



LEV

Basic Maths Revision

Do also have a look at our 'Intro to Basic Maths for LEV' video:

<https://www.oxyl8.com/delegate-area/oxyl8-videos/>

If you are happy with the following equations, then you need read no further than this front page!

So, it may have been a while since you did this at school?

Typical Equations Used in P601

$$\text{Area of a circle} = \pi D^2/4$$

Where $\pi = 3.142$ D = dia (in metres)

or πr^2

Where r = radius = half diameter in metres(!)

$$\text{Velocity } V = 1.29\sqrt{VP}$$

Where VP = Velocity Press (Pa)

$$\text{Velocity Pressure} = (V/1.29)^2$$

$$\text{Flowrate, } Q = V \times A$$

Where V = velocity in m/s

A = area in m²

Q = m³/s



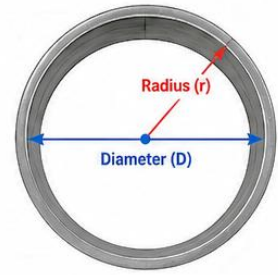
If the above seems like a foreign language and the equations seem a bit complicated, you **must** try to enlist someone to work through the maths with you before the course. We do go through the maths in the course, but if these maths ideas are truly new to you then you will struggle.

The morning open-book exam uses the above maths, so it's very important that you come to the course able to follow the above concepts.

First – 😬 **DON'T PANIC!** Some of this might look daunting at first sight but get a coffee and sit down and work through the exercises.

Areas of a Circle

Use either πr^2 or $\pi D^2/4$ to get the area of a Circle (they both give the same answer). I prefer $\pi D^2/4$ only because we normally measure ducts as a "Diameter" and not as a Radius.



And... you will forget to half the Diameter to get a Radius, trust me you will!

You take π and multiply it by **D** and again by **D** and then divide the answer by **4**. For some reason it is common to forget to divide by 4 ... but I'm sure you won't do that. 😊

π is always **3.142**.



Usually, we measure duct diameters in mm but we display areas in m².

So, the first thing we have to do is convert the diameter into a diameter in metres. Do this by dividing the diameter you measured in mm by 1000 (as there are 1000mm in 1m).

So, a 200mm duct is 0.2m diameter (0.1m radius), and a 450mm duct is 0.45m in diameter (0.225m in radius) and so on.

Example: 300mm duct diameter is = 300/1000 or = 0.3m

Let's try some duct area calculations:

Say you have a duct diameter measured at 200mm. What is the duct area?

First

Convert the diameter in mm to a diameter in metres. So, 200mm becomes 200/1000 which is 0.2m. **D = 0.2m**

Second

Using the equation **Area = $\pi D^2/4$** and putting in the values for π and **D** we get the following:-

$$A = \frac{3.142 \times 0.2 \times 0.2}{4} = 0.0314\text{m}^2$$

Common error

Not reading the screen on the calculator properly! How many zeros after the decimal point? It will usually be one but sometimes it can be two, so do look carefully at the screen!

Areas of a Circle

Now try some on your own.

Exercise 1

What would be the area of the following ducts?

Note: Round your answers to 4 decimal places, i.e. 0.0196375 becomes 0.0196

100mm

150mm

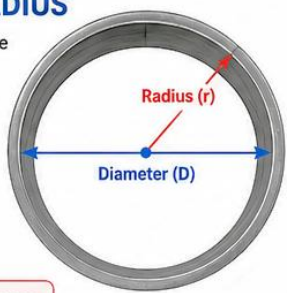
250mm

300mm

500mm

DIAMETER vs RADIUS

For a circle we measure the DIAMETER (D) across the duct.



Radius (r) = D/2
Example:
D = 200 mm
r = 100 mm
(0.2 m and 0.1 m)

MOST COMMON MISTAKE
Using 200 instead of 0.2
(Always convert mm to m first!)

Answers

If you want to check your answers, they are on the back of the last page. *

* Don't worry if your last figure in your answer is one digit too small or too large from the answers given. That is caused by calculator 'rounding' and is nothing to worry about.

If you found circles easy, then you'll easily pick up how to calculate areas for ovals, too. It's not needed in the written exam, but you do need to do an oval area in the course!

Areas of an Oval

Let's stick with diameters, so the equation to use for ovals is $\pi Dd/4$

It's the same principle as for circles but this time we have a big diameter "**D**" and a small diameter "**d**".

