

$$x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} \times x^{\circ} = x^{\circ}$$

# THE

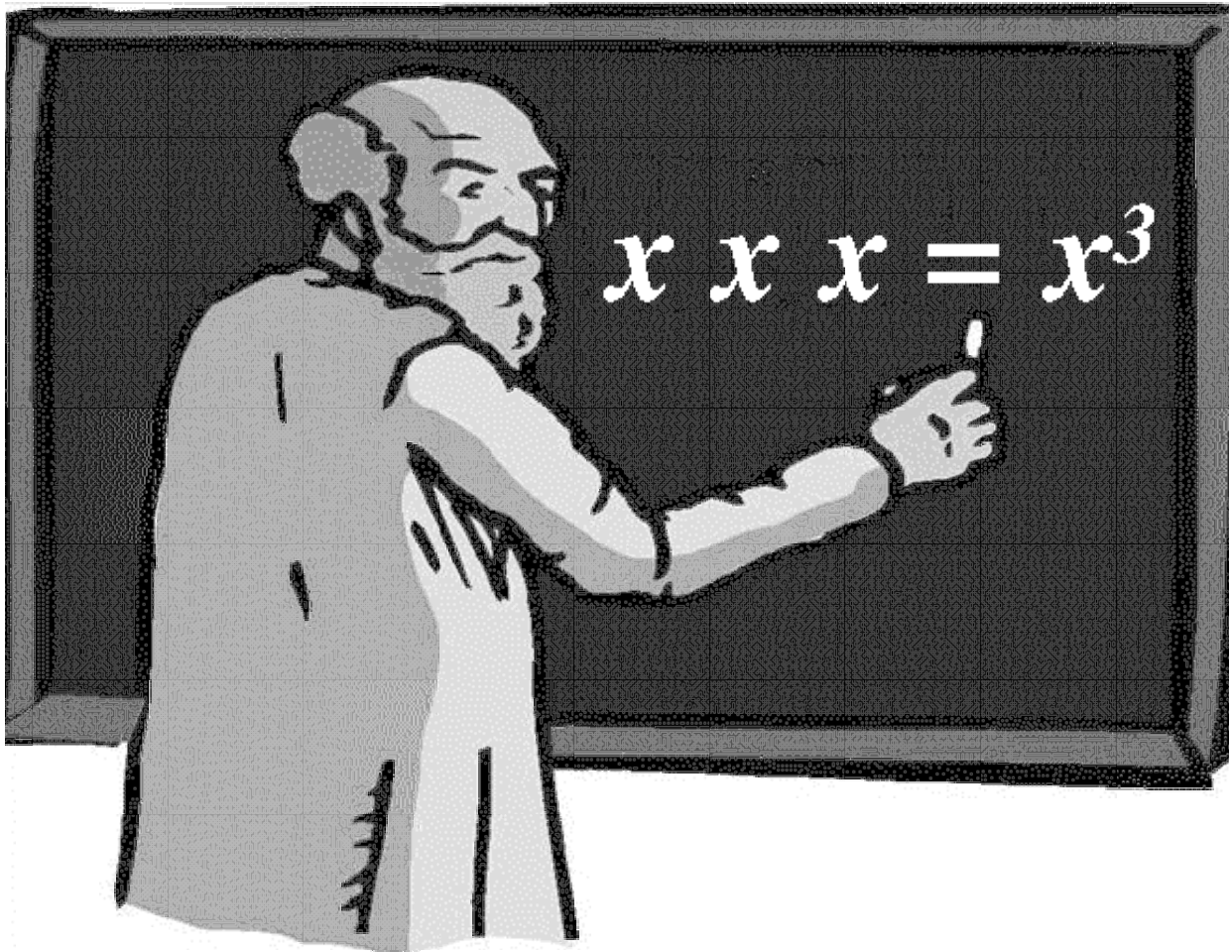
$$x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 \times x^1 = x^{17}$$

# INDEX

$$x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 \times x^2 = x^{34}$$

# FORM

$$x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 \times x^3 = x^{51}$$



# Index Form

## Chapter 1.

### 1.1 Explained without words.

#### 1<sup>st</sup> Law : When multiplying, indices add.

$$\begin{aligned} & 7^3 \times 7^2 \\ &= (7^3) \times (7^2) \\ &= (7 \times 7 \times 7) \times (7 \times 7) \\ &= 7 \times 7 \times 7 \times 7 \times 7 \\ &= 7^5 \\ &\therefore 7^3 \times 7^2 = 7^5 \end{aligned}$$

*The 1<sup>st</sup> Law : When multiplying, indices add.*

$$a^m \times a^n = a^{m+n}$$

#### 2<sup>nd</sup> Law : When dividing, indices subtract.

$$\begin{aligned} & \frac{7^5}{7^3} \\ &= \frac{7 \times 7 \times 7 \times 7 \times 7}{7 \times 7 \times 7} \\ &= \frac{(7 \times 7 \times 7) \times (7 \times 7)}{(7 \times 7 \times 7)} \\ &= 7 \times 7 \\ &= 7^2 \\ &\therefore \frac{7^5}{7^3} = 7^2 \end{aligned}$$

*The 2<sup>nd</sup> Law : When dividing, indices subtract.*

$$\frac{a^m}{a^n} = a^{m-n}$$

**3<sup>rd</sup> Law : When powering a power, indices multiply.**

$$\begin{aligned} & (7^3)^2 \\ &= (7^3) \times (7^3) \\ &= (7 \times 7 \times 7) \times (7 \times 7 \times 7) \\ &= 7 \times 7 \times 7 \times 7 \times 7 \times 7 \\ &= 7^6 \\ &\therefore (7^3)^2 = 7^6 \end{aligned}$$

*The 3<sup>rd</sup> Law : When powering a power, indices multiply.*

$$(a^m)^n = a^{mn}$$

**4<sup>th</sup> Law : A square root halves the index.**

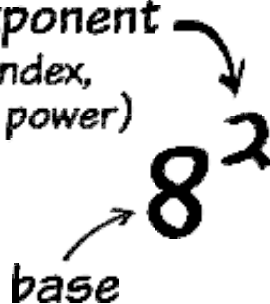
$$\begin{aligned} & \sqrt{7^6} \\ &= \sqrt{7 \times 7 \times 7 \times 7 \times 7 \times 7} \\ &= \sqrt{(7 \times 7 \times 7) \times (7 \times 7 \times 7)} \\ &= (7 \times 7 \times 7) \\ &= 7^3 \\ &\therefore \sqrt{7^6} = 7^3 \end{aligned}$$

*The 4<sup>th</sup> Law : A square root halves the index.*

$$\sqrt{a^m} = a^{\frac{m}{2}}$$

exponent  
(or index,  
or power)

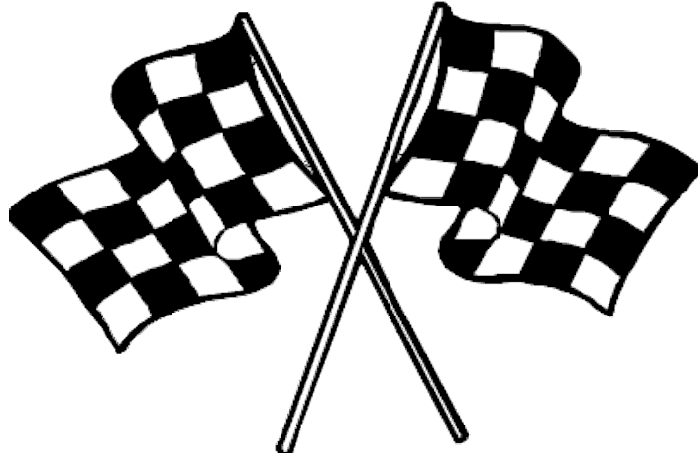
base



## 1.2 Exercise

# Index Form Race N°. 1

Do NOT use a calculator



Write the answers in prime index form,  $p^m$ , for some prime,  $p$ .

*Target time : 15 minutes*

(a)  $13^5 \times 13^4$

(b)  $7^8 \times 7^6$

(c)  $11 \times 11^4$

(d)  $5^4 \times 5^4 \times 5^4$

(e)  $(5^7)^3$

(f)  $(2^7)^5$

(g)  $101^{20} \times 101^5$

(h)  $5^{82} \times 5^{54}$

(i)  $(3^4)^2 \times (3^2)^5$

(j)  $\frac{7^8}{7^3}$

(k)  $\frac{5^{50}}{5^{25}}$

(l)  $\frac{11^7}{11}$

(m)  $\frac{13^5}{13^5}$

(n)  $\frac{103^{50}}{103^{10}}$

(o)  $\frac{7^{102}}{7^{51}}$

$$(p) \quad (3^2)^3 \times 3^5$$

$$(q) \quad (5^4)^3 \times 5^2$$

$$(r) \quad (23^7)^2 \times 23^5$$

$$(s) \quad \frac{2^7}{2^4} \times \frac{2^5}{2^3}$$

$$(t) \quad \frac{5^6}{5^4} \times \frac{5^7}{5^2}$$

$$(u) \quad \sqrt{5^8}$$

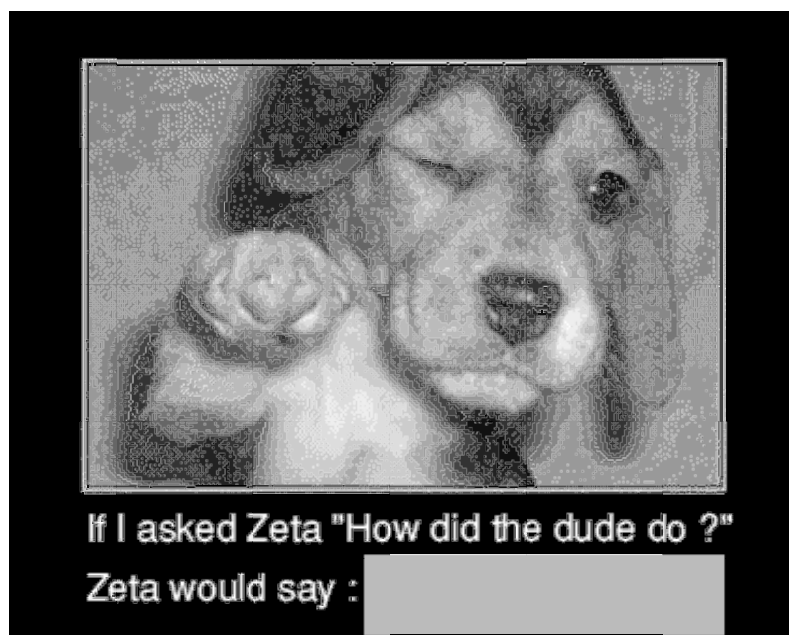
$$(v) \quad \frac{7^{11}}{7^4} \times \frac{7^6}{7^3}$$

$$(w) \quad \frac{3^5 \times 3^4}{3^2 \times 3^3}$$

$$(x) \quad \frac{(5^3)^4}{(5^2)^3}$$

$$(y) \quad \sqrt{11^6}$$

$$(z) \quad \sqrt{\frac{5^{11}}{5^5}}$$



### 1.3 Homework

*Non - Calculator*

For each question;

(a) Write the answer as a single power

(b) Write your part (a) answer without any power.

