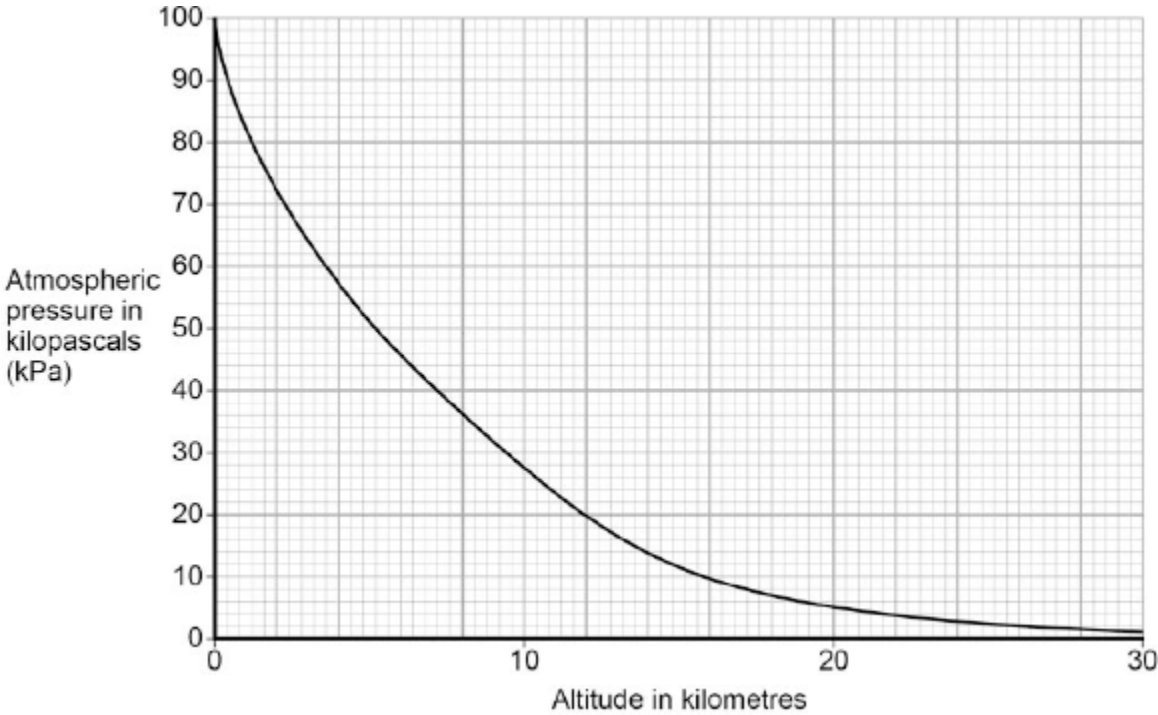


1

Figure 1 shows how atmospheric pressure varies with altitude.

Figure 1



(a) Explain why atmospheric pressure decreases with increasing altitude.

.....

.....

.....

.....

.....

.....

(3)

(b) When flying, the pressure inside the cabin of an aircraft is kept at 70 kPa.

The aircraft window has an area of 810 cm².

Use data from **Figure 1** to calculate the resultant force acting on an aircraft window when the aircraft is flying at an altitude of 12 km.

Give your answer to two significant figures

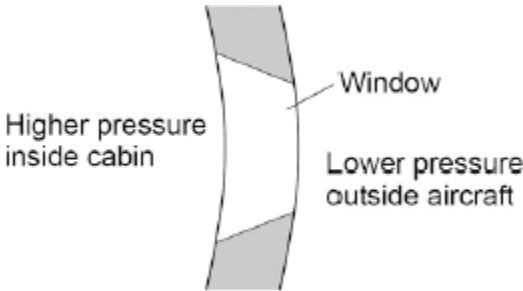
.....
.....
.....
.....
.....
.....

Resultant force = N

(5)

(c) **Figure 2** shows the cross-section of one type of aircraft window.

Figure 2



Explain why the window has been designed to have this shape.

.....
.....
.....

