Physics. You work it out.

Step up to GCSE Density 30.6

GCSE

A $750\,\mathrm{cm^3}$ bottle contains a mixture of pure water and ethanol. 10% of the volume is ethanol. Ethanol and pure water have densities $0.79\,\mathrm{g/cm^3}$ and $1.00\,\mathrm{g/cm^3}$ respectively.

In this question, assume that the total volume doesn't change when water is mixed with ethanol.

Part A Volume of ethanol

Calculate the volume of the ethanol.

Part B Mass of ethanol

Calculate the mass of the ethanol.

Part C Volume of water

State the volume of the water.

Part D Mass of water

Calculate the mass of water.

Part E Density of mixture

Calculate the density of the mixture.

Step up to GCSE Density 30.8

GCSE

An airliner has a mass (when empty) of $43\,000\,\mathrm{kg}$. It is about to carry 150 people with an average mass of $80\,\mathrm{kg}$ each. It is not safe to take off if the total mass is more than $75\,000\,\mathrm{kg}$. Jet fuel has a density of $850\,\mathrm{kg/m^3}$.

Part A Maximum mass of fuel

Calculate the maximum mass of fuel allowed.

Part B Volume of fuel

How many $\mathrm{m^3}$ of fuel can be carried?

Gameboard:

STEM SMART Physics 31 - Fluids

Physics. You work it out.

Step up to GCSE Floating 31.3

GCSE

C C C

Water has a density of $1.00\,\mathrm{g/cm^3}$. A $100\,\mathrm{g}$ apple with a volume of $110\,\mathrm{cm^3}$ is held under the surface in a bucket of water.

Part A Volume of water displaced

State the volume of water displaced.

Part B Mass of water displaced

Calculate the mass of water displaced.

Part C Weight of water displaced

Calculate the weight of water displaced. (Take $g = 10\,\mathrm{N/kg}$)

Part D Weight of apple

Calculate the weight of the apple.

Part E Float or sink?

Will the apple float or sink when released?

- Float
- Sink

Gameboard:

STEM SMART Physics 31 - Fluids

Step up to GCSE Floating 31.8

GCSE

An airship has a $4000\,\mathrm{m}^3$ gas balloon filled with helium.

Part A Weight of the helium

Calculate the weight of the helium, ($\rho = 0.17\,\mathrm{kg/m^3}$), and remember to use $g = 10\,\mathrm{N/kg}$.

Part B Weight of air displaced

Calculate the weight of air displaced. ($\rho = 1.20\,\mathrm{kg/m^3}$)

Part C Maximum payload

Calculate the maximum mass of the structure and payload if the airship is to be able to float on air.

Part D Extra payload

How much more payload (in kg) could it carry if it were filled with hydrogen ($\rho = 0.084\,\mathrm{kg/m^3}$) instead?

Gameboard:

STEM SMART Physics 31 - Fluids

Step up to GCSE Floating 31.10

GCSE

A boat has a horizontal cross sectional area of $3.3\,\mathrm{m}^2$. Two $70\,\mathrm{kg}$ people get in. How far will the sea water's surface rise up the boat's side? ($\rho = 1030\,\mathrm{kg/m}^3$). Give your answer to 2 s.f..

Gameboard:

STEM SMART Physics 31 - Fluids

Step up to GCSE Challenge Questions 47.8

Year 9 GCSE

A water-ethanol mixture has a density of $0.95\,\mathrm{g/cm^3}$. What percentage of the volume of the mixture is ethanol? For water $\rho_w = 1.00\,\mathrm{g/cm^3}$, for ethanol $\rho_e = 0.79\,\mathrm{g/cm^3}$.

In this question, assume that the total volume doesn't change when water is mixed with ethanol.

Gameboard:
STEM SMART Physics 31 - Fluids

isaac Physics. You work it out.

Essential GCSE Physics 17.7

Year 7&8 GCSE

C C C C C C

Where needed, assume water has a density of $1000\,\mathrm{kg/m^3}$ and atmospheric pressure is $101\,\mathrm{kPa}$.

A beaker has a cross sectional area of $0.080\,\mathrm{m}^2$ and is filled to a depth of $0.12\,\mathrm{m}$.

Part A Volume

Calculate the volume of water in m^3.

Part B Mass

Calculate the mass of water in kg.

Part C Weight

Calculate the weight of water in N.

Part D Pressure

Calculate the extra pressure caused by the water on the base in Pa.

