1. Simplify.

$\sqrt{180} \div \sqrt{2}$

..... **[2]**

2(a).

Work out.

$\left(\frac{1}{64}\right)^{\frac{1}{3}}$

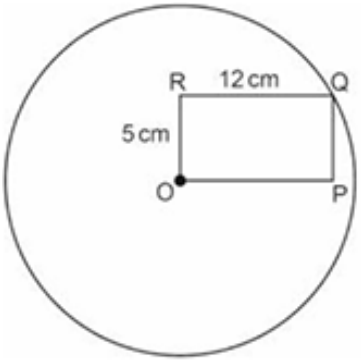
..... **[1]**

(b). $3^x \times 9^y = 27$

Show that $y = \frac{3-x}{2}$.

[4]

3(a). The diagram shows a rectangle, OPQR, and a circle, centre O, which passes through Q.
OR = 5 cm and RQ = 12 cm.

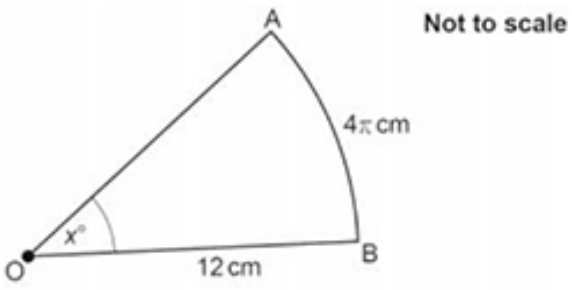


Not to scale

Find the circumference of the circle.
Give your answer in terms of π.

..... cm **[4]**

(b). AOB is a sector of a circle, centre O and radius 12 cm.
Angle AOB = $x°$.
The arc, AB, has length 4π cm.



Find the area of the sector.
Give your answer in terms of π.

..... cm^2 **[4]**

4. Work out.

$$1\frac{1}{10} - \frac{2}{5} \div \frac{3}{7}$$

..... **[4]**

5(a). $N = 8a^6$.

Write the following in the form.

$N^{\frac{1}{6}} =$ ..... a .....

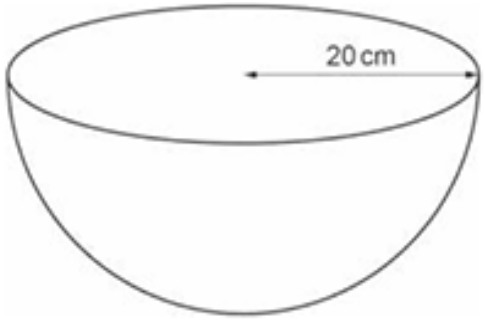
[2]

(b).

$N^{\frac{2}{3}} =$ ..... a .....

[2]

6. A bowl in the shape of a hemisphere with radius 20 cm is used to collect raindrops.



Assume each raindrop has the volume of a sphere of radius 4×10^{-4} cm.

Calculate how many raindrops it takes to completely fill the bowl.
Give your answer in standard form.
You must show your working.

[The volume V of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

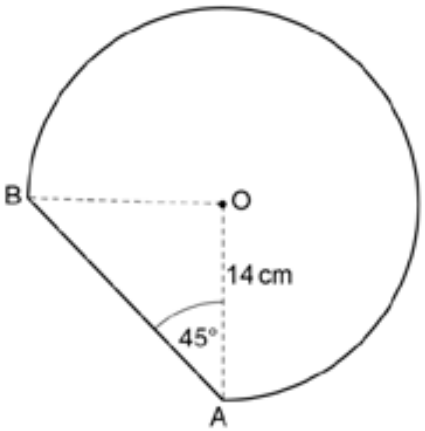
.....**[6]**

7. Show that $\frac{6\sqrt{2}-5}{\sqrt{32}+4}$ can be written in the form $\frac{a-b\sqrt{2}}{4}$

You must show each step in your working.

