1. Rearrange the equation $5c + 9t = a(2c + t)$ to make c the subject.

[4]

2. A circle has diameter d, circumference C, and area A. Starting with the standard formulae for a circle, show that $Cd = kA$, finding the numerical value of k.

[3]

3. Rearrange the following formula to make r the subject, where $r > 0$.

$$V = \frac{1}{3}\pi r^2(a + b)$$

[3]

4. Make a the subject of $3(a + 4) = ac + 5f$.

[4]

5. You are given that $a = \frac{3c+2a}{2c-5}$. Express a in terms of c.

[4]

6. Find the coordinates of the point of intersection of the lines $2x + 3y = 12$ and $y = 7 - 3x$.

[4]

7. Find the coordinates of the point of intersection of the lines $2x + 5y = 5$ and $x - 2y = 4$. [4]

8. Rearrange the formula $r = \sqrt{\frac{V}{a+b}}$ to make b the subject. [4]

9. Find the set of values of k for which the equation $2x^2 + kx + 8 = 0$ has distinct real roots. [3]

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

Find the set of values of x for which the line $y = 5x - 6$ lies below the curve $y = x^2$.

[4]

END OF QUESTION paper

Mark scheme

Question			Answer/Indicative content	Marks	Part marks and guidance	
1			$5c + 9t = 2ac + at$	M1	for correct expansion of brackets	
			$5c - 2ac = 9t$ oe	M1	for correct collection of terms, ft eg after M0 for $5c + 9t = 2ac + t$ allow this M1 for $5c - 2ac = -8t$ oe	for each M, ft previous errors if their eqn is of similar difficulty;
			$c(5 - 2a) = at - 9t$ oe	M1	for correctly factorising, ft; must be $c \times$ a two-term factor	may be earned before t terms collected
			$[c =]\ \dfrac{at - 9t}{5 - 2a}$ or $\dfrac{t(a - 9)}{5 - 2a}$ oe as final answer	M1	for correct division, ft their two-term factor **Examiner's Comments** A good number were successful in the rearrangement, but some very poor work was also seen, revealing fundamental misconceptions about algebraic manipulation. Common errors included dividing some terms by a but not others, and confusion of division and subtraction.	treat as MR if t is the subject, with a penalty of 1 mark from those gained, marking similarly
			Total	4		
2			obtaining a correct relationship in any 3 of C, d, r and A or obtaining a correct relationship in k and no more than 2 other variables	M2	may substitute into given relationship; or M1 for at least two of $A = \pi r^2$, $C = \pi d$, $C = 2\pi r$, $d = 2r$ or $r = \dfrac{d}{2}$ seen or used	eg M2 for $Cd = 4\pi r^2$ or $\pi d^2 = k\pi r^2$ seen/obtained condone eg Area = πr^2; allow $A = \pi\left(\dfrac{d}{2}\right)^2$ to imply $A = \pi r^2$ and $r = \dfrac{d}{2}$ and so earn M1, if M2 not earned
			convincing argument leading to $k = 4$	A1	must be from general argument, not just substituting values for r or d; may start from given relationship and derive $k = 4$ **Examiner's Comments** Many candidates did not know where to start. Having picked up on the keyword 'circle' many just wrote down the general equation of a circle and nothing else, or offered no response at all. For some	eg M1only for eg $A = \pi r/2$ and $C = \pi d$ and so $k = 4$ with no further evidence

