CONTENTS

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**.

MATHEMATICS

GCE Advanced Level and GCE Advanced Subsidiary Level

Paper 9709/01

Paper 1

General comments

Most candidates found the paper to their liking and there were many excellent well presented scripts. The standard of algebraic and numerical manipulation was generally good. Understanding of the syllabus was sound though there was considerable confusion over the idea of 'unit vectors' (**Question 11**), of 'range' as applied to a trigonometric graph (**Question 7**) and the use of '$\sin^{-1}$' (**Question 7**). There was no evidence that candidates had insufficient time to complete the paper.

Comments on specific questions

Question 1

This was generally well answered with most candidates realising the need to integrate and to include the constant of integration. Evaluation of $\frac{2}{3}\times 3^3$ presented a few difficulties. The most common error however was from candidates assuming that the equation of the curve was the same as the equation of the tangent; using a gradient of 13 in the equation $y = mx + c$.

Answer: $y = \frac{2x^3}{3} - 5x + 5$.

Question 2

The majority of candidates differentiated $y = \frac{12}{x^2 - 4x}$ correctly – usually by the chain rule, but also as a quotient or product and even by expressing the equation as the sum of two partial fractions. Omission of '$x(2x - 4)$' was the most common error and a significant number of those using the quotient rule assumed the differential of 12 to be 12.

Answer: $-\frac{8}{3}$.

Question 3

The majority coped comfortably, either by collecting terms to reach $\sin\theta = 3\cos\theta$ and hence $\tan\theta = 3$ or by dividing by $\cos\theta$ and collecting terms. Occasionally $\frac{\cos\theta}{\cos\theta}$ was assumed to be 0. The first solution of 71.6º was usually obtained, but a significant number of candidates lost the last mark through giving four answers (one in each quadrant) or by expressing the second solution as 252º, rather than to 1 decimal place as required by the rubric.

Answers: **(ii)** 71.6º and 251.6º.

Question 4

Part **(i)** was well answered, though occasionally one or other of the second and third terms had the incorrect sign. A few expressed $(2-x)^6$ incorrectly as $2\left(1-\frac{x}{2}\right)^6$. Part **(ii)** presented more difficulty with many candidates failing to recognise that there are two terms in x^2 in the expansion of $(1+kx)(2-x)^6$.

Answers: **(i)** $64 - 192x + 240x^2$; **(ii)** 1.25.

Question 5

Surprisingly there were relatively few completely correct solutions. Virtually all candidates found the coordinates of *M*; only about half coped with *A* and a minority with *C*. Most candidates found the gradient of *BD*, and then deduced the gradient and equation of *AC*. Unfortunately errors over the use of $m_1m_2 = -1$ and numerical errors in finding the equation of *AC* were all frequent. Only a small minority realised that the coordinates of *C* could be deduced directly, either by taking *M* as the mid-point of *AC* or by vector moves. Most candidates attempted to find the equations of two of the lines *BC*, *AC* or *CD* and to solve by simultaneous equations. Others attempted to use distance equations and made little progress with complex quadratic expressions.

Answers: *M* (4, 6), *A* (−8, 0), *C* (16, 12).

Question 6

This question was very well answered and a high proportion of candidates scored full marks. Misuse of the appropriate formulae was rare and most errors stemmed from numerical slips. Premature approximations prior to completing the calculation meant that many candidates obtained inexact values for the first and last terms of the arithmetic progression.

Answers: 175 and 205.

Question 7

This was poorly answered. The majority of candidates showed a lack of confidence and lack of understanding of trigonometric functions. Less than a half of all attempts realised that the range of f could be obtained directly from the knowledge that '$-1 \leqslant \sin x \leqslant 1$'. There were a significant number of correct sketch graphs in part **(ii)** that, usually by plotting at 0º, 90º etc., correctly showed the maximum and minimum values to be 5 and 1 and yet these same candidates failed to realise the link with part **(i)**. Candidates were more at ease with obtaining the inverse of g in part **(iv)**, than in realising that, since an inverse only exists if g is a one-one function, *A* = 90. There were a significant number of candidates who depressingly gave the answer to part **(iv)** as $\frac{3-x}{\sin^{-1}}$.

Answers: **(i)** $1 \leqslant f(x) \leqslant 5$; **(iii)** 90; **(iv)** $\sin^{-1}\left(\frac{3-x}{2}\right)$.

Question 8

This was well answered with candidates showing accuracy in the arithmetic calculations involved. Part **(i)** caused most problems with many candidates failing to state that angle *BOD* = $\pi - 2.4$ radians and to show sufficient evidence as to why *BD* = 6.08 cm. Use of the formulae $s = r\theta$ and $A = \frac{1}{2}r^2\theta$ was good and, even when candidates converted 2.4 radians to degrees at the beginning, it was rare to see either formula used with the angle in degrees. Omission of the length *OA* = 9 cm in finding the perimeter was the most common error.

Answers: **(ii)** 43.3 cm; **(iii)** 117 cm^2.

Question 9

The main difficulty with this question occurred with candidates failing to realise that $\frac{1}{\sqrt{x}} = x^{-\frac{1}{2}}$. ($x^{-1}$ and $x^{\frac{1}{2}}$ being the most common alternatives). Candidates did however cope well with the ideas involved in the question, attempting to differentiate in part **(i)** and integrate in part **(ii)**. In part **(i)** a small minority took $\frac{dy}{dx}$ to be the gradient of the normal and others failed to find a numerical value for the gradient before using $y = mx + c$ to find the equation of the normal. Part **(ii)** was very well answered.

