Q1

1

Identify the calculation you will need to work out.

Thickness of 500 sheets = 500 × thickness of one sheet = $500 \times (9 \times 10^{-3})$

Evaluate by multiplying 9 by 500.

$$500 \times 9 \times 10^{-3} = 4500 \times 10^{-3}$$

[1]

This is not in standard form as a is not in the interval $1 \le a < 10$.
Convert to standard form by first converting 4500 to standard form.

$$4500 \times 10^{-3} = 4.5 \times 10^{3} \times 10^{-3}$$

[1]

Simplify using the law of indices $a^m \times a^n = a^{m+n}$.

Thickness of 500 sheets = $4.5 \times 10^{3-3} = 4.5 \times 10^{0} = 4.5 \times 1 = 4.5$ cm

No, the paper tray is not deep enough as 500 sheets are 4.5 cm thick [1]

Q2

2

Convert each number to an ordinary number to make comparing them easier.

0.038×10^2.

$$0.038 \times 100 = 3.8$$

3800×10^{-4}.

$$3800 \div 10\,000 = 0.38$$

0.38×10^{-1}.

$$0.38 \div 10 = 0.038$$

Write the numbers out.

$0.038 \times 10^2 = 3.8$ $\quad 3800 \times 10^{-4} = 0.38$ $\quad 380$ $\quad 0.38 \times 10^{-1} = 0.038$

Order the numbers.

$0.38 \times 10^{-1} = 0.038$ $\quad 3800 \times 10^{-4} = 0.38$ $\quad 0.038 \times 10^2 = 3.8$ $\quad 380$

Write the numbers in order of size in their original form.

$\mathbf{0.38 \times 10^{-1},\ 3800 \times 10^{-4},\ 0.038 \times 10^{2},\ 380}$

At least one evaluated correctly, or three in correct order [1]

Fully correct answer [1]

Q3

3a

Any number raised to the power of zero is always 1.

$\mathbf{10^0 = 1}$ [1]

3b

Simplify using the index law: $a^{-x} = \frac{1}{a^x}$.

$$10^{-2} = \frac{1}{10^2}$$

$\mathbf{\frac{1}{100}}$ [1]

3c

Convert each number to an ordinary number to make comparing them easier.

2.73×10^3.

$$2.73 \times 1000 = 2730$$

27.3×10^{-3}.

$$27.3 \div 1000 = 0.0273$$

273×10^2.

$$273 \times 100 = 27300$$

Write the numbers out.

$$2.73 \times 10^3 = 2730 \qquad 27.3 \times 10^{-3} = 0.0273 \qquad 273 \times 10^2 = 27300 \qquad 0.00273$$

Order the numbers.

$$0.00273 \qquad 27.3 \times 10^{-3} = 0.0273 \qquad 2.73 \times 10^3 = 2730 \qquad 273 \times 10^2 = 27300$$

Write the numbers in order of size in their original form.

$\mathbf{0.00273,\ 27.3 \times 10^{-3},\ 2.73 \times 10^3,\ 273 \times 10^2}$

At least one evaluated correctly, or three in correct order [1]

Fully correct answer [1]

Q4

4a

Simplify using the index law: $a^{\frac{1}{2}} = \sqrt{a}$ and $10^2 = 100$.

$$\sqrt{100} = 10$$

10 [1]

4b

Simplify using the index law: $a^{mn} = (a^m)^n$.

$$(125)^{\frac{2}{3}} = 125^{\frac{1}{3} \times 2} = \left((125)^{\frac{1}{3}}\right)^2$$

Simplify using the index law: $a^{\frac{1}{3}} = \sqrt[3]{a}$ and $5^3 = 125$.

$$(\sqrt[3]{125})^2 = (5)^2$$

25 [1]

Q5

5a

Simplify using the index law: $a^{\frac{1}{2}} = \sqrt{a}$ and $6^2 = 36$.

$$\sqrt{36} = 6$$

6 [1]

5b

Any number raised to the power of zero is always 1.

$\mathbf{23^0 = 1}$ [1]

5c

Simplify using the index law: $a^{-x} = \frac{1}{a^x}$.

$$(27)^{-\frac{2}{3}} = \frac{1}{(27)^{\frac{2}{3}}}$$

[1]

Simplify using the index law: $a^{mn} = (a^m)^n$.

$$\frac{1}{27^{\frac{2}{3}}} = \frac{1}{27^{\frac{1}{3}\times 2}}$$

Simplify using the index law: $a^{\frac{1}{3}} = \sqrt[3]{a}$ and $3^3 = 27$.

$$\frac{1}{(\sqrt[3]{27})^2} = \frac{1}{3^2}$$

$\frac{1}{9}$ [1]

Q6

6a

All of the masses are given in standard form, $a \times 10^n$, where $1 \le a < 10$, so the planet with the greatest mass is the planet with the greatest value of n.

