Edexcel GCSE

Mathematics

Higher Tier

Number: Surds

Information for students

The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 15 questions in this selection.

Advice for students

Show all stages in any calculations.
Work steadily through the paper. Do not spend too long on one question.
If you cannot answer a question, leave it and attempt the next one.
Return at the end to those you have left out.

Information for teachers

The questions in this document are taken from the 2009 GCSE Exam Wizard and include questions from examinations set between January 2003 and June 2009 from specifications 1387, 1388, 2540, 2544, 1380 and 2381.

Questions are those tagged as assessing “Surds” though they might assess other areas of the specification as well. Questions are those tagged as “Higher” so could have (though not necessarily) appeared on either an Intermediate or Higher tier paper.

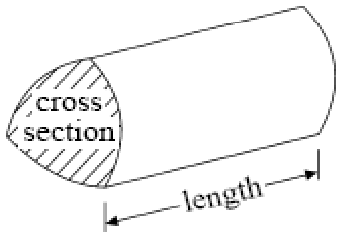
GCSE Mathematics

Formulae: Higher Tier

You must not write on this formulae page.

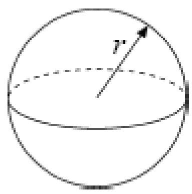
Anything you write on this formulae page will gain NO credit.

Volume of prism = area of cross section × length



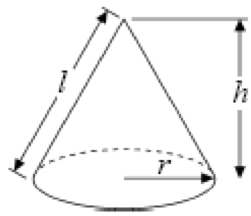
Volume of sphere $\frac{4}{3}\pi r^3$

Surface area of sphere = $4\pi r^2$

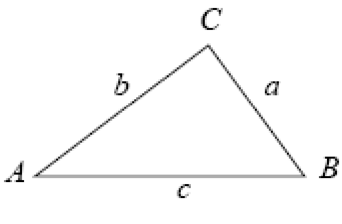


Volume of cone $\frac{1}{3}\pi r^2 h$

Curved surface area of cone = πrl



In any triangle ABC



Sine Rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Cosine Rule $a^2 = b^2 + c^2 - 2bc \cos A$

Area of triangle = $\frac{1}{2}ab \sin C$

The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$

where $a \neq 0$, are given by

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

1. (a) Write down the exact value of 3^{-2}

....

(1)

(b) Simplify fully $\dfrac{7^2 \times 7^4}{7^3}$

....

(2)

(c) Expand $(2+\sqrt{3})(1+\sqrt{3})$

Give your answer in the form $a+b\sqrt{3}$, where a and b are integers.

....

(2)

(Total 5 marks)

2. Work out

$$\frac{(5+\sqrt{3})(5-\sqrt{3})}{\sqrt{22}}$$

Give your answer in its simplest form.

....

(Total 3 marks)

3. (a) Evaluate

(i) 3^{-2}

....

(ii) $36^{\frac{1}{2}}$

....

(iii) $27^{\frac{2}{3}}$

....

(iv) $\left(\frac{16}{81}\right)^{-\frac{3}{4}}$

....

(5)

(b) (i) Rationalise the denominator of $\dfrac{21}{\sqrt{7}}$ and simplify your answer.

....

(ii) Expand $\left(\sqrt{5}+2\sqrt{3}\right)\left(\sqrt{5}-2\sqrt{3}\right)$
Express your answer as simply as possible.

....

(4)
(Total 9 marks)

4. (a) Find the value of $16^{\frac{1}{2}}$

....

(1)

(b) Given that $\sqrt{40} = k\sqrt{10}$, find the value of *k*.

....

(1)

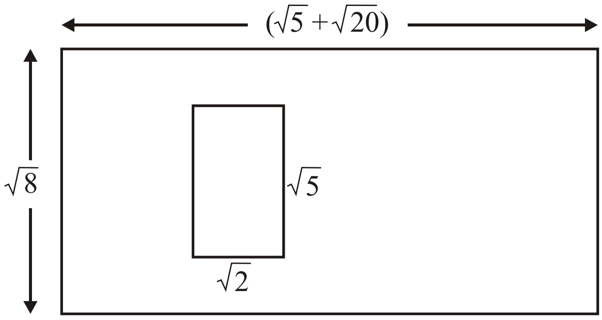


Diagram **NOT** accurately drawn

A large rectangular piece of card is ($\sqrt{5}+\sqrt{20}$) cm long and $\sqrt{8}$ cm wide.

