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FOREWORD

This booklet contains reports written by Examiners on the work of candidates in certain papers. **Its contents are primarily for the information of the subject teachers concerned**.

UNIVERSITY *of* CAMBRIDGE
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MATHEMATICS

GCE Advanced Level and GCE Advanced Subsidiary Level

The thresholds (minimum marks) for Grades C and D are normally set by dividing the mark range between the B and the E thresholds into three. For example, if the difference between the B and the E threshold is 24 marks, the C threshold is set 8 marks below the B threshold and the D threshold is set another 8 marks down. If dividing the interval by three results in a fraction of a mark, then the threshold is normally rounded down.

Grade Thresholds are published for all GCE A/AS and IGCSE subjects where a corresponding mark scheme is available.

Boundaries for 8719 AS Level are lower than for the A Level syllabus.

> **Paper 9709/01**
> **Paper 1**

General comments

Most candidates found the paper to be well within their grasp and it was rare to see candidates struggling for time at the end of the paper. It was pleasing to see that the last question (**Question 10**) generally yielded high marks. The standard of numeracy, of algebra and of presentation were all pleasing, though there are still some Centres in which candidates split the page vertically into two halves, thereby making marking more difficult. Particular points of note occurred in **Questions 7**, **8** and **9** in which many candidates were unaware of the following points:

- the meaning of the term perpendicular bisector;

- the notation $f'(x)$;

- the connection between the gradient of a line and the angle made with the *x*-axis.

Comments on specific questions

Question 1

The majority of candidates replaced $\sin^2\theta$ by $1-\cos^2\theta$ to obtain a quadratic in $\cos\theta$. Unfortunately, incorrect algebra often resulted in $3\cos^2\theta - 2\cos\theta = 0$ instead of $3\cos^2\theta + 2\cos\theta = 0$. A large number of candidates cancelled the $\cos\theta$ or failed to realise that $\cos\theta = 0$ yielded the solution $\theta = 90^\circ$. The solution of $\cos\theta = -\dfrac{2}{3}$ often resulted in $\theta = 48.2^\circ$ instead of 131.8°.

Answers: 90º, 131.8º.

Question 2

The majority of candidates obtained full marks and used the formulae for arc length and sector area correctly. In part **(ii)**, a small minority assumed that 28.9 cm represented the difference between the perimeters of sectors *OBD* and *OAC*.

Answers: **(i)** 62.4 cm²; **(ii)** 0.65.

Question 3

There were many completely correct solutions, especially to part **(i)**. *BE* = 2√3*d*sin60° instead of 2√3*d*cos60° and *ED* = 2*d*cos30° instead of 2*d*sin30° were common errors in part **(i)**. The majority of candidates realised the need to use the tangent of angle *CAD* in triangle *ACD* and most used 'opposite ÷ adjacent'. Unfortunately a significant proportion failed to realise the need to use the exact ratios of sin60° etc. and reverted to decimals. These candidates must realise that such decimal answers, even if checked against (2 ÷ √3), are insufficient to give the final accuracy mark.

Answer: **(i)** 4*d*.

Question 4

Use of the scalar product in part **(i)** was nearly always correct – though occasionally candidates used $\overrightarrow{PO}.\overrightarrow{OQ}$ instead of $\overrightarrow{OP}.\overrightarrow{OQ}$ to calculate angle *POQ*. In part **(ii)**, most candidates evaluated $\overrightarrow{PQ}$ as **q** − **p**, though **q** + **p** was still a common error and the **k**-component was often given as '*q* + 1'. Use of $\left|\overrightarrow{PQ}\right| = \left|\mathbf{q}\right| - \left|\mathbf{p}\right|$ was also a frequent error. The most common error in part **(ii)** however resulted from the equation '$(q-1)^2 = 16$' being given as $q - 1 = 4$ instead of $q - 1 = \pm 4$.

Answer: **(ii)** q = 5 or −3.

Question 5

Part **(i)** was poorly answered with very few candidates realising the need to use similar triangles. A few candidates realised that since the perpendicular height of the cone was equal to the diameter of the base, then the height of the upper cone was equal to the base (2*r*) and that consequently $h = 12 - 2r$. It was pleasing that virtually all of the candidates who were unable to attempt part **(i)** proceeded to part **(ii)**. This part was well answered with the majority of candidates realising the need to differentiate and set the differential to zero. A significant number of candidates obtained r = 4 but failed to realise the need to evaluate *V*.

Answers: **(i)** $h = 12 - 2r$; **(ii)** 64π or 201 cm³.

Question 6

This was poorly answered with a large number of candidates failing to realise that plan *A* involved a geometric progression and plan *B* an arithmetic progression. A minority of attempts realised that '*r*' in parts **(i)** and **(ii)** was 1.05. A less serious error was to assume that 2008 was the 8th rather than the 9th year, though this error did not affect part **(ii)**. Method marks were usually obtained in part **(iii)**, though the final answer mark was often lost due to premature approximation of the answer to part **(ii)**.

Answers: **(i)** $369 000; **(ii)** $3 140 000; **(iii)** 14 300.

Question 7

There were many excellent solutions and, for many less able candidates, this was a source of high marks. Unfortunately some candidates were unsure of the term 'perpendicular bisector' for it was common in part **(i)** to see equations that were neither perpendicular to *AB*, nor passed through the mid-point of *AB*. In part **(ii)**, the majority of candidates correctly obtained the equation of the line *BC* and attempted to solve the simultaneous equations for *BC* and the line obtained in part **(i)**.