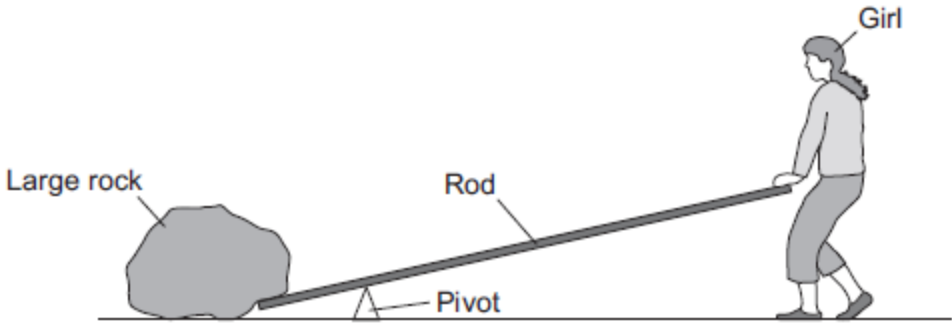
(2)
(Total 10 marks)

2

Levers and hydraulic systems can act as force multipliers.

(a) **Figure 1** shows a girl trying to lift a large rock using a long rod as a lever.

Figure 1



The girl is pushing down on the rod but is just unable to lift the rock.

Which of the following changes would allow her to lift the rock?

Tick (✓) **two** boxes.

Change	Tick (✓)
Move the pivot away from the rock	
Make the rod longer	
Push the rod upwards	
Push down on the rod with a greater force	

(2)

(b) Liquids are used in hydraulic systems because they are virtually incompressible.

Explain how the spacing of particles in a liquid cause it to be virtually incompressible.

.....

.....

.....

.....

(2)

(c) **Figure 2** shows a man using a car jack to lift his car.

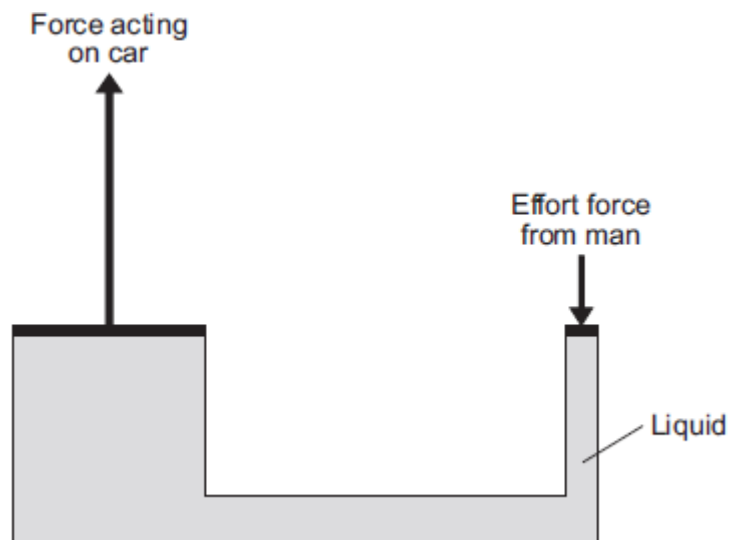
Figure 2



© lisafx/iStock/Thinkstock

Figure 3 shows a simple diagram of a car jack.

Figure 3



(i) The man pushes down with an effort force. This results in a much larger force acting upwards on the car.

Use information from **Figure 3** to explain how.

.....

.....

.....

.....

.....

(4)

(ii) Which of the following statements about the forces in **Figure 3** is correct?

Tick (✓) **one** box.

	Tick (✓)
The force acting on the car moves a greater distance than the effort force.	
The force acting on the car moves less distance than the effort force.	
The force acting on the car moves the same distance as the effort force.	

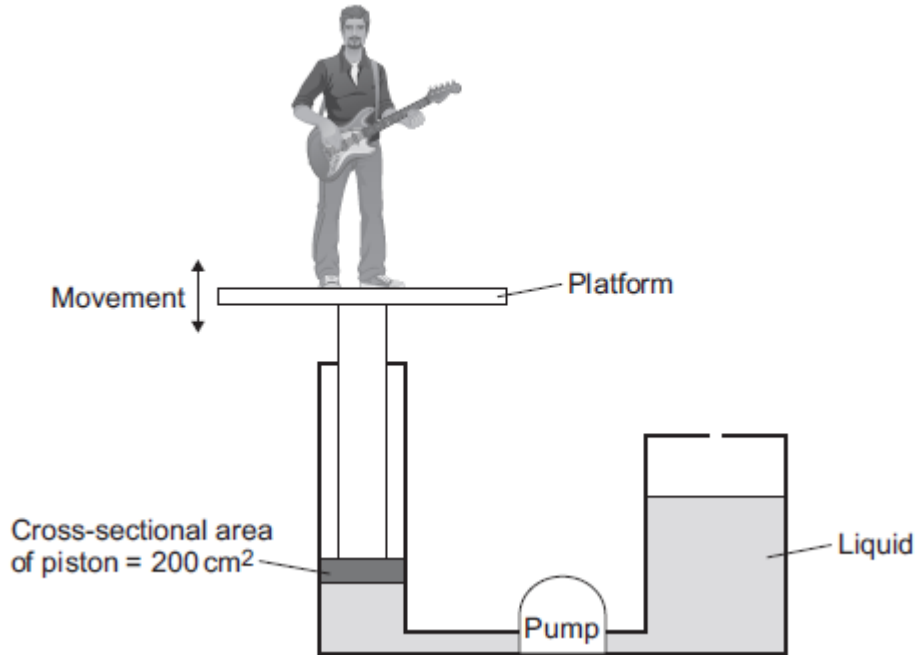
(1)