Answers: **(i)** 14.4; **(ii)** 8 unit^2.

Question 10

Attempts varied considerably with part **(iii)** being the only part to be really well answered. In part **(i)**, most candidates realised the need to find the coordinates of the stationary point and most obtained $x = 1.5$, usually by calculus. The majority also realised the need to find the y value (1.75) but then assumed this to be sufficient to answer the question. A majority of attempts lost a mark through failure to show that the point was a minimum rather than a maximum point. Only a small proportion of candidates realised that the function was decreasing for all x values to 'the left' of the stationary point. Part **(iii)** was very well answered, but only about a half of all attempts at part **(iv)** realised that '$b^2 = 4ac$' led to the answer directly. Many candidates attempted part **(iv)** by equating gradients, though '$2x - 3$' was often equated to 2, or even 0, rather than to -2.

Answers: **(ii)** $x < 1.5$; **(iii)** $(-1, 8)$ and $(2, 3)$; **(iv)** $3\frac{3}{4}$.

Question 11

Part **(i)** was well answered with the majority scoring full marks. A minority used $\overrightarrow{AO}.\overrightarrow{OB}$ to find angle AOB and, more worryingly, many candidates either deliberately assumed the angle to be acute or deliberately took the modulus of the numerical answer for 'cosAOB'. In part **(ii)**, a majority of candidates still failed to understand the term 'unit vector' and only obtained the one mark available for a correct expression for $\overrightarrow{AB}$. Others obtained the modulus of $\overrightarrow{AB}$ as 7 but failed to divide by 7 to obtain the unit vector. In part **(iii)** the majority of candidates evaluated the length of $\overrightarrow{AB}$ but errors in obtaining a correct expression for $\overrightarrow{AC}$ (usually $-2\mathbf{i} + 3\mathbf{j} + (p - 1)\mathbf{k}$) led to an incorrect equation in p. A surprising number of candidates used $\overrightarrow{OC}$ instead of $\overrightarrow{AC}$ and the equation $6^2 + p^2 = 7^2$ was common.

Answers: **(i)** 99°; **(ii)** $\frac{1}{7}(2\mathbf{i} - 6\mathbf{j} + 3\mathbf{k})$; **(iii)** $p = -7$ or 5.

Paper 9709/02

Paper 2

General comments

The Examiners noted a distinct improvement in candidates' manipulative and algebraic skills compared to previous years.

Providing guidance on appropriate techniques for use in **Question 2 (a)** and **Question 3 (i)** proved useful in concentrating candidates towards eliminating previously seen uncertainty in these areas. Particularly well attempted were **Question 2 (a)**, **Question 3 (i)**, **Question 4**, **Question 5 (i)** and **Question 7 (i)**. All but the very best candidates struggled with **Question 2 (b)**, **Question 3 (ii)**, **Question 6 (ii)** and **(iii)** and **Question 7 (ii)**.

Candidates' work was generally neat and well-presented and there was no sign of candidates running out of time. Almost all candidates made a serious attempt at all seven questions.

Comments on specific questions

Question 1

Squaring each side and solving the resultant quadratic inequality proved fruitful to almost all who used this method, though many lost the final mark by muddling the inequality signs, for example, $x < \frac{1}{2}$, $x > 1$. Those finding the roots by inspection rarely scored more than 1 mark for saying that $x < 1$.

Answer: $\frac{1}{2} < x < 1$.

Question 2

(a) Almost every candidate scored both marks. A few said that $x\ln 3 = 8$.

(b) There were very few correct solutions. Many noted correctly that $2\ln y = \ln y^2$ but most solutions either failed to see this or collapsed due to use of the falsity $\ln(A + B) = \ln A + \ln B$, or that $\ln A + \ln B = \ln C$ implies that $A + B = C$. Thus $\ln(y + 2)$ was equated to $\ln y + \ln 2$ and z was equated to $y + 2 - y^2$.

Answers: **(a)** 1.89; **(b)** $z = \frac{y+2}{y^2}$.

Question 3

(i) Almost all candidates worked to 4 decimal places, but some left their final answer correct to 4 decimal places or stopped one iteration short of a convincing argument.

(ii) Very few candidates appreciated the need to let both x_n and x_{n+1} tend to the limit α in the given interation formula from part **(i)**.

Answers: **(i)** 1.68; **(ii)** $8^{\frac{1}{4}}$.

Question 4

(i) This was very well attempted and only a small number of candidates evaluated p(1) and/or p(–2), or made numerical errors.

(ii) Solutions were generally excellent.

Answers: **(i)** $a = 2$, $b = 4$; **(ii)** $x^2 - 2x + 4$.

Question 5

(i) This proved tricky for many candidates, who were unable to differentiate $(\cos\theta)^{-1}$ by the chain rule or $\frac{1}{\cos\theta}$ by the quotient rule.

(ii) Many candidates could derive or quote the derivative of $x = 1 + \tan\theta$ but tried unsuccessfully to find the derivative of $y = \sec\theta$, despite this being a given from part **(i)**.

(iii) Although candidates determined that $\theta = \frac{1}{6}\pi^c$ or 30°, few candidates could then substitute this value correctly in $x(\theta)$ and $y(\theta)$ expressions. Many believed that x, like θ, equalled $\frac{1}{6}\pi$.

