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Examiners' report

AS LEVEL

MATHEMATICS A

OCR Level 3 Advanced Subsidiary GCE in Mathematics A

H230

For first teaching in 2017

H230/02 Summer 2025 series

Version 1

ocr.org.uk/maths

Contents

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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. A selection of candidate responses is also provided. 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 and the mark scheme can be downloaded from Teach Cambridge.

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Paper 2 series overview

H230/02 is one of the two examination components for AS Level Mathematics A. The examination is structured in two sections. Section A : Pure Mathematics (this paper consists of eight questions allocated 49 marks) and Section B : Mechanics (this paper consists of three questions allocated 26 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.

This year there were quite a few questions giving specific instructions to candidates about how to write their answer. In Question 1 the form '$ax + by + c = 0$,where a, b and c are integers' was requested. In Question 2 the form '$(a + b\sqrt{3})$cm, where a, b and c are integers to be determined' was requested. In Question 5 candidates were asked to 'Give your answer in interval notation' and in Question 11 (a) 'Determine, in terms of g, the tension…' was specified. It should be noted that if these instructions were not followed, full marks were not likely to be awarded.

Similarly, when an exact answer was requested this was required to obtain full credit.

The 'command words' are fully explained in the Specification Document, Their implications need to be continually reinforced and the individual question comments will highlight this. This year '**Show that**' was used in several questions. The Specification reads : 'Candidates are given a result and have to show that it is true. Because they are given the result, the explanation has to be sufficiently detailed to cover every step of their working.' Here for full marks examiners expected fully accurate working, since the answer has been given to candidates, and sufficient explanation for it. Individual question comments will provide more detail, but in some of the questions, candidates did not always give sufficient explanation.

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

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Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• demonstrated a comprehensive understanding of the Specification by making good attempts at all the questions. Illustrative of this would be good attempts at Questions 6 (b), 8, 10 (b) and 11 • gave answers in the required form • put together responses which were tidy and showed sufficient explanation • understood the implication of the command words • showed competence with algebra • handled the extended Questions, e.g. 11 well.	• showed a more limited understanding of the Specification, struggling with some questions. Weaker attempts at Questions 6 (b), 8, 10 (b) and 11 • did not give responses in the required form and/or did not provide exact responses when requested • had responses which were untidy, perhaps with insufficient working • seemed less sure of the implication of the command words, perhaps using the calculator when algebraic working needed to be shown • were less secure algebraically - prone to sign errors and ineffective simplification • struggled with extended questions.

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Section A overview

This is a 1 hour 30 minute paper and Section A compromises 49 out of 75 marks, so candidates are urged to consider this when deciding how long to spend on this Section.

The instruction '**In this question you must show detailed reasoning**' (**DR**) appears three times in this Section and the relevant commentaries below discuss in detail what working examiners expected to see.

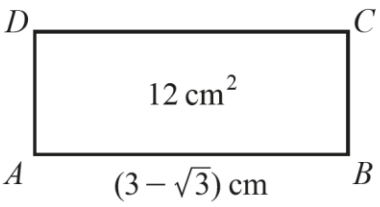
Question 1

1 Determine the equation of the line that passes through the point $(1, 3)$ and is perpendicular to the line with equation $3x+6y-5=0$. Give your answer in the form $ax+by+c=0$ where a, b and c are integers to be determined. **[3]**

This question was done well, with many candidates knowing how to find the required gradient and its perpendicular. Both $y - y_1 = m(x - x_1)$ and $y = mx + c$ were used accurately to find the line. The most common error in good attempts was to leave the final answer as $y = 2x + 1$. A candidates scored less well as they took the initial gradient to be 3 or -3.

Question 2

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



The diagram shows the rectangle $ABCD$ where $AB = (3-\sqrt{3})$ cm.

The area of $ABCD$ is 12 cm^2.

Find the perimeter of $ABCD$. Give your answer in the form $(a+b\sqrt{3})$ cm, where a and b are integers to be determined. **[4]**

This was the first of the three **DR** questions, so candidates need to be aware that sufficient working and explanation of methods is required. This means they need to consider calculator use carefully – calculators can be used to check or support working but candidates should consider writing down calculations for each step. Exemplar 1 and its commentary illustrate a common deficiency.