Answers: **(i)** $3x + 2y = 31$; **(ii)** (7, 5).

Question 8

The most worrying factor about this question was the number of candidates who were unfamiliar with the notation of f $'(x)$ and many solutions were seen in which f $'(x)$ and f $^{-1}(x)$ were interchanged. When recognised as the differential of f(x), f $'(x)$ was usually correctly obtained and it was pleasing to see the inclusion of '×2' (the differential of the bracket) in the chain rule. Occasionally however, candidates left '−8' in the answer to f $'(x)$. Although many candidates in part **(i)** realised that 'increasing function' implied 'gradient positive', the vast majority thought it sufficient to evaluate either f $'(x)$ or f(x) at the end-points $x = 2$ and $x = 4$; very rarely did candidates recognise that $(2x - 3)^2$ was always positive. Part **(ii)** was more successfully answered and the algebra involved in making x the subject was pleasing. Surprisingly only a few candidates realised that the domain of f^{-1} was the same as the range of f and that this could be obtained directly from the end-points of f since f was an increasing function.

Answers: **(i)** $6(2x - 3)^2$; **(ii)** $\dfrac{\sqrt[3]{(x+8)} + 3}{2}$, $-7 \leqslant x \leqslant 117$.

Question 9

Apart from the occasional algebraic slip, part **(i)** was very well answered and usually correct. In part **(ii)** a minority of candidates realised the need to look at '$b^2 - 4ac$' for the quadratic formed by eliminating either x or y from the equation of the line and the curve. Of these, a large proportion assumed that '$b^2 - 4ac$' was either zero or positive. Of those attempting to solve $k^2 - 96 < 0$, the majority obtained the solution '$k < \sqrt{96}$' but failed to realise that either there were two values of k or gave the solution as '$k < \sqrt{96}$ and $k < -\sqrt{96}$'. Part **(iii)** caused problems for nearly all candidates. It was very rare to see a solution in which candidates recognised the basic fact that the numerical value of the gradient of a line was equal to the tangent of the angle between the line and the x-axis. The question involved nothing more than finding the gradients of the line and the tangent and evaluating the difference between the corresponding angles.

Answers: **(i)** $(1\frac{1}{2}, 8)$, (4, 3); **(ii)** $-\sqrt{96} < k < \sqrt{96}$; **(iii)** 8.1°.

Question 10

In part **(i)**, the majority of candidates realised the need to integrate, and the standard of integration was generally good, though the integral of x^{-3} was often seen as $\frac{1}{4}x^{-4}$ rather than $\frac{1}{2}x^{-2}$. Considerably more candidates however failed to realise the need to include the constant of integration. Many weaker candidates failed to recognise the need to integrate and used '$y = mx + c$' with m equal to the value of $\dfrac{\mathrm{d}y}{\mathrm{d}x}$. Part **(ii)** proved to be more problematical with many candidates failing to recognise that if the gradient of the normal is $-\dfrac{1}{2}$, then the gradient of the tangent, and therefore $\dfrac{\mathrm{d}y}{\mathrm{d}x}$, is equal to 2. The solution of the equation $\dfrac{16}{x^3} = 2$, was pleasing, though occasionally x was given as $\frac{1}{2}$ rather than 2 and occasionally as ±2 rather than 2. Part **(iii)** was well answered though occasionally the formula for volume of rotation was used or 'π' was included in the formula for area. Most candidates realised the need to integrate the equation of the curve obtained in part **(i)** and the use of limits was very good.

Answers: **(i)** $y = -\dfrac{8}{x^2} + 12$; **(ii)** $2y + x = 22$; **(iii)** 8 unit².

> **Paper 9709/02**
> **Paper 2**

General comments

The first four questions were generally well attempted, but most responses to the final three questions were very disappointing. This was especially so in **Questions 6** and **7**. Two misreads were common in **Questions 5** and **7**. Candidates' grasp of the basic rules and results for differentiation and integration proved very poor. As the syllabus for the paper is based so strongly on these techniques, Centres are urged to concentrate more intensively on these topics.

Comments on specific questions

Question 1

Invariably candidates correctly took logarithms of each side of the given expression, but the majority then divided each side by ln0.8, a negative quantity, without the necessary resultant change in direction of the inequality sign. Others gave too few decimal places or too general a form $\dfrac{\ln 0.5}{\ln 0.8}$, and 3.12 was also quite common.

Answer: $x > 3.11$.

Question 2

(i) Many candidates performed long division instead of simply evaluating f(1), but few failed to score both marks. A tiny minority evaluated f(−1).

(ii) Few candidates scored full marks. Some omissions were understandable, e.g. failing to specify the quotient and the remainder, and making errors in long division calculations. More worryingly, a large proportion of candidates divided the cubic expression by a different quadratic, e.g. $x^2 + 3x + 5$ from part **(i)**, or by a linear expression. Among those attempting the correct division many obtained a quotient of the form $\{x + 1 + \text{term(s) in } x^{-1}\}$. Some assumed that there was no remainder.

Answers: **(i)** 8; **(ii)** quotient $x + 1$, remainder $2x + 4$.

Question 3

(i) A few attempts with $R = \sqrt{169}$ or ± 13 were seen, and some had $\tan\alpha = \dfrac{12}{5}$ or $\tan\alpha = -\dfrac{5}{12}$, followed by the correct value for α.