Answers: **(iii)** $x = 1 + \frac{1}{\sqrt{3}}$, $y = \frac{2}{\sqrt{3}}$.

Question 6

(i) This part was well answered.

(ii) A minority of candidates could differentiate *y* correctly. Many obtained a single term, based on the derivative of a product being equal to the product of the derivatives. Others obtained minus the correct derivative or had a wrong, or non-existing, denominator term.

(iii) A large minority of candidates worked with only 3 ordinates and with h = 1 in the formula, or 4 ordinates and $h = \frac{4}{3}$. Several candidates tried unsuccessfully to integrate exactly.

(iv) Reasoning was poor; many mentioned convexity, or concavity, or mentioned the trapezium, rather than the three trapezia. What was required was a simple diagram, showing all 3 trapezia lying below the curve.

Answers: **(i)** (1, 0); **(ii)** (e, $\frac{1}{e}$); **(iii)** 0.89; **(iv)** under-estimate.

Question 7

(i) Most candidates began very well and a majority of these scored full marks. Others made sign errors or lost a factor.

(ii) Few candidates used the hint and first made the integrand a linear combination of sin$x$ and sin3x, from the formula in part **(i)**. Errors frequently seen for the integral of $\sin^3 x$ were:

$\frac{\sin^4 x}{4}$, $\frac{\sin^4 x}{4\cos x}$ and $\frac{\cos^4 x}{4}$.

Papers 8719/03 and 9709/03

Paper 3

General comments

The standard of work by candidates on this paper varied considerably and resulted in a wide and even spread of marks from zero to full marks. The paper appeared to be accessible to candidates who were fully prepared and no question seemed to be of unreasonable difficulty. All questions discriminated well and adequately prepared 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 1** (binomial expansion) and **Question 9** (calculus). Those which were least well answered were **Question 2** (trapezium rule) and **Question 10 (ii)** (vector geometry).

The presentation of work and attention to accuracy by candidates continues to be generally satisfactory. However, where the answer to a problem is given in the question paper, for example as in **Question 4 (i)**, candidates do not always show sufficient steps in their solution to justify this given answer. Similarly where a question requests candidates to justify their conclusions, for example as in **Question 5 (iii)**, failure to provide appropriate justification is penalised.

The detailed comments that follow inevitably refer to common errors and can lead to a cumulative impression of poor work on a difficult paper. In fact there were many scripts showing a good and sometimes very good understanding of all the topics being 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

This was generally found to be straightforward by candidates and was usually well answered. Apart from arithmetical errors in simplifying the binomial coefficients the main error was the failure to handle the square and cube of 4*x* correctly.

Answer: $1-2x+6x^2-20x^3$.

Question 2

The first part was poorly answered. The question requires the use of three ordinates, at $x = -0.6, 0, 0.6$. However, many candidates used the wrong number of ordinates, e.g. 2, 4, 5, …, 13. Those that used three sometimes worked with those at $x = 0, 0.6, 1.2$. Failure to match the interval width to the number of ordinates was a source of error; misapplication of the formula for the trapezium rule was another. The second part was answered better, though quite often candidates gave a general explanation of why the trapezium rule gives reasonably accurate results rather than refer to the particular case in question.

Answer: **(i)** 1.23.

Question 3

In part **(i)** the solution of a quadratic with a complex coefficient caused problems for some. Those who applied the formula correctly and reached $\mathrm{i} \pm 2$ often changed their answer to $2 \pm \mathrm{i}$, presumably believing that the roots have to be complex conjugates. Errors in the simplification of $\frac{2\mathrm{i} \pm 4}{2}$ were common. In parts **(ii)** and **(iii)** candidates often found correct moduli and arguments for their roots and drew satisfactory Argand diagrams. However, some candidates seem to believe that the argument of say $a + \mathrm{i}b$, is always the value of $\arctan\left(\frac{b}{a}\right)$. For example the argument of $-2 + \mathrm{i}$ was often stated to be -0.464 rather than 2.68.

Answers: **(i)** $2 + \mathrm{i}$, $-2 + \mathrm{i}$; **(ii)** 0.464 (or 26.6°), 2.68 (or 153.4°).

Question 4

The transformation and evaluation of a definite integral by the method of substitution appeared to be unfamiliar or else unknown to many candidates. In the first part they simply replaced d*x* by dθ, and in the second part, if they attempted the integral of $\cos 2\theta$ they failed to transform the limits of integration. By contrast those familiar with the method had little or no difficulty with the question.

Answer: **(ii)** $\frac{1}{2}$.

Question 5

This question was only moderately well answered. In part **(i)** candidates usually used long division or inspection to find the other quadratic factor, the value of *a* arising as a bi-product. The error $a = 6$ was common amongst those who divided. A very small minority found *a* by substituting one of the complex zeroes of $x^2 - x + 3$ in p(*x*), equating the expression to zero and solving for *a*. The question asks for p(*x*) to be factorised completely yet many omitted to factorise the second quadratic factor.

In part **(ii)** Examiners expected candidates to demonstrate that $x^2 - x + 3 = 0$ has no real roots and that $x^2 + x - 2 = 0$ has two real roots. Completely satisfactory justifications were rare.

Answers: **(i)** $a = -6$, $p(x) \equiv (x^2 - x + 3)(x + 2)(x - 1)$; **(ii)** 2.