The methods needed here were well understood, with many solutions obtaining $18 + 2\sqrt{3}$. A few candidates had responses that went no further than the value for BC , seemingly forgetting to find the perimeter. Use of 12^2 for the area was seen.

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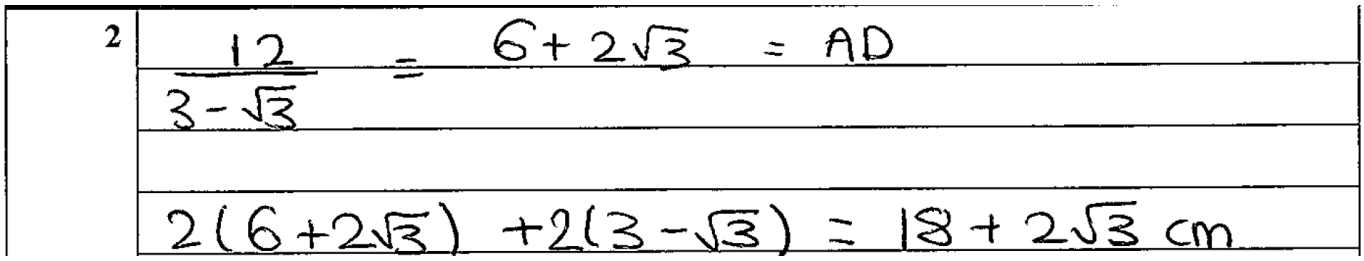
Exemplar 1



This solution, seen quite frequently, scored B1 M0 M1 A0 only. **DR** requires, to quote the Specification, a solution which leads to a conclusion showing a detailed analytical method.' Here we wanted to see the working for the rationalisation of the denominator, refer the mark scheme for details, and it is not given here. $6 + 2\sqrt{3}$ comes from the calculator. Hence M0 and A0.

Question 3 (a)

3 In a triangle ABC, $AB = 9\,\text{cm}$, $BC = 7\,\text{cm}$ and $AC = 4\,\text{cm}$.

(a) Show that $\cos CAB = \frac{2}{3}$. **[2]**

The cosine rule was used correctly by many. Note that since this was a 'Show that…' the question required at least one step of simplification from applying the formula to the given response. Quite a few candidates did not provide this. A few efforts assumed the triangle was right – angled and argued that 4/9 = 2/3.

Question 3 (b)

(b) Hence find the exact value of $\sin CAB$. **[2]**

This part was found to be more challenging. Those who knew how to obtain an exact answer were generally successful. An answer of only $\sqrt{5}/3$ scored A0. Many used their calculator to obtain a decimal value, gaining no credit.

Question 3 (c)

(c) Find the exact area of triangle ABC. **[2]**

The formula ½*ab*sin*C* was well known and usually applied correctly, often with *C* = 48.2° rather than with exact working. A few evaluated ½(4)(9)($\frac{2}{3}$).

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Question 4 (a)

4 The cubic polynomial $2x^3 - kx^2 + 4x + k$, where k is a constant, is denoted by $f(x)$.
It is given that $f'(2) = 16$.

(a) Show that $k = 3$. **[4]**

This question was very well done with many fully correct solutions seen. Once again it was a 'Show that….' question but it was rare not to see sufficient working. A common error in less successful responses was to use f(2) =16.

Question 4 (b)

For the remainder of the question, you should use this value of k.

(b) Use the factor theorem to show that $(2x + 1)$ is a factor of $f(x)$. **[2]**

The majority of candidates who knew what the factor theorem was calculated f(-½) to be zero, but we wanted a conclusion to be stated and some did not do this satisfactorily and just gained M1. Again the question said '….to show that…' so candidates should expect to give more than just f(½) = 0. Some used long division, ignoring the instruction to use the factor theorem.

