1 A large stone block is to be part of a harbour wall. The block is supported beneath the surface of the sea by a cable from a crane. Fig. 2.1 shows the block with its top face a distance *h* beneath the surface of the sea.

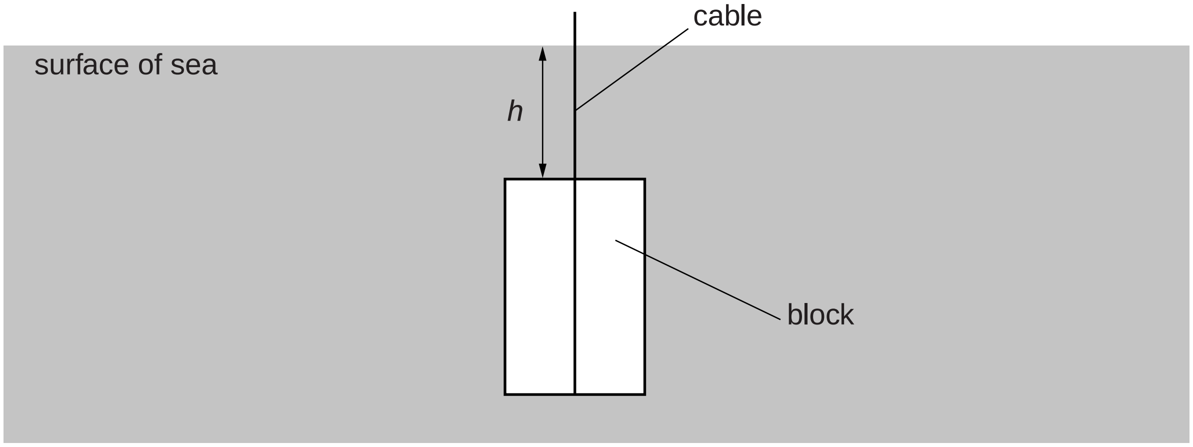

Fig. 2.1

The force acting downwards on the top face of the block, due to the atmosphere and the depth *h* of water, is 3.5×10^4 N.

(a) The top face of the block has an area of $0.25\,\text{m}^2$.

(i) Calculate the pressure on the top face of the block.

pressure = ... [2]

(ii) The atmospheric pressure is 1.0×10^5 Pa.

Calculate the pressure on the top face of the block due to the depth *h* of water.

pressure = ... [1]

(iii) The density of sea water is $1020\,\text{kg/m}^3$.

Calculate the depth *h*.

h = ... [2]

(b) Suggest two reasons why the tension force in the cable is not 3.5×10^4 N.

1. ....

2. ....

[2]

(c) The block is lowered so that it rests on the sea-bed.

State what happens to the tension force in the cable.

.... [1]

[Total: 8]

2 A surveyor measures the dimensions of a room of constant height. Fig. 2.1 is a top view of the room and shows the measurements taken.

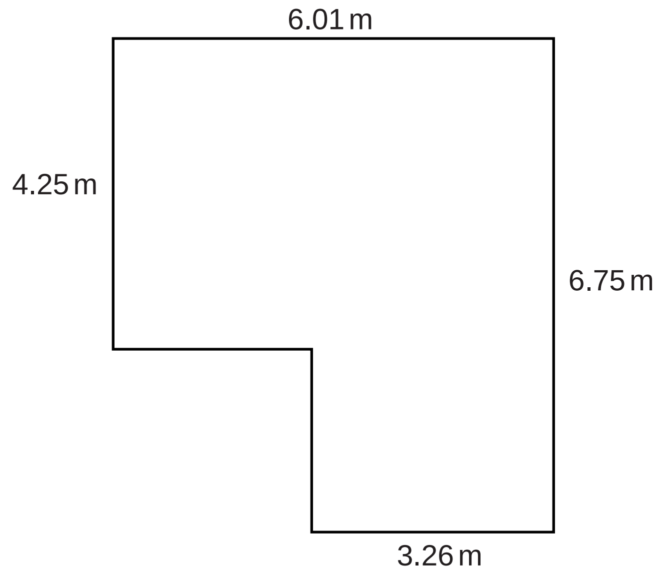

Fig. 2.1

(a) State an instrument that would be suitable to take these measurements.