(ii) This was quite well done, though a few candidates missed the second solution or obtained one by taking the first solution from 360°. Several transferred $\cos(\theta + 22.62°)$ from part **(i)** into $\cos(\theta - 22.62°)$ in part **(ii)**. As is usual, a large number of candidates attempted part **(ii)** without reference to part **(i)**, by squaring each side and inventing various formulae to delete unwanted terms, for example. Centres should stress that there is only one consistently effective method to attempt part **(ii)**, using the information obtained in part **(i)**.

Answers: **(i)** $R = 13$, $\alpha = 22.62°$; **(ii)** 17.1°, 297.7°.

Question 4

(i) Many candidates never differentiated at any stage and wrote purely in terms of x and y. Most, however, scored very highly, bar the occasional '$2y^2 \dfrac{dy}{dx}$', and '$-9y + 9x \dfrac{dy}{dx}$' on the left-hand side, for example.

(ii) A surprising number of candidates failed to correctly calculate the result of part **(i)** when $x = 2$ and $y = 4$. However, solutions were usually very competent. A minority used as their gradient in part **(ii)** the general solution from part **(i)**, with no reference to the point (2, 4).

Answer: **(ii)** $5y = 4x + 12$.

Question 5

(i) Graphs were very poor and few gave more than the first quadrant portion of $y = \dfrac{1}{x}$. Some candidates drew a parabola for their graph. Many graphs of $y = \ln x$ had $y'' \geqslant 0$ as x increases. Some candidates correctly showed the first-quadrant intersection, but showed no further parts of either graph. This was an understandable omission that cost the second mark.

(ii) This was well done. Only a few failed to accurately calculate f(1) and f(2).

(iii) For most candidates, this seemed like stating the obvious, and no valid argument was produced.

(iv) A common misread was to begin with $x_{n+1} = \dfrac{1}{\exp(x_n)}$ and not $x_{n+1} = \exp\left(\dfrac{1}{x_n}\right)$. Among those avoiding this error, the Examiners were very pleased with candidates invariably working to four decimal places at intermediate stages. Many lost marks, however, by giving their final answer to three or four decimal places, or rounding to 1.77.

Answer: **(iv)** 1.76.

Question 6

(i) Few candidates could integrate e^{2x} correctly, and many omitted the constant c.

(ii) Beyond the first mark, almost no-one could proceed. Attempts at logarithms of $e^{2x} - 2e^{-x} = 0$ resulted in expressions such as $2\ln x - x \ln 2 = 0$, for example. Hardly anyone saw that $e^{3x} = 2$ and proceeded accordingly. There were many errors in handling $\dfrac{dy}{dx} = 0$ with $\log(a + b) \equiv \log a + \log b$ being the most often seen.

Answers: **(i)** $y = \dfrac{1}{2}e^{2x} + 2e^{-x} - \dfrac{3}{2}$; **(ii)** minimum when $x = 0.231$.

Question 7

(i) Surprisingly few candidates could correctly differentiate and $\dfrac{dy}{dx} = 2\sin x$ or $\dfrac{dy}{dx} = 2\cos x$ were not uncommon. Working back from the answer proved fruitless also. A small minority of solutions were correct.

(ii) Working in degrees was common, as was finding only the first solution or finding two correct solutions plus two incorrect ones.

(iii) A misread here was to assume that $\sin^2 x = \cos 2x$, hence area $= \int_0^{\pi} \cos 2x\,dx$, etc. A substantial number of candidates believed that 'in terms of' meant 'can be replaced by' or 'is equal to'. Thus only a small minority of solutions featured the correct integrand $\dfrac{1}{2}(1 - \cos 2x)$. Many of these were competently handled, barring the odd sign error for $\int \cos 2x\,dx$ or obtaining $2\sin 2x$ for $\dfrac{1}{2}\sin 2x$. Like **Question 6**, this proved a question beyond most candidates' capabilities.

Answers: **(ii)** $\dfrac{\pi}{12}$, $\dfrac{5\pi}{12}$; **(iii)** $\dfrac{\pi}{2}$.

> **Papers 8719/03 and 9709/03**
> **Paper 3**

General comments

The standard of work by candidates varied considerably. The paper seemed to be accessible to adequately prepared candidates and no question appeared to be of unreasonable difficulty. All the questions discriminated well and candidates seemed to have sufficient time to attempt all of them. The questions or parts of questions on which candidates generally scored highly were **Question 8** (differential equation), **Question 9** (partial fractions) and **Question 10 (i)** (vector geometry). Those which were least well answered were **Question 1** (inequality), **Question 2** (logarithms) and **Question 6** (integration).

The presentation of work and attention to accuracy by candidates continues to be generally satisfactory.

The detailed comments that follow inevitably refer to common errors and could produce a cumulative impression of poor work on a demanding paper. In fact there were many scripts which showed a very good and sometimes excellent understanding of all the topics tested.

Where numerical and other answers are given after the comments on individual questions it should be understood that alternative forms are often possible and that the form given is not necessarily the sole 'correct answer'.

Comments on specific questions

Question 1

Though the strongest candidates found this question to be straightforward it was generally poorly answered. Most attempts began with a correct non-modular quadratic inequality in *a* and *x*. However, though the question stated that *a* was a positive constant, many candidates tried to 'solve' the inequality for *a* in terms of *x* rather than for the variable *x* in terms of *a*. Those who solved for *x* sometimes failed to reverse the inequality when dividing both sides by a negative quantity.

Examiners saw some good solutions based on sketch graphs. A small number of candidates attempted to work with non-modular linear inequalities equivalent to the modular linear inequality given in the question. Hardly any produced a comprehensive and completely correct solution using this approach.