(i)

$$2^3 \times 2^3$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(ii)

$$3^2 \times 3^3$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(iii)

$$5^2 \times 5$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(iv)

$$7^4 \div 7^3$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(v)

$$10^4 \times 10^3$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(vi)

$$6 \times 6 \times 6$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(vii)

$$\frac{10^7}{10^3}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(viii)

$$(2^3)^2$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(ix)

$$\frac{5 \times 5 \times 5 \times 5 \times 5}{5 \times 5 \times 5}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(x)

$$(2^2)^5$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(xi)

$$\sqrt{10^6}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(xii)

$$8^7 \div 8^6$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

## 1.4 Solutions

### 1.4.1 Answers to Index Form Race N<sup>o</sup>. 1 (Exercise 1.2)

(a)	$13^9$	(b)	$7^{14}$	(c)	$11^5$	
(d)	$5^{12}$	(e)	$5^{21}$	(f)	$2^{35}$	
(g)	$101^{25}$	(h)	$5^{136}$	(i)	$3^{18}$	
(j)	$7^5$	(k)	$5^{25}$	(l)	$11^6$	
(m)	$13^0$	(= 1)	(n)	$103^{40}$	(o)	$7^{51}$
(p)	$3^{11}$	(q)	$5^{14}$	(r)	$23^{19}$	
(s)	$2^5$	(t)	$5^7$	(u)	$5^4$	
(v)	$7^{10}$	(w)	$3^4$	(x)	$5^6$	
(y)	$11^3$	(z)	$5^3$			

### 1.4.2 Answers to Homework

(i)	(a)	$2^6$	(ii)	(a)	$3^5$
	(b)	64		(b)	243
(iii)	(a)	$5^3$	(iv)	(a)	$7^1$
	(b)	125		(b)	7
(v)	(a)	$10^7$	(vi)	(a)	$6^3$
	(b)	10 000 000		(b)	216
(vii)	(a)	$10^4$	(viii)	(a)	$2^6$
	(b)	10 000		(b)	64
(ix)	(a)	$5^2$	(x)	(a)	$2^{10}$
	(b)	25		(b)	1024
(xi)	(a)	$10^3$	(xii)	(a)	$8^1$
	(b)	1000		(b)	8



## Chapter 2.

### 2.1 The meaning of an index of half and zero.

#### 5<sup>th</sup> Law : A index of half means square root.

Recall;

4<sup>th</sup> Law : A square root halves an index.

$$\begin{aligned} & \sqrt{7^6} \\ &= \sqrt{7 \times 7 \times 7 \times 7 \times 7 \times 7} \\ &= \sqrt{(7 \times 7 \times 7) \times (7 \times 7 \times 7)} \\ &= (7 \times 7 \times 7) \\ &= 7^3 \end{aligned}$$

$$\therefore \sqrt{7^6} = 7^3$$

The question naturally arises, "Can we write  $\sqrt{x}$  in index form ?"

Mathematically a number for  $b$  is sought that satisfies the following equation;

$$\sqrt{(7^6)} = (7^6)^b$$

$$7^3 = 7^{6b}$$

$$\text{So } b = \frac{1}{2}$$

And in conclusion;

$$\sqrt{(7^6)} = (7^6)^{\frac{1}{2}}$$

*The 5<sup>th</sup> Law : A power of half means square root.*

$$x^{\frac{1}{2}} = \sqrt{x}$$

$$\sqrt{x} = x^{\frac{1}{2}}$$

**Example.**

$$16^{\frac{1}{2}} = (2^4)^{\frac{1}{2}} = 2^2$$

$$(\quad = 4)$$

**6<sup>th</sup> Law : Anything to the power zero equals one.**

Recall;

*The 2<sup>nd</sup> Law : When dividing, indices subtract;*

$$\begin{aligned} & \frac{7^5}{7^3} \\ &= \frac{7 \times 7 \times 7 \times 7 \times 7}{7 \times 7 \times 7} \\ &= \frac{(7 \times 7 \times 7) \times (7 \times 7)}{(7 \times 7 \times 7)} \\ &= 7 \times 7 \\ &= 7^2 \\ &\therefore \frac{7^5}{7^3} = 7^2 \end{aligned}$$

Consider  $7^5 \div 7^5$  in two different ways.

◇ Firstly, anything divided by itself is 1.

$$\frac{7^5}{7^5} = 1$$

◇ Secondly, by *The 2<sup>nd</sup> Law : When dividing, indices subtract;*

$$\frac{7^5}{7^5} = 7^0$$

These two answers to the same question must equal each other;

$$\therefore 7^0 = 1$$

*The 6<sup>th</sup> Law : Anything to the power zero equals one.*

$$x^0 = 1$$

**Example.**

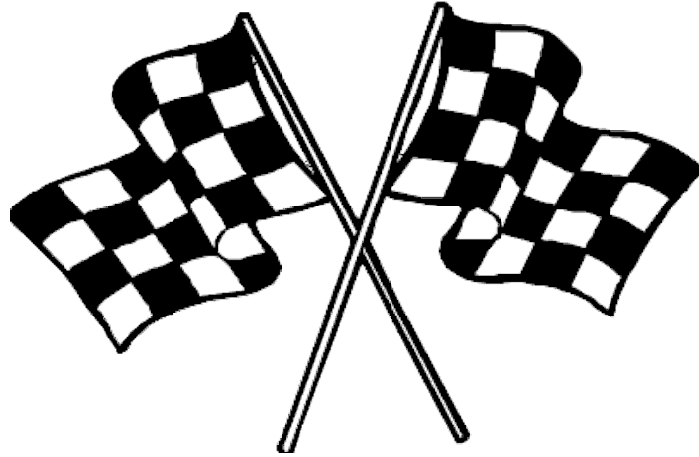
$$\begin{aligned} & 11^5 \times 11^0 \\ &= 11^5 \times 1 \quad \text{using the 6<sup>th</sup> Law} \\ &= 11^5 \end{aligned}$$

This example could have also been done using an earlier Law.  
Which Law ?

## 2.2 Exercise

# Index Form Race N°. 2

Do NOT use a calculator



Write the answers in prime index form,  $p^m$ , for some prime,  $p$ .

*Target time : 15 minutes*

(a)  $17^{15} \times 17^{10}$

(b)  $7^8 \times 7^0$

(c)  $107^0 \times 107^{\frac{1}{2}}$

(d)  $5^4 \times 5$

(e)  $(5^4)^6$

(f)  $(5^4)^{\frac{1}{2}}$

(g)  $(13^{\frac{1}{2}})^{12}$

(h)  $7^{\frac{1}{2}} \times 7^{\frac{1}{2}}$

(i)  $(17^4)^{\frac{1}{2}} \times (17^2)^4$

(j)  $\frac{11^{13}}{11^8}$

(k)  $\frac{\sqrt{7}}{7^{\frac{1}{2}}}$

(l)  $\sqrt{5} \times \sqrt{5}$

(m)  $\frac{17^{\frac{1}{2}}}{17^{\frac{1}{2}}}$

(n)  $\frac{(23)^{0.5}}{(23)^0}$

(o)  $19^0 \times 19$

$$(p) \quad (29^{20})^3 \times 29^7$$

$$(q) \quad (7^{10})^{\frac{1}{2}} \times \frac{7^{14}}{7^3}$$

$$(r) \quad (2^8)^8 \times 2^5$$

$$(s) \quad \frac{5^7}{5^2} \times \frac{5^0}{5^3}$$

$$(t) \quad \frac{13^{14} \times 13^6}{13^2 \times 13^8}$$

$$(u) \quad \sqrt{41^{22}}$$

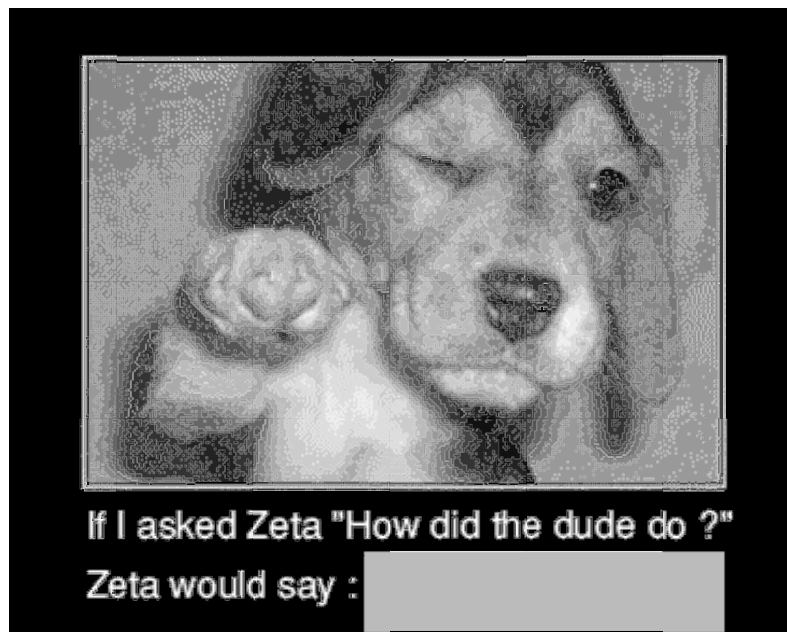
$$(v) \quad \frac{7^1}{7^{\frac{1}{2}}} \times \frac{7^2}{7^{\frac{1}{2}}}$$

$$(w) \quad (\sqrt{13^6})^0$$

$$(x) \quad \frac{(5^8)^4}{(5^2)^5}$$

$$(y) \quad \sqrt{19^{56}}$$

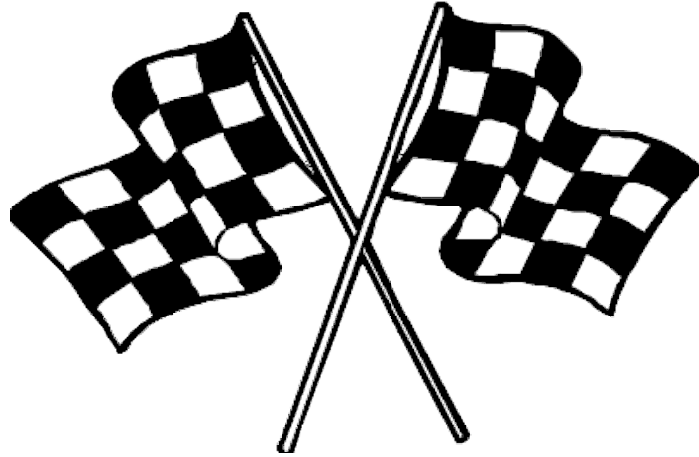
$$(z) \quad \sqrt{\frac{(5^4)^{11}}{5^6}}$$



## 2.3 Exercise

# Index Form Race N°. 3

Do NOT use a calculator



Write the answers in prime index form,  $p^m$ , for some prime,  $p$ .

*Target time : 15 minutes*

(a)  $17^{50} \times 17^{60}$

(b)  $\sqrt{13^{48}}$

(c)  $11^{45} \times 11^0$

(d)  $\frac{19^{33}}{19^{11}}$

(e)  $23^{25} \times 23^4$

(f)  $(13^{44})^2$

(g)  $(\sqrt{3})^8$

(h)  $p^{21} \times p^{53}$

(i)  $\sqrt{\sqrt{5^{20}}}$

(j)  $\frac{p^{36}}{p^4}$

(k)  $(p^5)^{10}$

(l)  $\frac{47^7}{47}$

(m)  $p^{53} \times p$

(n)  $\frac{(7^8)^5}{(7^6)^3}$

(o)  $\frac{p^{25}}{p}$

$$(p) \quad (p^9)^3 \times p^{23}$$

$$(q) \quad (17^{20})^{\frac{1}{2}} \times \frac{17^{12}}{17^3}$$

$$(r) \quad (31^7)^7 \times 31^5$$

$$(s) \quad \frac{p^9}{p^2} \times \frac{p^7}{p^6}$$

$$(t) \quad \frac{p^5 \times p^7}{p^8}$$

$$(u) \quad \sqrt{p^{24}}$$

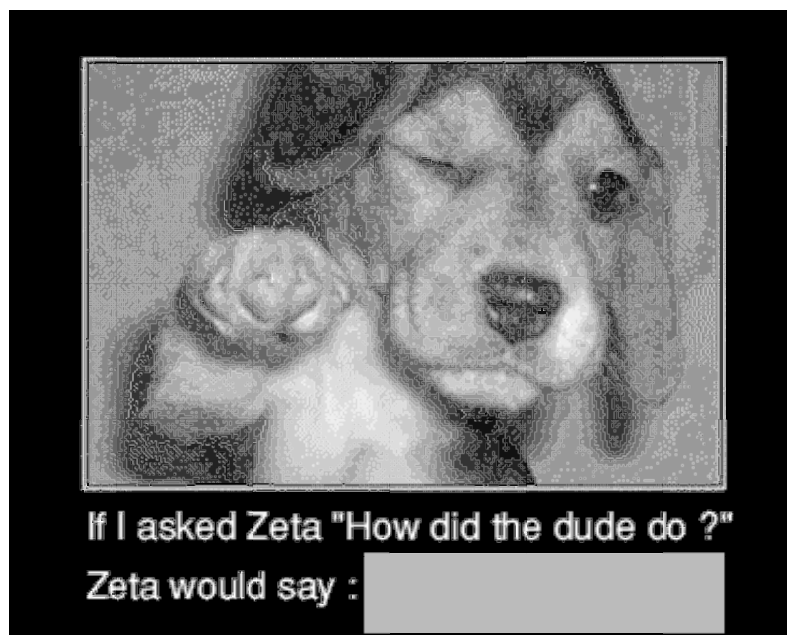
$$(v) \quad \frac{7^{10}}{7^{\frac{1}{2}}} \times \frac{7^{20}}{7^{\frac{1}{2}}}$$

$$(w) \quad p^{\frac{1}{2}} \times p^{\frac{1}{2}}$$

$$(x) \quad \frac{(p^7)^4}{(p^2)^6}$$

$$(y) \quad \sqrt{17^{12} \times 17^{26}}$$

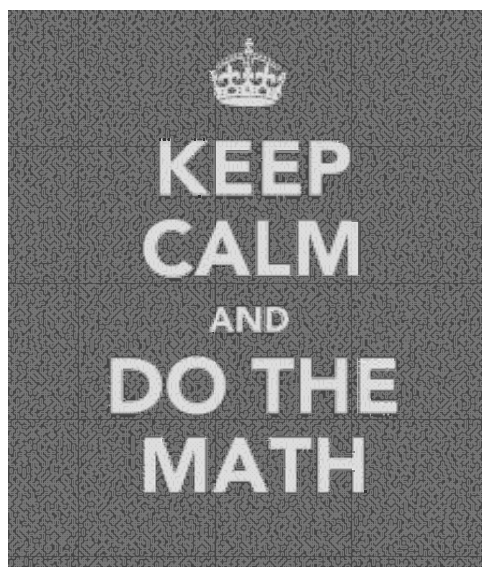
$$(z) \quad \sqrt{\frac{(23^2)^{14}}{23^8}}$$



## 2.4 Homework

### Index Form Race N°. 4

Do NOT use a calculator



Write the answers in prime index form,  $p^m$ , for some prime  $p$ .

