1 A scuba diver is on a sandy beach.

She checks her compressed air cylinders before a dive.
She has two identical steel cylinders, A and B.
Each cylinder contains the same amount of compressed air.

Figure 25 shows the diver's cylinders.

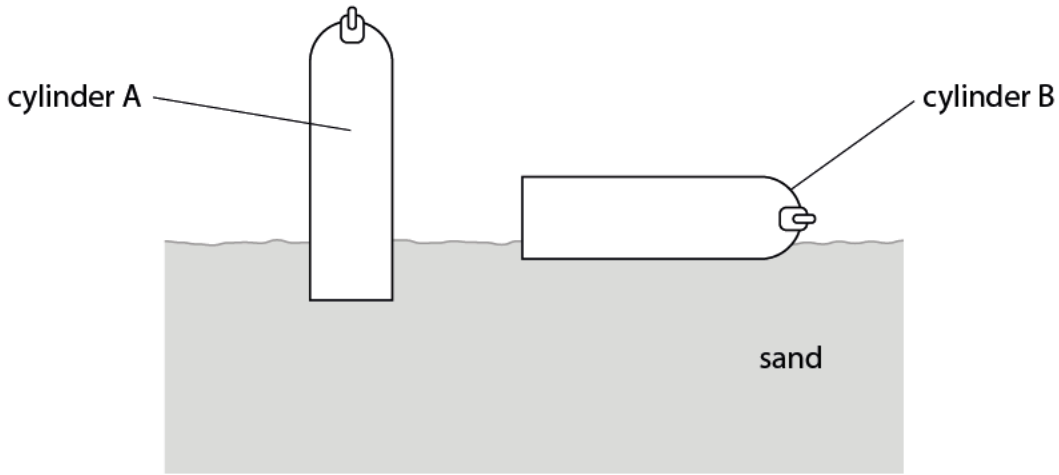


Figure 25

(a) Explain why cylinder A sinks further into the sand than cylinder B.

Use ideas about pressure, force and area in your answer.

(4)

(b) When underwater, the diver tries to move a large stone block.

The diver uses a long iron bar and a pivot, as shown in Figure 26.

When pushing down with a force of 120 N, the block is balanced.

Not to scale

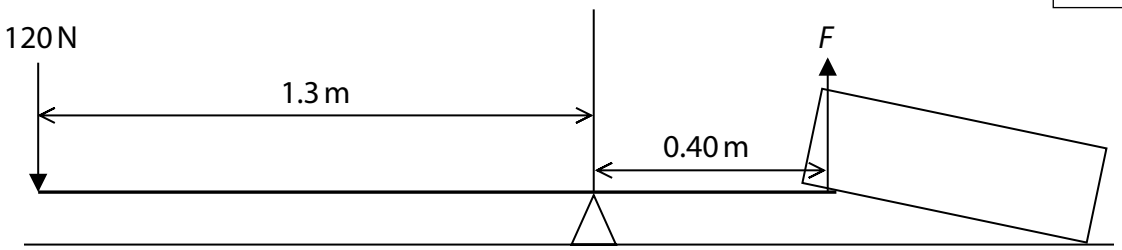


Figure 26

Calculate the size of the force, *F*, of the bar on the block.

(3)

force = ... N

*(c) When the diver is swimming under water, she breathes out bubbles of gas, as shown in Figure 27.



(Source: © mihtiander/123RF)

Figure 27

The bubbles of gas rise to the surface.
The temperature of the gas does not change.

Explain what happens to a bubble as it rises to the surface.
Your answer should refer to gas equations, kinetic theory and particles.

(6)

(Total for Question 10 = 13 marks)

2 The espresso machine shown in Figure 27 is an electrical appliance.



(Source: © tanawaty/123RF)

Figure 27

(a) The espresso machine has an electrical heater connected to a 440 V mains supply.

The power of the electrical heater is 3.5 kW.

(i) The rating of a fuse is the current above which it melts.

Which of these is the most suitable fuse for the espresso machine circuit?

(1)

- ☒ **A** 1 A
- ☒ **B** 5 A
- ☒ **C** 10 A
- ☒ **D** 13 A

(ii) Before the espresso machine can be used, its heater must raise the temperature of some cold water.

The specific heat capacity of water is 4200 J/kg K.

Show that it takes the heater about 90 s to raise the temperature of 1 kg of water from 18 °C to 95 °C.

Use an equation from the formula sheet.

(3)

(b) The espresso machine has a steam pipe that can be used to heat milk in a jug, as shown in Figure 28.



(Source: © Wavebreak Media Ltd/123RF)

Figure 28

Steam from the pipe enters the milk, where steam condenses to water.

The steam and hot water heat the milk.

(i) Describe, in terms of energy, how the arrangement and movement of particles in the steam changes as the steam enters the milk, condenses and cools.

(2)

.....

