwise excellent attempts to part (b) had answers in terms of an introduced variable T (or similar); this could only be given full marks if T was explicitly defined as part of the solution.

	AfL	Algebra uses letters to represent numbers that may be unknown parameters or changing variables. Exam questions may define what a selection of letters represent but if a candidate wishes to introduce additional, then these should be defined in order to provide a full mathematical argument.

Part (c) and part (d) proved the most challenging, with only the most able candidates making any meaningful progress. Both parts required careful notation to avoid confusing terms. For example, in part (d) some candidates recognised $\tan\theta = \dfrac{\text{Vertical component of velocity}}{\text{Horizontal component of velocity}}$ but the working suggested they used values at *O* rather than *A*.

Guidance on using this paper as a mock

This paper has a good range of questions on Pure and Mechanics and while overall there was a nice gradient on demand, it should be noted that Question 2 proved more challenging for this cohort than was expected with respect to its position on the paper.

Section A Pure	***Section B Mechanics***
Mensuration in non-right angle triangles.	Constant acceleration problem using vectors.
Curve transformations.	Investigate linear motion of particle with variable acceleration.
Inverse and compound functions.	Particles connected by pulley system involving rough slope.
Investigating ln curves using calculus and numerical methods.	Moments problem involving rod held in equilibrium.
Investigating gradients and enclosed areas of curves defined parametrically.	Investigating flight of a projectile over level ground.
Investigating curves using implicit differentiation.	

Supporting you

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.

Supporting you through 2020-2021

Our priority is supporting you and your students this autumn and to support you as you prepare for summer 2021 exams. We'll update our website information regularly with resources, guidance and key information.

Take a look at our support for:

- Teachers
- Students
- Exams officers
- Assessment specialists

Keep up-to-date

We are sending a weekly roundup to tell you about important updates. You can also sign up for your subject specific updates. If you haven't already, sign up here.

OCR Professional Development

Attend one of our popular CPD courses to hear directly from a senior assessor or drop in to a Q&A session. All our courses for the academic year 2020-2021 are being delivered live via an online platform, so you can attend from any location.

Please find details for all our courses on the relevant subject page on our website or visit OCR professional development.

Signed up for Exambuilder?

ExamBuilder is the question builder platform for a range of our GCSE, A Level, Cambridge Nationals, Cambridge Technicals and Functional Skills qualifications. See the full list of available qualifications in the sign up form.

ExamBuilder is **free for all OCR centres** with an Interchange account and gives you unlimited users per centre. We need an Interchange username to validate the identity of your centre's first user account for ExamBuilder.

If you do not have an Interchange account please contact your centre administrator (usually the Exams Officer) to request a username, or nominate an existing Interchange user in your department.

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our Customer Support Centre.

General qualifications
01223 553998
general.qualifications@ocr.org.uk

Vocational qualifications
02476 851509
vocational.qualifications@ocr.org.uk

For more information visit

- **ocr.org.uk/i-want-to/find-resources/**
- **ocr.org.uk**
- **/ocrexams**
- **/ocrexams**
- **/company/ocr**
- **/ocrexams**

We really value your feedback

Click to send us an autogenerated email about this resource. Add comments if you want to.
Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.

I like this **I dislike this**