1 Fig. 1.1 is the top view of a tank in an aquarium. The tank is filled with salt water.

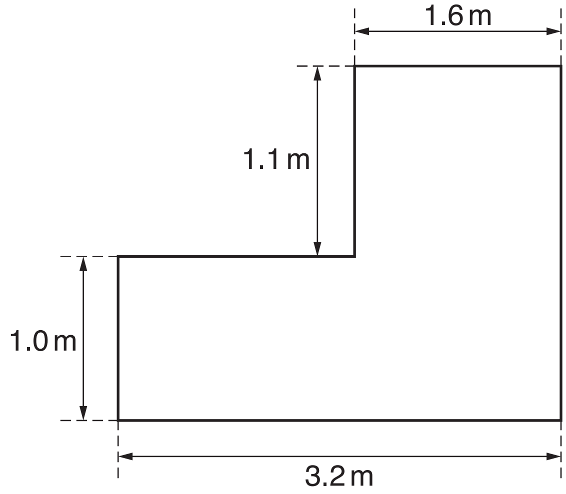

Fig. 1.1 (not to scale)

The depth of the water in the tank is 2.0 m.

(a) Calculate the volume of the water in the tank.

volume = ... [3]

(b) The density of the water in the tank is $1.1 \times 10^3 \, kg/m^3$.

Calculate the mass of the water in the tank.

mass = ... [2]

(c) Calculate the pressure due to the water at a level of 0.80 m above the base of the tank.

pressure = ... [3]

[Total: 8]

MARKING SCHEME:

(a)	attempt to use 2 rectangles for A	**C1**
	A = ((1 × 3.2) + (1.1 × 1.6) = 3.2 + 1.76 =) 4.96 (m^2)	**C1**
	9.9 m^3	**A1**
(b)	$\rho = m / V$ OR $m = \rho V$ OR (m =) 9.9 × 1.1 × 10^3	**C1**
	(m =) 1.1 × 10^4 kg	**A1**
(c)	depth of water = 1.2 m	**C1**
	(P =) ρgh OR (P = 1.1 × 10^3 × 10 × 1.2)	**C1**
	(P =) 1.3 × 10^4 Pa	**A1**

2 Fig. 1.1 is the top view of a rectangular paddling pool of constant depth. The pool is filled with sea water.

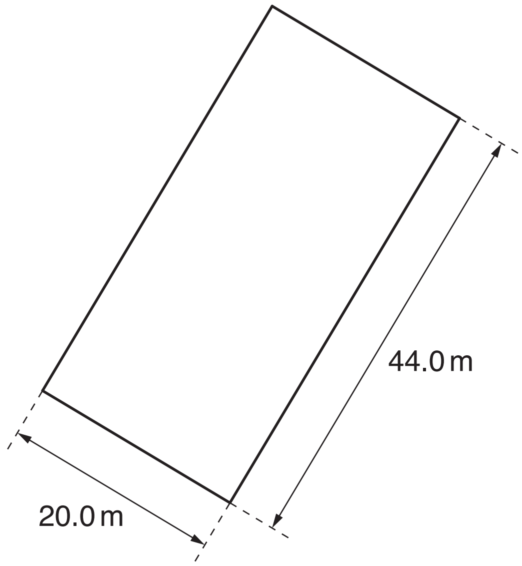

Fig. 1.1 (not to scale)

(a) The volume of the sea water in the pool is 264 m^3.

Calculate the depth of the pool.

depth = ... [3]

(b) The mass of the sea water in the pool is 2.70×10^5 kg.

Calculate the density of the sea water. Give your answer to 3 significant figures.

density = ... [2]

(c) Calculate the pressure due to the sea water at the bottom of the pool.

pressure = ... [2]

(d) State a suitable instrument for measuring the dimensions given in Fig. 1.1.