A small rectangle $\sqrt{2}$ cm long and $\sqrt{5}$ cm wide is cut out of the piece of card.

(c) Express the area of the card that is left as a percentage of the area of the large rectangle.

..................................%

(4)

(Total 6 marks)

5. (a) Express $\frac{6}{\sqrt{2}}$ in the form $a\sqrt{b}$, where a and b are positive integers.

....
(2)

The diagram shows a right-angled isosceles triangle.

The length of each of its equal sides is $\frac{6}{\sqrt{2}}$ cm.

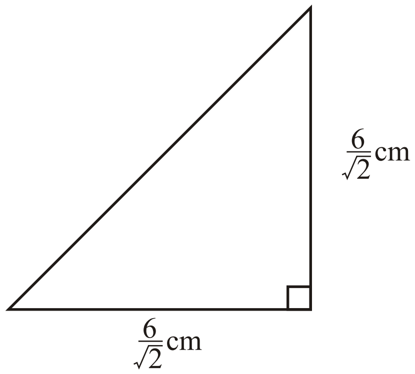


Diagram **NOT** accurately drawn

(b) Find the area of the triangle.
Give your answer as an integer.

.... cm^2
(2)
(Total 4 marks)

6. (a) Find the value of

(i) 64°

………………………..

(ii) $64^{\frac{1}{2}}$

……………………….

(iii) $64^{-\frac{2}{3}}$

……………………….

(4)

(b) $3 \times \sqrt{27} = 3^n$

Find the value of n.

n = ……………

(2)

(Total 6 marks)

7. (a) Rationalise

$$\frac{1}{\sqrt{7}}$$

....

(2)

(b) (i) Expand and simplify

$$(\sqrt{3} + \sqrt{15})^2$$

Give your answer in the form $n + m\sqrt{5}$, where n and m are integers.

....

(ii)

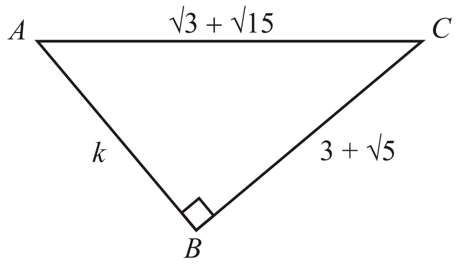


Diagram **NOT** accurately drawn

All measurements on the triangle are in centimetres.

ABC is a right-angled triangle.
k is a positive integer.

Find the value of k.

k = ...

(5)
(Total 7 marks)

8.

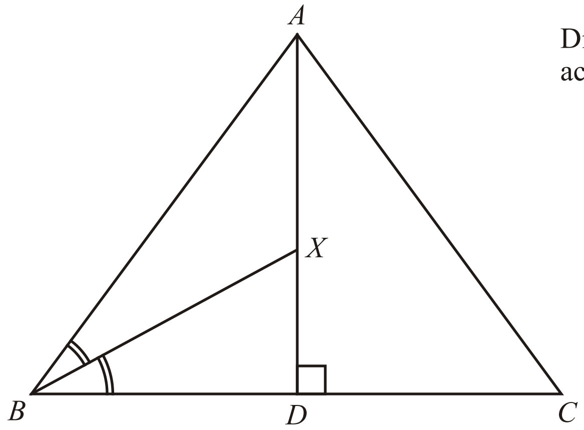


Diagram **NOT** accurately drawn

ABC is an equilateral triangle.
AD is the perpendicular bisector of *BC*.
BX is the angle bisector of angle *ABC*.

(a) Show that triangle *BXD* is similar to triangle *ACD*.

(2)

In triangle ACD,
$AC = 2$ cm,
$AD = \sqrt{3}$ cm.

(b) Show that $XD = \dfrac{1}{\sqrt{3}}$ cm.

(3)
(Total 5 marks)

9. (a) Write down the value of $8^{\frac{1}{3}}$

....
(1)

$8\sqrt{8}$ be written in the form 8^k

(b) Find the value of k.

k = ...
(1)

$8\sqrt{8}$ can also be expressed in the form $m\sqrt{2}$ where m is a positive integer.