Part E New volume

If the beaker had a cross sectional area of $0.80\,\mathrm{m}^2$, but the same depth of water, what would be the volume of water in m^3?

Part F New mass

If the beaker had a cross sectional area of $0.80\,\mathrm{m}^2$, but the same depth of water, what would be the mass of water in kg?

Part G New weight

If the beaker had a cross sectional area of $0.80\,\mathrm{m}^2$, but the same depth of water, what would be the weight of water in N?

Part H New pressure

If the beaker had a cross sectional area of $0.80\,\mathrm{m}^2$, but the same depth of water, what would be the pressure on the base from the water in Pa?

Gameboard:
STEM SMART Physics 31 - Fluids

Physics. You work it out.

Home Gameboard Physics Mechanics Statics Essential GCSE Physics 17.8

Essential GCSE Physics 17.8

Year 7&8 GCSE

Where needed, assume water has a density of $1000\,\mathrm{kg/m^3}$ and atmospheric pressure is $101\,\mathrm{kPa}$.

A watch states that it is 'water resistant to $30\,\mathrm{m}$'.

Part A Extra pressure

What extra pressure can it withstand before leaking?

Part B Pressure at $10\,\mathrm{m}$

What is the extra pressure on the watch at a depth of $10\,\mathrm{m}$?

Gameboard:

STEM SMART Physics 31 - Fluids

Step up to GCSE Dimensional Analysis - Algebra With Units 48.2

Year 9 P P P
A Level C C C

If ρ is the density of air, A is the cross sectional area of a wind turbine, and v is the speed of the wind,

Part A Work out the units of $\rho A v$

Work out the units of $\rho A v$.

- $\mathrm{kg\,m/s}$
- $\mathrm{kg/s}$
- $\mathrm{kg\,m/s^2}$
- $\mathrm{m/s^2}$

Part B Suggest what $\rho A v$ might represent.

Suggest what $\rho A v$ might represent.

Gameboard:
STEM SMART Physics 31 - Fluids

Bernoulli's Equation

A Level
C C C

Bernoulli's equation relates the pressure and the speed of a fluid if we assume that the fluid is incompressible. This is a very good approximation for most liquids, but also applies to many subsonic flows of gases such as air. The equation comes from the principle of Conservation of Energy.

In this section, we will use the symbols given below to represent the important quantities. The units are given in brackets.

- p the pressure of the fluid $\left(\mathrm{N\,m^{-2}} \text{ or } \mathrm{Pa}\right)$
- V the volume of a parcel of fluid in the flow $\left(\mathrm{m^3}\right)$
- v the speed of the parcel of fluid $\left(\mathrm{m\,s^{-1}}\right)$
- ρ the density of the fluid $\left(\mathrm{kg\,m^{-3}}\right)$

Part A Kinetic energy

Write an expression for the kinetic energy of volume V of fluid moving at speed v.

The following symbols may be useful: `V`, `rho`, `v`

Part B Work done by fluid behind

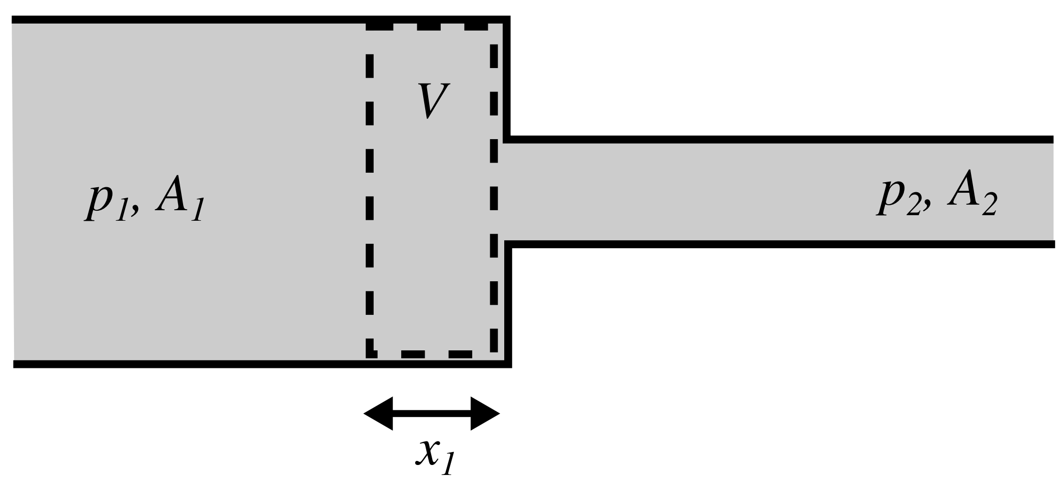

Figure 1: Incompressible fluid moving from a wider pipe to a narrower one.