[5]

8. The shape below is part of a circle, centre O and radius 14 cm.
Angle OAB = 45°.



Not to scale

Work out the perimeter of the shape.

Give your answer in its simplest terms in the form $a\sqrt{b}+k\pi$.
You must show your working.

..... **[7]**

9. Write $\frac{4x^6 \times 3\sqrt{x}}{2x^3}$ in the form kx^m.

..... **[4]**

10(a). $N = 4a^6$.

Write the following in the form ka^m.

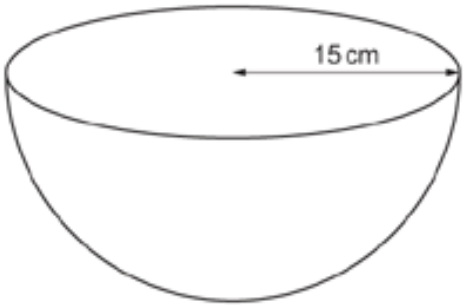
N^{-1} = ... a.....

[2]

(b). $N^{\frac{3}{2}}$ = ... a.....

[2]

11. A bowl in the shape of a hemisphere with radius 15 cm is used to collect raindrops.



Assume each raindrop has the volume of a sphere of radius 3×10^{-4} cm.

Calculate how many raindrops it takes to completely fill the bowl.
Give your answer in standard form.
You must show your working.

[The volume V of a sphere with radius r is $V = \frac{4}{3}\pi r^3$]

..... **[6]**

12. Simplify.

$\sqrt{160} \div \sqrt{2}$

..... **[2]**

13(a).

Work out.

$\left(\frac{1}{8}\right)^{\frac{1}{3}}$

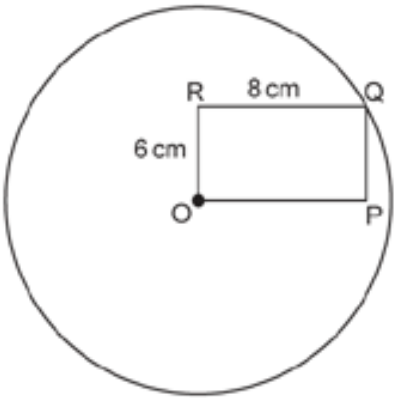
..... **[1]**

(b). $2^x \times 4^y = 16$

Show that $y = 2 - \frac{x}{2}$.

[4]

14(a). The diagram shows a rectangle, OPQR, and a circle, centre O, which passes through Q. OR = 6 cm and RQ = 8 cm.

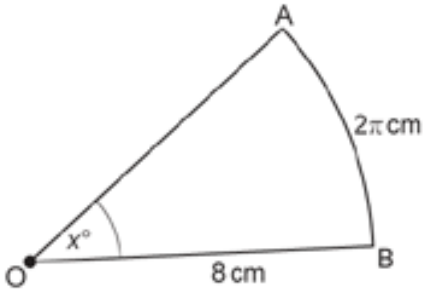


Not to scale

Find the circumference of the circle.
Give your answer in terms of π.

..... cm **[4]**

(b). AOB is a sector of a circle, centre O and radius 8 cm.
Angle AOB = $x°$.
The arc, AB, has length 2π cm.



Not to scale

Find the area of the sector.
Give your answer in terms of π.