1. Take π
2. Multiply it by **D** (largest diameter)
3. Then multiply by **d** (shortest diameter)
4. Then divide the answer by 4

Again, we usually measure hood diameters in **mm** but we display areas in **m²**.

So, we need to convert from **mm** into **m** by dividing by 1000.

Example:

260mm large diameter is: $260/1000 = 0.26\text{m}$

180mm small diameter is: $180/1000 = 0.18\text{m}$

Let's try an oval hood calculation:

Say you have a hood with longest diameter measured at 260mm and a short diameter of 180mm, what is the hood inlet area?

First

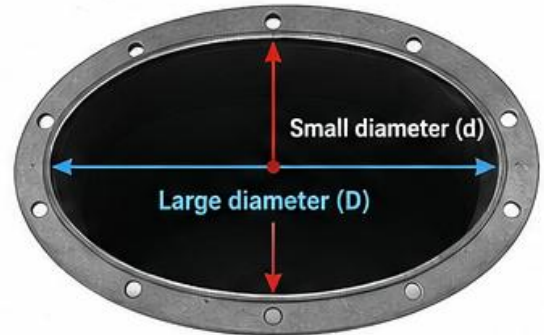
Convert the diameters in mm to diameters in metres.

So, **D = 0.26m** ... and **d = 0.18m**

Second

Using the equation **Area = $\pi Dd/4$** and putting in the values for π , **D** and **d** we get the following:-

$$A = \frac{3.142 \times 0.26 \times 0.18}{4} = 0.0368\text{m}^2$$



Remember: π is 3.142
(or use the π symbol on your calculator if it has one)

Areas of an Oval

Now try some areas of an oval on your own.

Exercise 2

What would be the area of the following hood inlets?

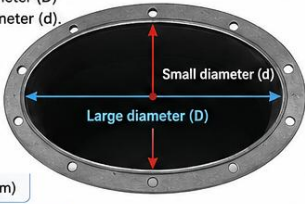
Note: Round your answers to 4 decimal places, i.e. 0.0196375 becomes 0.0196

D = 200mm d = 110mm

D = 250mm d = 130mm

D = 120mm d = 65mm

OVAL (ELLIPTICAL) HOOD
Use the large diameter (D)
and the small diameter (d).



Example:
D = 260 mm
d = 180 mm
(0.26 m and 0.18 m)

Remember:
Area = $\pi Dd/4$
(Use metres, not mm)

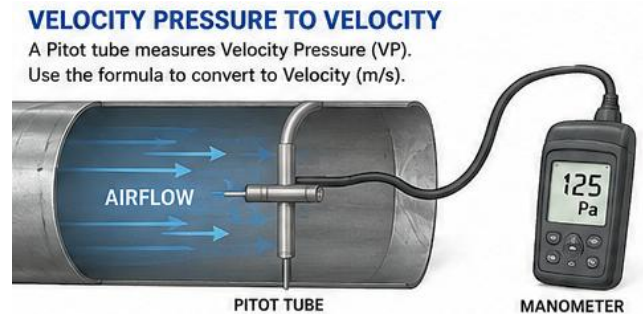
Answers

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Velocity (m/s) from Velocity Pressure (Pa)

The **Pitot Tube** connected to a **Manometer** takes duct velocity readings but in reality, it takes **Velocity Pressure** readings, and in the exam, you need to be able to convert those pressures into **Velocities (in m/s)**.

Yes, I know your Manometer probably does the conversion automatically, but the examiners are sadists and you will need to do the calculations manually!



The simplified equation we use for this is:-

$$\text{Velocity} = 1.29\sqrt{V_p} \quad \text{Where } V_p = \text{Velocity Press (measured in Pascals)}$$

To work it out, simply put the velocity pressure into your calculator screen, press the square root key (the one which looks like $\sqrt{\quad}$) and multiply the answer you get by 1.29

Let's look at an example:

Pitot Tube and Manometer record an average Velocity Pressure of **148Pa**.

What would the velocity be at that point?

Using the above equation, the first thing to do is put the **148Pa** into your calculator and then hit the " $\sqrt{\quad}$ " button.

That should give you the answer **12.1655250606**
(OK, maybe too many numbers there - you can round it to 2 decimal places)

Then

Keeping this figure in your calculator, multiply it by **1.29** to get the final answer of **15.7m/s** (metres/second), rounded to 1 decimal place (in ducts).

