PART A

1) Show why each of the following is true.

a) $\left(2^3\right)^4 = 2^{12}$ b) $(2\times3)^4 = 2^4\times3^4$ c) $\left(\frac{2}{3}\right)^4 = \frac{2^4}{3^4}$

2) State the value that should be placed in each box.

a) $\left(2^3\right)^5 = 2^{\square}$ b) $\left(x^5\right)^3 = x^{\square}$ c) $\left(3^4\right)^6 = \square^{24}$ d) $\left(y^3\right)^{\square} = y^{18}$

e) $(xy)^4 = x^4y^{\square}$ f) $(3pq)^{\square} = 3^{10}p^{10}q^{10}$ g) $\left(\frac{5}{6}\right)^7 = \frac{5^7}{6^{\square}}$ h) $\left(\frac{a}{b}\right)^{\square} = \frac{a^9}{b^9}$

3) State the value that should be placed in each box.

a) $\left(x^4y^6\right)^2 = x^{\square}y^{12}$ b) $\left(35x^4y^6\right)^2 = 1225x^{\square}y^{12}$ c) $\left(\frac{x^8}{y^3}\right)^4 = \frac{x^{\square}}{y^{12}}$ d) $\left(\frac{a^2}{b^3}\right)^{\square} = \frac{a^{14}}{b^{21}}$

PART B

4) The table on the right contains five expressions. Identify all of these expressions that are equal to $\left(p^3\right)^2$.

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

5) Use at least one exponent rule to find an equivalent/simplified expression.

a) $\left(6^5\right)^4$ b) $\left(x^3\right)^6$ c) $(xy)^8$ d) $\left(\frac{x}{y}\right)^7$ e) $(2x)^3$ f) $\left(\frac{1}{2}xy\right)^2$

g) $\left(\frac{a}{4}\right)^3$ h) $\left(x^2y^3\right)^5$ i) $\left(\frac{x^8}{y^4}\right)^3$ j) $\left(4^2a^3b^6\right)^3$ k) $\left(-2mn^4\right)^6$ l) $\left(\frac{-5}{p^8}\right)^3$

6) Use at least one exponent rule to find an equivalent/simplified expression and then evaluate for $x=-1$ and $y=2$.

a) $\left(\frac{x}{y}\right)^3$ b) $(3xy)^4$ c) $\left(x^2y\right)^2$ d) $\left(\frac{x^5}{y^3}\right)^2$ e) $\left(\frac{4}{y^2}\right)^3$ f) $\left(\frac{1}{2}x^5y^2\right)^4$

7) Express 4^3 as a power with a base of 2.

8) Express 25^4 as a power with a base of 5.

9) Express 27^2 as a power with a base of 3.

10) Express $\left(\frac{1}{81}\right)^4$ as a power with a base of $\frac{1}{3}$.

11) Without actually calculating the value of either power, show that 16^3 is equal to 4^6.

12) Without actually calculating the value of either power, show that 5^{183} is equal to 125^{61}.

PART C

13) Simplify $\left[\left(x^2\right)^3\right]^4$.

14) Simplify $\left(\left(\left(m^2n^3\right)^2\right)^4\right)^5$.

15) Simplify $\left[\dfrac{\left(a^3\right)^2}{\left(b^2\right)^4}\right]^5$

16) Kendra needs to quickly determine whether 3^{40} is greater than or less than 4^{30}, but she does not have access to a calculator. How can she use her knowledge that $3^4 = 81$ and $4^3 = 64$ to solve her problem. Which power has the greater value?

17) A cube has a side length of x^4 cm.
   a) Express the volume of the cube as a power of a power.
   b) Express the volume of the cube in simplified form.
   c) Determine an expression for the surface area of the cube in simplified form.

ANSWERS

1) a) One possible explanation is as follows:

$$\begin{aligned}\left(2^3\right)^4 &= 2^3\times2^3\times2^3\times2^3\\ &=(2\times2\times2)\times(2\times2\times2)\times(2\times2\times2)\times(2\times2\times2)\\ &=2\times2\times2\times2\times2\times2\times2\times2\times2\times2\times2\times2\\ &=2^{12}\end{aligned}$$

b) One possible explanation is as follows:

$$\begin{aligned}(2\times3)^4 &= (2\times3)\times(2\times3)\times(2\times3)\times(2\times3)\\ &=2\times3\times2\times3\times2\times3\times2\times3\\ &=2\times2\times2\times2\times3\times3\times3\times3\\ &=(2\times2\times2\times2)\times(3\times3\times3\times3)\\ &=2^4\times3^4\end{aligned}$$

c) One possible explanation is as follows:

$$\begin{aligned}\left(\frac{2}{3}\right)^4 &= \frac{2}{3}\times\frac{2}{3}\times\frac{2}{3}\times\frac{2}{3}\\ &=\frac{2\times2\times2\times2}{3\times3\times3\times3}\\ &=\frac{2^4}{3^4}\end{aligned}$$

2) a) 15 b) 15 c) 3 d) 6 e) 4 f) 10 g) 7 h) 9

3) a) 8 b) 8 c) 32 d) 7

4) $p\times p\times p\times p\times p\times p$, $p^2\times p^2\times p^2$, $p^3\times p^3$, p^6

5) a) 6^{20} b) x^{18} c) x^8y^8 d) $\dfrac{x^7}{y^7}$ e) $8x^3$ f) $\dfrac{1}{4}x^2y^2$ g) $\dfrac{a^3}{64}$ h) $x^{10}y^{15}$ i) $\dfrac{x^{24}}{y^{12}}$

j) $4096a^9b^{18}$ k) $64m^6n^{24}$ l) $-\dfrac{125}{p^{24}}$

6) a) $\dfrac{x^3}{y^3}$; $-\dfrac{1}{8}$ b) $81x^4y^4$; 1296 c) x^4y^2 ; 4 d) $\dfrac{x^{10}}{y^6}$; $\dfrac{1}{64}$ e) $\dfrac{64}{y^6}$; 1

f) $\dfrac{1}{16}x^{20}y^8$; 16

7) 2^6 **8)** 5^8 **9)** 3^6 **10)** $\left(\dfrac{1}{3}\right)^{16}$

11) $16^3=\left(4^2\right)^3 = 4^6$ **12)** $5^{183}=5^{3\times61} = \left(5^3\right)^{61} = 125^{61}$ **13)** x^{24} **14)** $m^{80}n^{120}$ **15)** $\dfrac{a^{30}}{b^{40}}$

16) 3^{40} can be expressed as $\left(3^4\right)^{10}$. 4^{30} can be expressed as $\left(4^3\right)^{10}$. Since Kendra knows that $3^4>4^3$, she can conclude that $\left(3^4\right)^{10}>\left(4^3\right)^{10}$. Therefore, 3^{40} is greater than 4^{30}.

17) a) $\left(x^4\right)^3$ cm^3 b) x^{12} cm^3 c) $6x^8$ cm^2