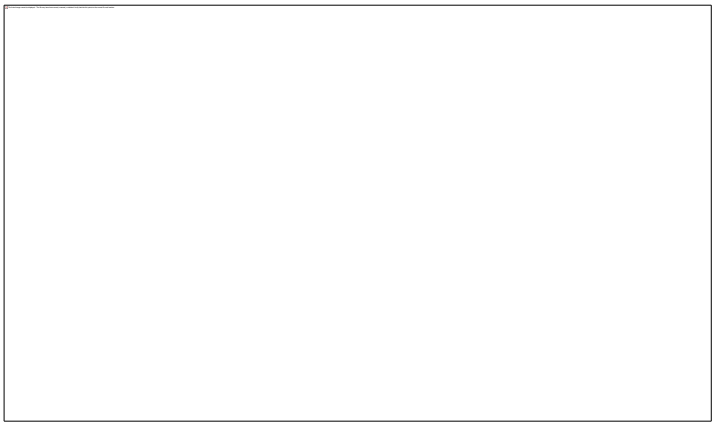
..... cm^2 **[4]**

15. Work out.

$$1\frac{5}{6} - \frac{2}{3} \div \frac{3}{4}$$

..... **[4]**

16(a). This shape is formed from a rectangle and two sectors of circles.



Points A, B and C lie on a straight line.
Angle CBD = 25°.
DE = $4t$ and EF = $2t$.

Explain why AB = $4t$.
Give a reason for each step of your explanation.

[2]

(b). Show that the perimeter of the shape is $\frac{31}{18}\pi t + 12t$.

[5]

17. Write these numbers in order of size, starting with the smallest.

0.22% $\frac{1}{472}$ 0.02 2.1×10^{-3}

,

,

,

[4]

smallest

18. Solve.

$x^{-\frac{1}{4}} = \frac{3x^{\frac{1}{2}}}{x^{\frac{7}{8}}}$, where $x \neq 0$

x = ... **[3]**

19. You are given this identity.

$$\frac{4-2\sqrt{8}}{\sqrt{8}+3} = a\sqrt{2}+b$$

Find the value of a and the value of b.
You must show each step in your working.

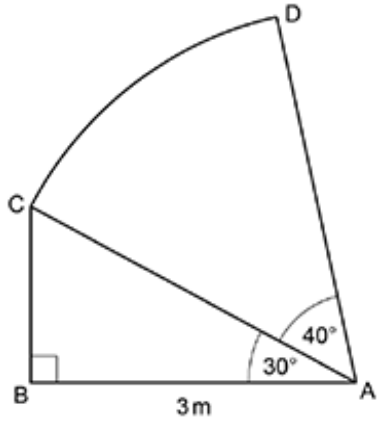
a = ...

b = ...

[6]

20(a). In the diagram,

- ABC is a right-angled triangle



Not to scale

- ACD is the sector of a circle with centre A.

Show that the area of the sector ACD is $\frac{4}{3}\pi m^2$.

[6]

(b). Work out the total area of the shape ABCD.

Give your answer in the form $\left(\frac{a\sqrt{k}}{b}+\frac{4}{3}\pi\right)\text{m}^2$.

..... m^2 **[3]**

21. Work out.

$49^{-\frac{1}{2}}$

..... **[2]**

22. Simplify.

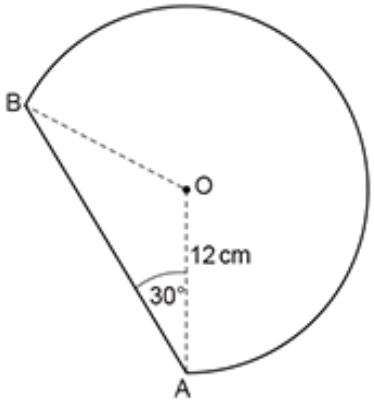
$2a^3 \times 6a^4$

..... **[2]**

23. Write $\frac{9x^7 \times 2\sqrt{x}}{3x^4}$ in the form kx^m.

..... **[4]**

24. The shape below is part of a circle, centre O and radius 12 cm.
Angle OAB = 30°.



Not to scale

Work out the perimeter of the shape.

Give your answer in its simplest terms in the form $a\sqrt{b} + k\pi$.
You must show your working.

..... **[7]**

25. Show that $\frac{\sqrt{3}+2}{\sqrt{48}-6}$ can be written in the form $\frac{a+b\sqrt{3}}{6}$.

You must show each step in your working.