.... [1]

[Total: 8]

MARKING SCHEME:

(a)	(A = 44 × 20 =) 880 (m^2)	**C1**
	V = A × depth in any form OR (d =) V / A	**C1**
	(d = 264 / 880 =) 0.30 m	**A1**
(b)	ρ = m / V in any form OR (ρ =) m / V	**C1**
	(ρ = 2.7 × 10^5 / 264 =) 1020 kg / m^3	**A1**
(c)	p = ρgh in any form OR (p =) ρgh	**C1**
	(p = 1020 × 10 × 0.3 =) 3 100 Pa	**A1**
(d)	tape measure	**B1**

3 Fig. 3.1 shows a gas contained in a cylinder enclosed by a piston.

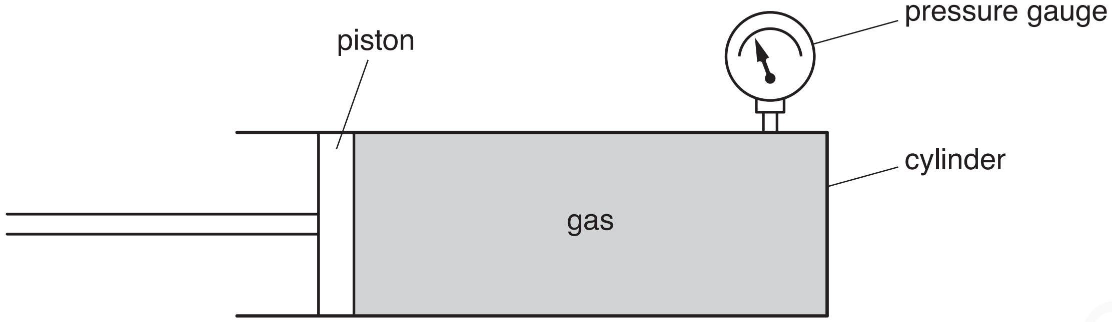

Fig. 3.1

(a) Describe, in terms of momentum of the molecules, how a pressure is exerted on the walls of the cylinder.

....

....

....

....

.... [3]

(b) The piston is pushed into the cylinder. The volume decreases from 820 cm^3 to 330 cm^3 . The pressure gauge measures the pressure after compression as 20 000 Pa. The temperature remains constant.

Calculate the value of the pressure before the gas was compressed.

pressure = ... [3]

[Total: 6]

MARKING SCHEME:

(a)	they / molecules collide with walls	**B1**
	change of momentum causes force (to be exerted on walls)	**B1**
	pressure = force / area (so pressure is exerted on walls)	**B1**
(b)	pV = constant or $p_1 V_1 = p_2 V_2$ in any form	**C1**
	$p_1 \times 820 = 20\,000 \times 330$ OR (p_1 =) $20\,000 \times 330 / 820$	**C1**
	(p_1 =) 8000 Pa	**A1**

4 Fig. 1.1 shows a cylinder made from copper of density 9000 kg / m^3.

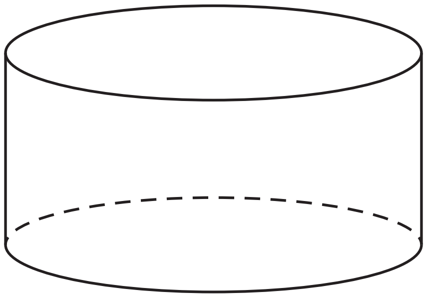

Fig. 1.1

The volume of the cylinder is 75 cm^3.

(a) Calculate the mass of the cylinder.

mass = ...[2]

(b) The gravitational field strength is 10 N / kg.

(i) Calculate the weight of the cylinder.

weight = ...[2]

(ii) State **one** way in which weight differs from mass.

....

....

....[1]

(c) Fig. 1.2 shows the cylinder immersed in a liquid.