(c) Express $8\sqrt{8}$ in the form $m\sqrt{2}$

....
(2)

(d) Rationalise the denominator of $\dfrac{1}{8\sqrt{8}}$

Give your answer in the form $\dfrac{\sqrt{2}}{p}$ where p is a positive integer.

....

(2)

(Total 6 marks)

10. Expand and simplify $\left(\sqrt{3}-\sqrt{2}\right)\left(\sqrt{3}+\sqrt{2}\right)$

....

(Total 2 marks)

11. (a) Rationalise the denominator of $\dfrac{1}{\sqrt{3}}$

....

(1)

(b) Expand $(2+\sqrt{3})(1+\sqrt{3})$

Give your answer in the form $a+b\sqrt{3}$ where a and b are integers.

....

(2)
(Total 3 marks)

12. (a) Write down the value of $49^{\frac{1}{2}}$

....

(1)

(b) Write $\sqrt{45}$ in the form $k\sqrt{5}$, where k is an integer.

....

(1)
(Total 2 marks)

13.

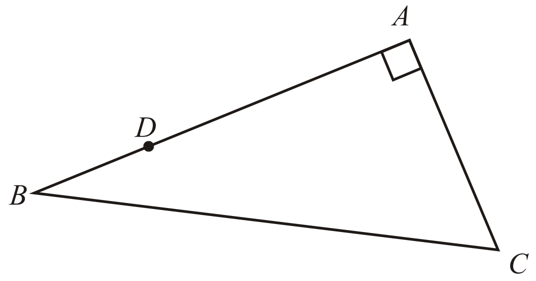


Diagram **NOT** accurately drawn

ABC is a right angled triangle.
D is the point on AB such that $AD = 3DB$.
$AC = 2DB$ and angle $A = 90°$.

Show that $\sin C = \frac{k}{\sqrt{20}}$, where k is an integer.

Write down the value of k.

k = ...

(Total 4 marks)

14. Write $\dfrac{\sqrt{18}+10}{\sqrt{2}}$ in the form $p + q\sqrt{2}$, where p and q are integers.

p = ..………..

q = …………

(Total 2 marks)

15. Expand and simplify

$(2 + \sqrt{3})(7 - \sqrt{3})$

Give your answer in the form $a + b\sqrt{3}$, where a and b are integers.

....

(Total 3 marks)

01. (a) $\dfrac{1}{9}$ 1

B1 for $\dfrac{1}{9}$ *(accept 0.1 recurring)*

(b) $\frac{7^6}{7^3}$ 2

7^3

M1 for $\frac{7^{2+4}}{7^3}\left(\frac{7^6}{7^3}\right)$ *or* $\frac{7^4}{7^{4-3}}\left(\frac{7^4}{7}\right)$ *or* $\frac{7^2}{7^{3-4}}\left(\frac{7^2}{7^{-1}}\right)$

A1 for 7^3 *(accept 343)*

(c) $2\times1+2\times\sqrt{3}+1\times\sqrt{3}+\sqrt{3}\times\sqrt{3}$ 2

$5+3\sqrt{3}$

M1 for $2\times1+2\times\sqrt{3}+1\times\sqrt{3}+\sqrt{3}\times\sqrt{3}$

A1 for $5+3\sqrt{3}$ *cao*

[SC: B1 for $a+3\sqrt{3}$ *or* $5+b\sqrt{3}$ *if M0 scored]*

[5]

02. $\sqrt{22}$ 3

$\left(5+\sqrt{3}\right)\left(5-\sqrt{3}\right)=5\times5-5\sqrt{3}+5\sqrt{3}-\sqrt{3}\sqrt{3}=5\times5-3$

$\frac{22}{\sqrt{22}}=\frac{22\sqrt{22}}{22}$

B1 for correct expansion $25-5\sqrt{3}+5\sqrt{3}-\sqrt{3}\ \sqrt{3}$ *with* 1^{st} *three terms reducing to 25* ***without*** *any errors seen*

B1 (indep) for $\sqrt{3}\ \sqrt{3}=3$

B1 for $\sqrt{22}$ *coming from* $\frac{22}{\sqrt{22}}$

(S.C $\frac{(5+\sqrt{3})(5-\sqrt{3})\sqrt{22}}{22}$ *gets B1)*

[3]