.... [1]

(b) The volume of air in the room is $76.4\,m^3$. The density of the air is $1.2\,kg/m^3$.

Calculate the mass of air in the room.

mass = ... [2]

(c) A window in the room is open. The next day, the temperature of the room has increased, but the pressure of the air has stayed the same.

State and explain what has happened to the mass of air in the room.

....

....

....

.... [3]

[Total: 6]

3 **(a)** Fig. 3.1 shows an oil can containing only air at atmospheric pressure.

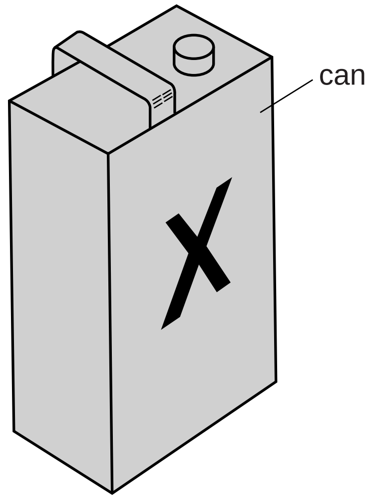

Fig. 3.1

Atmospheric pressure is 1.0×10^5 Pa.

The pressure of the air in the can is reduced by means of a pump. The can collapses when the pressure of the air in the can falls to 6000 Pa.

(i) Explain why the can collapses.

....

....[1]

(ii) The surface area of face X of the can is $0.12\,m^2$.

Calculate the resultant force on face X when the can collapses.

force = ...[3]

(b) Mercury is poured into a U-shaped glass tube. Water is then poured into one of the limbs of the tube. Oil is poured into the other limb until the surfaces of the mercury are at the same level in both limbs.

Fig. 3.2 shows the result.

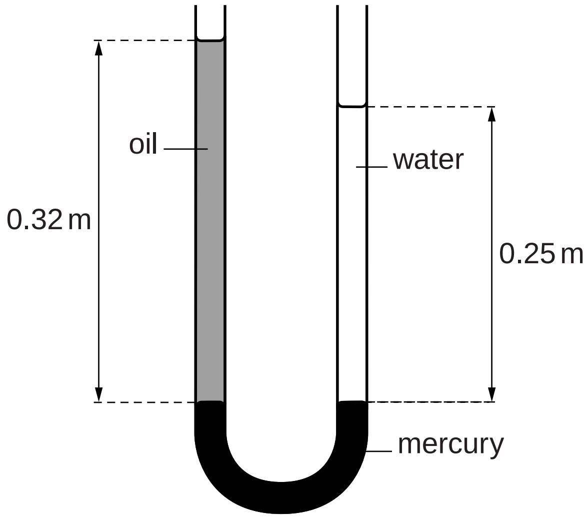

Fig. 3.2

(i) State a condition that must be true in order for the mercury surfaces to be at the same level in both limbs of the tube.

....[1]

(ii) The height of the water column is 0.25 m. The height of the oil column is 0.32 m. The density of water is 1000 kg / m^3.

Calculate

1. the pressure exerted by the water on the surface of the mercury,

pressure = ...[2]

2. the density of the oil.

density = ...[2]

[Total: 9]

4 Fig. 4.1 shows a small wind-turbine used to generate electricity.

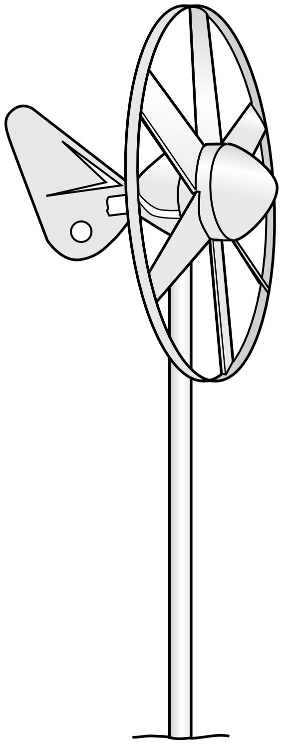

Fig. 4.1

The wind-turbine drives an electric generator.

The wind blows with a velocity of 7.0 m/s at right angles to the plane of the turbine. The mass of air passing per second through the turbine is 6.7 kg.