Answer: *x* < 2*a*.

Question 2

This was another poorly answered question. Only a minority appreciated that the graph of ln y against ln x had the constants n and ln A as its gradient and ln-y intercept respectively. Many answers simply used the coordinates of two of the four data points in connection with either the given relation $y = Ax^n$ or with ln y = ln A + $n$ln x. Some of these answers confused the coordinates by regarding them as (x, y) values rather than $(\ln x, \ln y)$ values. There were also some poor attempts at a logarithmic form of the given relation, for example ln y = Anln x and ln y = n(ln A + ln x).

Answers: A = 2.01; n = 0.25.

Question 3

This was fairly satisfactorily answered and discriminated well. Examiners were surprised that many candidates could not obtain the derivative of x + cos $2x$ correctly. Also a significant minority failed to give their answers in radians. Most candidates had a sound method for determining the nature of a stationary point, usually using the second derivative.

Answers: $\frac{1}{12}\pi$, maximum; $\frac{5}{12}\pi$, minimum.

Question 4

This was generally well answered and nearly all candidates gave the results of iteration to 4 decimal places as requested. However in part **(iii)** some did not give the final answer to 2 decimal places. They gave it as 1.6717 instead of rounding it to 1.67. Most answers found that formula (A) produced a divergent sequence. A few candidates treated formula (B) as if it were $x_{n+1} = \frac{1}{3}(x_n + 3)$. With initial value x_1 = 1.5, this misinterpretation produced a convergent sequence of values all of which were equal to 1.5.

Answer: **(ii)** 1.67 using formula (B).

Question 5

This was found to be fairly straightforward by many candidates, though errors in finding α were made quite frequently. Having found an acute angled solution, some candidates lacked an appropriate method for finding the second solution in the given range. Instead of working with the supplement of $\arcsin\left(\frac{7}{10}\right)$ they simply wrote down the supplement of their solution.

Answer: θ = 81.3° or 172.4°.

Question 6

The transformation and evaluation of a definite integral by the method of substitution appears to be unfamiliar or else unknown to many candidates. In the first part such candidates simply replace dx by dθ, and in the second part they fail to transform the limits of integration. By contrast those familiar with the method and the formulae for cos 2θ had little difficulty with the question.

Answer: **(ii)** $\frac{1}{6}\pi - \frac{1}{4}\sqrt{3}$.

Question 7

In part **(ii)** nearly all candidates were able to state that the conjugate 1 – 2i was also a root.

There were many futile attempts at part **(i)**, for example treating the 3-term cubic as if it were a quadratic. However a variety of successful methods were seen, for example (a) verification by substitution, (b) factorising the cubic and then finding the zeros of the quadratic factor, and (c) showing that the quadratic with 1 ± 2i as zeros is a factor of the cubic. For part **(iii)** there were some excellent solutions but it needs to be realised by some that geometrical shapes will become distorted if the scales on the axes of the Argand diagram are not the same. For if the scales are unequal the 'perpendicular bisector' should not be drawn at right angles to the line joining the origin to the point representing the complex number 1 + 2i. It was disappointing to see many answers in which the locus was thought to be a circle.

Answer: **(ii)** 1 – 2i.

Question 8

This question was answered well in general. In part **(i)** most candidates separated variables correctly, integrated accurately and evaluated a constant of integration. The main errors were poor integration of –kt and the omission of the constant. In part **(ii)** those working correctly sometimes lost the final accuracy mark for the value of t on account of premature approximation at an earlier stage.

Answers: **(i)** $\ln x = -\dfrac{1}{2}kt^2 + \ln 100$; **(ii)** 51.3 s.

Question 9

Part **(i)** was done well, there being only a few attempts which started out with an incorrect form of partial fractions. In part **(ii)** candidates were usually successful in expanding the fraction with quadratic denominator and linear numerator. They were less successful with the fraction with denominator (2 + x). Many candidates took (2 + x)$^{-1}$ to be $2\left(1+\dfrac{1}{2}x\right)^{-1}$, and errors were also made in the expansion.

Answers: **(i)** $\dfrac{2}{2+x} + \dfrac{x-1}{x^2+1}$; **(ii)** $\dfrac{1}{2}x + \dfrac{5}{4}x^2 - \dfrac{9}{8}x^3$.

Question 10

Part **(i)** was very well answered. The majority of candidates had a sound method, the main sources of error being arithmetical slips.

Most candidates had an appropriate method for part **(ii)** but some ended up with the complement of the correct angle. It would appear that such candidates did not realise that they had found the angle between the line *AB* and the normal to the plane rather than the angle between *AB* and the plane. A simple sketched diagram might have helped clarify the situation for such candidates.

Many were unable to make worthwhile progress in part **(iii)**. However, there were some successful attempts by a variety of methods.

Answers: **(i)** 4**i** – 2**j** – **k**; **(ii)** 24.1°.

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Paper 9709/04

Paper 4
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General comments

Most candidates were well prepared for the examination and there were few very low scores. Nearly all candidates worked through the questions in sequence, which is the recommended strategy. However, a significant minority of candidates either omitted **Question 3** or left it out of sequence and answered it last, suggesting that this question was found to be difficult.

A notable feature of the work of a significant number of candidates is the failure to appreciate the scenario described by the question. Illustrations of this feature include:

- treating the problem in **Question 2 (iii)** as a Statics problem

- treating the crate in **Question 2 (iii)** as though it is on an inclined plane

- assuming the particles are accelerating in **Question 3**

- failing to appreciate the continuity of $s(t)$ at $t = 3$ in **Question 6 (ii)**

- failing to appreciate that particle B continues upwards after A reaches the floor in **Question 7 (iii)**.