(Total 9 marks)

3

Musicians sometimes perform on a moving platform.

The figure below shows the parts of the lifting machine used to move the platform up and down.



(a) What name is given to a system that uses liquids to transmit forces?

Draw a ring around the correct answer.

electromagnetic

hydraulic

ionising

(1)

(b) To move the platform upwards, the liquid must cause a force of 1800 N to act on the piston.

The cross-sectional area of the piston is 200 cm².

Calculate the pressure in the liquid, in N / cm², when the platform moves.

.....
.....
.....

Pressure = N / cm²

(2)

(c) A new development is to use oil from plants as the liquid in the machine.

Growing plants and extracting the oil requires **less energy** than producing the liquid usually used in the machine.

Draw a ring around the correct answer to complete the sentence.

Using the oil from the plants gives

- | |
|------------------|
| an environmental |
| an ethical |
| a social |

advantage over the liquid

usually used.

(1)

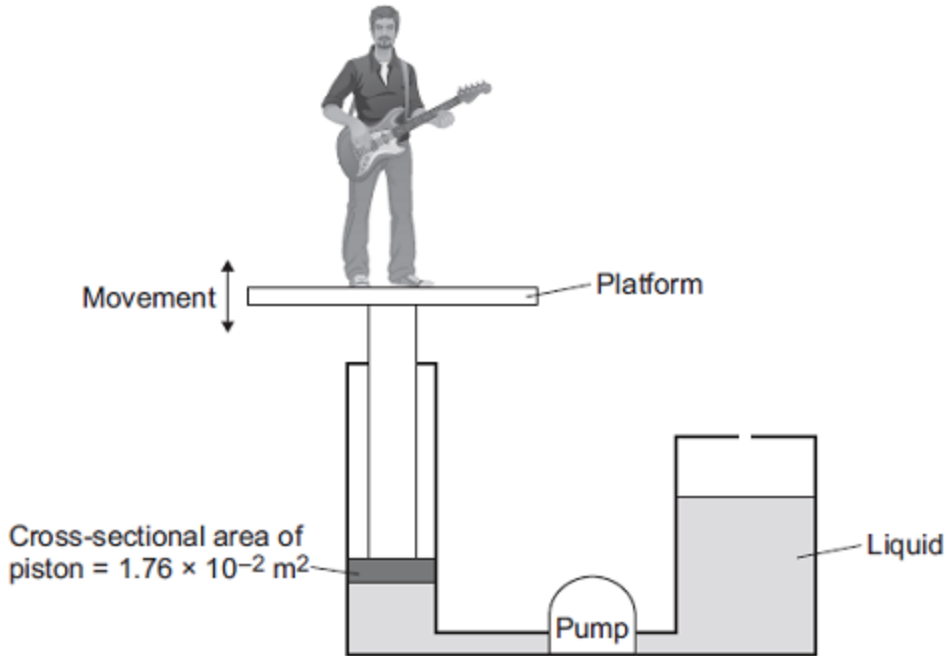
(Total 4 marks)

4

Musicians sometimes perform on a moving platform.

Figure 1 shows the parts of the lifting machine used to move the platform up and down.

Figure 1



(a) What type of system uses a liquid to transmit a force?

.....

(1)

(b) The pump creates a pressure in the liquid of $8.75 \times 10^4 \text{ Pa}$ to move the platform upwards. Calculate the force that the liquid applies to the piston.

.....
.....
.....