*Target time : 15 minutes*

(a)  $61^{13} \times 61^{26}$

(b)  $\sqrt{2^{32}}$

(c)  $17^{45} \times 17$

(d)  $\frac{29^{44}}{29^{22}}$

(e)  $23^0 \times 23^{54}$

(f)  $(53^{24})^3$

(g)  $\sqrt{(7^5)^{10}}$

(h)  $p^{11} \times p^{11}$

(i)  $p^{\frac{1}{2}} \times p^{\frac{1}{2}}$

(j)  $\frac{p^{20}}{p^5}$

(k)  $(p^{55})^2$

(l)  $\frac{17^{17}}{17^0}$

(m)  $p^0 \times p^0$

(n)  $\frac{(11^7)^5}{(11^9)^3}$

(o)  $\sqrt{p^{56}}$

$$(p) \quad (13^8)^3 \times 13^{32}$$

$$(q) \quad (11^{12})^{\frac{1}{2}} \times \frac{1}{11^5}$$

$$(r) \quad (p^6)^6 \times p^{15}$$

$$(s) \quad \frac{p}{p^5} \times \frac{p^{17}}{p^8}$$

$$(t) \quad \frac{p^4 \times p^{11}}{p^9}$$

$$(u) \quad ((7^2)^3)^4$$

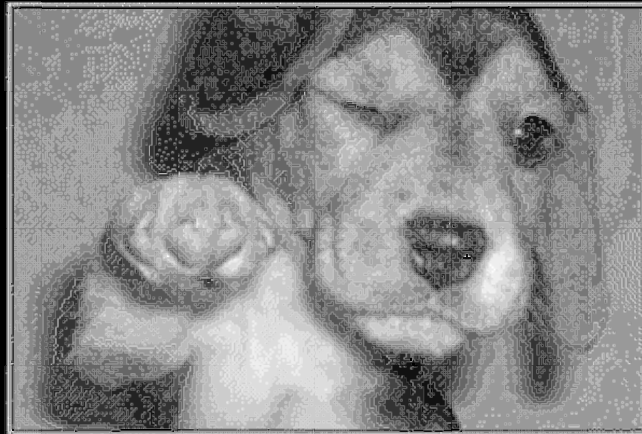
$$(v) \quad \frac{7^{14}}{7^{18}} \times \frac{7^{21}}{7^8}$$

$$(w) \quad (\sqrt{p})^{14}$$

$$(x) \quad \frac{(3^3)^9}{(3^4)^5}$$

$$(y) \quad \sqrt{59^{10} \times 59^{20}}$$

$$(z) \quad \sqrt{\frac{(67^2)^8}{67^{12}}}$$



If I asked Zeta "How did the dude do ?"  
Zeta would say :



## 2.5 Solutions

### 2.5.1 Answers to Index Form Race N° 2. (2.2 Exercise)

(a)	$17^{25}$	(b)	$7^8$	(c)	$107^{1/2}$
(d)	$5^5$	(e)	$5^{24}$	(f)	$5^2$
(g)	$13^6$	(h)	7	(i)	$17^{10}$
(j)	$11^5$	(k)	$7^0 (= 1)$	(l)	5
(m)	$17^0 (= 1)$	(n)	$23^{1/2}$	(o)	19
(p)	$29^{67}$	(q)	$7^{16}$	(r)	$2^{69}$
(s)	$5^2$	(t)	$13^{10}$	(u)	$41^{11}$
(v)	$7^2$	(w)	$13^0 (= 1)$	(x)	$5^{22}$
(y)	$19^{28}$	(z)	$5^{19}$		

### 2.5.2 Answers to Index Form Race N° 3 (2.3 Exercise)

(a)	$17^{110}$	(b)	$13^{24}$	(c)	$11^{45}$
(d)	$19^{22}$	(e)	$23^{29}$	(f)	$13^{88}$
(g)	$3^4$	(h)	$p^{74}$	(i)	$5^5$
(j)	$p^{32}$	(k)	$p^{50}$	(l)	$47^6$
(m)	$p^{54}$	(n)	$7^{22}$	(o)	$p^{24}$
(p)	$p^{50}$	(q)	$17^{19}$	(r)	$31^{54}$
(s)	$p^8$	(t)	$p^4$	(u)	$p^{12}$
(v)	$7^{29}$	(w)	$p$	(x)	$p^{16}$
(y)	$17^{19}$	(z)	$23^{10}$		

### 2.5.3 Answers to Index Form Race N° 4 (2.4 Homework)

(a)	$61^{39}$	(b)	$2^{16}$	(c)	$17^{46}$
(d)	$29^{22}$	(e)	$23^{54}$	(f)	$53^{72}$
(g)	$7^{25}$	(h)	$p^{22}$	(i)	$p$
(j)	$p^{15}$	(k)	$p^{110}$	(l)	$17^{17}$
(m)	$p^0 (= 1)$	(n)	$11^8$	(o)	$p^{28}$
(p)	$13^{56}$	(q)	11	(r)	$p^{51}$
(s)	$p^5$	(t)	$p^6$	(u)	$7^{24}$
(v)	$7^9$	(w)	$p^7$	(x)	$3^7$
(y)	$59^{15}$	(z)	$67^2$		

## Chapter 3.

### 3.1 The meaning of a negative index.

**7<sup>th</sup> Law : A negative index means reciprocal.**

$$\begin{aligned} & \frac{7^3}{7^5} \\ &= \frac{7 \times 7 \times 7}{7 \times 7 \times 7 \times 7 \times 7} \\ &= \frac{(7 \times 7 \times 7)}{(7 \times 7 \times 7) \times (7 \times 7)} \\ &= \frac{1}{7 \times 7} \\ &= \frac{1}{7^2} \end{aligned}$$

By *The 2<sup>nd</sup> Law* : When dividing, indices subtract :

$$\frac{7^3}{7^5} = 7^{-2}$$

Thus :

$$7^{-2} = \frac{1}{7^2}$$

*The 7<sup>th</sup> Law : A negative index means reciprocal.*

$$\begin{aligned} a^{-m} &= \frac{1}{a^m} \\ \frac{1}{a^m} &= a^{-m} \end{aligned}$$

### 3.2 Exercise

## Index Form Race N° 5

Do NOT use a calculator



Write answers in prime index form,  $p^m$ , where  $p$  is a prime number.

*Target time : 15 minutes*

(a)  $\frac{1}{5^8}$

(b)  $\frac{1}{3^7}$

(c)  $\frac{1}{7}$

(d)  $5^9 \times 5^{-4}$

(e)  $13^{13} \times 13^{-3}$

(f)  $7^5 \times 7^{-13}$

(g)  $2^9 \times 2^{-9}$

(h)  $\frac{1}{11^5}$

(i)  $2 \times 2^{-7}$

(j)  $\frac{11^8}{11^5}$

(k)  $\frac{7^5}{7^{11}}$

(l)  $\frac{17^7}{17^{13}}$

(m)  $\frac{13^{-3}}{13^6}$

(n)  $\sqrt{7^{-12}}$

(o)  $(5^{-8})^2$

$$(p) \quad (11^2)^{-3}$$

$$(q) \quad (7^{-10})^{-5}$$

$$(r) \quad (2^7)^7 \times 2^{-25}$$

$$(s) \quad \frac{5^7}{5^3} \times \frac{5^{-2}}{5^0}$$

$$(t) \quad \frac{1}{(3^4)^{\frac{1}{2}}}$$

$$(u) \quad \sqrt{5^{-2}}$$

$$(v) \quad \frac{1}{2^3}$$

$$(w) \quad \frac{1}{2^{-2}}$$

$$(x) \quad \frac{(5^2)^4}{(5^5)^3}$$

$$(y) \quad \sqrt{17^{-26}}$$

$$(z) \quad \sqrt{\frac{(2^3)^{11}}{2^{55}}}$$

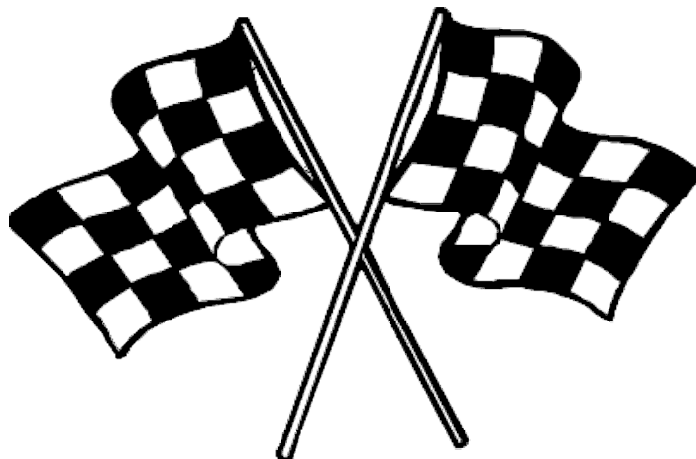


If I asked Zeta "How did the dude do ?"  
Zeta would say :

### 3.3 Exercise

## Index Form Race N° 6

Do NOT use a calculator



Write answers in prime index form,  $p^m$ , where  $p$  is a prime number.