Question 6

This was only moderately well answered on the whole. In part **(i)** most attempts worked from left to right. Whereas most could express cos 2θ in terms of $\cos\theta$ (or $\sin\theta$) the handling of cos 4θ proved to be more difficult and solutions often broke down at this point. Nevertheless, some excellent succinct proofs were seen.

In part **(ii)** most candidates reached $\cos\theta = \sqrt[4]{\frac{5}{8}}$ but thereafter faulty or incomplete calculations abounded, few candidates including the two solutions corresponding to the negative fourth root.

Answers: **(ii)** 27.2°, 152.8°, 207.2°, 332.8°.

Question 7

Part **(i)** was poorly answered. Many candidates seemed unfamiliar with the cosecant function and its graph. There were also some poor attempts at the graph of the linear function. Those who made an adequate sketch of a suitable pair of graphs often omitted to complete the solution by indicating that the presence of an intersection over the given range implied the existence of a root in that range.

Those who had a suitable method usually completed the calculations accurately in part **(ii)**.

Part **(iii)** was well done by those who had a correct understanding of the inverse sine function.

Nearly all had a correct general appreciation of the iterative process in part **(iv)**. Those that calculated in radian mode usually exhibited iterates to 4 decimal places as requested and halted at the first appropriate point, though some went on far too far. However, it was quite common for them to give the final answer as 0.79 even though their last two iterates rounded to 0.80. Examiners felt that such candidates were truncating rather than rounding the last two values. Those that calculated in degree mode with initial value 0.75 obtained 46.6582 as their first iterate. Since an earlier part of the question had stated that the desired root lay between 0.5 and 1, the size of this iterate should have signalled that something was wrong. Yet such candidates continued iterating, sometimes obtaining over twenty iterates, wasting valuable time in fruitless work.

Answer: **(iv)** 0.80.

Question 8

Part **(i)** was quite well answered. A sign error in the integral of $\frac{1}{4(4-y)}$ was a common mistake. Most candidates realised the connection between parts **(i)** and **(ii)** and picked up marks for separating variables, solving the differential equation and evaluating a constant. However, there were also some poor attempts at separation and integration which were of little or no merit. A correct solution having been obtained, only the best candidates could combine logarithms, exponentiate and reach a correct expression for y in terms of x. Finally, very few candidates completed part **(iii)** correctly.

Answers: **(i)** $\frac{1}{4}\ln y - \frac{1}{4}\ln(4-y)$; **(ii)** $y = \frac{4}{3\,e^{-4x}+1}$; **(iii)** The value of y tends to 4.

Question 9

Examiners reported that most candidates scored highly here. Part **(i)** was usually completed successfully. In part **(ii)** most candidates recognised, or found after making a substitution, that the integral of $\frac{x}{x^2+1}$ was a multiple of $\ln(x^2+1)$. In part **(iii)** those who reached an equation of the form $\ln(p^2+1)=k$ did not always have a correct strategy for solving it. The error of taking an expression of the form ln(a + b) to be equal to ln a + ln b was quite frequently seen in part **(ii)** or part **(iii)** of this question.

Answers: **(i)** 1; **(ii)** $\frac{1}{2}\ln(p^2+1)$; **(iii)** 2.53.

Question 10

Part **(i)** was quite well answered. Most candidates found a vector equation for the line *AB* and tried to show that the equations obtained by equating components of the position vectors of general points on *l* and *AB* were inconsistent. No credit was given to the minority who equated the components of a general point on *l* to those of *OA* or a direction vector for *AB*.

In part **(ii)** many candidates lacked a sound method for tackling this problem and made little or no progress. Those that had a viable strategy usually found a vector parallel to the plane and not parallel to *l*. Using the fact that this vector and the given direction vector for *l* are perpendicular to the normal to the plane, they either set up and solved two simultaneous equations or used a vector product to find the ratio $a : b : c$. They then substituted the coordinates of a point on the plane, e.g. *A*, to find a value for *d* and complete the solution. A minority used the above pair of vectors to form a 2-parameter equation for the plane and then converted it to cartesian form. Other methods included (*a*) the use of the coordinates of three relevant points to form three simultaneous equations in *a*, *b*, *c*, *d*, and (*b*) the use of the coordinates of two relevant points together with the equation $a + 2b + c = 0$.

In general the candidates who had a sound method carried it out with commendable accuracy.

Answer: **(ii)** $6x + y - 8z = 6$.

Paper 9709/04

Paper 4

General comments

Very many candidates failed to observe, or failed to understand the requirement to work to an accuracy of three significant figures. Truncated values were often given in **Questions 1** (36.8), **2** (5.08 and 9.3) and **4 (i)** (0.666), and answers to two significant figures were often given in **Questions 2** (5.1), **3** (0.35), **4 (i)** (0.67) and **6 (iv)** (1.3).

Some candidates seem to believe that the formula $(m_1 + m_2)a = (m_1 - m_2)g$ is a recipe for all connected particles problems in which a string passes over a pulley. Candidates should be encouraged to consider, before using this formula, whether it is appropriate to the question in hand. It is only appropriate when the particles are moving, and doing so vertically and in opposite directions with the string taut. It is certainly not appropriate if one or both of the particles moves in a direction which is not vertical, or if the particles are stationary.

Some candidates have a weak understanding of the formulae $v = \frac{s}{t}$ for constant speed *v*, and $\frac{u+v}{2} = \frac{s}{t}$ for constant acceleration. This weakness is reflected in the frequent use of distance = $(0 + 1.5) \times \frac{20}{2}$ in **Question 1**, $v = \frac{2.25}{1.5}$ (and subsequently $a = \frac{v}{1.5}$) in **Question 3** and speed = $\frac{10}{5}$ in **Question 6 (i)**.