Force = N

(2)

- (c) The liquid usually used in the machine is made by processing oil from underground wells. A new development is to use plant oil as the liquid.

Extracting plant oil requires less energy than extracting oil from underground wells.

Suggest an environmental advantage of using plant oil.

.....

.....

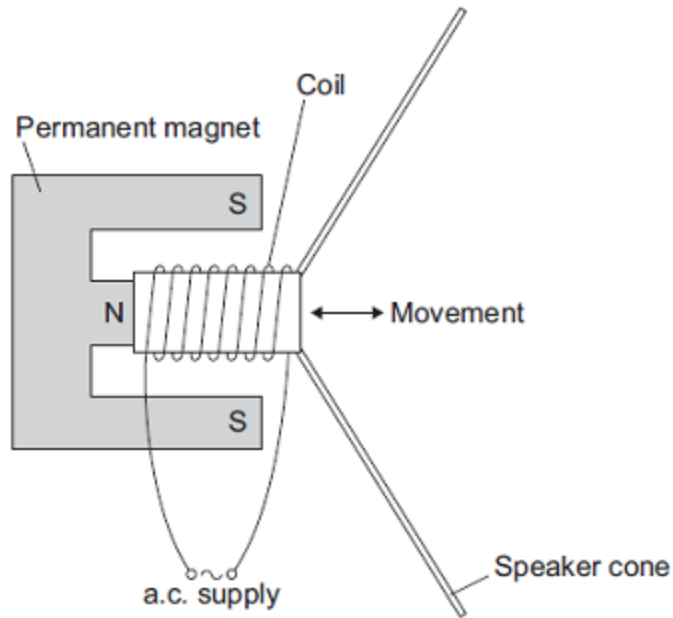
.....

(1)

(d) Musicians often use loudspeakers.

Figure 2 shows how a loudspeaker is constructed.

Figure 2



The loudspeaker cone vibrates when an alternating current flows through the coil.

Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)
(Total 8 marks)

5

Some students fill an empty plastic bottle with water. The weight of the water in the bottle is 24 N and the cross-sectional area of the bottom of the bottle is 0.008 m².

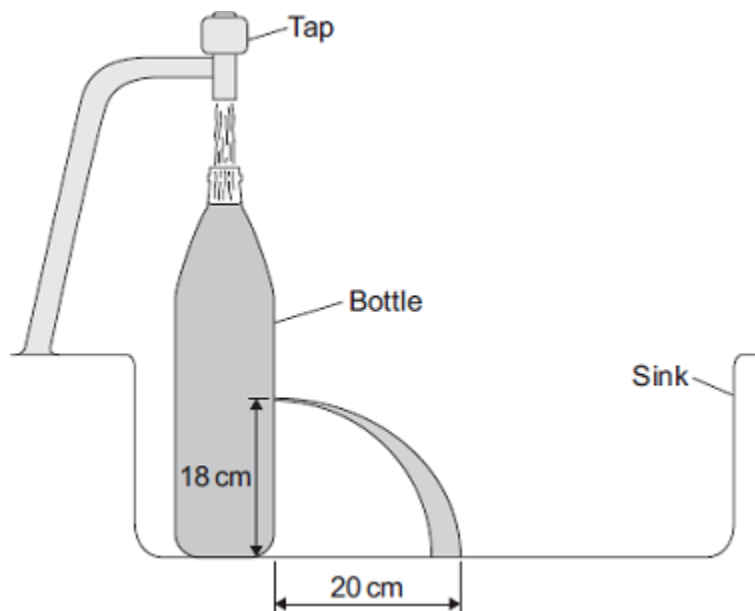
(a) Calculate the pressure of the water on the bottom of the bottle and give the unit.

.....

Pressure =

(3)

(b) The students made four holes in the bottle along a vertical line. They put the bottle in a sink. They used water from a tap to keep the bottle filled to the top.



The students measured and recorded the vertical heights of the holes above the sink. They also measured the horizontal distances the water landed away from the bottle. A pair of measurements for one of the holes is shown in the diagram.

The complete data from the experiment is shown in the table.

Hole	Vertical height in cm	Horizontal distance in cm
J	24	15
K	18	20
L	12	30
M	6	40

(i) Which hole is shown in the diagram?

Draw a ring around the correct answer.

J K L

(1)

(ii) On the diagram, draw the path of the water coming out of hole **M**.

Use the information in the table to help you.