Unfortunately such lack of understanding of the problem denies the candidate the opportunity to apply the relevant Mechanics principles. Key indicators that should have prevented such misunderstanding in the first three cases are the words 'dragged along a horizontal floor' in **Question 2** and 'the strings are in equilibrium' in **Question 3**.

In the remaining two cases the candidates should have realised that P does not 'jump' from its position 18 m from O to some other position instantaneously when $t = 3$, in **Question 6**, and that B does not change its speed from 2.4 ms^{-1} to zero instantaneously in **Question 7**. The answers to part **(i)** of **Question 6** and part **(ii)** of **Question 7** provide the data necessary to ensure the continuity conditions are met, and the existence of these parts provide strong hints on how to proceed to the next stage.

As previously reported, some candidates have a weak understanding of the formulae $v = \dfrac{s}{t}$ for constant speed v, and $\dfrac{u+v}{2} = \dfrac{s}{t}$ for constant acceleration. This weakness is reflected again in this paper by the widespread misuse of $v = \dfrac{s}{t}$ in **Question 5 (ii)**.

Comments on specific questions

Question 1

This question was well attempted.

Question 2

Most candidates answered part **(i)** correctly but far fewer were successful in part **(ii)**. A common incorrect answer was 3000 J, from (400 – 250) x 20.

In part **(iii)** many candidates just solved 400cosα – 250 = 0, taking no account of the acceleration. Those who included the 'ma' term usually obtained the correct value of α.

Among candidates who used work/energy, those who said that the work done by the resultant force on the crate {(400 cosα – 250) x 20} is equal to the gain in kinetic energy, were generally more successful than those who considered the work done by the applied force {400cosα x 20}. In the latter case the candidate often omitted the work done against resistance or the increase in kinetic energy, from the work/energy equation, or used an incorrect value of the work done against the resistance.

Question 3

This question was not well attempted. Very many candidates resolved forces vertically; some who considered the forces acting at the knot failed to distinguish between the tensions in the two outer strings. Many other candidates included the weights W_1 and W_2 with the three forces acting at the knot.

A few of the candidates who resolved forces vertically at the knot, did so without also resolving forces horizontally and could not therefore make progress towards solving for W_1 and W_2 (or T_1 and T_2). A significant minority of candidates obtained T_1 and T_2 correctly, but then used $W_1 = T_1\cos 40^o$ and $W_2 = T_2\cos60^o$, thus obtaining incorrect values for W_1 and W_2.

Although not specifically a syllabus topic, Lami's rule was well known and many candidates were successful using this method. The triangle of forces method was less popular.

Question 4

Part **(i)** of this question was poorly attempted. $R = 3200$ was a common incorrect answer.

Some candidates just wrote $0.96X$ in isolation without indicating whether this was the intended answer or whether this was a stage in working which was then abandoned. Some candidates solved the equation $X\cos \theta = 3200$ for X, ignoring the required force. In these cases it is clear that candidates did not 'understand that a contact force between two surfaces can be represented by two components, the normal component and the frictional component' (section 1 of the syllabus).

$R = 3200 + 0.96X$ was also a very common wrong answer.

In part **(ii)** most candidates could quote $F = \mu R$, but often the F substituted was not a credible number or expression for the frictional force, X and 3200 being common. Where candidates explicitly resolved forces horizontally the correct expression for F, $X\sin \theta$, was usually found.

$X\cos \theta$ and 3200 were often substituted for R, but in some cases a correct expression for R was used following an incorrect answer in part **(i)**.

Question 5

This question was very well attempted, except that in part **(ii)** candidates used the constant speed formula $v = \dfrac{s}{t}$, instead of $\dfrac{u+v}{2} = \dfrac{s}{t}$ with $u = 0$, obtaining the incorrect value for v of 5 ms^{-1}.

Question 6

Part **(i)** of this question was very well attempted with most candidates obtaining the correct answer. In part **(ii)** most candidates obtained the term $-\dfrac{54}{t}$ on integrating $\dfrac{54}{t^2}$. However, many omitted the hugely important constant of integration, and an even greater number evaluated the constant incorrectly.

The most common wrong answer in part **(ii)** was $s(t) = 18 - \dfrac{54}{t}$, which arose in two ways. Some candidates obtained this answer by effectively redefining $s(t)$ as the displacement from the point, say A, 18 m from O at time t seconds after leaving O. Thus $s(3) = 0$ was used. Although such candidates failed to score the two marks for finding the constant of integration in part **(ii)** (the question requires the displacement from O), they could and often did score all three marks in part **(iii)** by first equating their $s(t)$ with $27 - 18$.

Unfortunately $s(t) = 18 - \dfrac{54}{t}$ also arose frequently in the case where candidates effectively redefined $s(t)$ as the displacement from O at time t seconds after leaving A, and then use $\dfrac{54}{0} = 0$ in applying $s(0) = 18$.

Only very good candidates were successful in obtaining the correct answer from correct working in part **(iii)**.

Question 7

Parts **(i)** and **(ii)** were very well attempted and very many candidates scored all five of the marks available.

The most common error in part **(iii)** was one of omission. Very many candidates found the height, 1.44 m, of *A*'s initial position above the floor and then gave the answer as 2.88 J, from 0.2 x 10 x 1.44, omitting the further increase in potential energy that arises from *B*'s movement above *A*'s original position.