03. (a) (i) $\frac{1}{9}$ 5

B1 cao

(ii) 6

B1 cao

(iii) 9

B1 cao

(iv) $\frac{27}{8}$ oe

$\left(\frac{2}{3}\right)^{-3} = \left(\frac{3}{2}\right)^{3}$

B2 for $\frac{27}{8}$ *oe*

(B1 for $\left(\frac{81}{16}\right)^{\frac{3}{4}}$ *or* $\left(\frac{2^3}{3^3}\right)^{-1}$ *or* $\left(\frac{2}{3}\right)^{-3}$ *or* $\left(\frac{3}{2}\right)^{3}$ *or better) or*

$\frac{1}{\frac{8}{27}}$ *or* $\frac{8}{27}$

(b) (i) $3\sqrt{7}$ 4

$\frac{21\sqrt{7}}{\sqrt{7}\times\sqrt{7}}$

M1 for $\frac{21\sqrt{7}}{\sqrt{7}\times\sqrt{7}}$

A1 cao

(ii) -7

$5 + 2\sqrt{3}\sqrt{5} - 2\sqrt{3}\sqrt{5} - 12$

M1 for correct expansion with at least one non zero integer term or 3 of our 4 terms correct and slip in 4^{th} ; or for $5 + k - k - 12$ where k is a surd

A1 for -7 with no error seen

[9]

04. (a) 4 — 1

B1 for 4 condone ± 4

(b) 2 — 1

B1 for 2 condone ± 2

(c) $\frac{500}{6}$ — 4

$\sqrt{160} = 4\sqrt{10}$;

$$\left[\frac{\sqrt{8}\left(\sqrt{5}+\sqrt{20}\right)-\sqrt{2}\times\sqrt{5}}{\sqrt{8}\left(\sqrt{5}+\sqrt{20}\right)}\right]\times 100$$

$$\left[\frac{6\sqrt{10}-\sqrt{10}}{6\sqrt{10}}\right]\times 100$$

B1 for ***either*** *$\sqrt{160} = 4\sqrt{10}$ or $\sqrt{8} = 2\sqrt{2}$* ***or*** *$\sqrt{20} = 2\sqrt{5}$*

M1 for $\left[\frac{\sqrt{8}\left(\sqrt{5}+\sqrt{20}\right)-\sqrt{2}\times\sqrt{5}}{\sqrt{8}\left(\sqrt{5}+\sqrt{20}\right)}\right]$ oe (× 100)

B1 for either $6\sqrt{10} - \sqrt{10}$ or $6\sqrt{10}$

A1 for $\frac{500}{6}$ (accept 83.3 if no obvious earlier error)

[6]

05. (a) $3\sqrt{2}$ — 2

$$\frac{6}{\sqrt{2}}\times\frac{\sqrt{2}}{\sqrt{2}} = \frac{6\sqrt{2}}{2} =$$

M1 for sight of multiplying top and bottom by $\sqrt{2}$ or $\sqrt{\frac{36}{2}}$

A1 for $3\sqrt{2}$ oe

(b) 9 — 2

$$\frac{1}{2}\times\frac{6}{\sqrt{2}}\times\frac{6}{\sqrt{2}} = \frac{36}{4} =$$

M1 for $\frac{1}{2}\times\frac{"6"}{\sqrt{2}}\times\frac{"6"}{\sqrt{2}}$ oe ft where $\frac{6}{\sqrt{2}}$ is in form $a\sqrt{b}$
where $\sqrt{b}$ is irrational
A1 for 9 cao

[4]

06. (a) (i) 1 — 1

B1 cao

(ii) 8 — 1

B1 cao

(iii) $\frac{1}{16}$ — 2

$64^{-\frac{2}{3}} = \frac{1}{64^{\frac{2}{3}}}$ or $64^{-\frac{2}{3}} = (4^2)^{-1}$

M1 for knowing negative power is a reciprocal or power of $\frac{1}{3}$ root is a cube root

A1 cao for $\frac{1}{16}$

(b) $\frac{5}{2}$ oe — 2

$\sqrt{27} = \sqrt{9 \times 3}$ or $\sqrt{27} = 3\sqrt{3}$ or $\sqrt{27} = 3^{3/2}$