Comments on specific questions

Question 1

The question was intended as a straightforward exercise on WD = $Fd\cos\theta$, and a very large proportion of candidates treated it as such, although some found the distance travelled incorrectly. There were many candidates however, who successfully introduced the concept of power, using $P = \frac{\text{WD}}{T}$ and $P = (F\cos\theta)v$ in combination.

A significant number of candidates had clearly been taught to consider all the forces acting, and correctly stated or implied that the frictional force F_r is equal to $F\cos\theta$. The work done by the given force is then stated or implied to be equal to the work done against the frictional force, and hence θ is found from $F_r d = 720$ and $d = 1.5 \times 20$.

A significant minority of candidates did not use the idea that the work done by the given force is the same as the work done against the frictional force. Thus $(30\cos\theta - F_r) \times 30 = 720$ and variations of this equation, with both θ and F_r unknown, were commonly stated with no further progress being made.

Answer: 36.9.

Question 2

Most candidates used correct methods for finding the components of the resultant in the '**i**' and '**j**' directions, and hence its magnitude. However the majority of such candidates failed to work with sufficient accuracy to obtain an answer for the magnitude which is correct to three significant figures. Using approximate values of $X = 5$ and $Y = 0.8$ for the components was common.

A very common error was to find the direction as the angle $\tan^{-1}\left(\frac{Y}{X}\right)$ *clockwise* from the *x*-axis instead of anticlockwise. This arises because candidates worked with a triangle in which directed lines representing the components of the resultant are both drawn outward from the origin, instead of lines in which relevant arrows on these lines are both clockwise or both anti-clockwise in the triangle. Candidates making this error did not score the method mark for the direction.

Answers: 5.09 N, 9.4° anticlockwise from the force of magnitude 7 N.

Question 3

This question was well attempted, most candidates recognising the need to use $s = \frac{1}{2}at^2$ (or equivalent), Newton's second law and $F_r = \mu R$ in succession. The most common error was to obtain $a = 1$ from the mis-use of constant acceleration formulae.

A significant minority of candidates used formulae for KE and PE, an equation for the WD against friction as a linear combination of PE loss and KE gain, WD as $F_r d$ and $F_r = \mu R$ in succession. The most common error in such cases was to obtain v as 1.5 instead of 3, giving the KE gain as 1.125 mJ.

Answer: 0.346.

Question 4

This question was poorly attempted. A very large proportion of candidates relied on an inappropriate recipe for what they perceived to be a ‘standard’ question, rather than on fundamental principles of Mechanics. Such candidates usually obtained an acceleration of -2ms^{-2}, notwithstanding the limiting *equilibrium*. Furthermore, to justify their use of the recipe the *horizontal* pulling force on *B* would need to act in the same direction as the weight!

Candidates usually had equations with a (non-zero) acceleration in part **(ii)**. Some candidates thought it was necessary to find the magnitude of the applied force by some contrived means which is independent of the use of *X*, and hence to find *X* by equating this magnitude with $\sqrt{X^2 + 1.8^2}$.

The relatively few candidates who demonstrated an understanding of the demands of the question answered with an economy of effort. Although many such candidates scored full marks in both parts, errors of sign were made by others in the equations obtained by resolving the forces on *B* vertically and horizontally.

Answers: **(i)** $\frac{2}{3}$; **(ii)** 2.8.

Question 5

This question was generally well attempted with many candidates scoring full marks. Some candidates failed to include a constant of integration in part **(i)**, thus obtaining incorrect answers of $x = 0.01t^3$ and $v = 3.24$ or 3.25 ms^{-1} in parts **(i)** and **(ii)** respectively.

Answers: **(i)** $0.01t^3 + 1.25$; **(ii)** 3 ms^{-1}.

Question 6

In part **(i)** very many candidates ignored the information contained in the graph and assumed implicitly, by using $\frac{u+v}{2} = \frac{s}{t}$ with $u = 0$, $s = 10$ and $t = 5$, that the motion for $0 < t < 5$ is one of the same constant acceleration throughout. Although this method gives an answer $v = 4$, its correctness is fortuitous and no marks were scored.

Part **(ii)** was very well attempted. Most candidates recognised the need to link area in the graph with displacement in part **(iii)**. The most common errors here were:

- to include the 10 m to reach the basement in the distance travelled *from* the basement
- to find the value of *t* at the end of the constant speed stage without subsequently subtracting 18.

Part **(iv)** was fairly well attempted, many candidates benefitting from following through previous errors in finding the required deceleration.

Answers: **(i)** 4ms^{-1}; **(ii)** 6; **(iii)** 2 s; **(iv)** $\frac{4}{3}\text{ ms}^{-2}$.

Question 7

Part **(i)** was fairly well attempted, although many candidates omitted either the driving force or the resistance in applying Newton’s second law. Some candidates inappropriately used $25 = 10 + 30.5a$.

Few candidates scored all eight marks in part **(ii)**, but most scored some marks. The marks for KE change were often scored, but a common mistake was to calculate this quantity from $\frac{1}{2}\times 1200(25 - 10)^2$. Very few candidates calculated the work done by the car’s engine correctly and the 30.5 s in the data of the question was generally unused. Many candidates failed to recognise that the driving force is continuously changing, and included $2000d$ to represent the work done by the engine in the work/energy equation. Another frequently occurring error was to represent the work done by the driving force by $(ma)d$ where the acceleration *a* used was its value found in part **(i)**. In some cases the work done by the driving force was not represented in the work/energy equation.