[5]

26(a). In space, distances can be measured in Astronomical Units.
In this question, use the conversion 1 Astronomical Unit = 1.5×10^8 km.

On a particular day the distance from Earth to Mars is 0.5222 Astronomical Units.

Calculate the distance from Earth to Mars in kilometres on that day.
Give your answer in standard form.

…….…….…… km **[3]**

(b). On a particular day the distance from Earth to Neptune is 4 364 000 000 km.

Calculate the distance from Earth to Neptune in Astronomical Units on that day.

…….…… Astronomical Units **[2]**

27. Given that $(2^k)^7 \times 16 = 2^{46}$, find the value of k.

k = ……..…….…… **[3]**

28(a). Simplify.

$\sqrt{5} \times \sqrt{30}$

……..…….…… **[2]**

(b). Rationalise the denominator and simplify.

$$\frac{35}{\sqrt{14}}$$

…… **[3]**

(c). Work out.

$$8^{\frac{5}{3}}$$

…… **[2]**

29(a). Write 546 000 in standard form.

…… **[1]**

(b). Write 2.9×10^{-3} as an ordinary number.

…… **[1]**

30(a). Show that $\sqrt{7} \times \sqrt{21} = 7\sqrt{3}$.

[1]

(b). Show that $\frac{\sqrt{7}}{5+\sqrt{21}}$ can be written in the form $\frac{a\sqrt{7}-7\sqrt{3}}{b}$ where a and b are integers.

[4]

31(a). Write 0.004 57 in standard form.

…….…….…….…….. **[1]**

(b). The speed of sound is 3.43×10^{-1} km/s.
An object is travelling at the speed of sound.

Work out how far the object travels in 20 hours.

…….…….…….…….…… km **[2]**

(c). In a science fiction story, a spacecraft travelling faster than the speed of light is said to be travelling at 'warp *n*' where *n* is an integer.

Warp *n* is defined as n^3 × the speed of light.

In the story, a spacecraft needs to travel from Earth to Neptune in less than 3 minutes.

- The speed of light is 3.00×10^5 km/s.
- The distance from Earth to Neptune is 4.41×10^9 km.

Find the smallest possible warp *n* at which the spacecraft can travel.
You must show your working.

n = …….…….…….…….…… **[3]**

32. Work out.

$32^{\frac{3}{5}}$

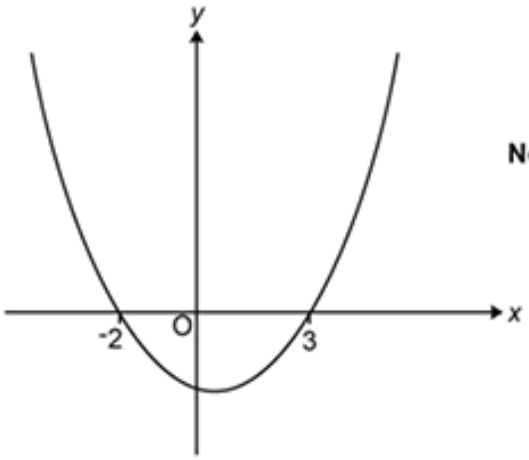
…….…….…….…… **[2]**

33. $\sqrt[4]{p^3} = \left(\sqrt[5]{m}\right)^3$ and $p = m^x$, where $p > 0$, $m > 0$ and $p \neq m$.

Show that the value of x is $\frac{4}{5}$.

[3]

34(a). Charlie sketches this quadratic graph.



Not to scale

Charlie says

The y-intercept is $^-6$.

Write 518 400 000 as a product of prime factors in index form.

..... **[2]**

(b). You are given that $176\,000 = 2^7 \times 5^3 \times 11$.

Find the highest common factor (HCF) of 518 400 000 and 176 000.