					candidates, lack of real understanding of algebra meant that when confronted with a different style of question they were unable to find an appropriate strategy. Some students did not remember the required circle formulae, eg $A = 2\pi$ was not uncommon. Those starting with the given form $Cd = kA$ and putting in the correct formulae were often most successful. The squaring of $\frac{d}{2}$ formulae were often most successful. The squaring of $\frac{d^2}{2}$ leading to $k = 2$. Many had several attempts at this question and solutions were often scrappily presented and difficult to follow.	
			Total	3		
3			$r = \sqrt{\frac{3V}{\pi(a+b)}}$ oe www as final answer	3	M1 for dealing correctly with 3 and M1 for dealing correctly with $\pi(a + b)$, ft and M1 for correctly finding square root, ft *their* 'r^2 ='; square root symbol must extend below the fraction line **Examiner's Comments** There were many good answers in rearranging the formula. Most candidates managed at least one mark; some triple-decker fractions or the use of ÷ signs were seen. The π and the $(a + b)$ sometimes became separated. The radius was sometimes considered to be ±, and the > sign was used on more than one occasion. It was encouraging to see very few penalties incurred due to a poor square root symbol.	M0 if triple-decker fraction, at the stage where it happens, then ft; condone missing bracket at rh end M0 if ±... or r >... for M3, final answer must be correct
			Total	3		
4			$3a + 12$ [$= ac + 5f$]	M1	for expanding brackets correctly	annotate this question if partially correct
			$3a - ac = 5f - 12$ or ft	M1	for collecting a terms on one side, remaining terms on other	ft only if two a terms
			$a(3 - c) = 5f - 12$ or ft	M1	for factorising a terms; may be implied by final answer	ft only if two a terms, needing factorising may be earned before 2nd M1

			$[a =]\frac{5f-12}{3-c}$ oe or ft as final answer	M1	for division by their two-term factor; for all 4 marks to be earned, work must be fully correct **Examiner's Comments** Rearranging the formula was usually done well. Those who found this difficult generally attempted to isolate just one a term and hence scored only the first mark. Other errors seen occasionally included sign errors and a final spoiling of the answer by invalidly 'cancelling' 3 into 12.	
			Total	4		
5			$a(2c-5) = 3c + 2a$ or $2ac - 5a = 3c + 2a$	M1	for multiplying up correctly (may also expand brackets)	annotate this question if partially correct
			$a(2c-5) - 2a = 3c$ or $2ac - 7a = 3c$ or ft	M1	for collecting *a* terms on one side, remaining term[s] on other [need not be simplified]	ft only if two or more *a* terms,
			$a(2c-7) = 3c$ or ft	M1	for factorising *a* terms, need not be simplified; may be implied by final answer	ft only if two or more a terms, needing factorising may be earned before 2nd M1 candidates whose final answer expresses *c* in terms of *a:* treat as MR after the first common M and mark equivalently, applying MR–1 if they gain further Ms. So that a final answer, correctly obtained, of $[c =]\frac{7a}{2a-3}$ or simplified equivalent earns 3 marks in total
			$[a =]\frac{3c}{2c-7}$ or simplified equivalent or ft as final answer	M1	for division by their two-term factor (accept a 3 term factor that would simplify to 2 terms); for all 4 marks to be earned, work must be fully correct and simplified and not have a triple-or quadruple-decker answer	**Examiner's Comments** The majority of the candidates were very familiar with the topic of rearranging to make a different variable the subject of a formula, and coped well with this example. Nearly all candidates correctly multiplied by $(2c-5)$ to give $a(2c-5) = 3c + 2a$. However it was surprising that a large number of candidates went on to make *c* rather than *a* the subject of the formula (albeit the majority did this correctly and scored 3 of the 4 marks available). Where errors occurred it was usually sign errors

						from moving terms from one side to the other and a small minority did not simplify their answers fully, giving say an answer of $a = 3c / (2c - 5 - 2)$. It was pleasing to see that the majority of candidates correctly factorised their a (or c) terms as this has in the past caused issues.
			Total	4		
6			substitution to eliminate one variable	M1	or multiplication or division to make one pair of coefficients the same; condone one error in either method	
			simplification to $ax = b$ or $ax - b = 0$ form, or equivalent for y		or appropriate subtraction / addition; condone one further error in either method	independent of first M1
			(9/7, 22/7) oe or $x = 9/7$ $y = 22/7$ oe isw	A2	**A1** each	A0 for just rounded decimals or for −9 / −7 oe **Examiner's Comments** This was a good source of marks for the majority of candidates, who found the demand of solving a pair of simultaneous equations relatively straightforward, although errors in coping with the fractional answer to x to find the y-value were quite common, as was occasionally forgetting to find the y-value. Very few candidates found the y-value first. Those who used substitution and wrote down $2x + 3(7 - 3x) = 12$ nearly always went on to get the correct answer for x - although it was particularly disheartening the number of times that $7x = 9$ became $x = 7/9$. Those who substituted for y and had $y = 7 - 3((12 - 3y)/2)$ were usually less successful, due to the fraction and the number of negative terms in the equation. Elimination methods were less frequently seen and not as successful - candidates often did not multiply all values by the required constant or they added or subtracted their pair of equations incorrectly.
			Total	4		