Answers: **(i)** 1.25 ms^{-2}; **(ii)** 590 m.

Papers 8719/05 and 9709/05

Paper 5

General comments

All candidates who had a basic understanding of mechanical ideas found that there were a number of questions on the paper in which they could make very good progress. However, **Questions 1** and **7** posed problems for nearly all candidates with only a limited number of fully correct solutions seen.

Compared with previous years there were more candidates who failed to time themselves properly and barely got started on **Question 7**.

As in former years, it was disappointing to see that candidates were needlessly throwing marks away through premature approximation in calculations. It does not necessarily follow that if all figures are rounded to 3 significant figures in the calculation process then the final answer will also be correct to this degree of accuracy. For instance, in **Question 2 (iii)**, taking the radius as 1.15 m leads to the incorrect answer 2.84 ms^{-1}.

Comments on specific questions

Question 1

The response to this question was poor across the ability range. Consequently there were few fully correct answers seen. Candidates failed to appreciate that attaching the particle to the mid-point of the string converted the problem into a two string problem, each with a natural length 0.4 m. The majority of the solutions had each part of the string with an incorrect natural length 0.8 m. This error was then further compounded by equating *mg* to the tension in the part *AP* of the string only, ignoring the fact that the string *PB* was still in tension. Regrettably the wrong answers 0.2 or 0.3 were seen all too often.

Answer: $m = 0.4$.

Question 2

On the whole, this question was very well answered, the most frequent error being the approach taken in the calculation of the speed which has been referred to earlier.

Answers: **(i)** 35; **(ii)** 1.83 N; **(iii)** 2.83 ms^{-1}.

Question 3

Finding the centre of mass of the solid was invariably correct. The most frequent error of the less able candidates was to break the L-shape down into two overlapping rectangles with total area 500 cm^2.

In part **(ii)** only the better candidates realised that, on the point of tilting, it was necessary to take moments about *F* in order to find *P*. There was a general weakness in not understanding the nature of the forces acting on a body in equilibrium. It was doubtful if many candidates were aware that there was a third force acting on the solid, namely the force of the table on the solid. Certainly those who took moments about *A* did not, as a frequent incorrect equation was $30P = 7.5W$. Examiners also felt that a number who took moments about *F* stumbled on the correct answer by accident without realising that, on the point of tilting, the frictional force and the normal component of the force of the table on the solid would be acting at *F* and thus have zero moment about that point.

Answers: **(i)** 7.5 cm; **(ii)** $\frac{5}{12}W$ $(= 0.417W)$.

Question 4

There was an all round very good response to this question. The major error of the weaker candidates was to find the initial tension in the string (8 N) and then incorporate the term 8 x 2 (= 16 J) into the energy equation in addition to the K.E. and E.P.E. terms. This demonstrated a complete misunderstanding of elastic potential energy in that the E.P.E. formula was derived in the first place by considering the work done by the variable tension in the string.

Able candidates experienced no difficulty with part **(ii)**, but weaker candidates divided the work done against friction by either 3.5 or 1.5. Some candidates equated the work done to μR.

Answers: **(i)** 0.8 J; **(ii)** 0.1.

Question 5

Part **(i)** of this question was well answered by the majority of the candidates. Inevitably there were those who thought that the acceleration was $\frac{dv}{dx}$, and there were those candidates who substituted the given expression for the acceleration into the equation $v^2 = u^2 + 2as$. It seemed to be lost on these candidates that, as x varied, so did the acceleration and hence it was not possible to use the constant acceleration formulae.

Part **(ii)** was only well answered by the better candidates. Most candidates did not seem to realise that it was necessary to equate $\frac{dv}{dx}$ to zero in order to find the turning point (or alliteratively use the equivalent idea that when the acceleration is zero the velocity is either a maximum or a minimum).

Answers: **(i)** $v = \sqrt{(x^2 - 4.8x + 6.25)}$; **(ii)** 0.7.

Question 6

Only the better candidates made any headway with part **(i)** of this question, but a number which were otherwise correct were marred by not working to a sufficient degree of accuracy in the calculation process. When the given distance to be verified was specified to 3 decimal places, then all figures in the calculation should have been expressed to at least 4 decimal places. In too many cases the final answer was obtained from $\sqrt{8} - 0.746$ which resulted in 2.082 m.

Fortunately candidates were not deterred by the inability to do part **(i)** and there was a high degree of success with both parts **(ii)** and **(iii)**. The most frequent error when taking moments about A was to have the moment of the tension as T x $2\sqrt{2}$ rather than T x 2.

Answers: **(ii)** 4.54; **(iii)** 4.54 N and 7 N.

Question 7

Because of a failure to read part **(i)** of this question properly a high proportion of candidates lost a lot of marks in part **(iii)**. Despite clear instructions in part **(i)** to find the height of A above the ground, the most frequent answer given was $5t^2$. This, of course, represented the distance fallen by A. Hence, when it was necessary in part **(iii)** to equate the answers to **(i)** and **(ii)(b)**, candidates obtained an equation from which no further progress could be made.

Only a very small minority of candidates made any progress in part **(iv)** as most failed to appreciate that a collision was possible only if either the height at which the collision took place was greater than zero, or that the range of the particle B had to exceed 24 m.