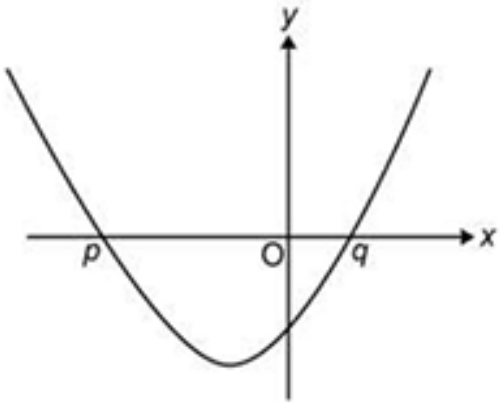
..... **[2]**

35. Light from the Sun travels 1 kilometre in 3.3×10^{-6} seconds.
The distance from the Sun to the planet Saturn is 1.5×10^{9} kilometres.

How long does it take light to travel from the Sun to Saturn?
Give your answer in minutes and seconds.

..... minutes ..... seconds **[4]**

36. The graph of $y = x^2 + 8x - 4$ is shown below.
The roots of the equation $x^2 + 8x - 4 = 0$ are at p and q.

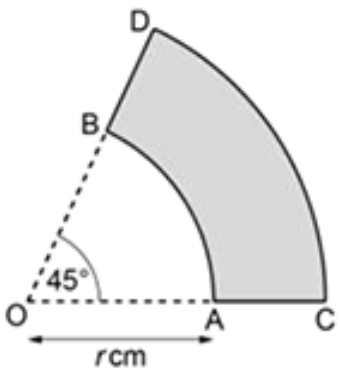


The exact value of q is $\frac{-8 + \sqrt{80}}{2}$.

Write $\frac{-8 + \sqrt{80}}{2}$ in the form $a + b\sqrt{c}$.

…… **[3]**

37. The diagram shows a shaded shape made by removing sector OAB from sector OCD.
Both sectors have an angle of 45°.
The radius, OA, of the smaller sector is *r* cm.
The ratio of radius OA to radius OC is 3 : 4.



Not to scale

Work out, in terms of π and *r*, the **total** length of arc AB and arc CD.
Give your answer in its simplest form.
You must show your working.

…….…….…….. cm **[5]**

38. Write $\sqrt{75} - \sqrt{12}$ in the form $k\sqrt{3}$.

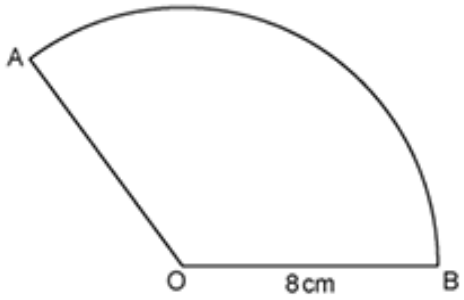
…….…….…… **[3]**

39. The point (4, $6\sqrt{3}$) lies on the circumference of a circle, centre (0, 0).

Find the equation of the circle.

…….…….…… **[4]**

40. AOB is a sector of a circle, centre O and radius 8 cm.



Not to scale

The area of the sector is 24π cm^2.

Work out the perimeter of the sector.
Give your answer in the form $a + b\pi$, where a and b are integers.
You must show your working.

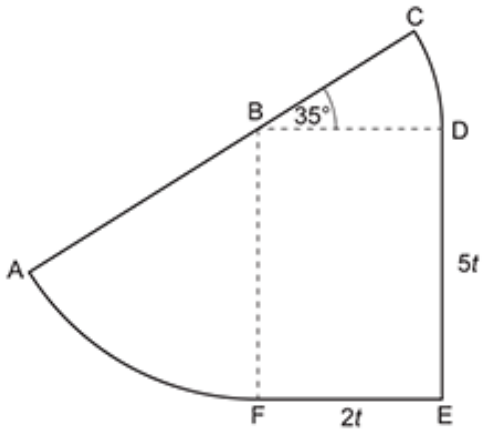
…….…….…….. cm **[6]**

41. Find the value of x.

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

x = …….…….…….. **[1]**

42(a). This shape is formed from a rectangle and two sectors of circles.