Velocity (m/s) from Velocity Pressure (Pa)

Now some you can try.

Exercise 3

What would be the velocity (in m/s) where the following velocity pressures were measured in the ducts?

Note: Round your answers to 1 decimal place

116Pa

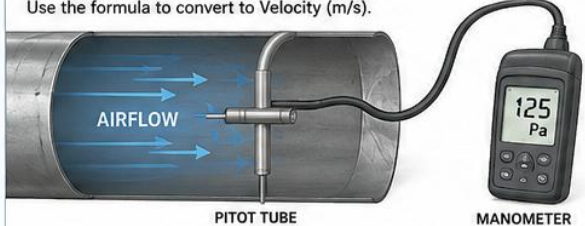
180Pa

224Pa

475Pa

624Pa

VELOCITY PRESSURE TO VELOCITY
A Pitot tube measures Velocity Pressure (VP).
Use the formula to convert to Velocity (m/s).



PITOT TUBE MANOMETER

FORMULA Velocity (m/s) = 1.29 × √VP (Pa)

STEPS

- 1 Enter VP (in Pa) into calculator
- 2 Press square root (√)
- 3 Multiply by 1.29

⚠ CHECK UNITS
VP must be in Pascals (Pa)
not mmWG, kPa, etc.

Answers

If you want to check your answers, they are on the back of the last page.

Flowrate - "Q"

Flowrate is obtained from the following equation:-

$$\text{Flowrate, } Q = V \times A$$

In this case Flowrate, "Q" can either be in m^3/s or m^3/hr (sometimes written m^3s^{-1} or m^3h^{-1} It's the same, just a different way of writing)

Velocity will always be in m/s
Area will always be in m^2

So, the answer for Flowrate "Q" from the above equation will give the result in m^3/s

Example:

Velocity = 15m/s
 Area of Duct = 0.0707m² (a 300mm diameter duct)

$$Q = V \times A$$

So - $Q = 15 \times 0.0707$ which = $1.0605 \text{ m}^3/\text{s}$

UNIT CONVERSIONS

<p style="text-align: center; margin: 0;">m³/s to m³/hr</p> <p style="text-align: center; margin: 0;">Multiply by 3600</p> <p style="text-align: center; margin: 0;">Example:</p> <p style="text-align: center; margin: 0;">0.5 m³/s × 3600 = 1800 m³/hr</p>		<p style="text-align: center; margin: 0;">m³/hr to m³/s</p> <p style="text-align: center; margin: 0;">Divide by 3600</p> <p style="text-align: center; margin: 0;">Example:</p> <p style="text-align: center; margin: 0;">3600 m³/hr ÷ 3600 = 1.0 m³/s</p>
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THE CALCULATION FLOW

From measurement to flowrate

Measure
Velocity
Pressure
(Pa)

Calculate
Velocity
(m/s)

Calculate
Area
(m²)

Calculate
Flowrate
(m³/s)

KEY FORMULAS

- Velocity (m/s) = $1.29 \times \sqrt{VP \text{ (Pa)}}$
- Area of Circle (m²) = $\pi D^2 / 4$
- Area of Oval (m²) = $\pi Dd / 4$
- Flowrate (m³/s) = Velocity (m³/s) × Area (m²)

★ TOP TIP
 Do each step in order and write down each answer with the units.

Exercise 4

What would be the flowrates in BOTH m^3/s and m^3/hr for the following velocities and areas?

$$A = 0.196\text{m}^2, \quad \text{Velocity} = 24\text{m/s}$$

$$A = 0.0176\text{m}^2, \quad \text{Velocity} = 12\text{m/s}$$











$$A = 0.0707\text{m}^2, \quad \text{Velocity} = 16.8\text{m/s}$$

$$A = 0.0314\text{m}^2, \quad \text{Velocity} = 9.6\text{m/s}$$

Answers

If you want to check your answers, they are on the back of the last page.