*Target time : 15 minutes*

(a)  $\frac{1}{7^9}$

(b)  $\frac{1}{3}$

(c)  $\frac{1}{7^{-4}}$

(d)  $7^{17} \times 7^{-14}$

(e)  $11^{-4} \times 11^{-6}$

(f)  $13^{15} \times 13^{-25}$

(g)  $19^{13} \times 19^{-12}$

(h)  $\frac{1}{17^5}$

(i)  $7 \times 7^{-17}$

(j)  $\frac{13^{15}}{13^{18}}$

(k)  $\frac{11^5}{11^{34}}$

(l)  $\frac{7^{100}}{7^{101}}$

(m)  $\frac{17^{-8}}{17^5}$

(n)  $\sqrt{17^{-24}}$

(o)  $(7^{-6})^5$

$$(p) \quad (31^{22})^{-4}$$

$$(q) \quad (17^{-12})^{-5}$$

$$(r) \quad (3^5)^5 \times 3^{-25}$$

$$(s) \quad 4 \times 2^{-5}$$

$$(t) \quad \frac{3^{-5}}{(3^4)^{\frac{1}{2}}}$$

$$(u) \quad \sqrt{(7^{-3})^{-6}}$$

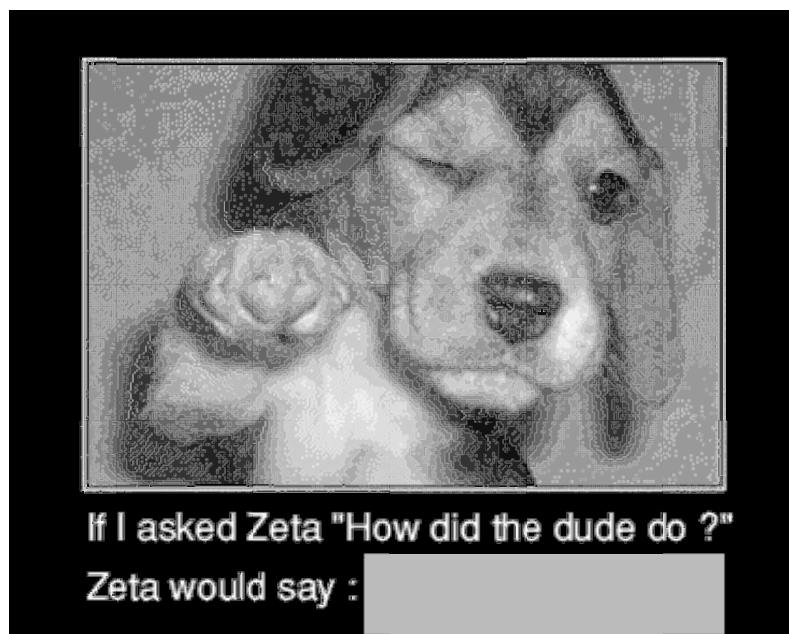
$$(v) \quad \frac{1}{23^4}$$

$$(w) \quad \frac{1}{23^{-4}}$$

$$(x) \quad \frac{(7^3)^5}{(7^6)^6}$$

$$(y) \quad \sqrt{47^{-206}}$$

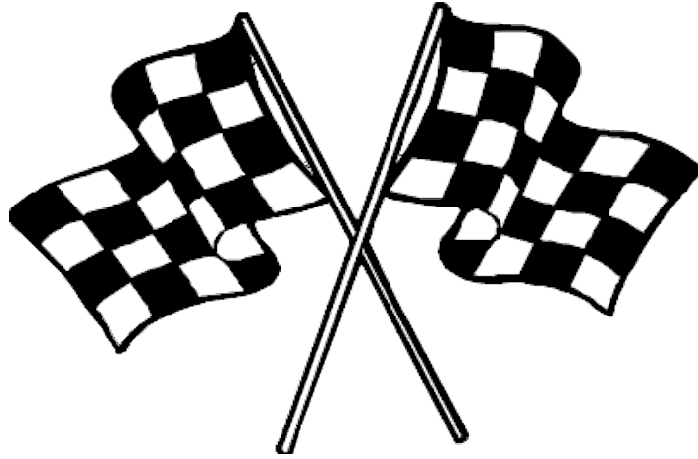
$$(z) \quad \sqrt{\frac{(2^{-3})^{11}}{2^{55}}}$$



### 3.4 Exercise

## Index Form Race N° 7

Do NOT use a calculator



Write answers in prime index form,  $p^m$ , where  $p$  is a prime number.

*Target time : 15 minutes*

(a)  $\frac{1}{p^{12}}$

(b)  $\frac{1}{p}$

(c)  $\frac{1}{p^{-7}}$

(d)  $p^7 \times p^{-4}$

(e)  $p^{-3} \times p^{-5}$

(f)  $p^8 \times p^{-13}$

(g)  $p^{-5} \times p^2$

(h)  $\frac{1}{p^7}$

(i)  $p \times p^{-1}$

(j)  $\frac{p^{12}}{p^{19}}$

(k)  $\frac{p^8}{p^{14}}$

(l)  $\frac{p^{20}}{p^{31}}$

(m)  $\frac{p^{-7}}{p^6}$

(n)  $\sqrt{p^{-4}}$

(o)  $(p^{-3})^8$



$$(p) \quad (p^{33})^{-3}$$

$$(q) \quad (p^{-13})^{-3}$$

$$(r) \quad (p^7)^3 \times p^{-25}$$

$$(s) \quad p^{-\frac{1}{2}} \times p^{-\frac{1}{2}}$$

$$(t) \quad \frac{p^{-4}}{(p^6)^{\frac{1}{2}}}$$

$$(u) \quad \sqrt{(p^{-5})^{-8}}$$

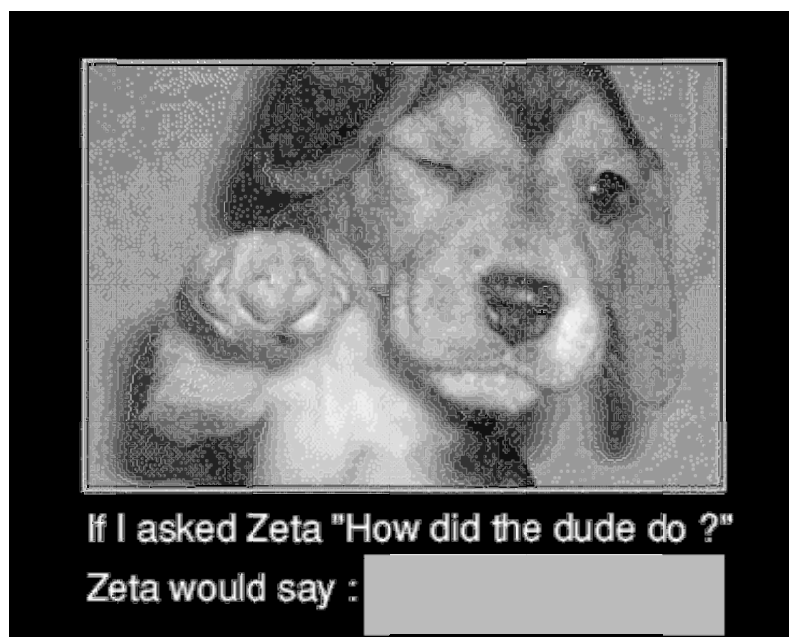
$$(v) \quad \frac{1}{p^5}$$

$$(w) \quad \frac{1}{p^{-5}}$$

$$(x) \quad \frac{(p^5)^5}{(p^6)^6}$$

$$(y) \quad \sqrt{p^{-888}}$$

$$(z) \quad \sqrt{\frac{(p^{-3})^{-11}}{p^{-55}}}$$



### 3.5 Solutions

#### 3.5.1 Answers to Index Form Race N° 5. (3.2 Exercise)

(a)	$5^{-8}$	(b)	$3^{-7}$	(c)	$7^{-1}$
(d)	$5^5$	(e)	$13^{10}$	(f)	$7^{-8}$
(g)	$2^0 (= 1)$	(h)	$11^{-5}$	(i)	$2^{-6}$
(j)	$11^3$	(k)	$7^{-6}$	(l)	$17^{-6}$
(m)	$13^{-9}$	(n)	$7^{-6}$	(o)	$5^{-16}$
(p)	$11^{-6}$	(q)	$7^{50}$	(r)	$2^{24}$
(s)	$5^2$	(t)	$3^{-2}$	(u)	$5^{-1}$
(v)	$2^{-3}$	(w)	$2^2$	(x)	$5^{-7}$
(y)	$17^{-13}$	(z)	$2^{-11}$		

#### 3.5.2 Answers to Index Form Race N° 6. (3.3 Exercise)

(a)	$7^{-9}$	(b)	$3^{-1}$	(c)	$7^4$
(d)	$7^3$	(e)	$11^{-10}$	(f)	$13^{-10}$
(g)	19	(h)	$17^{-5}$	(i)	$7^{-16}$
(j)	$13^{-3}$	(k)	$11^{-29}$	(l)	$7^{-1}$
(m)	$17^{-13}$	(n)	$17^{-12}$	(o)	$7^{-30}$
(p)	$31^{-88}$	(q)	$17^{60}$	(r)	$3^0 (= 1)$
(s)	$2^{-3}$	(t)	$3^{-7}$	(u)	$7^9$
(v)	$23^{-4}$	(w)	$23^4$	(x)	$7^{-21}$
(y)	$47^{-103}$	(z)	$2^{-44}$		

### 3.5.3 Answers to Index Form Race N° 7. (3.4 Exercise)

(a)	$p^{-12}$	(b)	$p^{-1}$	(c)	$p^7$
(d)	$p^3$	(e)	$p^{-8}$	(f)	$p^{-5}$
(g)	$p^{-3}$	(h)	$p^{-7}$	(i)	$p^0 (= 1)$
(j)	$p^{-7}$	(k)	$p^{-6}$	(l)	$p^{-11}$
(m)	$p^{-13}$	(n)	$p^{-2}$	(o)	$p^{-24}$
(p)	$p^{-99}$	(q)	$p^{39}$	(r)	$p^{-4}$
(s)	$p^{-1}$	(t)	$p^{-7}$	(u)	$p^{20}$
(v)	$p^{-5}$	(w)	$p^5$	(x)	$p^{-11}$
(y)	$p^{-444}$	(z)	$p^{44}$		

## Chapter 4.

### 4.1 Converting answers out of index form.

Our work on indices has become fairly abstract.

We've become familiar with writing answers in index form...

$$\text{e.g. } 5^{-2}, \quad 9^{\frac{1}{2}}, \quad 7^0, \quad 8^{\frac{1}{3}} \quad \text{and} \quad 4^{-\frac{1}{2}}$$

... and it's quite easy to stop understanding what numbers these actually represent.

It's important to be able to write numbers such as these without the power.

$$5^{-2}$$

$$9^{\frac{1}{2}}$$

$$7^0$$

$$8^{\frac{1}{3}}$$

$$4^{-\frac{1}{2}}$$

$$2^{-3}$$

$$11^{-1}$$

$$16^{\frac{1}{4}}$$

## 4.2 You Try

$$8^2$$

$$7^{-1}$$

$$3^{-2}$$

$$36^{\frac{1}{2}}$$

$$13^0$$

$$125^{\frac{1}{3}}$$

$$9^{-\frac{1}{2}}$$

$$2^{-5}$$

$$4^{-1}$$

$$16^{-\frac{1}{4}}$$

### 4.3 Exercise

*Non - Calculator*

For each question;

(a) Write the answer as a single power

(b) Write your part (a) answer without any power.

(i)

$$2^3 \times 2^{-7}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(ii)

$$3^{-3} \times 3^2$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(iii)

$$5^{-1} \times 5^{-1}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(iv)

$$7^4 \div 7^6$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(v)

$$16^{\frac{1}{4}} \times 16^{\frac{1}{4}}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(vi)

$$6^{-3} \times 6^2 \times 6^{-1}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(vii)

$$\frac{10^7}{10^{11}}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(viii)

$$(2^{-3})^{-2}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(ix)

$$\frac{4 \times 4 \times 4}{4 \times 4 \times 4 \times 4 \times 4}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(x)

$$(2^2)^{-5}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(xi)

$$\sqrt{10^{-6}}$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(xii)

$$8^8 \div 8^9$$

(a) \_\_\_\_\_

(b) \_\_\_\_\_

## 4.4 Solutions

### 4.4.1 Answers to Introduction (4.1 Converting answers out of index form)

$$5^{-2} = \frac{1}{25}$$

$$9^{\frac{1}{2}} = 3$$

$$7^0 = 1$$

$$8^{\frac{1}{3}} = 2$$

$$4^{-\frac{1}{2}} = \frac{1}{2}$$

$$2^{-3} = \frac{1}{8}$$

$$11^{-1} = \frac{1}{11}$$

$$16^{\frac{1}{4}} = 2$$

### 4.4.2 Answers to 4.2 You Try

$$8^2 = 64$$

$$7^{-1} = \frac{1}{7}$$

$$3^{-2} = \frac{1}{9}$$

$$36^{\frac{1}{2}} = 6$$

$$13^0 = 1$$

$$125^{\frac{1}{3}} = 5$$

$$9^{-\frac{1}{2}} = \frac{1}{3}$$

$$2^{-5} = \frac{1}{32}$$

$$4^{-1} = \frac{1}{4}$$

$$16^{-\frac{1}{4}} = \frac{1}{2}$$

### 4.4.3 Answers to 4.3 Exercise

(i) (a)  $2^{-4}$   
(b)  $\frac{1}{16}$

(ii) (a)  $3^{-1}$   
(b)  $\frac{1}{3}$

(iii) (a)  $5^{-2}$   
(b)  $\frac{1}{25}$

(iv) (a)  $7^{-2}$   
(b)  $\frac{1}{49}$

(v) (a)  $16^{\frac{1}{2}}$   
(b) 4

(vi) (a)  $6^{-2}$   
(b)  $\frac{1}{36}$

(vii) (a)  $10^{-4}$   
(b)  $\frac{1}{10\,000}$

(viii) (a)  $2^6$   
(b) 64

(ix) (a)  $4^{-2}$   
(b)  $\frac{1}{16}$

(x) (a)  $2^{-10}$   
(b)  $\frac{1}{1024}$

(xi) (a)  $10^{-3}$   
(b)  $\frac{1}{1000}$

(xii) (a)  $8^{-1}$   
(b)  $\frac{1}{8}$



## Chapter 5A.

### 5A.1 REVISION (Topic exit at A)

#### PART ONE

##### Question 1.

Find the value of the following sums

$$(-3) + 7 =$$

$$(-6) - (-5) =$$

$$(-3) \times (-6) =$$

$$(-12) \div 4 =$$

$$(-9) \div (-3) =$$

$$(-16) \div 8 + (-3) =$$

##### Question 2.

Find the value of the following without using a calculator;

$$2^5 =$$

$$8^{\frac{1}{3}} =$$

$$4^3 =$$

$$131^1 =$$

$$7^{-1} =$$

$$1^{57} =$$

$$9^{-2} =$$

$$67^0 =$$

$$16^{\frac{1}{2}} =$$

$$25^{\frac{3}{2}} =$$

**Question 3.**

Simplify the following, giving your answer in index form;

$$2^7 \times 2^8 =$$

$$11^{13} \div 11^{-5} =$$

$$5^8 \div 5^2 =$$

$$(3^7)^{10} =$$

$$13^4 \times 13^5 =$$

$$(7^5)^{-3} =$$

**Question 4.**

Given  $a = 3$ ,  $b = 10$  and  $c = -2$ , evaluate the following;

$$b + 2a$$

$$a^2b$$

$$5b - 3c$$

$$\frac{b}{a - c}$$

**Question 5.**

Simplify the following algebraic expressions

$$7x + 3x - 4x =$$

$$5(h - 4) + 12 =$$

$$7x - 4y - 3x - 8y =$$

$$2x^5 \times 5x^3 =$$

$$4(u + 6) + 9 =$$

$$10m^9 \div 5m^{-2} =$$

## PART TWO

### Question 1.

Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$7 \times 7 \times 7 \times 7 \times 7$$

