A Level · Edexcel · Maths

3 hours 36 questions

2.1 Laws of Indices & Surds

2.1.1 Laws of Indices / 2.1.2 Manipulating Surds / 2.1.3 Surds - Rationalising the Denominator

Easy (10 questions)	/27
Medium (9 questions)	/40
Hard (9 questions)	/42
Very Hard (8 questions)	/49
Total Marks	**/158**

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Easy Questions

1 Write down the value of

(i) $81^{\frac{1}{4}}$

(ii) $8^{\frac{2}{3}}$

(iii) 5^{-2}

(3 marks)

2 Simplify

(i) $x^3 \times x^5$

(ii) $\frac{a^2}{a^4}$

(iii) $\frac{y^{\frac{5}{7}} \times y^{\frac{1}{7}}}{y^{\frac{3}{7}}}$

(3 marks)

3 Write the following in the form $a\sqrt{b}$

(i) $\sqrt{2}+\sqrt{8}$

(ii) $4\sqrt{3}-\sqrt{12}+4\sqrt{48}$

(iii) $\left(2\sqrt{2}\right)^3+3\sqrt{2}$

(3 marks)

4 Rationalise the denominator of $\frac{3}{\sqrt{2}}$.

(2 marks)

5 Rationalise the denominator of $\frac{2}{3+\sqrt{5}}$.

(2 marks)

6 Write $\frac{6x^2+5x^3}{x^4}$ in the form ax^m+bx^n where a, b, m and n are constants to be found.

(2 marks)

7 Show that $(p+2\sqrt{5})(p-2\sqrt{5}) = p^2 - 20$.

(3 marks)

8 Simplify

$$\frac{28x^2(2x^2+3)}{7x^{\frac{1}{2}}}$$

(3 marks)

9 Simplify

$$\frac{3-2\sqrt{3}}{4-\sqrt{3}}$$

(3 marks)

10 Solve the equation

$$\frac{1}{9}x^{\frac{4}{5}} = 9$$

(3 marks)

Medium Questions

1 (a) Write down the value of $27^{\frac{1}{3}}$

(1 mark)

(b) Use your answer to part (a) to show that $27^{\frac{2}{3}} = 9$.

(2 marks)

2 (a) Given that $a^{\frac{1}{3}} = 2$, find the value of a.

(2 marks)

(b) Simplify $x^2 \div x^{\frac{5}{3}}$

(2 marks)

3 (a) Simplify the following expressions:

$4x^2 \times 3x^{-1}$

(2 marks)

(b) $24x^3 \div 8x^{\frac{11}{5}}$

(2 marks)

(c) $15x^{-\frac{2}{3}} \div 10x^{-\frac{2}{3}}$

(2 marks)

4 (a) Given that $y = \frac{1}{16}x^4$, express each of the following in the form ax^n, where a and n are constants.

$y^{\frac{1}{2}}$

(1 mark)

(b) y^{-1}

(1 mark)

(c) $y^{-\frac{3}{2}}$

(2 marks)

5 (a) Simplify $3\sqrt{5}+4\sqrt{3}-7\sqrt{3}+\sqrt{5}$

(2 marks)

(b) By expanding and simplifying, show that

$$\left(\sqrt{3}-5\right)\left(\sqrt{3}+5\right) = -22$$

(2 marks)

6 (a) Give an example to show that $\sqrt{a}+\sqrt{b}=\sqrt{a+b}$ is not true in general.

(1 mark)

(b) Show that $\dfrac{14}{4+\sqrt{2}}=4-\sqrt{2}$.

(3 marks)

7 Solve the equation $6-x\sqrt{7}=\dfrac{2x}{\sqrt{7}}$, giving your answer in the form $\dfrac{a\sqrt{7}}{b}$ where a and b are integers.

(4 marks)

8 A rectangle has an area of 14 m^2 and a length of $\left(3-\sqrt{2}\right)$ m. Find the width of the rectangle, showing clear algebraic working. Give your answer as an exact value.

(4 marks)

9 (a) Show that $\frac{(3-\sqrt{x})^2}{x}$ can be written as $9x^{-1}-6x^{-\frac{1}{2}}+1$.

(2 marks)

(b) Given that $128\sqrt{2}=2^a$, find the value of a.

(3 marks)

(c) Show that $\frac{x(2x^4-\sqrt{x})}{\sqrt{x}}$ can be written as $2x^a-x^b$, where a and b are rational numbers to be found.

(2 marks)

Hard Questions

1 (a) Write down the value of $64^{\frac{1}{3}}$.

(1 mark)

(b) Use your answer to part (a) to show that $64^{-\frac{2}{3}} = \frac{1}{16}$

(2 marks)

2 (a) Given that $a^{\frac{1}{3}} = -4$, find the value of a.

(2 marks)

(b) Simplify $x^{\frac{11}{6}} \div x^{\frac{4}{3}}$

(2 marks)

3 (a) Simplify the following expressions, giving your answers in the form ax^n where a and n are rational numbers and any fractions are in lowest terms.

$$7x^{-3} \div 2x^{-\frac{1}{3}}$$

(2 marks)

(b) $\frac{2}{3}x^{\frac{7}{6}} \times \frac{5}{2}x^{-\frac{5}{3}}$

(2 marks)

(c) $\left(3x^{-\frac{2}{3}}\right)^2 \div 6x^{-\frac{1}{6}}$

(3 marks)

4 (a) Given that $y = \frac{8}{27}x^6$, express each of the following in the form ax^n, where a and b are constants.

