## AS-2007 Q2

A piece of ice floats in a glass filled with water. The ice contains a small stone, so that when the ice has all melted, the stone sinks to the bottom of the glass. What will happen to the level of the water in the glass, firstly as the ice melts, and secondly as the stone is released from the ice and sinks to the bottom?
The water in the glass will

A. remain the same then rise  B. rise and fall  C. fall then remain the same  D. remain the same then fall

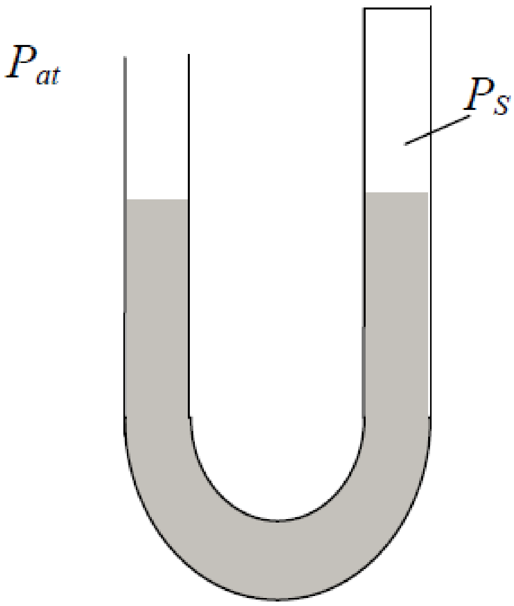
## AS-2010 Q3

A two litre sealed container is filled with air at atmospheric pressure. It is connected to a vacuum pump which can pump air at a flow rate that is proportional to the difference in pressure within the container to the pressure outside. This tells us that the pressure drops exponentially with time. If it takes 20 seconds for the pressure in the container to halve, how long would it take to reduce the pressure in a five litre container from atmospheric pressure to $1/8^{\text{th}}$ of atmospheric pressure

**A.** 48 s  **B.** 150 s  **C.** 200 s  **D.** 250 s

# AS-2010 Q8

A glass U-tube is sealed at one end with the other end being open to the atmosphere. It contains mercury so that the levels in the two sides of the U-tube are the same. The pressure above the mercury in the sealed end is $P_S$ and the pressure of the atmosphere is $P_{at}$. What can be said about the pressures in this system?




**A.** $P_S = P_{at}$

**B.** The pressure at all points in the mercury is the same

**C.** $P_S > P_{at}$

**D.** $P_S < P_{at}$

AS-2012 Q8

A heavy piece of apparatus used to measure sea salinity is attached by a short rope to a flexible rubber balloon filled with air. The balloon should sit on the surface of the sea. On one occasion too little air is put in and the balloon sits just below the surface of the sea. The sea becomes rough and the balloon sinks down just a little further. What is likely to happen to the apparatus?

A. It sinks to the ocean floor

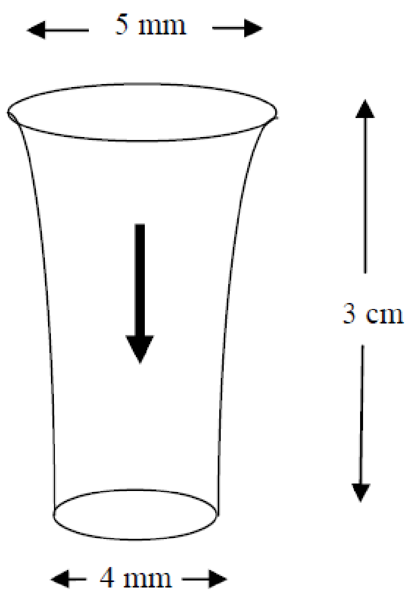
B. It sinks to some reasonable depth and stays there

C. It rises again and sits just below the surface of the sea

D. It remains at the level it has just sunk to

# AS-2009 Q12

A stream of water flows vertically downwards from a running tap, as shown below. Some way down the flow, there is a 3 cm long segment of flowing water where the diameter of the circular stream reduces from $d_1 = 5$ mm to a diameter $d_2 = 4$ mm. From this we can determine the flow rate and how long it will take to fill a beaker of volume 200 $cm^3$. We shall assume that water is incompressible.




a) Explain why the segment of water becomes narrower.

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b) If the speed of the water at the top of the segment is $v_1$ then what is the speed $v_2$ of the water at the bottom of the segment expressed in terms of $v_1$, $d_1$ and $d_2$ ?