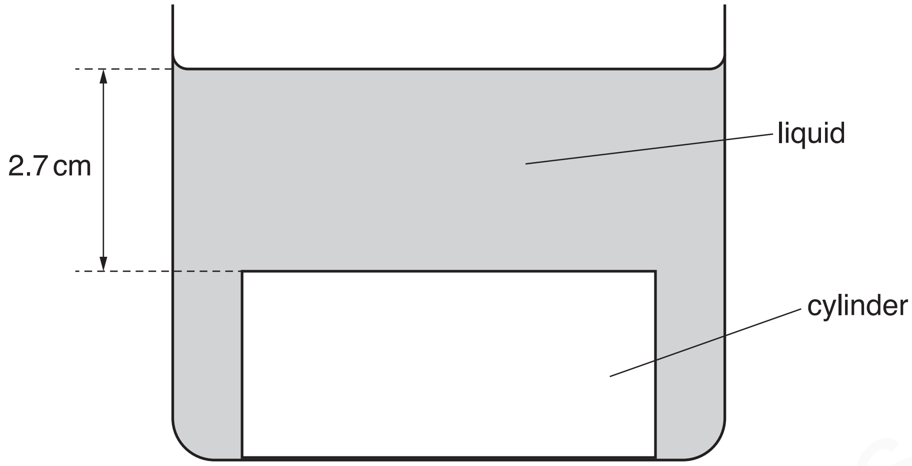

Fig. 1.2 (not to scale)

The upper face of the cylinder is at a depth of 2.7 cm below the surface of the liquid.

The pressure due to the liquid at the upper face of the cylinder is 560 Pa.

(i) Calculate the density of the liquid.

density = ... [2]

(ii) Explain why the cylinder does **not** float in this liquid.

....

.... [1]

[Total: 8]

MARKING SCHEME:

(a)	$\rho = m / V$ in any form OR (m =) ρV OR (m =) $9000 \times 7.5 \times 10^{-5}$	**C1**
	(m =) 0.68 kg **accept** 680 g	**A1**
(b)(i)	$W = m g$ in any form or (W =) $m g$ OR (W =) 0.68×10	**C1**
	(W =) 6.8 N	**A1**
(b)(ii)	any **one** of: weight has direction / mass does not weight is a vector / mass is not weight varies / mass does not mass is amount of matter weight is a force / mass is not	**B1**
(c)(i)	$p = h \rho g$ in any form OR (ρ =) $p / h g$ OR (ρ =) $560 / (0.027 \times 10)$	**C1**
	(ρ =) 2.1×10^3 kg / m^3	**A1**
(c)(ii)	explains why there is a resultant downward force	**B1**

5 A cube of side 0.040 m is floating in a container of liquid. Fig. 3.1 shows that the surface of the liquid is 0.028 m above the level of the bottom face of the cube.

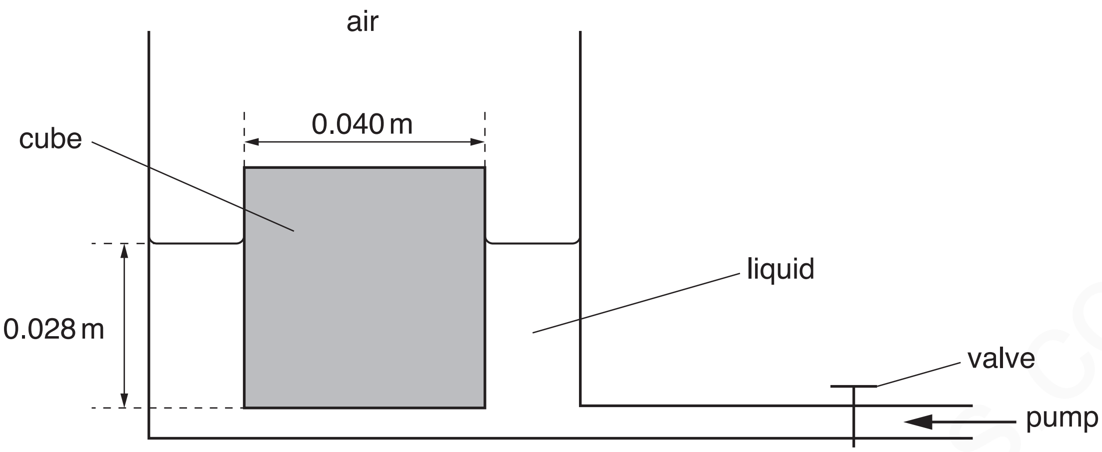

Fig. 3.1

The pressure of the air above the cube exerts a force on the top face of the cube. The valve is closed.

(a) Explain, in terms of air molecules, how the force due to the pressure of the air is produced.

....

....

....

.... [3]

(b) The density of the liquid in the container is 1500 kg / m^3.