7			$2(4 + 2y) + 5y = 5$ oe in x or $2x - 4y = 8$ oe $9y = -3$ or $9x = 30$ oe $\left(\frac{30}{9}, -\frac{3}{9}\right)$ oe isw	M1 M1 A2 [4]	for subst to eliminate one variable; condone one error; or for multn or divn of one or both eqns to get a pair of coeffts the same, condoning one error for collecting terms and simplifying; condoning one error ft or for appropriate addn or subtn to eliminate a variable, condoning an error in one term; if subtracting, condone eg x instead of 0 if no other errors or $x = 30/9$, $y = -3/9$ oe isw eg $x = 10/3$, $y = -1/3$ allow **A1** for each coordinate	

					Examiner's Comments Candidates coped very well with equation and fraction manipulation. Both method marks were nearly always earned. A variety of methods were used with the substitution of $x = 2y + 4$ into the first equation being the most common. Some multiplied both equations, in order to be able to use elimination. Where the second equation was multiplied by 2 there were some errors in subtracting the equations. Rearranging both equations to get x =… or y =… and then equating the results was also fairly common and, even though this resulted in fractions, was usually successful. However, handling the signs when rearranging the second equation was a source of error. A minority of candidates stopped after finding one of the values (usually y) and failed to find the coordinates, as requested in the question. It should be noted that very few candidates checked their answers and it is advisable to do so in questions of this nature.	
			Total	4		
8			$r^2 = \frac{V}{a+b}$ $r^2(a+b) = V$ or $r^2a + r^2b = V$ $r^2b = V - r^2a$ or $a + b = \frac{V}{r^2}$	M1 M1 M1 M1	each M1 is for a correct, constructive step following through correctly from previous step for squaring both sides for multiplying both sides by denominator for this and all subsequent Ms, ft for equiv // allow candidates to combine two or three stages in one working statement eg award first two Ms for $r^2(a+b) = V$ seen as	

<table>
<tr><td></td><td></td><td></td><td>$b = \frac{V - r^2 a}{r^2}$ or $b = \frac{V}{r^2} - a$
as final answer</td><td>[4]</td><td><table><tr><td>difficulty</td><td>first step</td></tr><tr><td>for getting b term on one side, other terms on other side

for dividing by coefficient of b

award 4 marks only if working is fully correct, with at least one interim step. Allow SC2 if there is no working, just the correct answer</td><td>3rd and 4th M1s may be earned in opposite order, as in second answer for these M1s

where rhs has two terms in the numerator, the division line must clearly extend under both terms</td></tr></table>
Examiner's Comments

There were many candidates who found the new subject both efficiently and accurately. It was rare to find a candidate who didn't know to square both sides straight away but there were a very small minority who went off the rails at that point, not coping with the a + b as a denominator. A small minority of candidates solved for a instead of b. There were a handful of candidates who insisted on using a diagonal fraction line instead of a horizontal one and this lead to algebraic missteps when manipulating the algebra. A common error was to take the correct answer of $b = \frac{V - r^2 a}{r^2}$ and cancel this incorrectly to b = V − a. .</td><td></td></tr>
</table>

			Total	4		
9			Discriminant $k^2 - 4 \times 2 \times 8 > 0$ $k > 8$ or $k < -8$	M1 (AO 1.1a) A1 (AO 1.1b) A1 (AO 1.1b) [3]	May be implied by $k^2 > 64$ oe without working; allow for ≥ used oe oe	Allow as part of the quadratic formula
			Total	3		
10			DR $x^2 > 5x - 6$ $x^2 - 5x + 6 > 0$ $(x - 2)(x - 3) > 0$ $x < 2$ or $x > 3$	M1(AO 3.1a) M1(AO 1.1) A1(AO 1.1) A1(AO 2.2a) [4]	Correct factors or values 2, 3 oe, e.g. $\{x : x < 2 \cup x > 3\}$	
			Total	4		