Question 4 (c)

(c) Hence show that the equation $f(x) = 0$ has only **one** real root. **[4]**

Most did long division here (generally accurately) to obtain the factor $x^2 – 2x + 3$, with comparatively few factorising and the occasional comparing coefficients. The discriminant was well done, only a few writing $-2^2 - 4(1)(3) = - 4 – 12$. Once again a conclusion was required and those who referred to $(2x + 1)$ as the one real root were penalised. This part says 'Hence' so examiners needed to see some use of the factor $(2x + 1)$ in this part. A small number of candidates attempted this part with a graphical approach, just producing a sketch of the cubic from their calculator for example. This generally scored no marks. Also some tried to show that the cubic had no turning points and deduce one real root from this, but unless the factor $(2x + 1)$ was involved in the argument somehow, credit was not awarded.

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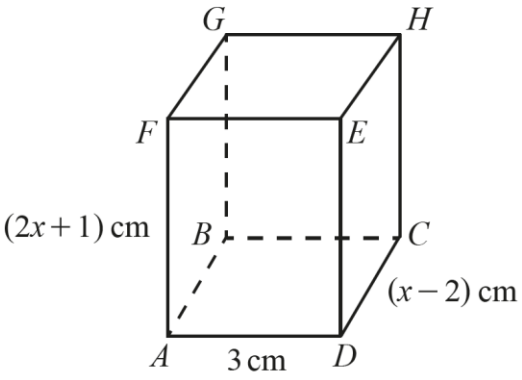
Question 5

5 In this question you must show detailed reasoning.



The diagram shows the cuboid $ABCDEFGH$ where $AD = 3\,\text{cm}$, $AF = (2x+1)\,\text{cm}$ and $DC = (x-2)\,\text{cm}$.

The volume of the cuboid is at most $9\,\text{cm}^3$.

Find the range of possible values of x. Give your answer in interval notation. **[5]**

Very few candidates scored full marks in this question since 'interval notation' did not seem to be well understood, with many candidates giving set notation in the final answer instead. Also many missed the significance of '2'. Many good attempts scored just the first 4 marks, usually with $-1 \leq x \leq 2.5$ getting the fourth mark. This was the second **DR** question on the paper. In this question candidates were expected provide the method used for solving the quadratic equation – as this is a skill required on the Specification, just doing it with the calculator scored B0. The **DR** instruction helps to indicate to candidates when this is required, and it is good practice to include working for all steps in a **DR** question. The other 4 marks were still available. Some candidates did not use the 9cm^3 at all, just giving the volume as a quadratic, simplifying this and then re-factorising and solving to produce - ½ and 2.

Question 6 (a)

6 (a) The curve $y = \ln x$ is stretched by a scale factor 3 in the x-direction.

State the equation of the curve after it has been stretched. **[2]**

The correct response appeared quite often and fewer candidates seemed to omit '$y =$' this series. Note that in this instance, credit was not given for only '$f(x) =$ ', as the question requested an equation of a curve. Some incorrect offerings : $3\ln x$, $\ln(x - 3)$, $\frac{1}{3}\ln x$, $\ln(-3x)$.

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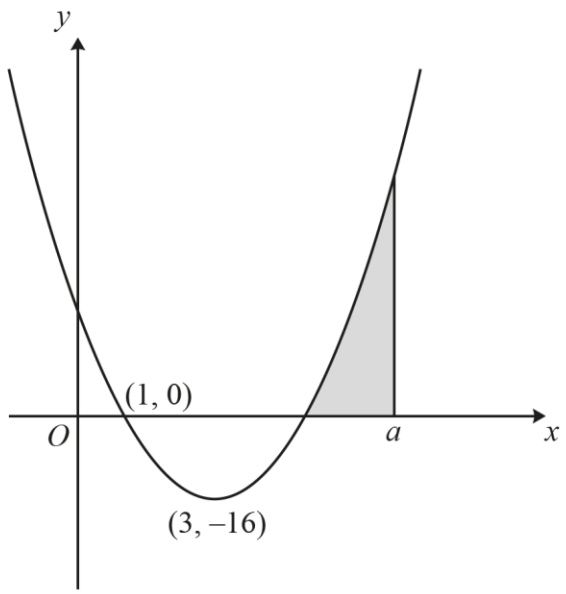
Question 6 (b)