Jupiter [1]

6b

Identify the calculation.

Mass (Venus) - mass (Mercury) = $4.869 \times 10^{24} - 3.302 \times 10^{23}$

Type the problem directly into your calculator.

$4.869 \times 10^{24} - 3.302 \times 10^{23} = 4.5388 \times 10^{24}$

4.5388×10^{24} kg [1]

6c

Find the scale factor by dividing the distance of Neptune from Earth by the distance of Venus from Earth.

$$\frac{\text{Distance (Neptune)}}{\text{Distance (Venus)}} = \frac{4.35 \times 10^9}{4.14 \times 10^7}$$

Type the problem directly into your calculator.

$$\frac{4.35 \times 10^9}{4.14 \times 10^7} = 105.072...$$

[1]

Yes, because 105.07... > 100 [1]

Q7

7

You should be able to type directly into your calculator.

$$(13.8 \times 10^7) \times (5.4 \times 10^{-12}) = 7.452 \times 10^{-4}$$

[1]

Convert to an ordinary number.

$$7.452 \times 10^{-4} = 7.452 \times 0.0001 = 0.0007452$$

0.0007452 [1]

Q8

8a

Any number raised to the power of zero is always 1.

$10^0 = 1$ [1]

8b

$10^{-5} = \frac{1}{10^5} = \frac{1}{100\,000} = 0.00001$, so 6.7×10^{-5} is the same as 6.7×0.00001

$$6.7 \times 0.00001 = 0.000067$$

Check your answer by counting how many times you need to move the decimal point to get from where it is in the question to where it is in the answer.
$n = -5$ so this should be 5 units.

0.000067 [1]

8c

Evaluate the number parts first by multiplying 3 by 9.

$$(3 \times 10^7) \times (9 \times 10^6) = (3 \times 9) \times (10^7 \times 10^6)$$
$$= 27 \times (10^7 \times 10^6)$$

[1]

Evaluate the powers using the law of indices $a^m \times a^n = a^{m+n}$.

$$27 \times (10^7 \times 10^6) = 27 \times 10^{(7+6)} = 27 \times 10^{13}$$

This is not in standard form as a is not in the interval $1 \le a < 10$.
Convert to standard form by first converting 27 to standard form.

$$27 \times 10^{13} = 2.7 \times 10^1 \times 10^{13}$$

Simplify using the law of indices $a^m \times a^n = a^{m+n}$.

2.7×10^{14} [1]

Q9

9

Evaluate the number parts first by multiplying 3 by 9.

$$9 \times 10^4 \times 3 \times 10^3 = 9 \times 3 \times 10^4 \times 10^3$$
$$= 27 \times (10^4 \times 10^3)$$

[1]

Evaluate the powers using the law of indices $a^m \times a^n = a^{m+n}$.

$$27 \times (10^4 \times 10^3) = 27 \times 10^{(4+3)} = 27 \times 10^7$$

This is not in standard form as a is not in the interval $1 \le a < 10$.
Convert to standard form by first converting 27 to standard form.

$$27 \times 10^7 = 2.7 \times 10^1 \times 10^7$$

Simplify using the law of indices $a^m \times a^n = a^{m+n}$.

2.7×10^8 [1]

Q10

10

Evaluate the number parts first by multiplying 3 by 9.

$$(9 \times 10^{-4}) \times (3 \times 10^{7}) = (9 \times 3) \times (10^{-4} \times 10^{7})$$
$$= 27 \times (10^{-4} \times 10^{7})$$

[1]

Evaluate the powers using the law of indices $a^m \times a^n = a^{m+n}$.

$$27 \times (10^{-4} \times 10^{7}) = 27 \times 10^{(-4+7)} = 27 \times 10^{3}$$

This is not in standard form as a is not in the interval $1 \leq a < 10$.
Convert to standard form by first converting 27 to standard form.

$$27 \times 10^{3} = 2.7 \times 10^{1} \times 10^{3}$$

Simplify using the law of indices $a^m \times a^n = a^{m+n}$.