(ii)

$$\frac{5 \times 5 \times 5 \times 5 \times 5 \times 5}{5 \times 5}$$

(iii)

$$\sqrt{3 \times 3 \times 3 \times 3 \times 3 \times 3}$$

(iv)

$$\frac{13 \times 13 \times 13}{13 \times 13 \times 13 \times 13}$$

### Question 2.

Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$7^6 \times 7^8$$

(ii)

$$5^7 \times 5^3 \times 5^6$$

(iii)

$$13^8 \times 13$$

(iv)

$$\sqrt{17^8}$$

(v)

$$\frac{11^9}{11^4}$$

(vi)

$$(19^4)^6$$

(vii)

$$5^8 \times 5^0$$

(viii)

$$7^5 \div 7$$

**Question 3.**

Write in index form;

**(i)**

$$7 \times 5 \times 5 \times 7 \times 7$$

**(ii)**

$$\frac{5 \times 2 \times 2 \times 2 \times 5 \times 5}{5 \times 5}$$

**(iii)**

$$\sqrt{3 \times 3 \times 3 \times 3 \times 23 \times 23}$$

**(iv)**

$$\frac{17 \times 13 \times 13 \times 13 \times 13 \times 13}{17 \times 13 \times 13 \times 13}$$

**Question 4.**Write in prime index form,  $p^m$ , for some prime  $p$ .**(i)**

$$3^5 \times 3^4 \times 3^2 \times 3^6$$

**(ii)**

$$13^7 \times 13^3 \times 13^0$$

**(iii)**

$$17^8 \times (17^5)^5$$

**(iv)**

$$\sqrt{11^8 \times 11^{10}}$$

**(v)**

$$\frac{(5^6)^3}{(5^2)^4}$$

**(vi)**

$$(29^8)^{\frac{1}{2}}$$

**(vii)**

$$\sqrt{\sqrt{7^{20}}}$$

**(viii)**

$$\left( (5^3)^4 \right)^3$$

**Question 5.**

Simplify;

**(i)**

$$p^{15} \times p^5 \times p^2 \times p^8$$

**(ii)**

$$\frac{p^{17}}{p^5}$$

**(iii)**

$$(p^4)^5 \times p^3$$

**(iv)**

$$\sqrt{p^6}$$

**(v)**

$$\frac{(p^{16})^2}{p}$$

**(vi)**

$$p^0$$

**(vii)**

$$\left(\frac{p^{19}}{p^{11}}\right)^2$$

**(viii)**

$$p^8 \div p^2$$

**Question 6.**Write in prime index form,  $p^m$ , for some prime,  $p$ .**(i)**

$$\frac{1}{5 \times 5 \times 5}$$

**(ii)**

$$\frac{7 \times 7}{7 \times 7 \times 7 \times 7}$$

**(iii)**

$$\frac{1}{13}$$

**(iv)**

$$\frac{11}{11 \times 11}$$

**Question 7.**Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$11^7 \times 11^{-3}$$

(ii)

$$5^{-7} \times 5^3$$

(iii)

$$19^{-8} \times (19^4)^5$$

(iv)

$$\sqrt{11^{-26}}$$

(v)

$$\frac{5^7}{5^9}$$

(vi)

$$\frac{11^{-23}}{11^5}$$

(vii)

$$\frac{(7^5)^3}{(7^6)^4}$$

(viii)

$$23^{-8} \times 23^{-7}$$

**Question 8.**Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$\frac{2^8 \times 2^7}{2^6 \times 2^3}$$

(ii)

$$\frac{2^{14} \times 2^{-5}}{2^4 \times 2^2}$$

(iii)

$$\frac{2^3 \times 2^6}{2^{-4}}$$

(iv)

$$\sqrt{\frac{2^{-23}}{2^{-5}}}$$

**Question 9.**

Simplify;

**(i)**

$$p^{13} \times p^{-3} \times p^7 \times p^{-2}$$

**(ii)**

$$\frac{p^{-14}}{p^4}$$

**(iii)**

$$(p^{-4})^5 \times p^{13}$$

**(iv)**

$$\sqrt{p^{-56}}$$

**(v)**

$$\frac{(p^{16})^{-2}}{p^{40}}$$

**(vi)**

$$\sqrt{p^2}$$

**(vii)**

$$\left(\frac{p^{19}}{p^{-11}}\right)^2$$

**(viii)**

$$(p^{-5})^{-8}$$

**Question 10.**

Simplify;

**(i)**

$$7 \times p^3 \times 6 \times p^7 \times p^{-8}$$

**(ii)**

$$\frac{16 p^{10}}{8 p^2}$$

**(iii)**

$$(2 p^5)^7$$

**(iv)**

$$\sqrt{49 p^{16}}$$

**(v)**

$$\frac{5 (p^{0.5})^{-8}}{p^4}$$

**(vi)**

$$\sqrt{9 p^2}$$

**(vii)**

$$\left( \frac{18 p^{-9}}{6 p^{-5}} \right)^2$$

**(viii)**

$$(0.5 p^{-3})^{-2}$$



## 5A.2 Solutions to the revision

### PART ONE

#### Answer 1.

$$4 \quad -1 \quad 18 \quad -3 \quad 3 \quad -5$$

#### Answer 2.

$$\begin{array}{ll} 32 & 2 \\ 64 & 131 \\ \frac{1}{7} & 1 \\ \frac{1}{81} & 1 \\ 4 & 125 \end{array}$$

#### Answer 3.

$$\begin{array}{ll} 2^{15} & 11^{18} \\ 5^6 & 3^{70} \\ 13^9 & 7^{-15} \end{array}$$

#### Answer 4.

$$\begin{array}{ll} 16 & 90 \\ 56 & 2 \end{array}$$

#### Answer 5.

$$\begin{array}{ll} 6x & 5h - 8 \\ 4x - 12y & 10x^8 \\ 4u + 33 & 2m^{11} \end{array}$$

### PART TWO

#### Answer 1.

$$\begin{array}{ll} \text{(i)} & 7^5 \\ \text{(iii)} & 3^3 \end{array} \quad \begin{array}{ll} \text{(ii)} & 5^4 \\ \text{(iv)} & 13^{-1} \end{array}$$

#### Answer 2.

$$\begin{array}{ll} \text{(i)} & 7^{14} \\ \text{(iii)} & 13^9 \\ \text{(v)} & 11^5 \\ \text{(vii)} & 5^8 \end{array} \quad \begin{array}{ll} \text{(ii)} & 5^{16} \\ \text{(iv)} & 17^4 \\ \text{(vi)} & 19^{24} \\ \text{(viii)} & 7^4 \end{array}$$

**Answer 3.**

**( i )**  $5^2 \times 7^3$

**( ii )**  $2^3 \times 5$

**( iii )**  $3^2 \times 23$

**( iv )**  $13^2$

**Answer 4.**

**( i )**  $3^{17}$

**( ii )**  $13^{10}$

**( iii )**  $17^{33}$

**( iv )**  $11^9$

**( v )**  $5^{10}$

**( vi )**  $29^4$

**( vii )**  $7^5$

**( viii )**  $5^{36}$

**Answer 5.**

**( i )**  $p^{30}$

**( ii )**  $p^{12}$

**( iii )**  $p^{23}$

**( iv )**  $p^3$

**( v )**  $p^{31}$

**( vi )**  $1$

**( vii )**  $p^{16}$

**( viii )**  $p^6$

**Answer 6.**

**( i )**  $5^{-3}$

**( ii )**  $7^{-2}$

**( iii )**  $13^{-1}$

**( iv )**  $11^{-1}$

**Answer 7.**

**( i )**  $11^4$

**( ii )**  $5^{-4}$

**( iii )**  $19^{12}$

**( iv )**  $11^{-13}$

**( v )**  $5^{-2}$

**( vi )**  $11^{-28}$

**( vii )**  $7^{-9}$

**( viii )**  $23^{-15}$

**Answer 8.**

**( i )**  $2^6$

**( ii )**  $2^3$

**( iii )**  $2^{13}$

**( iv )**  $2^{-9}$

**Answer 9.**

**( i )**  $p^{15}$

**( ii )**  $p^{-18}$

**( iii )**  $p^{-7}$

**( iv )**  $p^{-28}$

**( v )**  $p^{-72}$

**( vi )**  $p$

**( vii )**  $p^{60}$

**( viii )**  $p^{40}$

**Answer 10.**

**( i )**  $42 p^2$

**( ii )**  $2 p^8$

**( iii )**  $128 p^{35}$

**( iv )**  $7 p^8$

**( v )**  $5 p^{-8}$

**( vi )**  $3 p$

**( vii )**  $9 p^{-8}$

**( viii )**  $4 p^6$

## Chapter 6A

### 6A.1 TEST (Topic exit at A)

#### PART ONE

##### Question 1.

Find the value of the following sums

$$(-7) + 11 =$$

$$(-5) - (-3) =$$

$$(-4) \times (-6) =$$

$$(-18) \div 3 =$$

$$(-15) \div (-3) =$$

$$(-18) \div 9 + (-5) =$$

##### Question 2.

Find the value of the following without using a calculator;

$$2^6 =$$

$$27^{\frac{1}{3}} =$$

$$7^2 =$$

$$93^1 =$$

$$5^{-1} =$$

$$1^{13} =$$

$$4^{-2} =$$

$$7^0 =$$

$$25^{\frac{1}{2}} =$$

$$16^{\frac{3}{2}} =$$

**Question 3.**

Simplify the following, giving your answer in index form;

$$2^6 \times 2^7 =$$

$$11^{10} \div 11^{-4} =$$

$$5^9 \div 5^3 =$$

$$(13^5)^8 =$$

$$11^5 \times 11^6 =$$

$$(3^7)^{-3} =$$

**Question 4.**

Given  $a = 5$ ,  $b = 8$  and  $c = -3$ , evaluate the following;

$$b + 2a$$

$$a^2 b$$

$$5b - 3c$$

$$\frac{b}{a - c}$$

**Question 5.**

Simplify the following algebraic expressions

$$11x + 7x - 5x =$$

$$4(h - 5) + 12 =$$

$$9x - 3y - 4x - 9y =$$

$$3x^6 \times 5x^3 =$$

$$6(u + 4) + 9 =$$

$$14m^9 \div 7m^{-3} =$$

## PART TWO

### Question 1.

Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$5 \times 5 \times 5 \times 5 \times 5 \times 5$$

(ii)

$$\frac{7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7}{7 \times 7}$$

(iii)

$$\sqrt{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2}$$

(iv)

$$\frac{11 \times 11 \times 11}{11 \times 11 \times 11 \times 11}$$

### Question 2.

Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$5^5 \times 5^7$$

(ii)

$$17^6 \times 17^4 \times 17^7$$

(iii)

$$23^7 \times 23$$

(iv)

$$\sqrt{19^{12}}$$

(v)

$$\frac{2^8}{2^5}$$

(vi)

$$(29^5)^6$$

(vii)

$$7^9 \times 7^0$$

(viii)

$$11^5 \div 11$$

**Question 3.**

Write in index form;

**(i)**

$$2 \times 3 \times 2 \times 3 \times 3$$

**(ii)**

$$\frac{3 \times 5 \times 3 \times 3 \times 5 \times 5}{5 \times 5}$$

**(iii)**

$$\sqrt{2 \times 2 \times 2 \times 2 \times 17 \times 17}$$

**(iv)**

$$\frac{17 \times 17 \times 17 \times 13 \times 13 \times 13}{17 \times 13 \times 13 \times 13}$$