(a) **(i)** Calculate the kinetic energy of the air blown through the turbine per second.

kinetic energy = ... [2]

(ii) Only 8% of this energy is converted to electrical energy.

Calculate the power output of the electric generator.

power output = ... [2]

(b) The volume of air passing through the turbine each second is 5.6 m^3 (flow rate is 5.6 m^3/s).

Calculate the density of the air.

density of air = ... [2]

(c) The turbine turns a generator.

Describe the essential action within the generator that produces electricity.

....

....

.... [2]

[Total: 8]

5 An archaeologist digging at an ancient site discovers a spoon. The spoon is made from an unidentified material.

(a) The archaeologist suspects that the spoon is made of metal. She places it above a flame, as shown in Fig. 1.1.

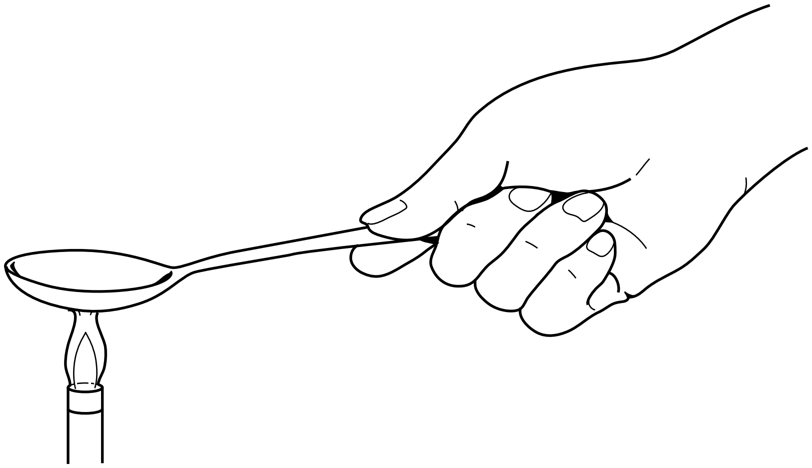

Fig. 1.1

(i) She notices that the handle of the spoon quickly becomes very hot.

State why this observation supports the suggestion that the spoon is made of metal.

....

.... [1]

(ii) Describe, in terms of its atoms, how thermal energy is transferred through a metal.

....

....

....

....

.... [3]

(b) The archaeologist hopes that, by determining its density, she will be able to identify the metal.

Describe a method for determining the density of the metal from which the spoon is made.

....

....

....

....

....

....

....[4]

[Total: 8]

6 Fig. 3.1 shows a house brick of dimensions 21.0 cm × 10.0 cm × 7.00 cm.

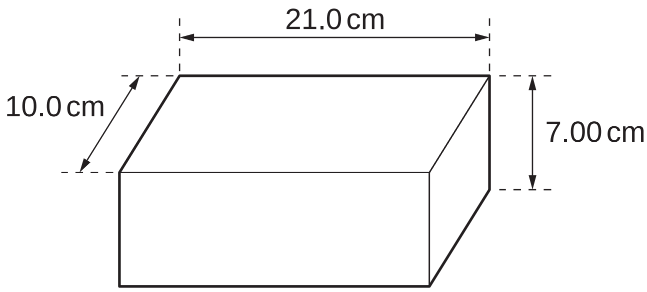

Fig. 3.1

The brick is held under water with its largest surfaces horizontal. The density of water is 1000 kg / m^3.

(a) Calculate the difference in pressure between the top and the bottom surfaces of the brick.

pressure difference = ... [2]

(b) Use your value from **(a)** to calculate the upward force exerted on the brick by the water.

upward force = ... [2]

(c) The mass of the brick is 3.09 kg. Calculate the acceleration of the brick when it is released.

acceleration = ... [3]

[Total: 7]