Calculate:

(i) the pressure due to the liquid at a depth of 0.028 m

pressure = ... [2]

(ii) the force on the bottom face of the cube caused by the pressure due to the liquid.

force = ... [2]

(c) The valve is opened and liquid is pumped into the container. The surface of the liquid rises a distance of 0.034 m.

The cube remains floating in the liquid with its bottom face 0.028 m below the surface of the liquid.

(i) Calculate the work done on the cube by the force in **(b)(ii)**.

work done = ... [2]

(ii) Suggest **one** reason why this is **not** an efficient method of lifting up the cube.

....

.... [1]

[Total: 10]

MARKING SCHEME;

(a)	(air) molecules / they move / collide	**B1**
	(air) molecules / they collide with cube / (upper) surface (of cube) / wall	**B1**
	impulse exerted (on surface) **OR** momentum change (of molecules)	**B1**
(b)(i)	$p = h\rho g$ in any form **OR** (p =) $h\rho g$ **OR** $0.028 \times 1500 \times 10$	**C1**
	420 Pa	**A1**
(b)(ii)	$F = pA$ in any form words, symbols or numbers **OR** (F =) pA **OR** 420×4.0^2 **OR** 420×0.040^2 **OR** 420×16 **OR** $420 \times 1.6 \times 10^{-3}$	**C1**
	0.67 N	**A1**
(c)(i)	$W = Fd$ in any form words, symbols or numbers **OR** (W =) Fd **OR** 0.67×0.034	**C1**
	0.023	**A1**
(c)(ii)	lifting liquid as well **OR** friction between liquid and container / pipe	**B1**

6 Gas of mass 0.23 g is trapped in a cylinder by a piston. The gas is at atmospheric pressure which is 1.0×10^5 Pa. Fig. 4.1 shows the piston held in position by a catch.

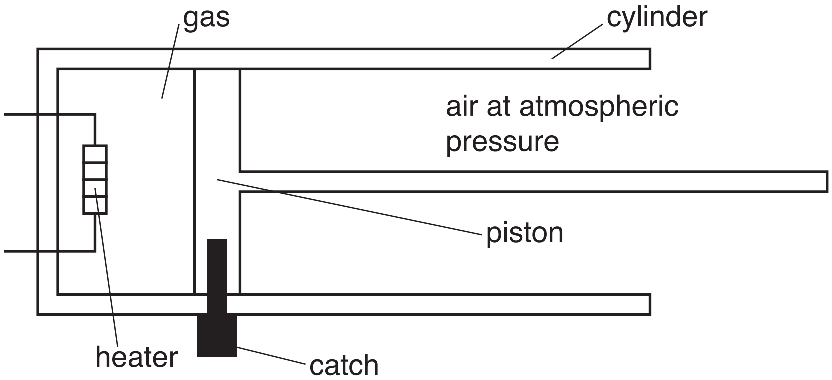

Fig. 4.1

The volume of the trapped gas is 1.9×10^{-4} m^3.

An electrical heater is used to increase the temperature of the trapped gas by 550 °C.

(a) The specific heat capacity of the gas is 0.72 J / (g °C).

(i) Calculate the energy required to increase the temperature of the trapped gas by 550 °C.

energy = ... [2]

(ii) The power of the heater is 2.4 W.

1. Calculate how long it takes for the heater to supply the energy calculated in **(a)(i)**.

time = ... [2]

2. In practice, it takes much longer to increase the temperature of the gas by 550 °C using the heater.

Suggest **one** reason for this.

....

....

.... [1]

(b) When the temperature of the gas has increased by 550 °C, its pressure is 2.9×10^5 Pa. The catch is then released allowing the piston to move. As the piston moves, the temperature of the gas remains constant.

(i) State and explain what happens to the piston.

....

....