**Question 4.**Write in prime index form,  $p^m$ , for some prime  $p$ .**(i)**

$$5^4 \times 5^6 \times 5^3 \times 5^7$$

**(ii)**

$$11^8 \times 11^3 \times 11$$

**(iii)**

$$19^3 \times (19^6)^5$$

**(iv)**

$$\sqrt{19^5 \times 19^{11}}$$

**(v)**

$$\frac{(5^7)^5}{(5^2)^3}$$

**(vi)**

$$(31^{14})^{\frac{1}{2}}$$

**(vii)**

$$\sqrt{\sqrt{11^{80}}}$$

**(viii)**

$$\left( (7^3)^2 \right)^3$$

**Question 5.**

Simplify;

**(i)**

$$p^{15} \times p^5 \times p^2 \times p^8$$

**(ii)**

$$\frac{p^{17}}{p^5}$$

**(iii)**

$$(p^7)^3 \times p^5$$

**(iv)**

$$\sqrt{p^8}$$

**(v)**

$$\frac{(p^{13})^3}{p}$$

**(vi)**

$$(\sqrt{p})^8$$

**(vii)**

$$\left(\frac{p^{17}}{p^{11}}\right)^2$$

**(viii)**

$$p^{12} \div p^3$$

**Question 6.**Write in prime index form,  $p^m$ , for some prime,  $p$ .**(i)**

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

**(ii)**

$$\frac{3 \times 3 \times 3}{3 \times 3 \times 3 \times 3 \times 3}$$

**(iii)**

$$\frac{1}{11}$$

**(iv)**

$$\frac{13}{13 \times 13}$$

**Question 7.**Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$13^9 \times 13^{-3}$$

(ii)

$$17^{-8} \times 17^3$$

(iii)

$$29^{-8} \times (29^7)^5$$

(iv)

$$\sqrt{3^{-206}}$$

(v)

$$\frac{5^{13}}{5^{19}}$$

(vi)

$$\frac{19^{-25}}{19^7}$$

(vii)

$$\frac{(2^6)^4}{(2^5)^5}$$

(viii)

$$31^{-12} \times 31^{-7}$$

**Question 8.**Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$\frac{3^{12} \times 3^5}{3^5 \times 3^4}$$

(ii)

$$\frac{2^{17} \times 2^{-6}}{2^5 \times 2^2}$$

(iii)

$$\frac{2^{14} \times 2^{16}}{2^{-4}}$$

(iv)

$$\sqrt{\frac{2^{-21}}{2^{-5}}}$$



**Question 9.**

Simplify;

**(i)**

$$p^{14} \times p^{-7} \times p^7 \times p^{-3}$$

**(ii)**

$$\frac{p^{-17}}{p^6}$$

**(iii)**

$$(p^{-5})^5 \times p^{13}$$

**(iv)**

$$\sqrt{p^{-36}}$$

**(v)**

$$\frac{(p^{25})^{-3}}{p^{60}}$$

**(vi)**

$$\sqrt{p^0}$$

**(vii)**

$$\left(\frac{p^{14}}{p^{-17}}\right)^2$$

**(viii)**

$$(p^{-6})^{-9}$$

**Question 10.**

Simplify;

**(i)**

$$5 \times p^4 \times 9 \times p^{11} \times p^{-7}$$

**(ii)**

$$\frac{20p^{12}}{4p^3}$$

**(iii)**

$$(2p^7)^5$$

**(iv)**

$$\sqrt{81p^{36}}$$

**(v)**

$$\frac{15(p^{0.5})^{-6}}{5p^4}$$

**(vi)**

$$\sqrt{25p^0}$$

**(vii)**

$$\left(\frac{24p^{-11}}{4p^{-5}}\right)^2$$

**(viii)**

$$(0.5p^{-2})^{-3}$$

### PART THREE

#### Question 1.

Determine the value of  $x$

(i)

$$2^3 \times 8^4 = 2^x$$

(ii)

$$27^5 \times 81^x = 3^{17}$$

(iii)

$$32 \times 16^3 \times 2^8 = 4^x$$

(iv)

$$\frac{4^{\frac{5}{2}}}{\sqrt{2}} = 2^x$$

#### Question 2.

Solve this equation

$$2^{2x} - 3 \times 2^{2+x} + 2^5 = 0$$

#### Question 3.

Given that

$$\sqrt{2}^{\sqrt{2}} = a^{b^c}$$

and that  $a$  and  $b$  are integers, and  $c$  is a fraction

State the values of  $a$ ,  $b$ , and  $c$ .

## 6A.2 Solutions to the test

### PART ONE

#### Answer 1.

$$4 \quad -2 \quad 24 \quad -6 \quad 5 \quad -7$$

#### Answer 2.

$$\begin{array}{ll} 64 & 3 \\ 49 & 93 \\ \frac{1}{5} & 1 \\ \frac{1}{16} & 1 \\ 5 & 64 \end{array}$$

#### Answer 3.

$$\begin{array}{ll} 2^{13} & 11^{14} \\ 5^6 & 13^{40} \\ 11^{11} & 3^{-21} \end{array}$$

#### Answer 4.

$$\begin{array}{ll} 18 & 200 \\ 49 & 1 \end{array}$$

#### Answer 5.

$$\begin{array}{ll} 13x & 4h - 8 \\ 5x - 12y & 15x^9 \\ 6u + 33 & 2m^{12} \end{array}$$

### PART TWO

#### Answer 1.

$$\begin{array}{ll} \text{(i)} & 5^6 \\ \text{(iii)} & 2^4 \end{array} \quad \begin{array}{ll} \text{(ii)} & 7^5 \\ \text{(iv)} & 11^{-1} \end{array}$$

#### Answer 2.

$$\begin{array}{ll} \text{(i)} & 5^{12} \\ \text{(iii)} & 23^8 \\ \text{(v)} & 2^3 \\ \text{(vii)} & 7^9 \end{array} \quad \begin{array}{ll} \text{(ii)} & 17^{17} \\ \text{(iv)} & 19^6 \\ \text{(vi)} & 29^{30} \\ \text{(viii)} & 11^4 \end{array}$$

**Answer 3.**

**( i )**  $2^2 \times 3^3$

**( ii )**  $3^3 \times 5$

**( iii )**  $2^2 \times 17$

**( iv )**  $17^2$

**Answer 4.**

**( i )**  $5^{20}$

**( ii )**  $11^{12}$

**( iii )**  $19^{33}$

**( iv )**  $19^8$

**( v )**  $5^{29}$

**( vi )**  $31^7$

**( vii )**  $11^{20}$

**( viii )**  $7^{18}$

**Answer 5.**

**( i )**  $p^{30}$

**( ii )**  $p^{12}$

**( iii )**  $p^{26}$

**( iv )**  $p^4$

**( v )**  $p^{38}$

**( vi )**  $p^4$

**( vii )**  $p^{12}$

**( viii )**  $p^9$

**Answer 6.**

**( i )**  $7^{-4}$

**( ii )**  $3^{-2}$

**( iii )**  $11^{-1}$

**( iv )**  $13^{-1}$

**Answer 7.**

**( i )**  $13^6$

**( ii )**  $17^{-5}$

**( iii )**  $29^{27}$

**( iv )**  $3^{-103}$

**( v )**  $5^{-6}$

**( vi )**  $19^{-32}$

**( vii )**  $2^{-1}$

**( viii )**  $31^{-19}$

**Answer 8.**

**( i )**  $3^8$

**( ii )**  $2^4$

**( iii )**  $2^{34}$

**( iv )**  $2^{-8}$

**Answer 9.**

**( i )**  $p^{11}$

**( ii )**  $p^{-23}$

**( iii )**  $p^{-12}$

**( iv )**  $p^{-18}$

**( v )**  $p^{-135}$

**( vi )**  $1$

**( vii )**  $p^{62}$

**( viii )**  $p^{54}$

**Answer 10.**

**( i )**  $45 p^8$

**( ii )**  $5 p^9$

**( iii )**  $32 p^{35}$

**( iv )**  $9 p^{18}$

**( v )**  $3 p^{-7}$

**( vi )**  $5$

**( vii )**  $36 p^{-12}$

**( viii )**  $8 p^6$

## Chapter 5.

### 5.1 Powers of prime numbers.

So far the laws of indices have only been applied to numbers with a base that is a prime number. They apply equally well when the base is composite.

For example :  $8^6 \times 8^4 = 8^{10}$

Some times (not always!) a question will ask that the answer be written in the form,  $a^m$ , where  $a$  is a prime number in which case there is extra work to do.

For example :  $8^6 \times 8^4 = 8^{10} = (2^3)^{10} = 2^{30}$

### 5.2 'Together' Questions.

Write each answer in the prime index form,  $p^m$ , where  $p$  is a prime number.

(a)  $4^4$

(b)  $8^5$

(c)  $16^{\frac{1}{2}}$

(d)  $4^3 \times 2^3$

(e)  $8 \times 4$

(f)  $\frac{2^{12}}{4^3}$

(g)  $2^5 \times \sqrt{16}$

(h)  $25^4$

(i)  $\frac{5^9}{25^2}$

### 5.3 Exercise.

#### Question 1.

Complete the following table.

Number	rewritten as a power of 2
2	$2^1$
4	$2^2$
8	
16	
32	
64	
128	

For each of the following, rewrite in prime index form,  $p^m$ , where  $p$  is a prime number.

(a)  $4^6$

(b)  $8^7$

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

(d)  $32^3 \times 2^3$

(e)  $128 \times 4$

(f)  $\frac{2^{25}}{4^3}$

(g)  $64^5 \times \sqrt{16}$

(h)  $128^4 \times 32^7$

(i)  $\frac{16^9}{64^2}$

**Question 2.**

Complete the following table.

Number	rewritten as a power of 3
3	$3^1$
	$3^2$
	$3^3$
243	
729	
2187	

For each of the following, rewrite in prime index form,  $p^m$ , where  $p$  is a prime number.

**(a)**  $9^7$

**(b)**  $81^7$

**(c)**  $81^{\frac{1}{2}}$

**(d)**  $243^4 \times 3^4$

**(e)**  $2187 \times 729$

**(f)**  $\frac{3^{18}}{9^3}$

**(g)**  $81^7 \times \sqrt{9}$

**(h)**  $27^9 \times 9^7$

**(i)**  $\frac{27^9}{2187}$



**Question 3.**

Complete the following table.

Number	rewritten as a power of 5
5	$5^1$
	$5^2$
	$5^3$
625	
3125	
15625	
78125	

For each of the following, rewrite in prime index form,  $p^m$ , where  $p$  is a prime number.

**(a)**  $3125^7$

**(b)**  $(25^3)^7$

**(c)**  $625^{\frac{1}{2}}$

**(d)**  $125^{13} \times 5^3$

**(e)**  $3125 \times 78125$

**(f)**  $\frac{25^8}{15625}$

**(g)**  $625 \times \sqrt{625}$

**(h)**  $25^{19} \times 625^7$

**(i)**  $\frac{78125^2}{25^3}$

**Question 4.**

Complete the following table.

Number	rewritten as a power of 7
7	$7^1$
	$7^2$
	$7^3$
2401	
16807	
117649	
823543	

For each of the following, rewrite in prime index form,  $p^m$ , where  $p$  is a prime number.