The diagram shows fluid moving from a wide pipe with cross sectional area A_1 to a narrower one with cross sectional area A_2. The pressure before the change is p_1. Here we will consider a part (or parcel) of this fluid, which has a volume V. In the next three parts of this question, you will calculate the net work done on this parcel as it moves from the wide pipe to the narrow one. We will assume that the fluid does not compress and so the volume of the parcel remains the same as it passes into the narrower pipe.

Our first stage is to calculate the work done on the parcel of fluid (by the fluid behind it) as it is pushed into the narrower pipe. The back surface of the parcel moves forward a distance x_1 during this time. For now, ignore the fluid in front of the parcel.

The following symbols may be useful: `A_1, V, p_1, rho, x_1`

Part C Work done on fluid ahead

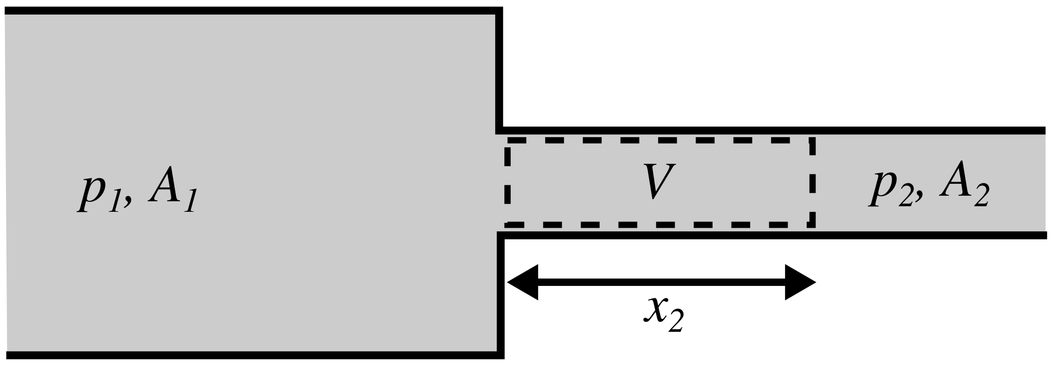

Figure 2: Incompressible fluid moving from a wider pipe to a narrower one.

The parcel of fluid, of volume V, has now passed into the narrow pipe, where it now has a length x_2. The narrower part of the pipe has cross sectional area A_2 and within it the fluid pressure is pressure p_2. Calculate how much work the parcel needed to do on the fluid in front of it as it pushed forward a distance x_2.

The following symbols may be useful: `A_2, V, p_2, rho, x_2`

Part D Net work done on fluid parcel

As the fluid moves from the wide pipe to the narrow one, work is done on it by the fluid behind. This increases its store of energy. However it must also do work on the fluid ahead, which decreases its store of energy. You have already calculated both of these energy changes.

Use your answers to the previous two questions to write an equation for the net work done on (net increase of energy stored by) the volume V of fluid when it passes from pressure p_1 to pressure p_2.

The following symbols may be useful: `V, p_1, p_2, rho`

Part E Gain in kinetic energy

Write an expression for the gain in kinetic energy of the volume V of fluid on passing from speed v_1 to speed v_2.

The following symbols may be useful: `V, rho, v_1, v_2`

Part F Conservation of energy

By equating the gain in kinetic energy of the fluid with the net work done on it, write an expression involving p_2 and v_2 which must be equal to $p_1 + \frac{\rho v_1^2}{2}$.

The following symbols may be useful: `V, p_2, rho, v_2`

Part G Dynamic pressure

The **dynamic pressure** of a fluid is the gain in pressure which would occur if the fluid stopped moving. Calculate the dynamic pressure of air with $\rho = 1.2\,\mathrm{kg\,m^{-3}}$ flowing at $v = 55\,\mathrm{m\,s^{-1}}$.

Part H Venturi

An incompressible fluid with $\rho = 1.2\,\mathrm{kg\,m^{-3}}$ accelerates from $55\,\mathrm{m\,s^{-1}}$ to a speed of $110\,\mathrm{m\,s^{-1}}$ in order to pass through a pipe which is getting narrower. Calculate its pressure change.