TOP 10 COMMON MISTAKES

-  Forgetting to convert mm to m
-  Forgetting to divide circle area by 4
-  Using radius instead of diameter
-  Using mm instead of m
-  Forgetting the square root
-  Mixing m^3/s and m^3/hr
-  Calculator in scientific notation
-  Rounding too early
-  Using wrong duct diameter
-  Wrong units for VP (not Pa)

Answers

Exercise 1

100mm	=	0.0079m ²
150mm	=	0.0177m ²
250mm	=	0.0491m ²
300mm	=	0.0707m ²
500mm	=	0.1963m ²

Exercise 2

200mm by 110mm	=	0.0173m ²
250mm by 130mm	=	0.0255m ²
120mm by 65mm	=	0.0061m ²

Exercise 3

116Pa	13.9m/s
180Pa	17.3m/s
224Pa	19.3m/s
475Pa	28.1m/s

Exercise 4

A = 0.196m ² ,	Velocity = 24m/s	Q = 4.704m ³ /s
A = 0.0176m ² ,	Velocity = 12m/s	Q = 0.211 m ³ /s
A = 0.0707m ² ,	Velocity = 16.8m/s	Q = 1.188 m ³ /s
A = 0.0314m ² ,	Velocity = 9.6m/s	Q = 0.301 m ³ /s

Additional Exercises

If you would like to try some 'real world' HARD examples prior to the course, then have a go at the following questions. These are not essential to do before the course... but they certainly get your 'grey cells' working and are excellent trial exercises.

Round duct - diameter is 200mm. Velocity Pressure (average) is 264 Pa.

What is the flowrate in this ducting?



First, calculate duct area using your normal 'circle' equation.

Then convert VP to velocity.

Use the 'triangle'. When using the triangle, cover up with your thumb the item you are trying to calculate (in this case "Q"), and the triangle tells you what to do with the other two (in this case multiply V by A).

Round duct - diameter is 250mm. Velocity Pressure (average) is 188 Pa.

What is the duct velocity and calculate flowrate in this ducting?

Would this be sufficient for a process involving cement dust?

First, calculate area (A).

Then convert VP to a velocity (compare with minimum required for cement dust – (hint: it is around 20m/s)).

Then, calculate Flowrate "Q" (use triangle to assist).

Round duct - diameter 250mm. Flowrate taken from the hood face readings is known to be 1876m³/hr.

Comment on the suitability of this system for sawdust?

First, calculate area (A).

Then convert m³/hr to m³/s (as can't do any further calcs if in m³/hr) (Q) – the triangle above only works in m³/s – that's why we always need to convert back if we are given Flowrate in m³/hr).

Use triangle to get duct velocity from Q and A (hint: you need to divide the "Q" by the "A")

Following readings were taken from the face of a round hood with a diameter of 180mm:-

7.8, 8.2, 8.8, 7.7, 9.1, 7.7, 8.9, 10.2, 9.3, 9.6 (m/s)

The hood is attached to 150mm flexible ducting.

(a) Calculate the volume flowrate into the hood.

Calculate area (A) of hood and of duct (2 separate areas to calculate – both circles).

Average the Velocities (V).

Use the triangle to get Q.

(b) Calculate the duct velocity (hint: use hood flowrate to help).

Use triangle (hint: if what you want is “V” – cover it up on the triangle, that shows you need to take the Flowrate “Q” and divide by the Area “A”).

From question (a) above - You have already calculated Q and the A of duct – so off you go!

(c) Would this be suitable for welding operations?

HSG250 Duct Velocity table says the minimum duct velocity for Welding Fume is 10m/s. Was your calculated duct velocity above or below that figure? If ‘below’ then the flowrate would not be suitable as it would give too low a duct. velocity in that size of duct.

A process handling metal turnings has two branch ducts and one main duct. The average velocity pressure measured at three different points in the ducting were:

TP1 420 Pa

TP2 345 Pa

TP3 225 Pa

Are these sufficient to prevent drop out in the duct?

Convert each separately into a Velocity using the Vp to Velocity equation.

What does metal turnings need as min duct velocity? (hint: it will be around 25m/s).

Do your converted/calculated velocities exceed the min required of 25m/s?

The following readings were measured at a fume cupboard opening:

0.47, 0.53, 0.58, 0.61, 0.51, 0.56, 0.59, 0.49, 0.51 (m/s)

Calculate the average face velocity and comment on the suitability of the airflow distribution.

Get an average face velocity. Add all readings and divide by the number of readings (in this case 9 readings).

Add 20% to that average you got (easy way is to take the average and multiply it by 1.2). Any of the individual readings above – greater than that new calculated number. If so, the face velocities are unacceptable.

Reduce the average face velocity you calculated by 20%. Easy way to do that is to take the 'average' you calculated and multiply this time by 0.8.

Again, if any of the individual readings in the face velocity results in the question were below that figure – again the face airflow distribution would be unacceptable.

Comment on your findings for all individual point velocities.