M1 for $\sqrt{27} = \sqrt{9 \times 3}$ or $\sqrt{27} = 3^{3/2}$

A1 for $\frac{5}{2}$ oe (cao)

Alternative method

M1 for $9 \times 27 = 3^{2n}$

A1 for $\frac{5}{2}$ oe (cao)

[6]

07. (a) $\frac{1}{\sqrt{7}} \times \frac{\sqrt{7}}{\sqrt{7}}$

$\frac{\sqrt{7}}{7}$ — 2

M1 $\frac{1}{\sqrt{7}} \times \frac{\sqrt{7}}{\sqrt{7}}$

A1 cao

(b) (i) $3 + 15 + 2\sqrt{(3 \times 15)}$
$18 + 2\sqrt{45}$
$18 + 6\sqrt{5}$
$18 + 6\sqrt{5}$ 5

M1 for $(\sqrt{3})^2 + (\sqrt{15})^2 + \sqrt{3} \times \sqrt{15} + \sqrt{15} \times \sqrt{3}$
A1 $18 + 2\sqrt{45}$
B1 for $18 + 6\sqrt{5}$

(ii) $(3 + \sqrt{5})^2 = 9 + 5 + 6\sqrt{5} = 14 + 6\sqrt{5}$
$(\sqrt{3} + \sqrt{15})^2 - (3 + \sqrt{5})^2 = 18 + 6\sqrt{5} - (14 + 6\sqrt{5}) = 4$
2

M1 for correct expansion of $(3 + \sqrt{5})^2$ *to* $3^2 + (\sqrt{5})^2 + 3\sqrt{5} + 3\sqrt{5}$
A1 cao

[7]

08. (a) Angle BDX = angle ADC = 90°
Angle BXD = angle ACD = 60°
Hence similar 2

B2 for 2 of (Angle BDX = angle ADC, Angle BXD = angle ACD, angle DAC = angle DBX)
B1 for 1 of the above

(b) $\frac{XD}{DC} = \frac{BD}{AD}, DC = BD = 1$ 3

M1 $\frac{XD}{DC} = \frac{BD}{AD}$ *or* $\frac{XD}{BD} = \frac{DC}{AD}$ *or a statement that ACD is an enlargement of BDX, scale factor* $\sqrt{3}$
A1 $\frac{XD}{1} = \frac{1}{\sqrt{3}}$
A1 $XD = \frac{1}{\sqrt{3}}$

[5]

09. (a) 2 1

B1 cao

(b) 1.5 — 1

B1 1.5 oe

(c) $8 \times \sqrt{4} \times \sqrt{2}$

$16\sqrt{2}$ — 2

M1 $(\sqrt{8} =)\sqrt{4 \times 2}$ *or* $\sqrt{2} \times \sqrt{2} \times \sqrt{2}$ *or* $\left(2^3\right)^{\text{"}\frac{3}{2}\text{"}}$

A1 for $16\sqrt{2}$ *(accept m=16)*

(d) $\frac{1}{8\sqrt{8}} \times \frac{\sqrt{8}}{\sqrt{8}}$

$= \frac{\sqrt{8}}{64} = \frac{\sqrt{2}}{32}$

$\frac{\sqrt{2}}{32}$ — 2

M1 $\frac{1}{8\sqrt{8}} \times \frac{\sqrt{8}}{\sqrt{8}}$ *or* $\frac{1}{8\sqrt{8}} \times \frac{8\sqrt{8}}{8\sqrt{8}}$ *or* $\frac{1}{\text{"}16\sqrt{2}\text{"}} \times \frac{\sqrt{2}}{\sqrt{2}}$ *oe*

or $\frac{1}{8\sqrt{8}} \times \frac{\sqrt{2}}{\sqrt{2}}$

A1 for $\frac{\sqrt{2}}{32}$ *(accept p = 32)*

[6]

10. $\left(\sqrt{3}\right)^2 + \sqrt{3}\sqrt{2} - \sqrt{3}\sqrt{2} - \left(\sqrt{2}\right)^2$

$= 3 - 2$

$= 1$ — 2

B2 cao

(B1 for $\sqrt{3}\sqrt{3} + \sqrt{3}\sqrt{2} - \sqrt{3}\sqrt{2} - \sqrt{2}\sqrt{2}$ *oe,*