Not to scale

Points A, B and C lie on a straight line.
Angle CBD = 35°.
DE = 5t and EF = 2t.

Explain why BC = 2t.
Give a reason for each step of your explanation.

[2]

(b). Show that the perimeter of the shape is $\frac{23}{12}\pi t + 14t$.

[5]

43. Write these numbers in order of size, starting with the smallest.

0.36% $\frac{1}{333}$ 0.03 3.1×10^{-3}

..... , ... , ... , ... **[4]**

smallest

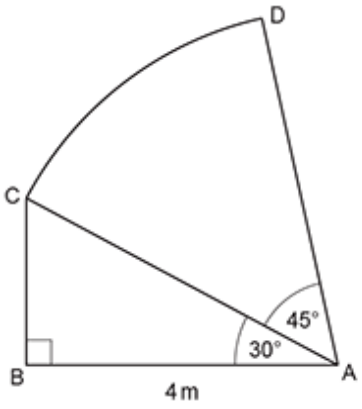
44. Work out.

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

..... **[2]**

45(a). In the diagram,

- ABC is a right-angled triangle
- ACD is the sector of a circle with centre A.



Not to scale

Show that the area of the sector ACD is $\frac{8}{3}\pi$ m^2.

[6]

(b). Work out the total area of the shape ABCD.

Give your answer in the form $\left(\frac{a\sqrt{k}}{b}+\frac{8}{3}\pi\right)\text{m}^2$.

..... m^2 **[3]**

46. Simplify.

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

..... **[2]**

47. Solve.

$x^{-\frac{1}{6}} = \frac{5x^{\frac{1}{3}}}{x^{\frac{3}{4}}}$, where $x \neq 0$

x = ... **[3]**

48. You are given this identity.

$$\frac{2-3\sqrt{18}}{\sqrt{18}+4} = a\sqrt{2}+b$$

Find the value of a and the value of b.
You must show each step in your working.

a = ...

b = ...
[6]

49(a). Write 0.003 86 in standard form.

..... **[1]**

(b). The speed of sound is 3.43×10^{-1} km/s.
An object is travelling at the speed of sound.

Work out how far the object travels in one day.

..... km **[2]**

(c). In a science fiction story, a spacecraft travelling faster than the speed of light is said to be travelling at 'warp n' where n is an integer.

Warp n is defined as $n^3 \times$ the speed of light.

In the story, a spacecraft needs to travel from Earth to Neptune in less than 2 minutes.

- The speed of light is 3.00×10^5 km/s.
- The distance from Earth to Neptune is 4.41×10^9 km.

Find the smallest possible warp n at which the spacecraft can travel.
You must show your working.

n = ... **[3]**

50(a). Show that $\sqrt{11} \times \sqrt{22} = 11\sqrt{2}$.

[1]

(b). Show that $\frac{\sqrt{11}}{13+\sqrt{22}}$ can be written in the form $\frac{a\sqrt{11}-11\sqrt{2}}{b}$ where a and b are integers.

[4]

51. Work out.

$64^{\frac{2}{3}}$

..... **[2]**

52. $\sqrt[5]{p^2} = (\sqrt[3]{m})^2$ and $p = m^x$, where $p > 0$, $m > 0$ and $p \neq m$.

Show that the value of x is $\frac{5}{3}$.

[3]

53. Given that $(2^k)^6 \times 8 = 2^{45}$, find the value of k.

k = ... **[3]**

54(a). In space, distances can be measured in Astronomical Units.
In this question, use the conversion 1 Astronomical Unit = 1.5×10^8 km.

On a particular day the distance from Earth to Neptune is 29.09 Astronomical Units.

Calculate the distance from Earth to Neptune in kilometres on that day.
Give your answer in standard form.