> **Papers 8719/05 and 9709/05**
> **Paper 5**

General comments

The response to this paper was very patchy. With the early questions, most candidates with a reasonable grasp of mechanical ideas performed well. Able candidates were able to score well on the later questions, with the exception of **Question 6** in which practically all candidates of all abilities performed poorly. With just a little bit more thought many candidates in the middle ability range would probably not have made the easily avoidable errors in these later questions.

Candidates are reminded of the rubric on the front page of the question paper with regard to accuracy of answers. Answers need to be given to the required level of accuracy. There were many candidates who, for example, considered that 6.9 ms^{-2} was an adequate answer in **Question 2 (ii)**.

Comments on specific questions

Question 1

On the whole this question was well answered with the majority of candidates appreciating that, in the critical position, the line of action of the weight of the cone acted through the point of contact with the table. As usual, with this sort of question, a few failed to consult the MF9 list properly and had the centre of mass of the cone $\frac{28}{3}$ cm above its base.

Question 2

Part **(i)** proved to be a straightforward question for most candidates. Most of the failures were due to an inability to express the value of the right angle correctly in radians.

Less able candidates had difficulty in part **(ii)** through not appreciating that, in circular motion, the acceleration of the aircraft was directed towards the centre of the circle. As it was there was a lot of spurious use of the equations of motion with constant acceleration along the arc of the circle.

Answer: **(ii)** 6.91 ms^{-2}.

Question 3

Again this question posed few problems for the good candidates. The principal error of many candidates was to take moments about *BD* but then to fail to recognise that the moments of the two triangles about this axis were in opposite senses. Thus these candidates added, rather than subtracted, the moments of the triangles and consequently the incorrect $\frac{13}{15}$ m appeared all too often as the answer to part **(i)**.

Some candidates chose to take moments about *A*. This method is slightly longer but is correct provided that they remembered to subtract 2 m from their answer to give the answer required by the question.

Despite errors in part **(i)** most candidates knew the method for solving part **(ii)**. The mark scheme allowed them to get maximum credit for this part of the question provided that their answers were consistent with their incorrect value of the distance of the centre of mass obtained in part **(i)**.

Answers: **(i)** $\frac{1}{3}$ m; **(ii)** tension = $\frac{8}{9}$ *W*, force at *C* = $\frac{1}{9}$ *W*.

Question 4

There were a number of ways of solving this problem and able candidates usually brought the solution to a successful conclusion. However, many of the rest did not seem to have any clear plan of campaign. They often wrote down all the equations they could think of and then attempted to find an equation in one unknown from a selection of these equations. The result was that often an expression for the time obtained from the complete motion was then substituted into an expression obtained from the motion up to the highest point of the trajectory. A simple diagram, with the relevant information on it, may have avoided this frequent error. Another failing was for candidates to obtain a correct equation in θ, but then to find themselves unable to manipulate the trigonometric equation to get it in solvable form.

The idea for solving part **(ii)** was usually well known, but a number of candidates took a slightly longer route by starting from scratch rather than substituting θ and u directly into the trajectory equation which is listed in the MF9 list.

Answers: **(i)** u = 20 ms^{-1}, θ = 45°; **(ii)** $y = x - 0.025x^2$.

Question 5

This question was well answered by able candidates, but many of the rest were confused by the elastic potential energy (E.P.E.) of the string. For instance, in the initial position, it was necessary to either consider one string of natural length 5.5 m and extension 1.0 m, or to consider two strings each of natural length 2.75 m and extension 0.5 m. The usual error was to take some incorrect combination of the two ideas. Despite this, the majority knew that the difference in the E.P.E.'s had to be equated to the loss in the gravitational potential energy. Inevitably there were a number of the weaker candidates who ignored the initial E.P.E. altogether.

Answer: $\lambda = 6$.

Question 6

Due to a woeful lack of understanding of the difference between speed and angular speed, this question was poorly answered by practically all candidates and only an exceedingly small minority managed to score the 10 marks available.

In part **(i)**, most candidates successfully found the tension in the string to be 250 N. In applying Newton's Second Law of Motion horizontally, most candidates asserted that the radius of the circle was 4 m rather than 5.4 m.

In part **(ii)** all that was needed was an appreciation that, as the speed of P was twice that of A, then P must be 8 m from the axis of rotation. The new value of θ could then be found (sin^{-1} 0.8). Knowing this value, the value of T and the speed of P readily followed. However, nearly all candidates assumed that the value of ω found in part **(i)** transferred to part **(ii)** and became the angular speed of the point A. It was then incorrectly stated that the angular speed of P was twice this value. To further compound this error, the value of θ given in part **(i)** was retained in part **(ii)**.

Answers: **(i)** ω = 0.735 rad s^{-1}; **(ii)(a)** T = 400 N, **(b)** speed of P = 10.3 ms^{-1}.

Question 7

Surprisingly, many candidates experienced difficulties with part **(i)** of this question. Although most knew that the acceleration was $v \dfrac{dv}{dx}$, it did not seem to occur to them that the numerical value of $\dfrac{dv}{dx}$ could be obtained by differentiating the given expression for the velocity. Despite the fact that the acceleration could not possibly be constant, this did not deter weaker candidates from using $v^2 = u^2 + 2ax$ in an effort to find the acceleration.

There were many good solutions to part **(ii)**. Even those who had the coefficient of ln(8 – 2x) as –2, rather than $-\dfrac{1}{2}$, could confidently manipulate the equation into the desired form.