.....

.....

.....

(ii) The specific heat capacity of milk is 3840 J/kg K.

The specific heat capacity of water is 4200 J/kg K.

The specific latent heat of condensation of steam is 2260 kJ/kg.

The temperature of the steam is 100 °C

The mass of steam that condenses is 25 g.

The temperature of the milk rises from 5 °C to 65 °C.

By considering the transfer of energy from the steam to the milk, calculate the mass of milk that is heated by the steam and hot water.

Use equations from the formula sheet.

(4)

mass of milk = ... kg

(iii) Give **two** reasons why the actual mass of steam needed to heat the milk from 5 °C to 65 °C is greater than 25 g.

(2)

1 .....

.....

2 .....

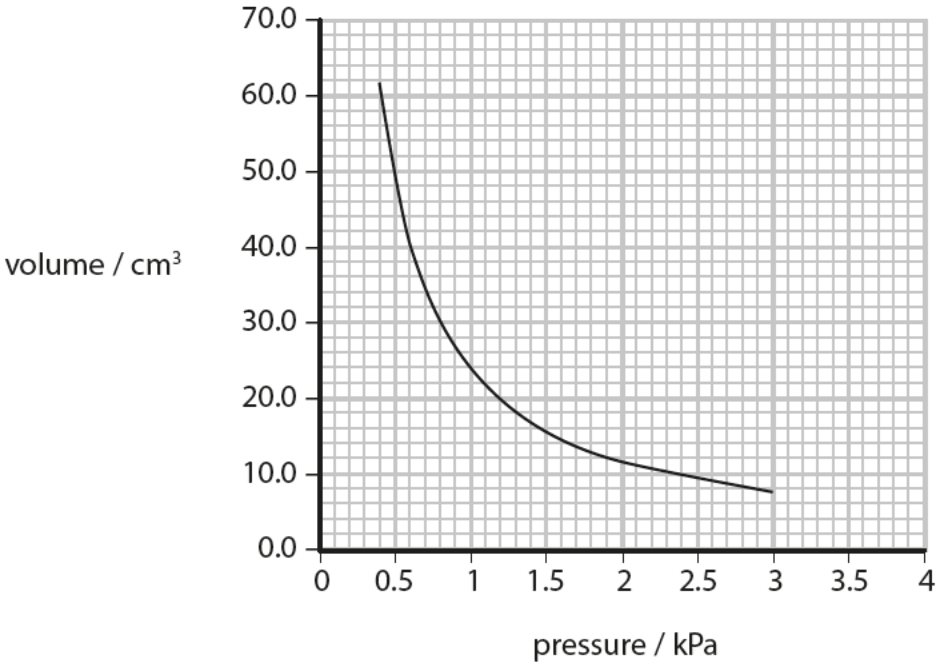
.....

(Total for Question 10 = 12 marks)

Gases

3 (a) A student investigated how the volume and pressure of a gas were related.

The graph shows how the volume of a gas changes with pressure.



The table shows the results used to plot the graph.

pressure / kPa	volume / cm^3
2.5	.....
2.0	11.9
.....	14.0
1.4	17.0
1.0	24.0
0.4	61.5

(i) Use the graph to complete the table.

(2)

(ii) The results were taken at a constant temperature of 23 °C.

Complete the sentence by putting a cross (☒) in the box next to your answer.

A temperature of 23 °C can be written in kelvin as

(1)

☒ **A** –273 K

☒ **B** 250 K

☒ **C** 273 K

☒ **D** 296 K

(iii) Estimate a value for the volume when the pressure becomes 4 kPa.

(1)

volume = ... cm^3

(iv) When the pressure of the gas is 2.2 kPa, the volume of the gas is 10.8 cm^3.

Use the equation

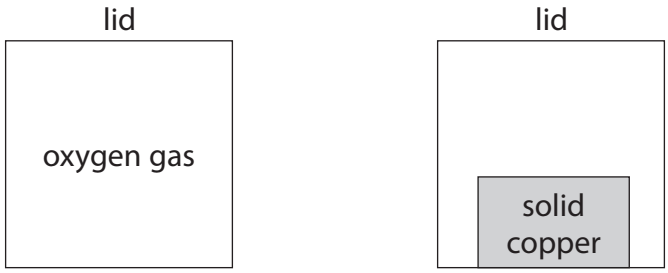
$$V_2 = \frac{P_1 V_1}{P_2}$$

to calculate the volume of the gas when the pressure of the gas is 0.2 kPa.

(2)

volume = ... cm^3

*(b) The diagrams show a block of solid copper and some oxygen gas in two closed containers.



The oxygen exerts a pressure on the lid of its container.

The copper does not exert a pressure on the lid of its container.

Explain, using kinetic theory, why the oxygen exerts a pressure on the lid but the copper does not.

(6)

(Total for Question 6 = 12 marks)