$\sqrt{3}\sqrt{3} - \sqrt{2}\sqrt{2}$ *oe,*

or for 2, 3, $\sqrt{4}\sqrt{6}\sqrt{9}$ *seen)*

[2]

11. (a) $\frac{1}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$

$\frac{\sqrt{3}}{3}$ 1

B1 for $\frac{\sqrt{3}}{3}$ *or* $\frac{k\sqrt{3}}{3k}$ *or* $\frac{\sqrt{3k^2}}{3k}$*, where k is an integer not equal to 0*

(accept $\frac{1\sqrt{3}}{3}, \frac{\sqrt{1}\sqrt{3}}{3}$ *or* $\frac{3^{0.5}}{3}$*)*

(b) $2 \times 1 + 2 \times \sqrt{3} + 1 \times \sqrt{3} + \sqrt{3} \times \sqrt{3}$

$5 + \sqrt{3}$ 2

M1 for $2 \times 1 + 2 \times \sqrt{3} + 1 \times \sqrt{3} + \sqrt{3} \times \sqrt{3}$ *or three of 2,* $2\sqrt{3}, \sqrt{3}, \sqrt{9}$ *, (or 3 or* $\sqrt{3^2}$ *or* $(\sqrt{3})^2$*)*

A1 for $5 + 3\sqrt{3}$ *cao*

(SC: B1 for $a + 3\sqrt{3}$ *or* $5 + b\sqrt{3}$ *if M0 scored, where a and b are integers not equal to 0)*

[3]

12. (a) 7 1

B1 for 7 (accept –7 or ±7)

(b) $3\sqrt{5}$ 1

B1 cao

[2]

13. Let DB = x, then AD = $3x$

And AC = $2x$

BC = $\sqrt{((4x)^2 + (2x)^2)} = \sqrt{20}x$

Sin $C = 4x / \sqrt{20}x$

Sin $C = 4/\sqrt{20}$ 4

M1 for correct ratio of AC and AB [4x and 2x]

M1 for correct use of pythagoras

A1 for BC = $\sqrt{20}\,x$

A1 for completion of proof

SC: B1 for k = 4

[4]

14. $3 + 5\sqrt{2}$ 2

$\frac{\sqrt{18}+10}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = \frac{\sqrt{36}+10\sqrt{2}}{2}$

M1 for multiplying by $\frac{\sqrt{2}}{\sqrt{2}}$ *or* $\frac{\sqrt{2\times 9}+\sqrt{2\times 50}}{\sqrt{2}}$

A1 for p = 3 and q = 5 or $3 + 5\sqrt{2}$

(SC:B1 for p = 3 ***or*** *q = 5)*

[2]

15. $2 \times 7 - 2 \times \sqrt{3} + 7 \times \sqrt{3} - \sqrt{3} \times \sqrt{3} =$

$14 + 5\sqrt{3} - 3$

$11 + 5\sqrt{3}$ 3

M1 for exactly 3 or exactly 4 terms correct including correct signs or all 4 terms correct with wrong signs.

M1(dep) for either collecting their two or three terms in $\sqrt{3}$ *or for* $\sqrt{3} \times \sqrt{3} = 3$

A1 cao

[3]

01. In part (a), only a minority of candidates showed any understanding of negative indices; ±9 and –6 being the most common answers. Many candidates, in part (b), gained at least one mark for writing 3677however a great many went on to simplify this incorrectly to 7^2. Some weaker candidates wrote $\frac{49^6}{7^3}$, whilst others tried to evaluate each of the powers of 7 and then wasted valuable trying to compute a solution using long multiplication and division. A correct answer of 343 would have gained full marks but this was rarely the result of this method.

In part (c), many candidates correctly expanded the brackets but then failed to accurately collect resulting terms. Answers of 3 (2 × 1) and √6 (2 × √3) were common errors in the expansion.

02. Mathematics A Paper 5

Although many candidates gained partial credit for their solution to this surds question, it was only a minority of candidates who went beyond $\frac{22}{\sqrt{22}}$ by rationalising the denominator to reach the final correct answer.