(b) Describe fully the **single** transformation that transforms the curve $y = x^2 + 1$ to the curve $y = x^2 - 6x + 8$. **[4]**

Perhaps completing the square was the most common route, but considering how the minima transformed was also prevalent. Move, shift and transform rather than translate still appear as explanations of the transformation but it was pleasing to see a vector being used regularly to describe the translation. Some gave a *y* component of – 1 rather than – 2 and occasionally the transformation of $y = x^2 - 6x + 8$ to the curve $y = x^2 + 1$ was given. Candidates should be encouraged to show how they reach their conclusions in transformation questions as some responses did not have much supporting evidence. In these instances, if the final answer is incorrect, it can difficult for examiners to follow the working in order to give credit. Many of those who struggled with this question used $-6x + 7$ somehow to explain the transformation.

Question 7 (a)

7



The diagram shows the curve with equation $y = f(x)$ where $f(x)$ is a quadratic function. The curve intersects the x-axis at the point $(1, 0)$ and has its minimum at the point $(3, -16)$.

(a) Show that $f(x) = 4x^2 - 24x + 20$. **[3]**

There were many different approaches to this part, as highlighted on the MS, and all were seen. It was another 'Show that…' so again we expected sufficient evidence whichever route was taken.

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Question 7 (b)

The shaded region is enclosed by the curve, the x-axis, and the line $x = a$. The area of the shaded region is $\frac{100}{3}$ units^2.

(b) Determine the exact value of the constant a. **[6]**

There were a lot of complete attempts to this part, although some did not get full marks only because they did not provide an exact answer or a justification for their answer. Many gained the first 3 marks, and the limit work was usually well done too, but some had them the wrong way round and -100/3 rather than +100/3 was used on the left hand side. In this instance, credit was given even if *a* = 0 was not given. Unfortunately, a small number of candidates started by differentiating.

Question 8 (a)

8 The curves $e^x - 2e^y = 1$ and $2e^x + 3e^{2y} = 41$ intersect at the point P.

(a) Show that the y-coordinate of P satisfies the equation $3e^{2y} + 4e^y - 39 = 0$. **[1]**

This was a 'Show that' question so we expected fully accurate working.

Question 8 (b)

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

Hence find the exact coordinates of P. **[5]**

This was the third **DR** question. The given equation was widely recognised as a quadratic and well solved (see note below). The negative root was often rejected with a good reason provided. We expected exact answers to be seen for full marks. Those who did not use a quadratic tended to write things like $\ln(3e^{2y}) + \ln(4e^y) = \ln(39)$ and not make any further progress.

Assessment for learning

In **DR** questions assessors expect the method for solving a quadratic equation (or indeed simultaneous equations) to be shown, so candidates should avoid using their calculators to **just** provide a solution. Thus, in Question 5 and here in 8 (b) we expected to see factorisation (or equivalent).

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Section B overview

This is a 1 hour 30 minute paper and Section B compromises 26 out of 75 marks, so candidates are urged to consider this when deciding how long to spend on this Section. It is good exam technique to look over the paper at the start and they should have noted that Question 11 was allocated 13 marks, so if they work through the paper sequentially they should leave sufficient time to do justice to this, the last, question.

Question 9 (a)

9 An athlete runs with velocity $v\,\text{m s}^{-1}$ along a horizontal straight running track AB. At time t seconds after passing A, $v = 0.05t^2 - 0.4t + k$, where k is a constant.

(a) Find the acceleration of the athlete when $t = 6$. **[2]**

This was very well done with many candidates getting the correct acceleration.

Question 9 (b)

(b) Given that the minimum velocity of the athlete is $6.6\,\text{m s}^{-1}$, show that $k = 7.4$. **[3]**

Usually $t = 4$ was found from the acceleration, but some completed the square. If this stage was successful, full marks generally followed provided sufficient working was shown – this was needed as the question gave the answer. A few solved the quadratic with 6.6 and the given $k = 7.4$ to get $t = 4$, but unless the significance of $t = 4$ was discussed (and it normally was not) no marks were given. Substitution of $t = 6$ into v in an attempt to find k was seen. The alternative method was seen less frequently but when seen, was largely successful.