(2)

(c) Suggest **one** problem that might arise from trying to collect data from a fifth hole with a vertical height of 1 cm above the sink.

.....
.....

(1)

(Total 7 marks)

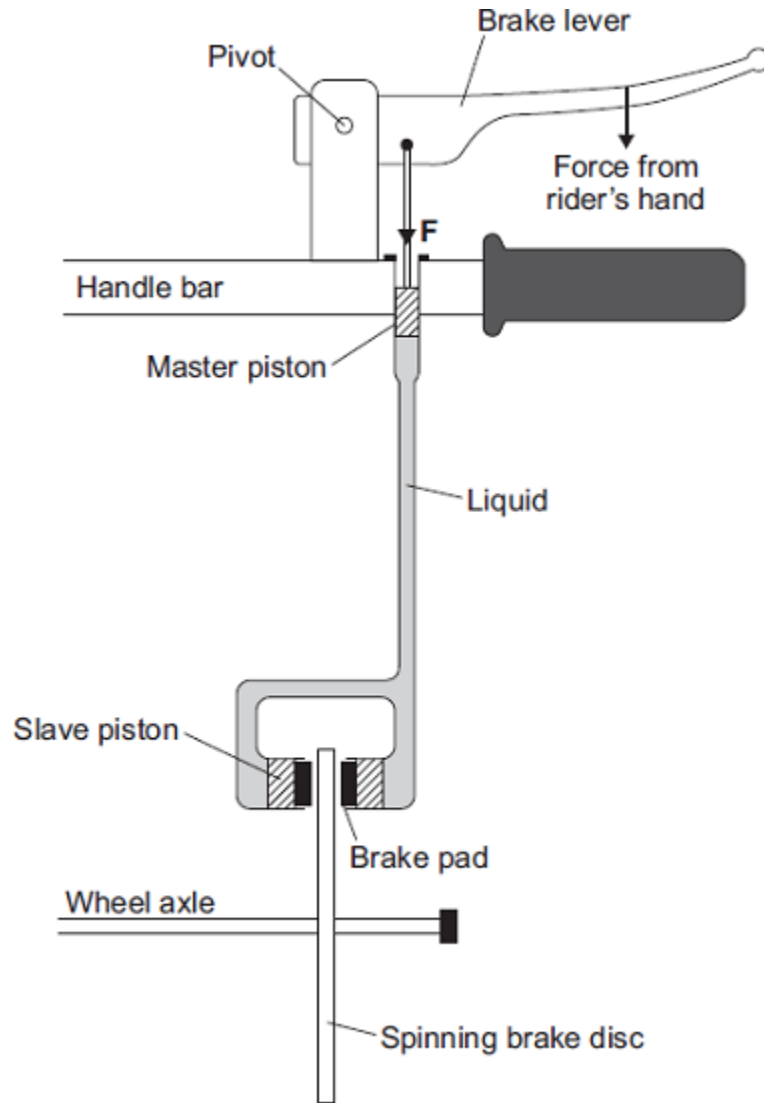
6

Mountain bike riders use brakes to slow down.



© Ljupco Smokovski/Shutterstock

Some mountain bikes use liquid-filled pipes to transmit the force from the rider's hand on the brake lever to the brake pads. These brakes are called hydraulic brakes.



(a) Draw a ring around the correct answer to complete each sentence.

(i) Liquids can be used to transmit the forces in a brake system,

because liquids

are incompressible.

can flow.

take the shape of the container.

(1)

(ii) The pressure in the liquid is transmitted

against force **F** only.

downwards only.

in all directions.

(1)

- (b) When the rider's hand pulls on the brake lever, the force **F** applied to the liquid by the master piston is 80 N. The cross-sectional area of this piston is 50 mm².

Calculate the pressure, in N/mm², exerted on the liquid by the master piston.

.....
.....
.....

Pressure = N/mm²

(2)

- (c) The unit N/mm² is **not** the usual unit of pressure.

Which unit is usually used when calculating pressure?

Draw a ring around the correct answer.

N

Nm²

Pa

(1)

- (d) The rider applies a larger force to the brake lever. How would this increase in force affect the pressure in the liquid?

.....