2.7×10^{4} [1]

Q11

11a

Simplify using the index law: $a^{-x} = \frac{1}{a^x}$.

$$25^{-3} = \frac{1}{25^3}$$

Use your calculator to evaluate the answer.

$\frac{1}{15625}$ [1]

The answer in standard form of 6.4×10^{-5} is also accepted

11b

Type into your calculator.

$$350^3 = 42875000$$

[1]

Convert to standard form.

$$42875000 = 4.2875 \times 10\,000\,000$$

4.2875×10^{7} [1]

Q12

12

Patrick has to work out the exact value of $64^{\frac{1}{4}}$

Patrick says,

"$\frac{1}{4}$ of 64 is 16 so $64^{\frac{1}{4}} = 16$"

Explain what is wrong with what Patrick says.

$64^{\frac{1}{4}} = \sqrt[4]{64}$ WHICH IS $2\sqrt{2}$ NOT $64 \div 4$

Q13

13a

Identify the calculation.

Surface area of Atlantic Ocean – Surface area of Indian Ocean = $1.06 \times 10^8 - 6.86 \times 10^7$

Type the calculation directly into your calculator.

$$1.06 \times 10^8 - 6.86 \times 10^7 = 37\,400\,000$$

[1]

Convert this answer to standard form. Standard form will be written as $a \times 10^n$.
Ignore the place value and find the value of a, a must be a number greater than 1 and less than 10.

$$a = 3.74$$

Count how many times you need to multiply a by 10 to get to the original number.

$$37\,400\,000 = 3.74 \times 10^7$$

3.74×10^7 [1]

13b

Form an equation from the information.

$$\text{surface area of Pacific Ocean} = k \times [\text{surface area of Arctic Ocean}]$$
$$1.56 \times 10^8 = k(1.41 \times 10^7)$$

Solve the equation by dividing both sides by 1.41×10^7.

$$k = \frac{1.56 \times 10^8}{1.41 \times 10^7} = (1.56 \times 10^8) \div (1.41 \times 10^7)$$

Type this directly into your calculator, in either of the two forms above.

$$k = 11.06382979\ldots$$

Round your answer to the nearest whole number as requested.

$k = 11$ [1]

Q14

14

Rewrite 8 as 2^3

$$(\sqrt[4]{2^3})^5$$

[1]

A fourth-root, $\sqrt[4]{}$, can be rewritten as a power of $\frac{1}{4}$

$$\left((2^3)^{\frac{1}{4}}\right)^5$$

Use the law of indices; $(x^m)^n = x^{m \times n}$

$$\left((2^3)^{\frac{1}{4}}\right)^5 = \left(2^{3 \times \frac{1}{4}}\right)^5 = \left(2^{\frac{3}{4}}\right)^5$$

[1]

Apply the same rule again

$$\left(2^{\frac{3}{4}}\right)^5 = 2^{\frac{3}{4} \times 5} = 2^{\frac{15}{4}}$$

$2^{\frac{15}{4}}$ [1]

Q15

15

Rewrite 9 as a power of 3 using $9=3^2$

$$3^n = 177147 \times (3^2)^5$$

[1]

Use the law of indices; $(x^n)^m = x^{n\times m}$

$$3^n = 177147 \times 3^{2\times 5}$$
$$3^n = 177147 \times 3^{10}$$

[1]

Use the fact that we were told; $177147 = 3^{11}$

$$3^n = 3^{11} \times 3^{10}$$

Use the law of indices; $x^m \times x^n = x^{m+n}$

$$3^n = 3^{11+10} = 3^{21}$$

Compare both sides of the equation to see the value of n

$n = 21$ [1]

Q16

16a

We need to find out how many sweets there are per packet, which will be the number of sweets, shared between (divided by) the total number of packets

$$\frac{1.47\times 10^7}{3.5\times 10^5}$$

[1]

42 [1]

16b

There are 288 days where sweets are made each year, and 1.47×10^7 sweets made each day

$$288 \times 1.47\times10^7$$

[1]

= 4 233 600 000

[1]

Write in standard form

4.2336×10^9 [1]

The number at the front needs to be at least 1 decimal place

16c

i) 1.47×10^7 sweets are made every day, and the machines operate for 15 hours each day

$1.47\times10^7 \div 15 = 980\,000$ sweets per hour

[1]

There are 152 machines

$980\,000 \div 152 = 6447.368...$

[1]

Round to the nearest 10

6450 [1]

ii)

This assumes that all the machines work at the same rate [1]