**1** Figure 24 shows a submarine underwater.

air

water

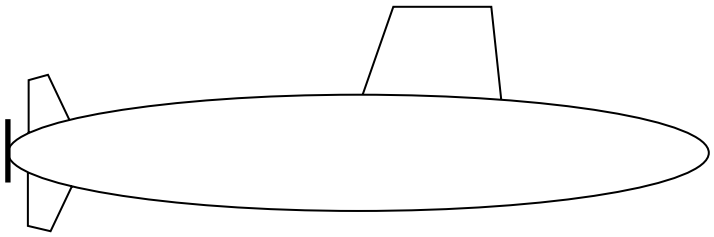


**Figure 24**

The motor in the submarine turns the gear wheels shown in Figure 25.

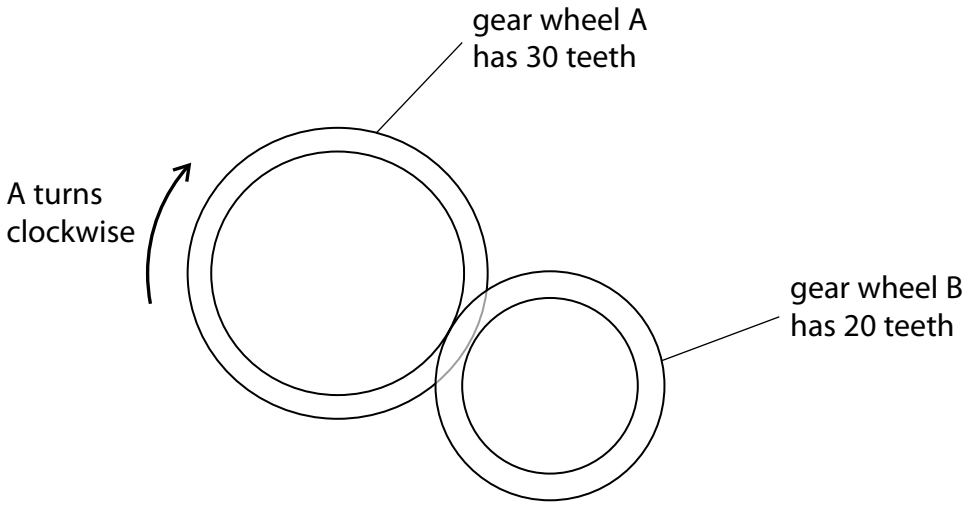



**Figure 25**

(a) Gear wheel A rotates clockwise through one complete turn.

Which of these is correct for gear wheel B?

**(1)**

| | amount that gear wheel B rotates | direction gear wheel B rotates |
|---|---|---|
| ☒ **A** | 1½ turns | clockwise |
| ☒ **B** | 1½ turns | anticlockwise |
| ☒ **C** | ⅔ of a turn | clockwise |
| ☒ **D** | ⅔ of a turn | anticlockwise |

(b) A bubble of gas escapes from the submarine.

The volume of the bubble is 23.0 $cm^3$.

The pressure of the gas inside the bubble is 297 kPa.

The bubble rises to the surface without changing temperature.

Calculate the volume of the bubble when it reaches the surface.

Atmospheric pressure = 101 kPa

Use an equation from the formula sheet.

**(3)**

volume = ..... $cm^3$

(c) A student is interested in the way that submarines are controlled.

She has several regular wooden blocks, a set of weights and a tank of water.
Wood floats in water.

The student plans to immerse the wooden blocks fully in the water and investigate the relationship between the upthrust and the weight of water displaced.

Describe how she should determine **one** of the variables in this investigation.

**(2)**

.....

.....

.....

.....

*(d) Figure 26 shows the submarine stationary and submerged at a depth of 10 m.

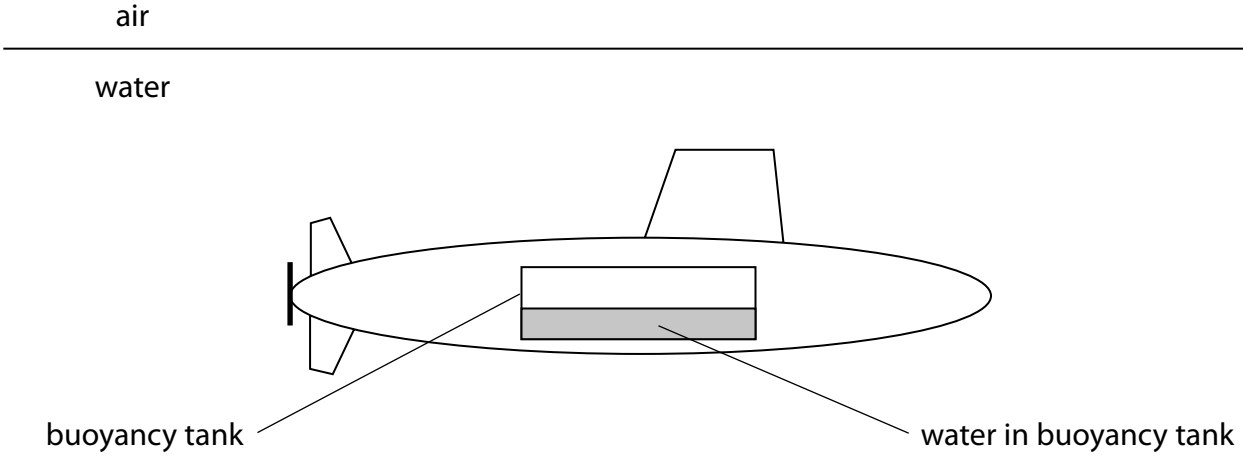



**Figure 26**

Explain how pumping water into and out of the buoyancy tank affects the depth of the submarine below the surface.

