

## Higher Check In – 3.01 Powers and roots

**Do not use a calculator.**

1. Estimate  $\sqrt{177}$  to the nearest whole number.
2. Evaluate  $-\frac{1}{3^{-2}}$ .
3. If  $x^a = \frac{1}{\sqrt{x^5}}$ , find  $a$ .
4. Evaluate  $64^{\frac{2}{3}} \div 16^{-\frac{1}{4}}$ .
5. Find the value of  $x$  which will satisfy the equation  $2^{4x-6} = \frac{1}{4}$ .
6. Max is trying to complete his maths homework, but can't remember the rule to simplify  $(2^3)^4$ . Lin says the rule is multiply the powers so the answer is  $2^{12}$ ; Kush says the rule is add the powers so the answer is  $2^7$ . Produce a step-by-step explanation to convince the three friends of the correct answer.
7. Using the laws of indices, show that any non-zero number raised to the power of zero equals one.
8. Marley says that  $9^{\frac{1}{3}} = 9 \times \frac{1}{3} = 3$ . You tell her that  $9^{\frac{1}{3}} = \sqrt[3]{9}$  but she doesn't believe you. By letting  $9^a \times 9^a \times 9^a = 9$ , prove that you are correct.
9. If  $x^{-\frac{3}{2}} = \frac{8}{27}$ , find  $x$ .
10. A cube has volume  $V$ . The area of one of the faces is  $A$ . Find a formula for  $A$  in terms of  $V$ , giving your answer in the form  $A = V^x$ .

### Extension

If  $\sqrt[3]{4096} = 16$ , evaluate  $4096^{\frac{5}{12}}$  without a calculator, demonstrating your working clearly.



## Answers

1. 13

2. -9

3.  $a = -\frac{5}{2}$

4. 32

5.  $x = 1$

6.  $(2^3)^4 = 2^3 \times 2^3 \times 2^3 \times 2^3$   
 $= (2 \times 2 \times 2) \times (2 \times 2 \times 2) \times (2 \times 2 \times 2) \times (2 \times 2 \times 2)$   
 $= 2^{12}$  so Lin is correct.

7.  $\frac{a^2}{a^2} = \frac{a \times a}{a \times a} = 1$  and  $\frac{a^2}{a^2} = a^{2-2} = a^0$ , so  $a^0 = 1$  oe

8. Let  $9^a \times 9^a \times 9^a = 9$                        $9^{3a} = 9^1$   
 $3a = 1$                       (equating powers)  
 $a = \frac{1}{3}$

which gives  $9^{\frac{1}{3}} \times 9^{\frac{1}{3}} \times 9^{\frac{1}{3}} = 9$  or  $(9^{\frac{1}{3}})^3 = 9$ , so this means  $\sqrt[3]{9} = 9^{\frac{1}{3}}$ .

9.  $x = \frac{9}{4}$ , either by inspection i.e. spotting that  $\frac{27}{8} = \left(\frac{3}{2}\right)^3$ , or by taking the inverse.

10. If you let the length of a side be  $l$ ,  $l = \sqrt[3]{V}$  and  $A = l^2$  so  $A = (\sqrt[3]{V})^2 = V^{\frac{2}{3}}$ .

## Extension

$$4096^{\frac{5}{12}} = (4096^{\frac{1}{12}})^5 = \left((4096^{\frac{1}{3}})^{\frac{1}{4}}\right)^5 = (16^{\frac{1}{4}})^5 = 2^5 = 32$$

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Assessment Objective	Qu.	Topic	R	A	G
AO1	1	Estimate a root to the nearest whole number			
AO1	2	Use a negative integer index to represent a reciprocal			
AO1	3	Use a fractional index to represent a combination of powers and roots			
AO1	4	Calculate fractional powers			
AO1	5	Calculate with integer powers			
AO2	6	Know and apply $(a^m)^n = a^{m \times n}$			
AO2	7	Know and apply $a^m \div a^n = a^{m-n}$			
AO2	8	Know and apply $a^m \times a^n = a^{m+n}$			
AO3	9	Solve a problem involving a fractional index			
AO3	10	Solve a contextual problem involving fractional indices			

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