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______________________________________ [1]

AS-2009 Q12
(continued)

c) Calculate the speed of the water flow at the top of the segment.
You may want to use the equation of motion $v^2 - u^2 = 2as$

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______________________________________________________________________ [3]

d) From your answer to part (b), calculate the volume flow of water per second.

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______________________________________________________________________ [1]

e) Calculate the time taken to fill a 200 $cm^3$ beaker.

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AS-2008 Q9

A gas consists of particles moving around in random directions. Air molecules move with an average speed of 500 m/s at room temperature. In a balloon filled with hydrogen gas at the same room temperature, the hydrogen molecules would have the same average kinetic energy as the air molecules.

average relative molecular mass of air molecule = 29

relative molecular mass of hydrogen molecule = 2.0

a) Calculate the average speed of a hydrogen molecule.

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______________________________________________ [3]

b) What is the average velocity of the hydrogen molecules in the balloon?

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______________________________________________ [1]

c) Comment on how the speed of sound in hydrogen would compare with the speed of sound in air at the same temperature?

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______________________________________________ [2]

d) If the mass of all the molecules of the hydrogen gas in the balloon is 1.0 g, calculate the sum of the kinetic energies of all the molecules in the balloon.

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______________________________________________ [1]

e) If a balloon was filled with an identical number of air molecules at the same temperature, how would the sum of the kinetic energies of the air molecules compare with the value calculated in part (d) for hydrogen?

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______________________________________________________________________ [1]

f) If one of the hydrogen molecules was directed upwards from the surface of a planet which had no atmosphere, but was similar in size and mass to the earth and had the same gravitational field strength, to what height would the molecule go?
(assume that g is independent of height)

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______________________________________________________________________ [2]

g) How does this height, calculated in part (f), compare with the height reached by an air molecule directed upwards from the planet in an identical manner? (A numerical answer is not required)

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______________________________________________________________________ [1]

h) This height is not enough to get away from the earth's gravitational pull, and yet the hydrogen molecules at the top of the atmosphere do escape completely from the earth's gravitational field. Explain how this could be so.

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______________________________________________________________________ [2]

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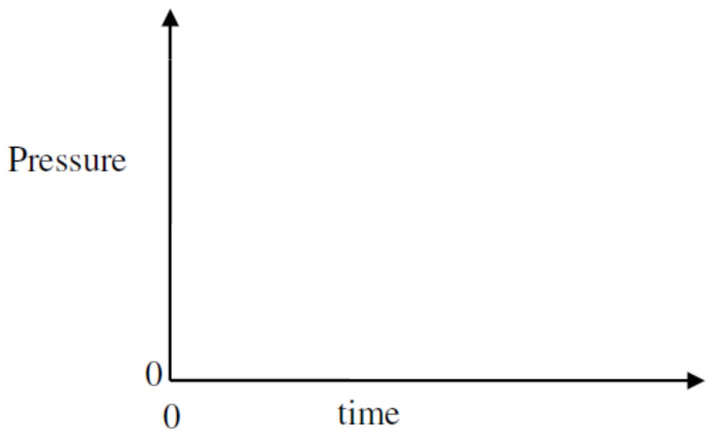
## AS-2012 Q14

The volume of a car tyre is 20 litres when correctly inflated. The tyre is found to be flat so that the rim of the wheel is sitting on the ground. It still has 16 litres of air in the tyre at atmospheric pressure. An electrically operated air pump is available. This works using a tiny piston in a cylinder which oscillates very fast and can pump air from the atmosphere through the pump at the rate of 4 litres/minute. We will assume that the temperature remains constant.

a) The extra volume of 4 litres would be filled in 1 minute at 4 litres/min. Explain why it takes very much longer than 1 minute to correctly inflate the car tyre.

[2]

b) Sketch a graph showing how the air pressure in the tyre might increase with time after the first few minutes.




[2]

c) When the tyre is filled with air at one atmosphere of pressure, it will not lift the rim off the ground. An excess pressure is required for that purpose. When inflated, each car tyre has about 130 $cm^2$ of area in contact with the ground. If the car has a mass of 1,200 kg, what is this excess pressure in a car tyre needed to lift the weight of the car? Express this in terms of atmospheric pressure.

Atmospheric pressure is $1.0 \times 10^5$ Pa.

[3]

d) Boyle's Law for a gas states that $P \times V$ = constant, and this can be used to relate the volume and pressure of the air inside and outside the tyre when it is correctly inflate What is the volume of air taken from the atmosphere which provides the excess pressure in the tyre?

[3]

e) How long would it take the pump to correctly inflate the tyre when it is flat and sitting on the rim with only 16 litres of air in it?

[2]

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