Question 9 (c)

The athlete runs in a straight line from A to B in 13.1 seconds.

(c) Calculate the distance AB. **[2]**

In this instance, candidates could answer this question part by calculator, but many instead showed integration. A fair proportion did not recognise variable acceleration, despite having (a) correct in the majority of cases, and worked with *suvat* equations or $d = vt$.

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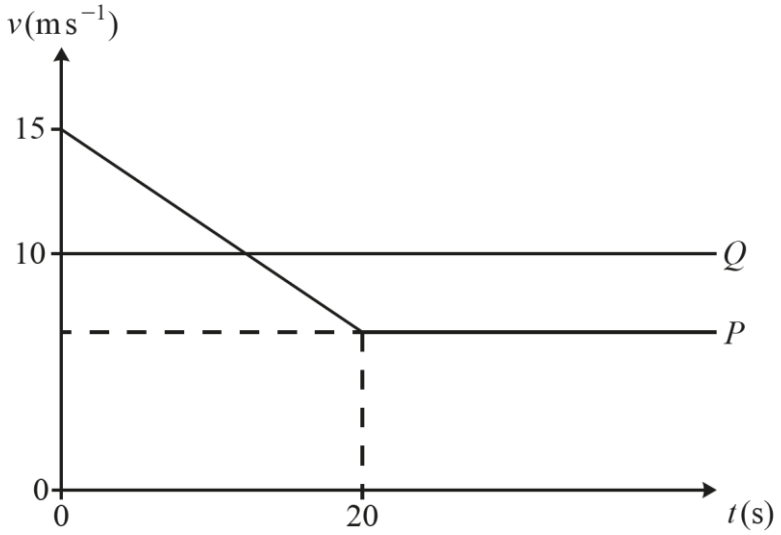
Question 10 (a)

10



The velocity-time graph represents the motion of two cyclists P and Q who are travelling along a straight, horizontal road. At time $t = 0$, the cyclists pass the same point on the road with P cycling at $15\,\text{m s}^{-1}$ and Q cycling at $10\,\text{m s}^{-1}$.

From time $t = 0$, P cycles with constant deceleration $0.4\,\text{m s}^{-2}$ for 20 seconds and Q cycles at a constant velocity of $10\,\text{m s}^{-1}$. From $t = 20$ onwards, P's velocity remains constant.

(a) Find the value of t when P and Q have the same velocity. **[2]**

This was also well done with many correct solutions.

Question 10 (b)

(b) Determine the value of t when Q overtakes P. **[4]**

The setting up of the equation required clear thinking and this proved to be more of a challenge to candidates. $10t = 220 + 7t$ was not uncommon. Many considered the time from 20s and added 20s to this at the end. Those who did not take the change in P's behaviour into account solved $10t = 15t - \frac{1}{2}(0.4)t^2$.

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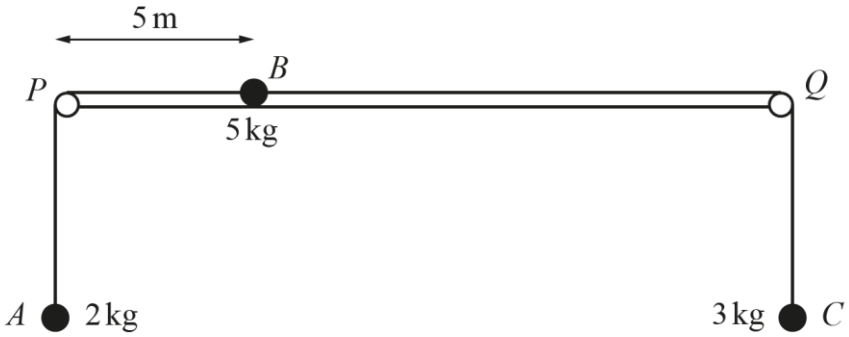
Question 11 (a)

11



One end of a light inextensible string is attached to a particle A of mass 2 kg. The other end of the string is attached to a second particle B of mass 5 kg. Particle B is in contact with a smooth horizontal surface. The string passes over a small smooth pulley P which is fixed at one edge of the surface. Particle A hangs vertically below P.