In part **(iii)** the justification for the distance to be less than 4 m was not often fully explained. In addition to stating that e^{-2t} was positive and tended to zero as the time tended to infinity, it was also necessary to state that its maximum value was +1 when t = 0. The latter part of the explanation was often omitted.

Answers: **(i)** acceleration = 4x –16; resisting force when x = 1 is 3 N; **(ii)** $x = 4(1 - \text{e}^{-2t})$.

General comments

This paper produced a wide range of marks from zero to full marks. The presentation of work was poor from some Centres. However, it was pleasing to see that premature approximation was not much in evidence and answers were mainly given correct to three significant figures.

Comments on specific questions

Question 1

Nearly twenty different forms of presentation were seen. There were many good diagrams, the most common ones being bar charts, percentage bar charts and pie charts. Many candidates failed to mention that the data represented drivers, thus losing a mark. Some candidates drew diagrams such as tree diagrams, box-and-whisker plots, stem-and-leaf diagrams, Venn diagrams and cumulative frequency curves. These could not represent the given data adequately so were awarded zero marks. Frequency polygons gained part marks but not full. A substantial minority did not attempt this question at all. Overall this question was a disappointing start to the paper.

Question 2

For a straightforward tree diagram question a surprising number of candidates failed to appreciate that the box had to be chosen first, before taking the sweets out. These candidates found the probability of choosing two sweets from each bag. This lost them a couple of marks but the second part allowed full marks for follow-through.

Answers: **(i)** 0.252; **(ii)** 0.440.

Question 3

In part **(i)** the number of candidates giving an answer of $_{13}C_9$ was very high. The key word 'arrangements' was not understood by some candidates. In part **(ii)** many candidates gained full marks or nearly so, and in part **(iii)** there was complete follow-through for those who made a mistake in either of parts **(i)** or **(ii)**. Overall this question was well done by a significant number of candidates.

Answers: **(i)** 259 459 200; **(ii)** 3 628 800; **(iii)** 0.986.

Question 4

Some candidates thought that the mean of the two groups meant the mean of 2 random variables X and Y, and used $E(X + Y) = E(X) + E(Y)$, which is not in the Paper 6 syllabus. Many did not score well on part **(i)** but managed to cope with part **(ii)** and recovered most of the marks. A common error was $\left(\sum x\right)^2$ for $\sum x^2$.

Answers: **(i)** 44.1; **(ii)** 14.0.

Question 5

This was found to be the most difficult question on the paper. It gave a high degree of differentiation between the weaker and the stronger candidates. In part **(i)**, many candidates found P(one disc not orange) to be $\frac{2}{3}$ after an unnecessary degree of effort and then failed to put it to a power of 5. In part **(ii)** many candidates thought that 300 discs were chosen, not 5. The mark scheme was made as generous as possible, with any binomial expression receiving a method mark, and if $\frac{1}{10}$ or equivalent was involved, then a further mark was given. Most candidates who gained full marks for this part also gained full marks for part **(iii)** and part **(iv)**. Part **(iv)** was given a follow-through mark for any candidate who stated what their *n* was (from 5 to 300) and their *p*, and worked out their mean and variance correctly.

Answers: **(i)** 0.132; **(ii)** 0.0729; **(iii)** 0.0100; **(iv)** $\frac{5}{3}$, $\frac{10}{9}$.

Question 6

Those candidates who used tree diagrams were usually more successful than those who did not. Some candidates misunderstood part **(i)** but were able to realise their error in part **(ii)** and make a full recovery. A common misconception was to interpret the charge as a charge for each throw. Both interpretations were given equal credit and full marks were given for any candidate who took this alternative scheme and got it all correct. If a candidate switched half way through, following their inability to reach the stated answer, then marks were subsequently awarded for either scheme. This meant that candidates were only penalised in the time spent in trying to obtain the stated answer, and most candidates did not find their mark any lower in this question than their average in the rest of the paper. It was done very well by candidates from certain Centres. Other candidates did not recognise that there can exist situations which are not binomial. The syllabus specifies that candidates should be able to 'construct a probability distribution table relating to a given situation'.

Answers: **(i)** $2; **(iii)** 4, 0.2; 2, 0.288; 0, 0.184; −1, 0.328; **(iv)** $1.05.

Question 7

This was well attempted by the majority of candidates, who scored full marks. There are still some who do not appreciate whether the required probability is greater than or less than 0.5, but overall there was a pleasing response. There are still candidates who do not use the critical values for the Normal Distribution tables at the foot of the Normal Tables, which gives the *z*-value for a Φ of 0.9 as being 1.282. Candidates who used other values were in danger of being penalised for premature approximation.

Answers: **(i)** 5080; **(ii)** 0.0273; **(iii)** 0.730.

General comments

Candidates, in general, made a reasonable attempt at this paper, with the latter part of the paper appearing to be more accessible to candidates than the initial few questions. Questions that caused particular problems were **Questions 3** and **6 (iii)**, whilst **Questions 5** and **6 (i)** and **(ii)** were, on the whole, well attempted. The paper produced a complete range of marks, from some excellent scripts to a few very poor ones where the candidates were totally unprepared for the examination, though scripts of this nature were very much in the minority.