$y^{\frac{1}{3}}$

(1 mark)

(b) y^{-1}

(1 mark)

(c) $y^{-\frac{4}{3}}$

(2 marks)

5 (a) Show that $2\sqrt{3}+4\sqrt{12}-3\sqrt{75}=-5\sqrt{3}$

(3 marks)

(b) By expanding and simplifying, show that

$$\left(\sqrt{3}-5\right)\left(5-\sqrt{3}\right)=10\sqrt{3}-28$$

(2 marks)

6 (a) $\sqrt{a}+\sqrt{b}=\sqrt{a+b}$ is not true in general. Give an example of an a and a b for which it is true.

(1 mark)

(b) Show that $\dfrac{3}{1+\sqrt{7}}=a+b\sqrt{7}$, where a and b are rational numbers to be found.

(3 marks)

7 Solve the equation $66+x\sqrt{75}=\dfrac{4x}{\sqrt{3}}$, giving your answer in the form $a\sqrt{b}$ where a and b are integers.

(4 marks)

8 The two parallel sides of a trapezium have lengths of $\left(4+\sqrt{3}\right)$ cm and $\left(6-3\sqrt{3}\right)$ cm, and the area of the trapezium is $\left(10\sqrt{3}-6\right)$ cm^2. Showing clear algebraic working, determine the perpendicular distance between the two parallel sides of the trapezium. Give your answer in the form $a\sqrt{b}$ where a and b are integers.

(4 marks)

9 (a) Show that $\frac{(5+2\sqrt{x})^2}{\sqrt{x}}$ can be written as $25x^{-\frac{1}{2}}+20+4x^{\frac{1}{2}}$.

(2 marks)

(b) Show that $\frac{729}{4\sqrt{3}-\sqrt{27}}=3^a$, where a is a rational number to be found.

(3 marks)

(c) Show that $\frac{2\sqrt{x}}{\sqrt{2}}\left(\sqrt{8x}+6x\right)$ can be written as ay^2+by^3, where $y=\sqrt{2x}$ and a and b are integers to be found.

(2 marks)

Very Hard Questions

1 (a) Write down the value of $256^{\frac{1}{4}}$

(1 mark)

(b) Use your answer to part (a) to show that $1 \div 256^{-\frac{3}{4}} = 64$.

(2 marks)

2 (a) Given that $a^{\frac{2}{3}} = 16$, find the possible values of a.

(3 marks)

(b) Simplify $x^{-\frac{2}{3}} \div x^{-\frac{3}{4}}$

(2 marks)

3 (a) Simplify the following expressions, giving your answers in the form ax^n where a and n are rational numbers and any fractions are in lowest terms.

$$(8x^2)^{-\frac{1}{3}} \times \frac{1}{4}x^{-\frac{1}{3}}$$

(3 marks)

(b) $$\left(\frac{2}{9}x^{\frac{1}{2}} \times \frac{1}{18}x^{-\frac{3}{4}}\right)^{-\frac{1}{4}}$$

(3 marks)

(c) $$\frac{\left(8x^{-\frac{2}{3}}\right)^{\frac{2}{3}}}{\left(64x^{-\frac{1}{3}}\right)^{\frac{1}{3}}}$$

(3 marks)

4 (a) Given that $y = \frac{81}{16}x^{-12}$, express each of the following in the form ax^n, where a and n are constants.

$y^{\frac{3}{4}}$

(1 mark)

(b) $y^{-\frac{1}{2}}$

(1 mark)

(c) $\left(y^{\frac{1}{2}}\right)^{-3}$

(2 marks)

5 (a) Show that $2\sqrt{18}+\sqrt{50}-5\sqrt{32}=a\sqrt{b}$, where a and b are integers.

(3 marks)

(b) By expanding and simplifying, show that

$$\left(\sqrt{12}-3\right)\left(2-\sqrt{75}\right)=19\sqrt{3}-36$$

(3 marks)

6 (a) $\sqrt{a}-\sqrt{b}=\sqrt{a-b}$ is not true in general. Give an example of an a and a b for which it is true.

(1 mark)

(b) Show that $\dfrac{2-\sqrt{3}}{1+\sqrt{3}}=a+b\sqrt{3}$, where a and b are rational numbers.

(4 marks)

7 Solve the equation $\sqrt{20}+\dfrac{\sqrt{5}}{2x}=\dfrac{1}{x\sqrt{45}}$

(5 marks)

8 (a) Expand $\left(a+b\sqrt{5}\right)^2$.

(2 marks)

(b) A square has an area of $\left(49+12\sqrt{5}\right)$ m^2 and a side length of $\left(a+b\sqrt{5}\right)$ m.

Show that $ab=6$, and explain why this proves that a and b must both be non-negative.

(2 marks)

(c) Show that $a^4-49a^2+180=0$.

(3 marks)

(d) By using the substitution $y=a^2$ or otherwise, solve the equation $a^4-49a^2+180=0$.
Hence determine the side length of the square.

(5 marks)