Mathematics B Paper 18

It was pleasing to see a number of candidates getting as far as 22/⌦22. This was, however, then rarely simplified to ⌦22. The most frequently seen errors in this question came from the belief of some candidates that 5 × ⌦3 = ⌦15. A number of candidates left ⌦3 × ⌦3 or ⌦9 in their answers.

03. In part (a) although many candidates gained some credit, it was rare to find correct answers to all four parts. A common error in (iii) and (iv) was to use the numerator of the index as a multiplier rather than a power which led to the wrong answers 6 and 4.5 respectively. In part (b)(i), some candidates just multiplied the denominator by $\sqrt{7}$ to get the wrong answer 3 or started the solution by squaring the given expression to eliminate the square root. Some better candidates gained the method mark for multiplying both the numerator and the denominator by $\sqrt{7}$ but then failed to simplify $\frac{21\sqrt{7}}{7}$. Many of the candidates who correctly expanded the brackets in part (b)(ii) failed to correctly simplify the resulting surds to –7. Only a small minority immediately saw it as a difference of two squares.

04. **Mathematics A Paper 5**

This surds question was poorly answered with many not even able to answer parts (a) and (b) correctly. The most common wrong answers were 8 (from half of 16) and 4 (by ignoring the square roots) respectively. Part (c) was beyond the ability of most of the candidates although some excellent elegant solutions were seen. Those candidates who applied the idea of part (b) to part (c) generally gained some credit but for most, solutions consisted of ignoring the square root signs at the first opportunity or writing "$\sqrt{5}+\sqrt{20}=\sqrt{25}$ "

Mathematics B Paper 18

Part (a) was usually correct although there was little evidence of understanding or technique in part (b). A common error in (c) was to write $\sqrt{20}$ + $\sqrt{5}$ as $\sqrt{25}$ and $\sqrt{200}$ – $\sqrt{10}$ as $\sqrt{190}$. Only a very few candidates were able to write down a fully correct method. Even fewer candidates were able to simplify their expressions containing surds to give a fully correct solution.

05. Only about 35% of candidates could fully rationalise the denominator in part (a) of this uncomplicated surd question with nearly 60% of candidates scoring no marks. In part (b) candidates were a little more successful with 40% gaining the correct solution and a further 24% able to write down an expression for the area of the triangle.

06. Specification A

Parts (a)(i) and a(ii) were generally done well, and many candidates scored one mark in part (a)(iii). A common incorrect answer for part (a)(i) was 0, and for part (a)(ii) was 32. Many candidates scored a mark in part (a)(iii) for writing $\sqrt[3]{64}$, or for expressing the negative power as a reciprocal.
Very few candidates were able to achieve full marks for part (b), but many scored a mark for attempting to deal with $\sqrt{27}$. Candidates often failed to combine indices in the final stages of their work- thus 1.5 was a common answer.

Specification B

Parts (a)(i) and (a)(ii) were answered correctly by about three quarters of candidates. In part (a)(iii) only a very few candidates gained full marks in this question. The majority of candidates were, however, able to gain one out of the two available marks by knowing that $64^{1/3}$ represented the cube root of 64 or that 64^{-1} represented the reciprocal of 64. A common incorrect answer was – 16.
In part (b) only a small minority of candidates were able to offer completely correct solutions to this question. A number of candidates were able to gain some credit by attempting to write 27 in powers of 3. A very few candidates recognised that squaring both sides of the equation was an alternative method of solution.

07. Many candidates knew what to do with the standard part (a). Parts (b) and c) proved to be challenging although the mark scheme was written to reward good attempts. A common error was to write $\sqrt{45} + \sqrt{45} = \sqrt{90}$. In part (c) many candidates obtained the answer k = 2 from the equivalent of $(x + y)2 = x^2 + y^2$.

08. There was a great deal of confusion between conditions for similarity and conditions for congruence., with such ‘explanations’ as ‘Angle, angle, side’ or ‘right angle, hypotenuse and angle’ being quoted. It was a pleasure to see good attempts at part (b), mainly using the similarity established in part (a) but with a few using the fact that tan 30° = $\frac{1}{\sqrt{3}}$ which can be obtained from triangle *ADC.*

09. Specification A

Most candidates had difficulty with this question, but part (a) was well done by about two-thirds of candidates. Common errors were $\frac{8}{3}, \frac{1}{8}$ and 8.333.