**(6)**

**(Total for Question 9 = 12 marks)**

**2** (a) Figure 13 shows a tank for holding water.

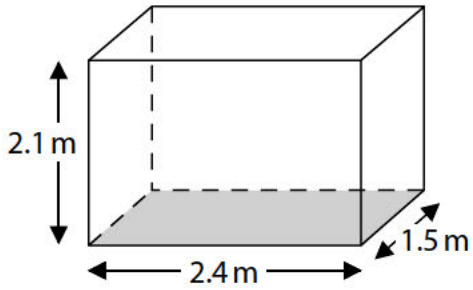



**Figure 13**

The tank has sides of 2.4 m, 2.1 m and 1.5 m.

The pressure at the bottom of the tank is 12 kPa.

(i) State the equation relating pressure, force and area.

**(1)**

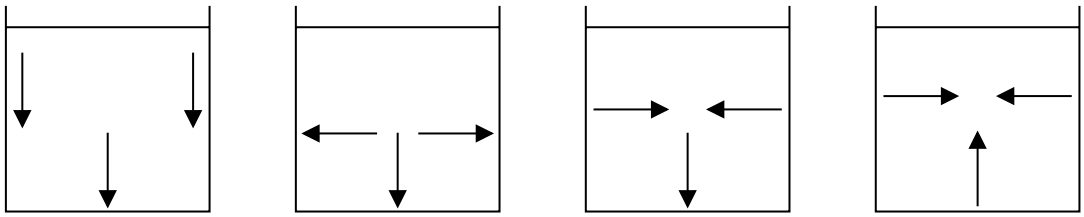
(ii) Calculate the weight of water in the tank.

**(4)**

weight = ..... N

(iii) Which diagram shows the direction of the forces from the water on the inside of the tank?

**(1)**



☒ **A** ☒ **B** ☒ **C** ☒ **D**

(b) A student makes the following hypothesis:

'*When I increase the pressure on a fixed mass of gas, the volume of the gas decreases*.'

She has the equipment shown in Figure 14.

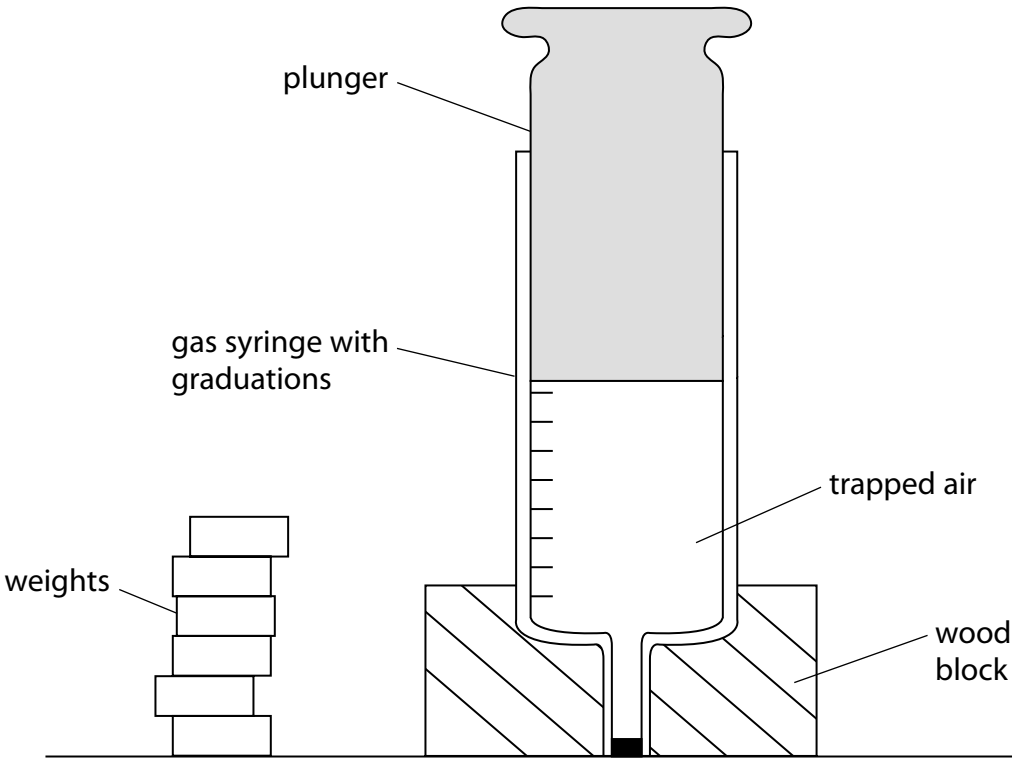



**Figure 14**

She measures the area of the plunger.

Devise a plan to test her hypothesis.

**(4)**

**(Total for Question 6 = 10 marks)**