A second light inextensible string is attached to B. The other end of this second string is attached to a third particle C of mass 3 kg. This string passes over a small smooth pulley Q which is fixed at the other edge of the surface. Particle C hangs vertically below Q (see diagram).

The system is released from rest with the strings taut and B a distance 5 m from P. In the subsequent motion A does not reach P.

(a) Determine, in terms of g, the tension in the string connecting B and C. **[4]**

Those candidates who realised that the tension in *AB* was not the same as the tension in *BC* were generally very successful in this part, usually providing accurate working. Occasionally the answer was not given in terms of g as requested. Many assumed there was only one tension to find, which gained at most the first M mark.

Question 11 (b)

When the particles have been in motion for 3 seconds the string connecting A and B breaks. Particle B reaches Q after a further 2 seconds.

(b) Determine the distance PQ. **[6]**

This question proved difficult for many candidates. There were some good solutions to this part seen, but full marks depended on a correctly obtained acceleration in (a). A few ignored the 5m when giving their final answer. Many candidates did not apply Newton's Second Law to the situation after the string broke, using their previous acceleration, or g, or 0, so gaining at most the 2 B marks.

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Exemplar 2

11(b)

PQ = 5m + d

F_A: $T_1 - 2g = 2\left(\frac{g}{10}\right)$

$T_1 = 2g + 2\left(\frac{g}{10}\right)$

$T_1 = \frac{11}{5}g$

$\frac{11}{5}g - 2g = 2a$

0.98 = a

11

11(b) (continued)

starts 9.41m from P

① $s = 5 + s_2$

$u = 0$

$v = ?$

$a = 0.98m^2$

$t = 3$

$s_2 = ut + \frac{1}{2}at^2$

$= 0 + \frac{1}{2}(0.98)(3)^2$

$s_2 = 4.41$

$s = 5 + 4.41$

$= 9.41$

$v = u + at$

$= 2.94$

② $s = ?$ ~~9.41m~~

$u = 2.94$

$v =$

$a = 5.292$

$t = 2$

F_B: $\frac{27}{10}g = 5a$

$5.292 = a$

$s = ut + \frac{1}{2}at^2$

$= 16.464$

$s_{total} = 9.41 + 16.464 = 25.874m$

In this solution, which follows from a fully correct part (a), the acceleration g/10 is correctly found although this had already been done in (a) actually so there was no need to repeat the calculation. It is used correctly for the 2 B marks to be given. Then T = 5*a*, one of the correct equations needed, is used with the tension found in part (a) and the equation 3g – *T* = 3*a* never appears. So M0 and no further marks were awarded.

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Question 11 (c)

(c) State what it would mean about the tension in the string connecting B and C if pulley Q could **not** be assumed to be smooth. **[1]**

The mark scheme lays out that to earn this mark 'Any statement which suggests the tension is not constant…' was required and this was rare. Most responses just said either the tension had increased or it had decreased.

Question 11 (d)

It is given that in fact the horizontal surface is **not** smooth. When the system, as shown in the diagram, is released, it remains at rest. (You may assume that pulley Q **is** smooth.)

(d) Complete the diagram in the Printed Answer Booklet showing all the forces acting on B. **[1]**

Diagrams often had at least one force missing, some missed the friction, others both the weight and the normal reaction. The tensions needed to be labelled differently and frequently were not. A few had friction going both to the left and right.

Question 11 (e)

(e) State the magnitude of the frictional force acting on B. Give a brief justification for your answer. **[1]**

This question part was not well done by many candidates. The most common incorrect answer was 4.9N, coming from the difference in the tensions in (a) – the new situation did not seem to be grasped by most candidates.

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