(1)

(Total 6 marks)

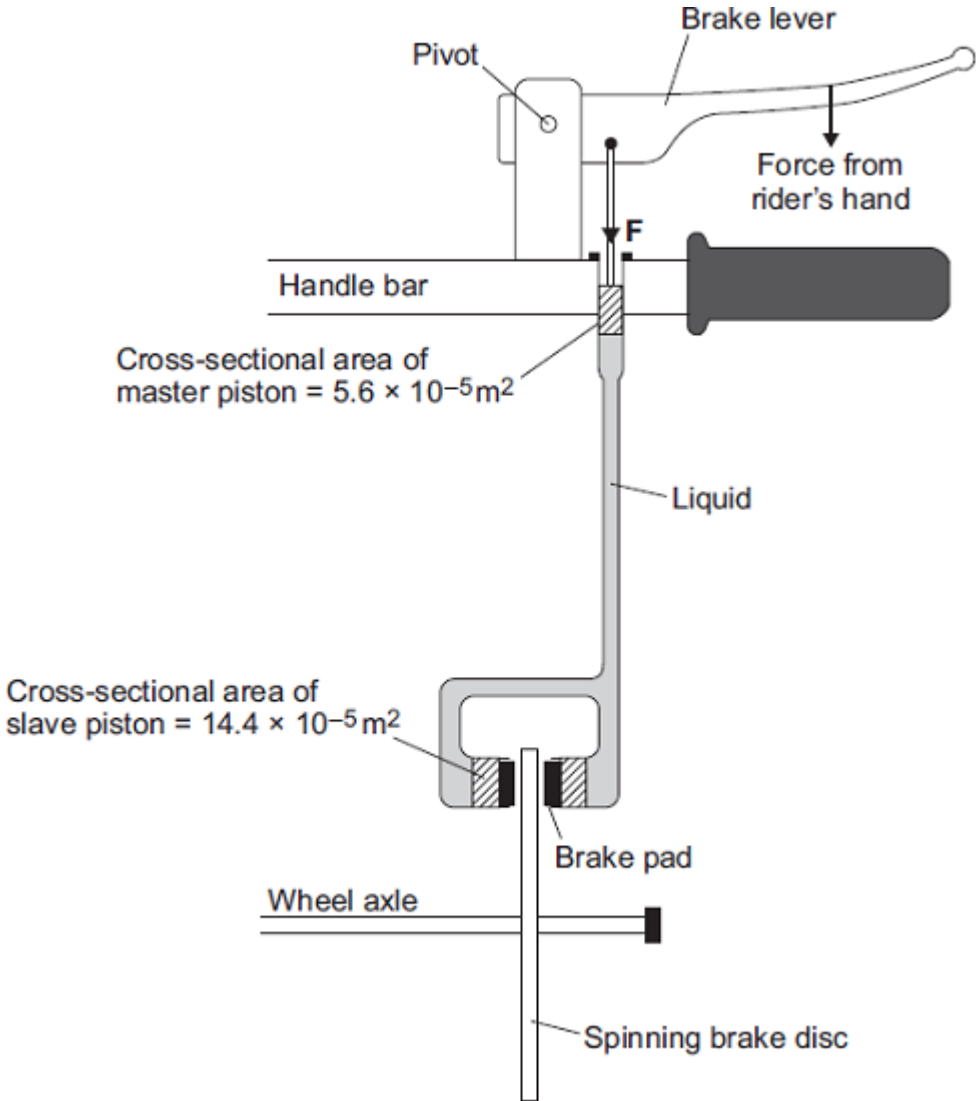
7

Mountain bike riders use brakes to slow down.



© Ljupco Smokovski/Shutterstock

Some mountain bikes have hydraulic brakes.



(a) What property of a liquid enables a hydraulic brake system to work?

.....

(1)

- (b) When the rider's hand pulls on the brake lever, the master piston applies a pressure of 1.5×10^6 pascals to the liquid.

Using information from the diagram, calculate the force **F** exerted on the liquid by the master piston.

.....

.....

.....

.....

Force **F** = N

(2)

- (c) The pressure in the liquid applies a force to move each slave piston.

How does the size of this force compare to the force **F** applied by the master piston?

.....

.....

Give a reason for your answer.

.....

.....