The quality of presentation was reasonably good, and on the whole solutions were presented with an adequate amount of working shown. **Question 6 (iii)** was a particular place on the paper where Examiners commented on some candidates' lack of essential working, since a trial and error solution requires all the steps of the working to be shown. Examiners also commented on a lack of rigour in candidates' mathematical presentation in **Question 5** where 'dx' was often omitted on integrals. Whilst this did not result in the loss of any marks, it is a case of poor practice on the part of the candidate.

As in previous years, questions requiring an answer 'in the context of the question' were, disappointingly, poorly attempted, with many candidates merely quoting text book definitions, which, although often correct, could not score marks as they were not related to the question in any way. This was particularly the case in **Question 2**. It was disappointing to find here that many candidates could calculate the probability of a Type 1 error, but could not explain, in the context of the question, what this actually meant.

Accuracy was better than has been seen in the past with the majority of candidates answering to the required level, and relatively few candidates losing marks for premature approximation.

There did not appear to be a problem with timing in that most candidates made attempts at all questions, though non-completion of the final question was very occasionally seen.

The individual question summaries that follow, include comments from Examiners on how candidates performed along with common errors that were made. However, it should be remembered when reading these comments that there were some excellent scripts as well, where candidates gave exemplary solutions.

Comments on specific questions

Question 1

This was a reasonably well attempted question, though a particularly common error was to standardise with a denominator of 26.8 rather than $\dfrac{26.8}{\sqrt{6}}$. This was often followed by incorrect attempts to incorporate the 6 at a later stage by multiplying their probability by 6 or raising it to the power 6.

Errors included standard deviation/variance mixes and some candidates were seen to use tables correctly but then chose the wrong area. The use of a diagram could have helped candidates here.

Answer: 0.739.

Question 2

Many candidates were unable to relate the idea of a Type 1 error to the given situation, and merely quoted a text book definition. This was not sufficient to score the mark. However, candidates were, in general, able to identify the correct outcome $P(X = 0$ or $1)$ and many successfully reached the correct answer. Some candidates incorrectly calculated $1 - P(X = 0$ or $1)$, but most used the correct Binomial distribution (though Normal and Poisson approximations were sometimes used).

Answers: **(i)** George says there are fewer than 20% red chocolate beans when there are 20%; **(ii)** 0.167.

Question 3

This was a poorly attempted question, with some candidates unable to make a start. For those who made an attempt, common errors included use of a two-tailed test (which as long as all working was consistent, could still score reasonably well). Other errors included omission of a continuity correction in their standardising attempt, and many candidates did not appreciate that the variance was 44. Comparisons between the test statistic and the critical value (or area comparisons) were not always clearly shown, and incorrect critical values were often seen. Most candidates were able to make the correct conclusion based upon their values, though on occasions contradictory statements were made.

Answer: Claim justified.

Question 4

In part **(i)** many candidates were able to give a legitimate reason for using a sample, however, to merely say 'it would be easier' was not sufficient. A variety of correct reasons were accepted by Examiners, with those given below just being examples of commonly accepted correct answers.

Calculation of the confidence interval in part **(ii)** was reasonably well attempted, though errors included incorrect *z*-values and use of 71.2 rather than 69.3 in the formula. It was disappointing to see that many candidates, whilst able to calculate a confidence interval, were unable to explain what it meant. Similarly, in part **(b)**, few candidates were able to successfully make, and justify, the correct conclusion based upon their confidence interval.

Answers: **(i)** for example: cheaper, less time consuming, not all destructive; **(ii)(a)**(68.0, 70.6), we are 90% confident that the true mean lies between 68.0 and 70.6, **(b)** 71.2 not in confidence interval, significant difference in life span from national average.

Question 5

This was a particularly well attempted question, with many candidates scoring full marks. Most candidates were able to correctly show that '*a*' was $\frac{1}{2}$, though some candidates had incorrect working (including failure to equate the integral to 1) leading to a correct answer. Common errors in part **(ii)** were the use of wrong limits (0 to 1.8 or 1 to 1.8 without the use of 1– their integral). Weaker candidates, whilst appreciating what they were required to integrate, made integration errors, often bringing the '*a*' outside the integral sign as though it was a factor of the integral (this error could potentially have been made on all three parts). Errors in part **(iii)** included attempts to find the median rather than the mean.

Answers: **(ii)** 0.227; **(iii)** 1.53.

Question 6

This question was, in general, well attempted with the exception of part **(iii)**.

Part **(i)** was usually correctly attempted even by weaker candidates, and part **(ii)** was also well attempted, with common errors including omission of P(4) or P(0) in the calculation of P(*X* > 4). Part **(iii)** required a solution by trial and error, and despite this method being clearly stated in the question candidates were often unable to make a sensible start. Many candidates merely calculated individual terms rather than P(*X* > 5) and P(*X* > 6), or equivalent, and even candidates who successfully found a suitable method, full and convincing working was not always shown. Many candidates tried to find expressions to solve involving '*n*' and made little progress.

Answers: **(i)** 0.209; **(ii)** 0.219; **(iii)** *n* = 6.

Question 7

Many candidates made a good attempt at this question. Some candidates failed to interpret the question correctly and only calculated the total time with one 'stage' instead of two, though if this was a consistent error some marks were still available. It was pleasing to note that many candidates correctly dealt with the 4 minutes for the fuel payment and were able to use the correct method to calculate the variance. Part **(ii)** was quite well attempted and in part **(iii)** many candidates made reasonable attempts to use the distribution $T_1 - T_2$ and calculate P($T_1 - T_2 > 0$).

Answers: **(i)** 0.387; **(ii)** mean = 10, variance = 11.56; **(iii)** 0.647.