..... km **[3]**

(b). On a particular day the distance from Earth to Mars is 78 340 000 km.

Calculate the distance from Earth to Mars in Astronomical Units on that day.

..... Astronomical Units **[2]**

55(a). Simplify.

$\sqrt{3} \times \sqrt{15}$

..... **[2]**

(b). Rationalise the denominator and simplify.

$\frac{40}{\sqrt{15}}$

..... **[3]**

(c). Work out.

$27^{\frac{4}{3}}$

..... **[2]**

56(a). Write 8.2×10^{-4} as an ordinary number.

..... **[1]**

(b).

Write 65 400 in standard form.

..... **[1]**

57(a). Write 15 552 000 000 as a product of prime factors in index form.

..... **[2]**

(b). You are given that 140 0 00 = $2^5 \times 5^4 \times 7$.

Find the highest common factor (HCF) of 15 552 000 000 and 140 000.

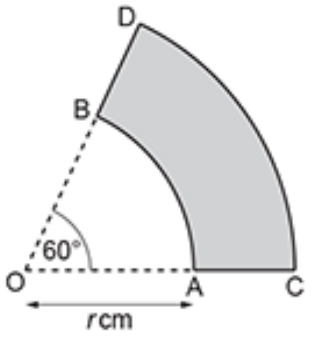
..... **[2]**

58. Light from the Sun travels 1 kilometre in 3.3×10^{-6} seconds.
The distance from the Sun to the Earth is 1.5×10^8 kilometres.

How long does it take light to travel from the Sun to the Earth?
Give your answer in minutes and seconds.

.....minutes ..... seconds **[4]**

59. The diagram shows a shaded shape made by removing sector OAB from sector OCD.
Both sectors have an angle of 60°.
The radius, OA, of the smaller sector is r cm.
The ratio of radius OA to radius OC is 2 : 3.



Not to scale

Work out, in terms of π and r, the **total** length of arc AB and arc CD.
Give your answer in its simplest form.
You must show your working.

..... cm **[5]**

60. The exact value of q is $\frac{-6+\sqrt{44}}{2}$.

Write $\frac{-6+\sqrt{44}}{2}$ in the form $a+\sqrt{b}$.

..... **[3]**

61(a). This table shows the names and areas of five lakes.

Name of Lake	Area in km^2
Ladoga	1.81×10^4
Mweru	5.12×10^3
Tana	3.20×10^3
Topozero	9.86×10^2
Victoria	6.89×10^4

Calculate the difference between the areas of Lake Ladoga and Lake Tana.
Give your answer in standard form, correct to **2** significant figures.

..... km^2 **[4]**

(b). Write the area of Lake Mweru as an ordinary number.

..... km^2 **[1]**

(c). Write the lakes in the order of their area, starting with the **smallest**.

---------- **[2]**

smallest *largest*

62. Write $\sqrt{20} + \sqrt{45}$ in the form $k\sqrt{5}$.

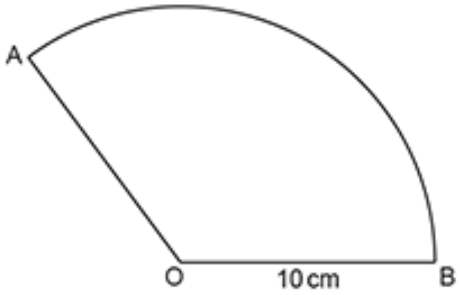
..... **[3]**

63. The point $(5, 7\sqrt{2})$ lies on the circumference of a circle, centre (0, 0).

Find the equation of the circle.

..... **[4]**

64. AOB is a sector of a circle, centre O and radius 10 cm.



Not to scale

The area of the sector is 40π cm^2.

Work out the perimeter of the sector.
Give your answer in the form $a + b\pi$, where a and b are integers.
You must show your working.

..... cm **[6]**

65. Find the value of x.

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

x = ...**[1]**

END OF QUESTION PAPER