Part (b) proved very challenging to most candidates. Not many could express $\sqrt{8}$ as $8^{\frac{1}{2}}$ and use the laws of indices to obtain the answer. In part (c), a some candidates could express $\sqrt{8}$ as $\sqrt{4 \times 2}$, but only a small number of these could express this as $2\sqrt{2}$. A common error was to write $\sqrt{8}$ as $4\sqrt{2}$ and give the final answer as $32\sqrt{2}$. Some candidates who got to $8\sqrt{4 \times 2}$ expressed this as $10\sqrt{2}$. In part (d), about a quarter of the candidates were able to apply the method for rationalising the denominator (usually by multiplying top and bottom by $8\sqrt{8}$) but most were unable to adequately simplify this to the required form. Common incorrect answers were $\frac{\sqrt{2}}{16}$ and $\frac{\sqrt{8}}{64}$

Specification B

In part (a) just over 60% of candidates were able to write down the value of $8^{1/3}$. In part (b) only about 5% of candidates were able to as a power of 8. In part (c) slightly more candidates were. The most common error here was to write $8\sqrt{8}$ as a power of 8. In part (c) slightly more candidates were able to express $8\sqrt{8}$ in the form of $m\sqrt{2}$. The most common error here was to write $\sqrt{8}$ as $2\sqrt{2}$ but then to add the 2 to the original 4 and give the final answer as $10\sqrt{2}$ rather than the correct value of $16\sqrt{2}$. In part (d) very few candidates realised that they had to multiply both the numerator and denominator by a suitable surd. Of those that took the first correct step over half then went onto carry out the subsequent multiplication incorrectly. A significant number of student gave the result of, for example, $8\sqrt{8} \times 8\sqrt{8}$ incorrectly as 64 seemingly cancelling the two $\sqrt{8}$ s rather than multiplying them.

10. Most candidates were able to score at least one mark on this question, usually for dealing correctly with the product of two surds, e.g. $\sqrt{3} \times \sqrt{3} = 3$. The most popular approach was to cancel the brackets conventionally and simplify the middle terms; only the best were able to use the difference of two squares to write down the answer immediately. A common incorrect method was $(\sqrt{3} - \sqrt{2})(\sqrt{3} + \sqrt{2}) = \sqrt{1} \times \sqrt{5}$. A surprising number of candidates gave their final answer as ‘3 − 2’.

11. Many candidates were able to score at least 1 mark in this question. In part (a), only the best candidates realized that they had to multiply both the numerator and the denominator by $\sqrt{3}$. Common incorrect answers here were $\frac{1}{3}$ and $\frac{1}{9}$. A large number of candidates attempted to expand the brackets in part (b), and most were able to score a mark for three correct terms. Common errors here were $(2+\sqrt{3})(1+\sqrt{3}) = 2+\sqrt{6}+\sqrt{3}+\sqrt{9}$ or $3+2\sqrt{3}+\sqrt{3}+\sqrt{9}$ or $2+2\sqrt{3}+\sqrt{3}+\sqrt{3}$

12. A great many candidates showed no understanding of fractional powers in part (a) and answers of 49.5 and 24.5 were very common indeed. In part (b) $9\sqrt{5}$ was the most common answer from candidates showing some knowledge of surds.

13. Very few correct answers were seen. A minority of candidates gained marks for the correct ratio of sides *AB* and *AC*. The idea of a proof seemed beyond the vast majority of candidates. Those who did attempt the question generally tried to find the size of angle *C*.

14. Less than 10% of candidates were able to provide a correct solution to this question. Those who were successful had generally started by multiplying both numerator and denominator of the given fraction by $\sqrt{2}$.

15. There were a refreshing number of correct or nearly correct answers to this question. Many candidates could expand the brackets more or less correctly and then go on to collect terms. Common errors were to evaluate $\sqrt{3}\times-\sqrt{3}$ as zero and to make sign errors on the expansion.

There were frequent examples of poor notation for example: where $7\sqrt{3}$ was written as the 7th root of 3, $\sqrt[7]{3}$, or $-2\sqrt{3}$ was written as $2-\sqrt{3}$ and there were many cases of $7\sqrt{3} = \sqrt{21}$.