**(a)**  $117649^5$

**(b)**  $(2401^{10})^7$

**(c)**  $117649^{\frac{1}{2}}$

**(d)**  $343^{11} \times 49^{13}$

**(e)**  $823543 \times 49$

**(f)**  $\frac{2401^8}{823543^2}$

**(g)**  $7^8 \times \sqrt{117649}$

**(h)**  $(343^4)^5 \times 16807^7$

**(i)**  $\frac{823543^{20}}{343^5}$

## 5.4 Solutions.

### 5.4.1 To the 'Together' questions.

- |     |       |     |          |     |       |
|-----|-------|-----|----------|-----|-------|
| (a) | $2^8$ | (b) | $2^{15}$ | (c) | $2^2$ |
| (d) | $2^9$ | (e) | $2^5$    | (f) | $2^6$ |
| (g) | $2^7$ | (h) | $5^8$    | (i) | $5^5$ |

### 5.4.2 To the exercise.

#### Answer 1.

- |     |          |     |          |     |          |
|-----|----------|-----|----------|-----|----------|
| (a) | $2^{12}$ | (b) | $2^{21}$ | (c) | $2^3$    |
| (d) | $2^{18}$ | (e) | $2^9$    | (f) | $2^{19}$ |
| (g) | $2^{32}$ | (h) | $2^{63}$ | (i) | $2^{24}$ |

#### Answer 2.

- |     |          |     |          |     |          |
|-----|----------|-----|----------|-----|----------|
| (a) | $3^{14}$ | (b) | $3^{28}$ | (c) | $3^2$    |
| (d) | $3^{24}$ | (e) | $3^{13}$ | (f) | $3^{12}$ |
| (g) | $3^{29}$ | (h) | $3^{41}$ | (i) | $3^{20}$ |

#### Answer 3.

- |     |          |     |          |     |          |
|-----|----------|-----|----------|-----|----------|
| (a) | $5^{35}$ | (b) | $5^{42}$ | (c) | $5^2$    |
| (d) | $5^{42}$ | (e) | $5^{12}$ | (f) | $5^{10}$ |
| (g) | $5^6$    | (h) | $5^{66}$ | (i) | $5^8$    |

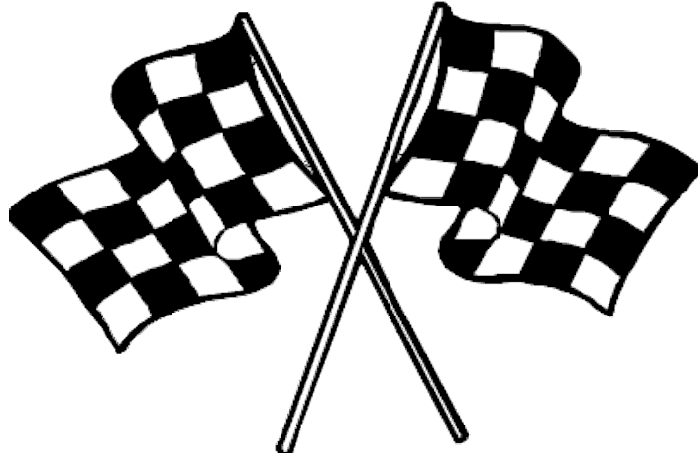
#### Answer 4.

- |     |          |     |           |     |           |
|-----|----------|-----|-----------|-----|-----------|
| (a) | $7^{30}$ | (b) | $7^{280}$ | (c) | $7^3$     |
| (d) | $7^{59}$ | (e) | $7^9$     | (f) | $7^{18}$  |
| (g) | $7^{11}$ | (h) | $7^{95}$  | (i) | $7^{125}$ |

5.5 Exercise

## Index Form Race N° 8

Do NOT use a calculator



Write the answers in prime index form,  $p^m$ , where  $p$  is a prime number.

*Target time : 15 minutes*

(a)  $4^{52}$

(b)  $25^8$

(c) 27

(d)  $8^7 \times 8^5$

(e)  $9^2 \times 27^4$

(f)  $(49^{11})^3$

(g)  $3 \times 81^2$

(h)  $25^4 \times 125^3$

(i)  $\sqrt{\sqrt{25^{20}}}$

(j)  $\frac{9^7}{27}$

(k)  $(8^5)^{10}$

(l)  $\frac{81^7}{3}$

(m)  $4^{53} \times 2$

(n)  $\frac{(8^8)^5}{(4^6)^3}$

(o)  $\frac{16^{25}}{4}$

$$(p) \quad (4^9)^3 \times 16$$

$$(q) \quad (27^{20})^{\frac{1}{2}}$$

$$(r) \quad (5^7)^7 \times 25^5$$

$$(s) \quad \frac{4^9}{4^2} \times \frac{4^7}{4^6}$$

$$(t) \quad \frac{9^5 \times 27}{3^8}$$

$$(u) \quad \sqrt{8^{24}}$$

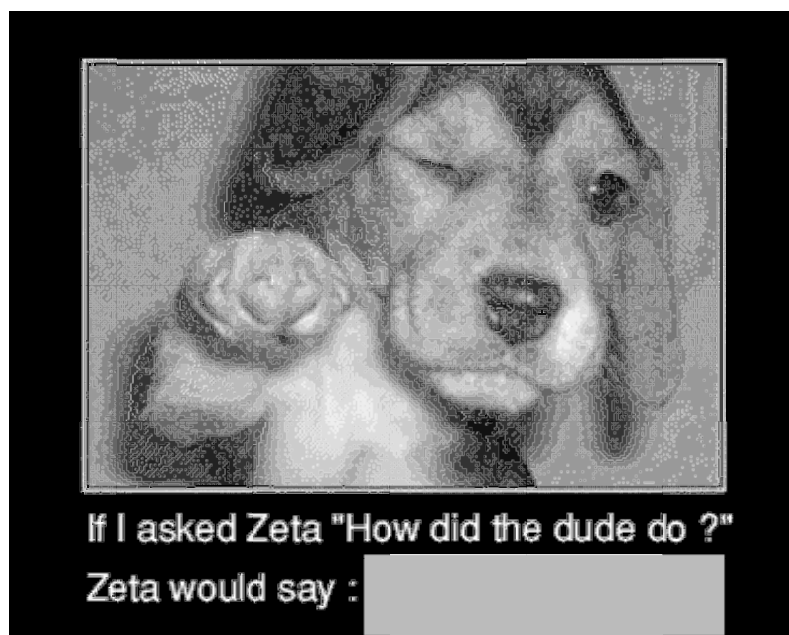
$$(v) \quad \frac{49^{10}}{7^{\frac{1}{2}}} \times \frac{7^{10}}{7^{\frac{1}{2}}}$$

$$(w) \quad 4^{\frac{1}{2}} \times 16^{\frac{1}{2}}$$

$$(x) \quad \frac{(121^7)^4}{(11^2)^6}$$

$$(y) \quad \sqrt{121^{12} \times 11^{26}}$$

$$(z) \quad \sqrt{\frac{(9^2)^{14}}{3^8}}$$



## 5.6 Answers to Index Form Race N° 8

(a)  $2^{104}$

(b)  $5^{16}$

(c)  $3^3$

(d)  $2^{36}$

(e)  $3^{16}$

(f)  $7^{66}$

(g)  $3^9$

(h)  $5^{17}$

(i)  $5^{10}$

(j)  $3^{11}$

(k)  $2^{150}$

(l)  $3^{27}$

(m)  $2^{107}$

(n)  $2^{84}$

(o)  $2^{98}$

(p)  $2^{58}$

(q)  $3^{30}$

(r)  $5^{59}$

(s)  $2^{16}$

(t)  $3^5$

(u)  $2^{36}$

(v)  $7^{29}$

(w)  $2^3$

(x)  $11^{44}$

(y)  $11^{25}$

(z)  $3^{24}$

## Chapter 6.

### 6.1 The fundamental theorem of arithmetic and indices.

The fundamental theorem of arithmetic says that any<sup>†</sup> positive integer which is not prime can be written as a product of primes.

Examples :      (i)       $35 = 5 \times 7$   
                      (ii)       $12 = 2^2 \times 3$

This idea is the key to answering some much harder questions involving indices.

#### 8<sup>th</sup> Law : The distributive law.

$$\begin{aligned} & 35^3 \\ &= (5 \times 7)^3 \\ &= (5 \times 7) \times (5 \times 7) \times (5 \times 7) \\ &= 5 \times 5 \times 5 \times 7 \times 7 \times 7 \\ &= 5^3 \times 7^3 \\ &\therefore 35^3 = (5 \times 7)^3 = 5^3 \times 7^3 \end{aligned}$$

*The 8<sup>th</sup> Law : The distributive law.*  
 $(a \times b)^m = a^m \times b^m$

### 6.2 'Together' Questions.

Write answers in prime index form,  $p^m q^n$ , where  $p$  and  $q$  are prime numbers.

(a)  $15^4$

(b)  $12^5$

(c)  $6^3 \times 2^2$

(d)  $10^3 \times 2^5$

(e)  $21^4 \times 3^2$

(f)  $20^3 \times 10^2$

<sup>†</sup> Except the number 1.

### 6.3 Exercise.

#### Question 1.

Complete the following tables.

Number	Written as a power of 2
2	$2^1$
4	$2^2$
	$2^3$
16	
	$2^5$
	$2^6$
128	

Number	Written as a power of 3
3	$3^1$
9	$3^2$
	$3^3$
	$3^4$
243	
729	
2187	

Write answers in prime index form,  $p^m q^n$ , where  $p$  and  $q$  are prime numbers.

(a)  $6^8$

(b)  $18^5$

(c)  $12^7$

(d)  $6^3 \times 2^3$

(e)  $18^3 \times 3^9$

(f)  $\frac{6^5}{2^3}$

(g)  $24^5$

(h)  $128^2 \times 2187^7$

(i)  $\frac{6^9}{6^2}$



**Question 2.**

Complete the following tables.

Number	Written as a power of 3
3	
	$3^2$
	$3^3$
81	
	$3^5$
729	
2187	

Number	Written as a power of 5
5	
	$5^2$
	$5^3$
625	
	$5^5$
15625	
78125	

Write answers in prime index form,  $p^m q^n$ , where  $p$  and  $q$  are prime numbers.

**(a)**  $15^7$

**(b)**  $75^4$

**(c)**  $45^8$

**(d)**  $15^5 \times 3^4$

**(e)**  $75^4 \times 3^7$

**(f)**  $\frac{15^8}{3^5}$

**(g)**  $45^7 \times 5^8$

**(h)**  $729^3 \times 15625^6$

**(i)**  $\frac{15^9}{15^4}$

**Question 3.**

Complete the following tables.

Number	Written as a power of 2
2	
	$2^2$
	$2^3$
16	
	$2^5$
	$2^6$
	$2^7$

Number	Written as a power of 5
5	
	$5^2$
125	
	$5^4$
	$5^5$
15625	
78125	

Write answers in prime index form,  $p^m q^n$ , where  $p$  and  $q$  are prime numbers.

**(a)**  $10^{12}$

**(b)**  $50^{14}$

**(c)**  $20^{18}$

**(d)**  $10^5 \times 4^3$

**(e)**  $50^4 \times 25^4$

**(f)**  $\frac{50^8}{10^5}$

**(g)**  $16^7 \times 10^8$

**(h)**  $78125^3 \times 100^6$

**(i)**  $\frac{40^9}{20^4}$

**Question 4.**

( a ) Write 135 as a product of primes.

( b ) Hence, or otherwise, write in prime index form,  $p^m q^n$ , where  $p$  and  $q$  are prime numbers, the value of;

$$135^6 \times 15^5$$

**Question 5.**

( a ) Write 180 as a product of primes.

( b ) Hence, or otherwise, write in prime index form,  $p^m q^n$ , where  $p$  and  $q$  are prime numbers, the value of;

$$180^6 \times 6^8$$

## Chapter 7.

### 7.1 REVISION.

#### Question 1.

Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$7 \times 7 \times 7 \times 7 \times 7$$

(ii)

$$\frac{5 \times 5 \times 5 \times 5 \times 5 \times 5}{5 \times 5}$$

(iii)

$$\sqrt{3 \times 3 \times 3 \times 3 \times 3 \times 3}$$

(iv)

$$\frac{13 \times 13 \times 13}{13 \times 13 \times 13 \times 13}$$

#### Question 2.

Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$7^6 \times 7^8$$

(ii)

$$5^7 \times 5^3 \times 5^6$$

(iii)

$$13^8 \times 13$$

(iv)

$$\sqrt{17^8}$$

(v)

$$\frac{11^9}{11^4}$$

(vi)

$$(19^4)^6$$

(vii)

$$9$$

(viii)

$$9^5$$

**Question 3.**

Write in index form;

**(i)**

$$7 \times 5 \times 5 \times 7 \times 7$$

**(ii)**

$$\frac{5 \times 2 \times 2 \times 2 \times 5 \times 5}{5 \times 5}$$

**(iii)**

$$\sqrt{3 \times 3 \times 3 \times 3 \times 23 \times 23}$$

**(iv)**

$$\frac{17 \times 13 \times 13 \times 13 \times 13 \times 13}{17 \times 13 \times 13 \times 13}$$

**Question 4.**Write in prime index form,  $p^m$ , for some prime  $p$ .**(i)**

$$3^5 \times 3^4 \times 3^2 \times 3^6$$

**(ii)**

$$13^7 \times 13^3 \times 13^0$$

**(iii)**

$$17^8 \times (17^5)^5$$

**(iv)**

$$\sqrt{11^8 \times 11^{10}}$$

**(v)**

$$\frac{(5^6)^3}{(5^2)^4}$$

**(vi)**

$$(29^8)^{\frac{1}{2}}$$

**(vii)**

$$\sqrt{\sqrt{7^{20}}}$$

**(viii)**

$$\left( (5^3)^4 \right)^3$$

**Question 5.**

Simplify;

**(i)**

$$p^{15} \times p^5 \times p^2 \times p^8$$

**(ii)**

$$\frac{p^{17}}{p^5}$$

**(iii)**

$$(p^4)^5 \times p^3$$

**(iv)**

$$\sqrt{p^6}$$

**(v)**

$$\frac{(p^{16})^2}{p}$$

**(vi)**

$$p^0$$

**(vii)**

$$\left(\frac{p^{19}}{p^{11}}\right)^2$$

**(viii)**

$$p^8 \div p^2$$

**Question 6.**Write in prime index form,  $p^m$ , for some prime,  $p$ .**(i)**

$$8$$

**(ii)**

$$8 \times 4$$

**(iii)**

$$9^5$$

**(iv)**

$$9^3 \times 3^3$$

**Question 7.**

Write in prime index form,  $p^m q^n$ , for some primes,  $p$  and  $q$ .