(2)
(Total 5 marks)

Mark schemes

- 1** (a) air molecules colliding with a surface create pressure 1
- at increasing altitude distance between molecules increases
- or**
- at increasing altitude fewer molecules (above a surface) 1
- so number of collisions with a surface decreases
- or**
- or so always less weight of air than below (the surface) 1
- (b) atmospheric pressure = 20 kPa from graph **and** conversion of 810 cm² to 0.081 m²
allow ecf for an incorrect value clearly obtained from the graph 1
- $5 \times 10^4 = \frac{F}{0.081}$
- $F = 5 \times 10^4 \times 0.081$ 1
- 4050 1
- 4100 (N) 1
- allow 4100 (N) with no working shown for 5 marks*
allow 4050 with no working shown for 4 marks
- (c) force from air pressure acting from inside to outside bigger than force acting inwards 1
- so keeps the window in position 1
- [10]**
- 2** (a) make the rod longer 1
- push down on the rod with a greater force 1
- (b) particles are close together 1

so no room for more movement

dependent on 1st marking point

1

- (c) (i) downward force produces pressure in liquid
reference to compression of liquid negates this mark

1

this pressure is the same at all points in a liquid

or

this pressure is transmitted equally through the liquid

and $P = F/A$ **or** $F = P \times A$

1

area (at load) bigger (so force bigger)

1

- (ii) the force acting on the car moves less distance than the effort force

1

[9]

3

- (a) hydraulic

1

- (b) 9

allow 1 mark for a correct substitution, ie $\frac{1800}{200}$ provided no subsequent step

2

- (c) an environmental

1

[4]

4

- (a) hydraulic (system)

1

- (b) 15.40×10^2

or

1540

allow 1 mark for correct substitution, ie

$$8.75 \times 10^4 = \frac{F}{1.76 \times 10^{-2}}$$

or

$$87\,500 = \frac{F}{0.0176}$$

or

$$F = 8.75 \times 10^4 \times 1.76 \times 10^{-2}$$

or

$$F = 87\,500 \times 0.0176$$

2

- (c) any **one** environmental **advantage**:
stating a converse statement is insufficient, or a disadvantage of the usual oil, ie the usual oil is non-renewable
- plant oil is renewable
- using plant oil will conserve (limited) supplies **or** extend lifetime of the usual / crude oil.
- plant oil releases less carbon dioxide (when it is being produced / processed)
- plant oil will add less carbon dioxide to the atmosphere (when it is being produced / processed, than the usual oil)
- plant oil removes carbon dioxide from **or** adds oxygen to the air when it is growing
stating that plant oil is carbon neutral is insufficient

1

- (d) (the current flowing through the coil) creates a magnetic field (around the coil)

1

(this magnetic field) interacts with the permanent magnetic field

or

current carrying conductor is in a (permanent) magnetic field

it must be clear which magnetic field is which

1

this produces a (resultant) force (and coil / cone moves)

1

when the direction of the current changes, the direction of the force changes to the opposite direction

accept for 2 marks the magnetic field of the coil interacts with the permanent magnetic field

1

[8]

5

- (a) 3000

correct substitution of 24 / 0.008 gains 1 mark provided no subsequent steps are shown

2

N / m² or Pa

1

- (b) (i) K

accept ringed K in table

1

- (ii) water exiting bottle one-third of vertical height of K

allow less than half vertical height of spout shown, judged by eye

1

water landing twice the distance of the spout shown in the diagram
*accept at least one and a half times further out than spout shown,
judged by eye*
*do **not** accept water hitting the side of the sink*
ignore trajectory

1

- (c) water will land on the (vertical) side of the sink
*accept sink **not** long / wide / big enough*

or

water will dribble down very close to the bottle

or

that part of the bottle is curved
*do **not** accept goes out of the sink*

1

[7]

6

- (a) (i) are incompressible
(ii) in all directions

1

1

- (b) 1.6

allow 1 mark for correct substitution, ie $\frac{80}{50}$ provided no

subsequent step shown

an answer 0.032 gains 0 marks

2

- (c) Pa

1

- (d) increases

1

[6]

7

- (a) (i) liquids are (virtually)
incompressible

1

(b) 84

allow 1 mark for correct substitution, ie

$$1.5 \times 10^6 = \frac{F}{5.6 \times 10^{-5}}$$

numbers may not be written in standard form, ie

$$1\,500\,000 = F \frac{F}{0.000\,056}$$

allow 1 mark for an answer 216

2

(c) it (the force on the slave pistons) is greater / larger

accept force (at slave piston) = 216 (N)

1

the area (touching the liquid) of the slave piston is greater than the area of the master piston

accept it has a bigger area

just quoting numbers, eg the master piston is 5×10^{-5} and the slave piston is 14.4×10^{-5} is insufficient

1

[5]