Answers: **(i)** $7 - 5t^2$; **(ii)(a)** $Vt\cos\theta$, **(b)** $V\sin\theta t - 5t^2$.

Paper 9709/06

Paper 6

General comments

This paper produced a wide range of marks. Whilst most candidates were able to attempt all the questions, there were some Centres who entered candidates who had clearly not covered the syllabus and who failed to reach the required standard.

Most candidates answered questions to a suitable degree of accuracy, and it was pleasing to observe that only a few lost marks due to premature approximation. This occurred mainly in the use of normal tables.

Candidates seemed to have sufficient time to answer all the questions, and only the weaker ones answered questions out of order.

Comments on specific questions

Question 1

This was well attempted by most of the candidates who had covered the syllabus. Nearly everyone recognised the normal approximation to the binomial and a pleasing number applied the continuity correction with almost all who did so getting it in the correct direction. As in previous years, many lost marks by finding the wrong area.

Answer: 0.677.

Question 2

This straightforward question on the mean and standard deviation of grouped frequencies produced many correct answers but some candidates provided answers which did not use the mid-point of the frequencies. The upper end, the lower end, the class width, and the semi-class width were all used. The mark scheme awarded method marks for trying something, so most candidates were able to score a few marks here. In part **(ii)** the correct mid-points had to be used to gain the method mark. A sizeable number of candidates worked backwards from the answer to show that f had to be 9 and then proceeded to verify it. This scored at most 2 marks out of the 4.

Answer: **(ii)** 16.1.

Question 3

Most candidates managed to obtain the given answer for part **(i)** but many failed to see any connection between this part and the next part, which was about completing the probability distribution table. The 4 decimal place requirement was not observed by everyone, some giving the answer as a fraction or to 3 significant figures, resulting in the loss of a mark. However, a mark was given for appreciating the values of X could be anything from 0 to 5 inclusive and many weaker candidates managed to pick up a mark here.

Answer: **(ii)** 0, 0.2373; 1, 0.3955; 2, 0.2637; 3, 0.0879; 4, 0.0146; 5, 0.0010.

Question 4

There are many useful features of a box-and-whisker plot, and comments such as ‘shows the distribution’, ‘none of the data are lost’, ‘easy to find the mode’ were all acceptable. Comments such as ‘quick and easy to understand’ were not deemed sufficient. There was generally good work at finding the medians and quartiles. A few failed to put in the decimal point, thus losing a mark. The graph was well done with most candidates knowing what a box-and-whisker plot was. The mark given for seeing the word ‘cholesterol’ somewhere on the graph was generally not obtained. Very few candidates gave a heading, or said that the axis represented cholesterol count.

Answer: **(ii)** 5.4, 6.5, 8.3.

Question 5

This question produced the greatest variety of answers. Candidates failed to appreciate that the results could be read off the table straight away, and used complicated tree diagram approaches. These did come up with the correct answer eventually if no mistakes were made. Part **(iii)** on independent events was poorly attempted, with many candidates using colloquial English rather than mathematics to argue their point, and others becoming muddled with independent events. Equivalent forms of the fractions were accepted.

Answers: **(i)** $\frac{618}{128}$; **(ii)** $\frac{412}{1281}$; **(iv)** $\frac{358}{564}$.

Question 6

There were some cases of premature approximation here, with candidates failing to use the normal tables properly, but generally part **(i)** was well done. Many candidates just ignored finding the probability that all 4 tyres had the required pressures, and just found the probability for one tyre. Very few got anywhere with part **(ii)**. Probably about 10% found the z-value to be 1.282, and another 10% found 0.842, which though incorrect, allowed them to score 2 marks out of 3 if their answer was correctly worked out. The rest scored nothing.

Answers: **(i)** 0.00429; **(ii)** 1.71 to 2.09.

Question 7

This, the last question on the paper, was well attempted by many candidates, with almost everyone scoring well on part **(ii)** and a significant number doing well on both parts.

Answers: **(i)** 15; **(ii)** 75; **(iii)** 90 720; **(iv)** 120.

Papers 8719/07 and 9709/07

Paper 7

General comments

Candidates, in general, made a reasonable attempt at this paper, particularly from **Question 4** onwards. Problems were encountered on the initial few questions rather than on the later ones, with **Question 3** causing candidates most problems. The paper produced a complete range of marks, from some excellent scripts to some very poor ones where the candidates were totally unprepared for the examination. The quality of presentation was reasonably good, though some scripts were found to contain work that was difficult to read. On the whole, solutions were presented with an adequate amount of working shown. As in previous years questions requiring an answer 'in the context of the question' were poorly attempted, with many candidates merely quoting text book definitions, which, although correct, could not score marks as they were not related to the question in any way. 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. It was surprising to see how many candidates gave a probability answer that was greater than 1, or even less than zero. It is important for candidates to check to see if their answer is a sensible one thus, possibly, enabling them to find their own error. There did not appear to be a problem with timing in that most candidates made attempts at all questions.

The individual question summaries that follow include comments from Examiners on how candidates performed, and the 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

Most candidates were able to find the equation that connected the means ($55 = 70a + b$), but many mistakes were made in finding the equation connecting the variances (or standard deviations). Incorrect equations such as $6.96^2 = a8.7^2$, $6.96 = 8.7a + b$ and $6.96^2 = 8.7a^2 + b$ were commonly seen. Candidates who correctly found the two initial equations usually went on to successfully solve for a and b.