(i)

$$12$$

(ii)

$$12^7 \times 2^3$$

(iii)

$$12^8 \times 4^4$$

(iv)

$$12^5 \times 6^3$$

**Question 8.**

(a) Write 40 as a product of primes.

(b) Hence, or otherwise, write in prime index form,  $p^m q^n$ , where  $p$  and  $q$  are prime numbers, the value of;

$$40^6 \times 6^5$$

**Question 9.**

Write in prime index form,  $p^m$ , for some prime,  $p$ .

(i)

$$\frac{1}{5 \times 5 \times 5}$$

(ii)

$$\frac{7 \times 7}{7 \times 7 \times 7 \times 7}$$

(iii)

$$\frac{1}{13}$$

(iv)

$$\frac{2}{8}$$

**Question 10.**Write in prime index form,  $p^m$ , for some prime  $p$ .**(i)**

$$11^7 \times 11^{-3}$$

**(ii)**

$$5^{-7} \times 5^3$$

**(iii)**

$$19^{-8} \times (19^4)^5$$

**(iv)**

$$\sqrt{11^{-26}}$$

**(v)**

$$\frac{5^7}{5^9}$$

**(vi)**

$$\frac{11^{-23}}{11^5}$$

**(vii)**

$$\frac{(7^5)^3}{(7^6)^4}$$

**(viii)**

$$23^{-8} \times 23^{-7}$$

**Question 11.**Write in prime index form,  $p^m$ , for some prime  $p$ .**(i)**

$$\frac{2^8 \times 2^7}{2^6 \times 2^3}$$

**(ii)**

$$\frac{2^{14} \times 2^{-5}}{2^4 \times 2^2}$$

**(iii)**

$$\frac{2^3 \times 2^6}{2^{-4}}$$

**(iv)**

$$\sqrt{\frac{2^{-23}}{2^{-5}}}$$



**Question 12.**

Simplify;

**(i)**

$$p^{13} \times p^{-3} \times p^7 \times p^{-2}$$

**(ii)**

$$\frac{p^{-14}}{p^4}$$

**(iii)**

$$(p^{-4})^5 \times p^{13}$$

**(iv)**

$$\sqrt{p^{-56}}$$

**(v)**

$$\frac{(p^{16})^{-2}}{p^{40}}$$

**(vi)**

$$\sqrt{p^2}$$

**(vii)**

$$\left(\frac{p^{19}}{p^{-11}}\right)^2$$

**(viii)**

$$(p^{-5})^{-8}$$

**Question 13.**Write in prime index form,  $p^m q^n$ , for some primes,  $p$  and  $q$ .**(i)**

$$(2^5 \times 3^2)^4$$

**(ii)**

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

**(iii)**

$$(\sqrt{5^8} \times \sqrt{7^6})^4$$

**(iv)**

$$(6^3 \times 4^2)^3$$

## 7.2 Solutions to the revision.

### Answer 1.

- |       |       |      |           |
|-------|-------|------|-----------|
| (i)   | $7^5$ | (ii) | $5^4$     |
| (iii) | $3^3$ | (iv) | $13^{-1}$ |

### Answer 2.

- |       |          |        |           |
|-------|----------|--------|-----------|
| (i)   | $7^{14}$ | (ii)   | $5^{16}$  |
| (iii) | $13^9$   | (iv)   | $17^4$    |
| (v)   | $11^5$   | (vi)   | $19^{24}$ |
| (vii) | $3^2$    | (viii) | $3^{10}$  |

### Answer 3.

- |       |                  |      |                |
|-------|------------------|------|----------------|
| (i)   | $5^2 \times 7^3$ | (ii) | $2^3 \times 5$ |
| (iii) | $3^2 \times 23$  | (iv) | $13^2$         |

### Answer 4.

- |       |           |        |           |
|-------|-----------|--------|-----------|
| (i)   | $3^{17}$  | (ii)   | $13^{10}$ |
| (iii) | $17^{33}$ | (iv)   | $11^9$    |
| (v)   | $5^{10}$  | (vi)   | $29^4$    |
| (vii) | $7^5$     | (viii) | $5^{36}$  |

### Answer 5.

- |       |          |        |          |
|-------|----------|--------|----------|
| (i)   | $p^{30}$ | (ii)   | $p^{12}$ |
| (iii) | $p^{23}$ | (iv)   | $p^3$    |
| (v)   | $p^{31}$ | (vi)   | 1        |
| (vii) | $p^{16}$ | (viii) | $p^6$    |

### Answer 6.

- |       |          |      |       |
|-------|----------|------|-------|
| (i)   | $2^3$    | (ii) | $2^5$ |
| (iii) | $3^{10}$ | (iv) | $3^9$ |

### Answer 7.

- |       |                   |      |                     |
|-------|-------------------|------|---------------------|
| (i)   | $2^2 \times 3$    | (ii) | $2^{17} \times 3^7$ |
| (iii) | $2^{24} \times 3$ | (iv) | $2^{13} \times 3^8$ |

### Answer 8.

- |     |                |     |                                |
|-----|----------------|-----|--------------------------------|
| (a) | $2^3 \times 5$ | (b) | $2^{23} \times 3^5 \times 5^6$ |
|-----|----------------|-----|--------------------------------|

### Answer 9.

- |       |           |      |          |
|-------|-----------|------|----------|
| (i)   | $5^{-3}$  | (ii) | $7^{-2}$ |
| (iii) | $13^{-1}$ | (iv) | $2^{-2}$ |

**Answer 10.**

- (i)  $11^4$
- (iii)  $19^{12}$
- (v)  $5^{-2}$
- (vii)  $7^{-9}$

- (ii)  $5^{-4}$
- (iv)  $11^{-13}$
- (vi)  $11^{-28}$
- (viii)  $23^{-15}$

**Answer 11.**

- (i)  $2^6$
- (iii)  $2^{13}$

- (ii)  $2^3$
- (iv)  $2^{-9}$

**Answer 12.**

- (i)  $p^{15}$
- (iii)  $p^{-7}$
- (v)  $p^{-72}$
- (vii)  $p^{59}$

- (ii)  $p^{-18}$
- (iv)  $p^{-28}$
- (vi)  $p$
- (viii)  $p^{40}$

**Answer 13.**

- (i)  $2^{20} \times 3^8$
- (iii)  $5^{16} \times 7^{12}$

- (ii)  $2^{42} \times 5^{-18}$
- (iv)  $2^{15} \times 3^9$

## Chapter 8.

### 8.1 TEST.

#### Question 1.

Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$5 \times 5 \times 5 \times 5 \times 5 \times 5$$

(ii)

$$\frac{7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7}{7 \times 7}$$

(iii)

$$\sqrt{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2}$$

(iv)

$$\frac{11 \times 11 \times 11}{11 \times 11 \times 11 \times 11}$$

#### Question 2.

Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$5^5 \times 5^7$$

(ii)

$$17^6 \times 17^4 \times 17^7$$

(iii)

$$23^7 \times 23$$

(iv)

$$\sqrt{19^{12}}$$

(v)

$$\frac{2^8}{2^5}$$

(vi)

$$(29^5)^6$$

(vii)

$$8$$

(viii)

$$8^6$$

**Question 3.**

Write in index form;

**(i)**

$$2 \times 3 \times 2 \times 3 \times 3$$

**(ii)**

$$\frac{3 \times 5 \times 3 \times 3 \times 5 \times 5}{5 \times 5}$$

**(iii)**

$$\sqrt{2 \times 2 \times 2 \times 2 \times 17 \times 17}$$

**(iv)**

$$\frac{17 \times 17 \times 17 \times 13 \times 13 \times 13}{17 \times 13 \times 13 \times 13}$$

**Question 4.**Write in prime index form,  $p^m$ , for some prime  $p$ .**(i)**

$$5^4 \times 5^6 \times 5^3 \times 5^7$$

**(ii)**

$$11^8 \times 11^3 \times 11$$

**(iii)**

$$19^3 \times (19^6)^5$$

**(iv)**

$$\sqrt{19^5 \times 19^{11}}$$

**(v)**

$$\frac{(5^7)^5}{(5^2)^3}$$

**(vi)**

$$(31^{14})^{\frac{1}{2}}$$

**(vii)**

$$\sqrt{\sqrt{11^{80}}}$$

**(viii)**

$$\left( (7^3)^2 \right)^3$$

**Question 5.**

Simplify;

**(i)**

$$p^{15} \times p^5 \times p^2 \times p^8$$

**(ii)**

$$\frac{p^{17}}{p^5}$$

**(iii)**

$$(p^7)^3 \times p^5$$

**(iv)**

$$\sqrt{p^8}$$

**(v)**

$$\frac{(p^{13})^3}{p}$$

**(vi)**

$$(\sqrt{p})^8$$

**(vii)**

$$\left(\frac{p^{17}}{p^{11}}\right)^2$$

**(viii)**

$$p^{12} \div p^3$$

**Question 6.**Write in prime index form,  $p^m$ , for some prime,  $p$ .**(i)**

$$9$$

**(ii)**

$$9 \times 3$$

**(iii)**

$$8^5$$

**(iv)**

$$8^3 \times 4^3$$

**Question 7.**

Write in prime index form,  $p^m q^n$ , for some primes,  $p$  and  $q$ .

(i)

$$18$$

(ii)

$$18^7 \times 2^3$$

(iii)

$$18^8 \times 4^4$$

(iv)

$$18^5 \times 6^3$$

**Question 8.**

(a) Write 24 as a product of primes.

(b) Hence, or otherwise, write in prime index form,  $p^m q^n$ , where  $p$  and  $q$  are prime numbers, the value of;

$$24^7 \times 6^7$$

**Question 9.**

Write in prime index form,  $p^m$ , for some prime,  $p$ .

(i)

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

(ii)

$$\frac{3 \times 3 \times 3}{3 \times 3 \times 3 \times 3 \times 3}$$

(iii)

$$\frac{1}{11}$$

(iv)

$$\frac{2}{8}$$

**Question 10.**Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$13^9 \times 13^{-3}$$

(ii)

$$17^{-8} \times 17^3$$

(iii)

$$29^{-8} \times (29^7)^5$$

(iv)

$$\sqrt{3^{-206}}$$

(v)

$$\frac{5^{13}}{5^{19}}$$

(vi)

$$\frac{19^{-25}}{19^7}$$

(vii)

$$\frac{(2^6)^4}{(2^5)^5}$$

(viii)

$$31^{-12} \times 31^{-7}$$

**Question 11.**Write in prime index form,  $p^m$ , for some prime  $p$ .

(i)

$$\frac{3^{12} \times 3^5}{3^5 \times 3^4}$$

(ii)

$$\frac{2^{17} \times 2^{-6}}{2^5 \times 2^2}$$

(iii)

$$\frac{2^{14} \times 2^{16}}{2^{-4}}$$

(iv)

$$\sqrt{\frac{2^{-21}}{2^{-5}}}$$



**Question 12.**

Simplify;

**(i)**

$$p^{14} \times p^{-7} \times p^7 \times p^{-3}$$

**(ii)**

$$\frac{p^{-17}}{p^6}$$

**(iii)**

$$(p^{-5})^5 \times p^{13}$$

**(iv)**

$$\sqrt{p^{-36}}$$

**(v)**

$$\frac{(p^{25})^{-3}}{p^{60}}$$

**(vi)**

$$\sqrt{p^0}$$

**(vii)**

$$\left(\frac{p^{14}}{p^{-17}}\right)^2$$

**(viii)**

$$(p^{-6})^{-9}$$

**Question 13.**Write in prime index form,  $p^m q^n$ , for some primes,  $p$  and  $q$ .**(i)**

$$(5^4 \times 7^5)^4$$

**(ii)**

$$(3^7 \times 5^{-3})^5$$

**(iii)**

$$(\sqrt{5^8} \times \sqrt{7^6})^8$$

**(iv)**

$$(6^5 \times 4^3)^2$$