7 A wind turbine has blades, which sweep out an area of diameter 25 m.

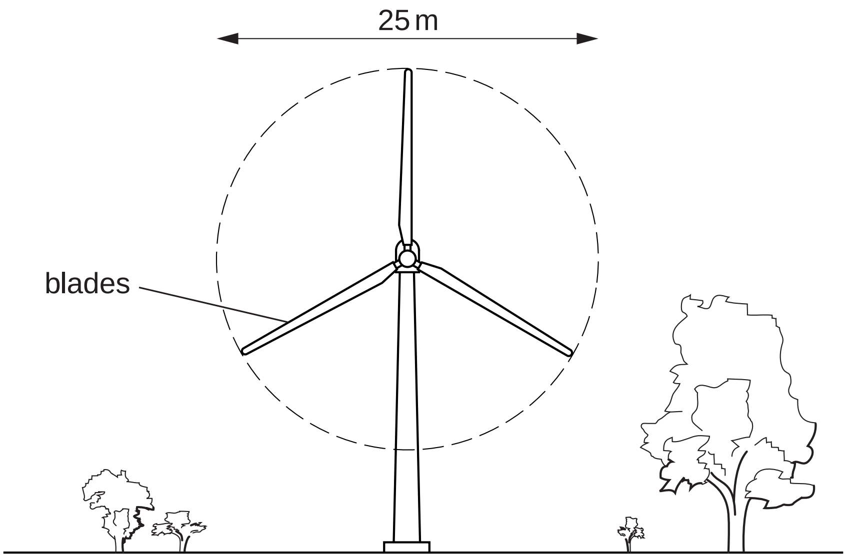

Fig. 5.1

(a) The wind is blowing directly towards the wind turbine at a speed of 12 m/s. At this wind speed, 7500 kg of air passes every second through the circular area swept out by the blades.

(i) Calculate the kinetic energy of the air travelling at 12 m/s, which passes through the circular area in 1 second.

kinetic energy = ... [3]

(ii) The turbine converts 10% of the kinetic energy of the wind to electrical energy.

Calculate the electrical power output of the turbine. State any equation that you use.

power = ... [3]

(b) On another day, the wind speed is half that in **(a)**.

(i) Calculate the mass of air passing through the circular area per second on this day.

mass = ... [1]

(ii) Calculate the power output of the wind turbine on the second day as a fraction of that on the first day.

fraction = ... [3]

[Total: 10]

8 Fig. 3.1 shows a pond that is kept at a constant depth by a pressure-operated valve in the base.

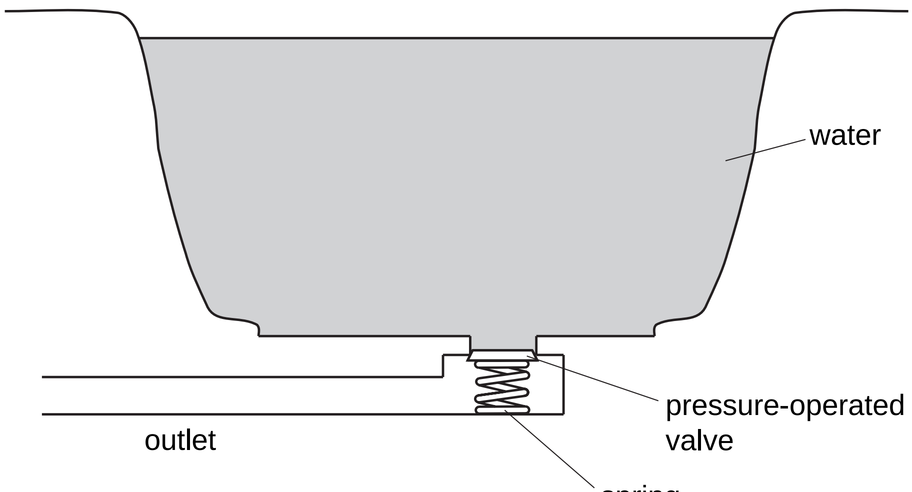

Fig. 3.1

(a) The pond is kept at a depth of 2.0 m. The density of water is 1000 kg/m^3.

Calculate the water pressure on the valve.

pressure =…………………….. [2]

(b) The force required to open the valve is 50 N. The valve will open when the water depth reaches 2.0 m.

Calculate the area of the valve.

area = ……………………….. [2]

(c) The water supply is turned off and the valve is held open so that water drains out through the valve.

State the energy changes of the water that occur as the depth of the water drops from 2.0 m to zero.

....

.... [2]

[Total : 6]