Answers: $a = 0.8$, $b = -1$.

Question 2

The majority of candidates did not answer part **(i)** in sufficient detail. A mere mention of 'random' or 'ensure it covers all groups' was not enough to gain the mark. Some candidates did successfully describe a correct random method, drawing names out of a hat or using random numbers with a list being the most popular. Other equivalent methods were accepted, including systematic sampling methods. Most candidates correctly found the population mean, but mistakes were made when finding the variance. Occasionally the biased variance was given, but this was not so common as has been seen in the past. The main error, which has been noted on previous examination sessions, was to substitute the value of the mean squared rather than $(\Sigma x)^2$ into their, often correctly quoted, formula. This may be caused by a confusion between the two different formulas for the population variance that could be used. Accuracy marks were sometimes lost due to premature approximation (use of 16.6). Most candidates realised that the population variance was more than the sample variance, though in some cases unnecessary calculations were done. The final part was not well answered, with many candidates giving a text book definition of what a 'population' was with no relation to the question. A common error was to state that the population was the total *number* of students, whilst other candidates confused population with sample.

Answers: **(i)** Put names in a hat and draw out; **(ii)** 16.6, 27.1; **(iii)** More; **(iv)** Pocket money of all pupils in Jenny's year at school.

Question 3

This was a poorly attempted question, with many candidates merely finding (or attempting to find) the mid point and then unable to progress further. Some candidates calculated half the range instead of the mid-point. In general, there were relatively few attempts at part **(ii)**. The candidates who successfully realised the significance of evaluating the mid-point in part **(i)**, usually found a correct n. There were some attempts to then find z and the confidence level, though even after a correct z value a level of 95% was often incorrectly given, and even 5% or 10% was seen.

Answers: **(i)** 0.244, 250; **(ii)** 90%.

Question 4

Many candidates set up their null and alternative hypotheses correctly, though errors were seen, and, despite the fact that the question clearly indicated that the null and alternative hypotheses should be stated, there were still candidates who failed to do so. The most common error was to use a one-tail test rather than a two tail, and in some cases incorrect use of 19.4 within the hypotheses was seen. Other errors included a wrong or omitted parameter. In calculating the z-value, omission of $\sqrt{90}$ was commonly seen, though many candidates did correctly find the test statistic. Candidates were then required to show a correct comparison, that is either a correct comparison of their test statistic with 1.96 (or equivalent if using a one-tail test), or a correct comparison of probabilities. For some candidates this proved to be confusing, and comparisons were, on occasions, not clearly shown. Final conclusions were sometimes contradictory. Part **(ii)** was another question that required an answer in the context of the question and once again many candidates merely quoted general text book definitions, which did not score any marks. Many candidates correctly stated the probability of a Type 1 error, though unnecessary calculations were sometimes seen, and on occasions the probability from the test was incorrectly thought to be the answer.

Answers: **(i)** H_0: $\mu = 21.2$, H_1: $\mu \neq 21.2$, Significant evidence to say not the same sentence length (or author); **(ii)** Say it is not the same sentence length (or author) when it is, 5%.

Question 5

There were many fully correct solutions to this question. However, some candidates were confused between the groupings of 4, 20 and 80 throughout the question, and whether to use 4, 4^2, $\frac{1}{4}$, $\frac{1}{4^2}$, etc. to calculate the appropriate variance. Other errors included using a wrong tail in part **(i)**, and use of the variance from part **(i)** or 5.95 from part **(i)**, in part **(ii)**, or confusing two different methods of approach in part **(ii)**. In general, though, most candidates were able to gain some marks on this question and demonstrate their understanding of the topic.

Answers: **(i)** 0.982; **(ii)** 0.0367.

Question 6

The majority of candidates correctly used a Poisson Distribution, though the correct mean was not always used. In part **(i)(a)** some candidates correctly found the probability of one or more cars travelling east, and the probability of one or more cars travelling west, but then failed to combine the two or incorrectly combined by adding their two probabilities (resulting in a probability greater than one). Other candidates incorrectly combined the means initially and used a mean of 3.25 (or even 13) in part **(a)** to find the probability. Another error seen, on occasions, was to calculate 1 – P(0) – P(1), rather than 1 – P(0). Part **(i)(b)** was particularly well attempted with a large number of candidates reaching the correct answer of 0.835. Many candidates used the correct method of solution in part **(ii)** and found the probability using a Normal approximation. The correct mean was usually used, though not always the correct variance, and other errors resulted from omission of a continuity correction or use of an incorrect one.

Answers: **(i)(a)** 0.617, **(b)** 0.835; **(ii)** 0.0593.

Question 7

This was a particularly well attempted question with a high proportion of candidates scoring very well. Attempts at integration on all three parts were, in general, very good. The value of *k* in part **(i)** was usually convincingly shown. Part **(ii)** produced the highest level of error with candidates using incorrect limits (integration between 0 and 1 was a common misconception) and some candidates left their answer as a probability rather than a number of days, or confused days with hours. The usual errors were seen in part **(iii)** with candidates attempting to find the median rather than the mean, and on occasions poor attempts at the integration were noted by Examiners, though this was only in a minority of cases. Other algebraic errors in removing brackets or attempting to include *x* within the brackets were seen. Some candidates attempted the integration in part **(iii)** by parts or substitution, and these solutions were relatively successful.

Answers: **(ii)** 104 or 105; **(iii)** 5.14.