.... [2]

(ii) Determine the volume of the gas when the piston stops moving.

volume = ... [2]

[Total: 9]

MARKING SCHEME:

(a)(i)	$E = mc\,(\Delta)T$ in any form words, symbols or numbers **OR** $(E =)\ mc\,(\Delta)T$ **OR** $0.23 \times 0.72 \times 550$	**C1**
	91 J	**A1**
(a)(ii)	1. $t = E / P$ in any form words, symbols or numbers **OR** $(t =)\ E / P$ **or** 91 / 2.4	**C1**
	38 s	**A1**
	2. (thermal) energy is used to increase the temperature of / lost to cylinder / piston / heater / surroundings	**B1**
(b)(i)	it / piston moves to the right / away from heater **OR** accelerates (to right)	**M1**
	pressure (of gas) greater / pressure greater (on left) / resultant force to right	**A1**
(b)(ii)	$V_2 = p_1V_1 / p_2$ in any form **OR** $(V_2 =)\ p_1V_1 / p_2$ **OR** $2.9 \times 10^5 \times 1.9 \times 10^{-4} / 1.0 \times 10^5$	**C1**
	$5.5 \times 10^{-4}\ m^3$	**A1**

7 Fig. 2.1 shows a vehicle designed to be used on the Moon.

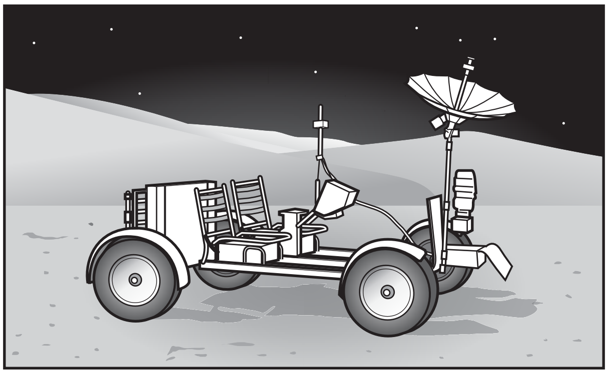

Fig. 2.1

The brakes of the vehicle are tested on Earth.

(a) The acceleration of free fall on the Moon is one sixth ($\frac{1}{6}$) of its value on Earth.

Tick **one** box in each column of the table to predict the value of that quantity when the vehicle is used on the Moon, compared to the test on Earth.

	mass of vehicle on Moon	weight of vehicle on Moon	deceleration of vehicle on Moon with same braking force
10 × value on Earth			
6 × value on Earth			
same as value on Earth			
$\frac{1}{6}$ × value on Earth			
$\frac{1}{10}$ × value on Earth			

[3]

(b) Fig. 2.2 shows the brake pedal of the vehicle.

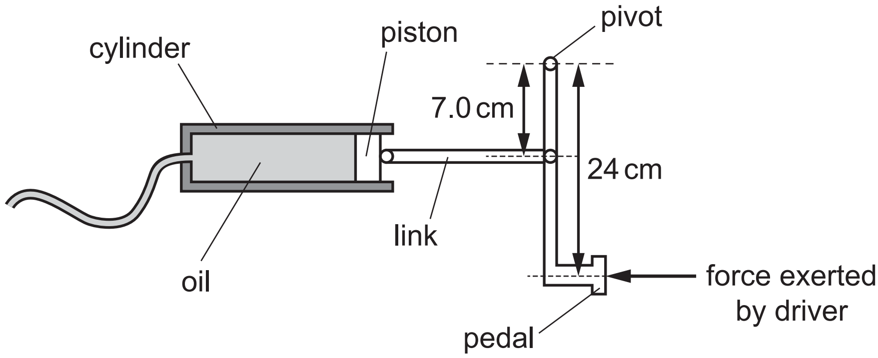

Fig. 2.2 (not to scale)

The driver exerts a force on the pedal, which increases the pressure in the oil to operate the brakes.

The area of the piston in the cylinder is $6.5 \times 10^{-4}\,m^2$ ($0.00065\,m^2$). The pressure increase in the oil is $5.0 \times 10^5\,Pa$ (500 000 Pa).

Calculate the force exerted by the driver on the brake pedal.

force = ...[4]

[Total: 7]

MARKING SCHEME:

(a)	Column 1 Box 3 mass same	**B1**
	Column 2 Box 4 weight 1/6	**B1**
	Column 3 Box 3 deceleration same	**B1**
(b)	P=F / A in any form or (F=) PA	**C1**
	(F_1 = 500 000 × 0.00065 =) 330 (N)	**C1**
	$F_1d_1 = F_2d_2$ in any form or F_1d_1/d_2	**C1**
	(F_2 = 325 × 7/24 =) 95 N	**A1**
	Total:	**7**