1. The pressure of a fixed mass of gas is 6·0 x 105 Pa.

The temperature of the gas is 27 ºC and the volume of the gas is 2·5 m3.

The temperature of the gas increases to 54 ºC and the volume of the gas increases to 5·0 m3.

What is the new pressure of the gas?

* 1. 2·8 x 105 Pa
  2. 3·3 x 105 Pa
  3. 6·0 x 105 Pa
  4. 1·1 x 106 Pa
  5. 1·3 x 106 Pa

1. A student is investigating the relationship between the volume and the kelvin temperature of a fixed mass of gas at constant pressure.

Which graph shows this relationship?

* 1. *volume*

(

m

3

)

0

*temperature* (K)

* 1. *volume*

(

m

3

)

0

*temperature* (K)

* 1. *volume*

(

m

3

)

0

*temperature* (K)

* 1. *volume*

(

m

3

)

0

*temperature* (K)

* 1. *volume*

(

m

3

)

0

*temperature* (K)

1. A liquid is heated from 17 ºC to 50 ºC. The temperature rise in kelvin is
   1. 33 K
   2. 67 K
   3. 306 K
   4. 340 K
   5. 579 K.

**MARKS**

**4.** A student is investigating the motion of water rockets. The water rocket is made from an upturned plastic bottle containing some water. Air is pumped into the bottle. When the pressure of the air is great enough the plastic bottle is launched upwards.

water rocket

pressurised

air

ground

water

fin resting on ground

to air pump

The mass of the rocket before launch is 0·94 kg.

1. Calculate the weight of the water rocket. **3**

*Space for working and answer*

1. Before launch, the water rocket rests on three fins on the ground.

The area of each fin in contact with the ground is 2·0 × 10−4 m2.

Calculate the total pressure exerted on the ground by the fins. **4**

*Space for working and answer*

**MARKS**

### 4 (continued)

1. Use Newton’s Third Law to explain how the rocket launches. **1**
2. At launch, the initial upward thrust on the rocket is 370 N.

Calculate the initial acceleration of the rocket. **4**

*Space for working and answer*

1. The student launches the rocket a second time.

For this launch, the student adds a greater volume of water than before.

The same initial upward thrust acts on the rocket but it fails to reach the same height.

Explain why the rocket fails to reach the same height. **2**

**Total marks 14**

1. A syringe containing air is sealed at one end as shown.

syringe

piston

air

seal

The piston is pushed in slowly.

There is no change in temperature of the air inside the syringe.

Which of the following statements describes and explains the change in pressure of the air in the syringe?

* 1. The pressure increases because the air particles have more kinetic energy.
  2. The pressure increases because the air particles hit the sides of the syringe more frequently.
  3. The pressure increases because the air particles hit the sides of the syringe less frequently.
  4. The pressure decreases because the air particles hit the sides of the syringe with less force.
  5. The pressure decreases because the air particles have less kinetic energy.

1. The pressure of a fixed mass of gas is 150 kPa at a temperature of 27 ºC.

The temperature of the gas is now increased to 47 ºC.

The volume of the gas remains constant.

The pressure of the gas is now

* 1. 86 kPa
  2. 141 kPa
  3. 150 kPa
  4. 160 kPa
  5. 261 kPa.

1. A block has the dimensions shown.

0·2

m

0·1

m

0·05

m

The block is placed so that one of the surfaces is in contact with a smooth table top.

The weight of the block is 4·90 N.

The **minimum** pressure exerted by the block on the table top is

* 1. 25 Pa
  2. 245 Pa
  3. 490 Pa
  4. 980 Pa
  5. 4900 Pa.

1. A syringe is connected to a pressure meter as shown.



pressure

meter

The syringe contains a fixed mass of air of volume 150 mm3.

The reading on the pressure meter is 120 kPa.

The volume of air inside the syringe is now changed to 100 mm3.

The temperature of the air in the syringe remains constant.

The reading on the pressure meter is now

* 1. 80 kPa
  2. 125 kPa
  3. 180 kPa
  4. 80 000 kPa
  5. 180 000 kPa.

1. A sample of an ideal gas is enclosed in a sealed container.

Which graph shows how the pressure *p* of the gas varies with the temperature *T* of the gas?

*p*

A

0

*T*

(°C)

B

*p*

0

*T*

(K)

C

*p*

0

*T*

(°C)

D

*p*

0

*T*

(K)

E

*p*

0

*T*

(°C)

1. The mass of a spacecraft is 1200 kg.

The spacecraft lands on the surface of a planet.

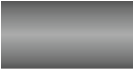
The gravitational field strength on the surface of the planet is 5·0Nkg-1

The spacecraft rests on three pads. The total area of the three pads is 1·5 m2

The pressure exerted by these pads on the surface of the planet is

1. 1·2 × 104 Pa
2. 9·0 × 103 Pa
3. 7·8 × 103 Pa
4. 4·0 × 103 Pa
5. 8·0 × 102 Pa.
6. A solid is heated from -15 °C to 60 °C. The temperature change of the solid is
   1. 45 K
   2. 75 K
   3. 258 K
   4. 318 K
   5. 348 K.

**12.** A bicycle pump with a sealed outlet contains 4·0 × 10-4 m3 of air.



The air inside the pump is at an initial pressure of 1·0 × 105 Pa.

The piston of the pump is now pushed slowly inwards until the volume of air in the pump is 1·6 × 10-4 m3 as shown.

final position initial position

sealed of piston of piston outlet

During this time the temperature of the air in the pump remains constant.

1. Calculate the final pressure of the air inside the pump. **3**

*Space for working and answer*

1. Using the kinetic model, explain what happens to the pressure of the air

inside the pump as its volume decreases.

(c) The piston is now released, allowing it to move outwards towards its original position.

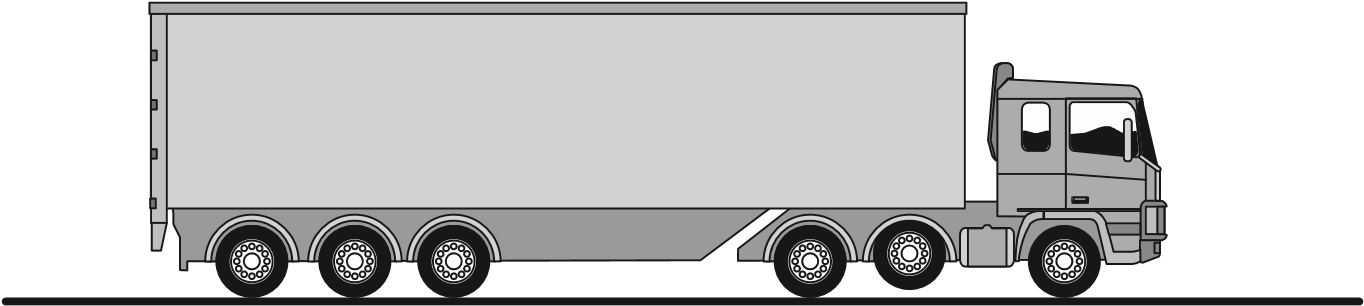
During this time the temperature of the air in the pump remains constant.

Using the axes provided, sketch a graph to show how the pressure of the air in the pump varies as its volume increases.

Numerical values are not required on either axis. **2**

(An additional diagram, if required, can be found on *Page 28*)

\*

1. An articulated lorry has six pairs of wheels.

One pair of wheels can be raised off the ground.

**Using your knowledge of physics**, comment on situations in which the wheels

may be raised or lowered.

1. A bicycle pump is sealed at one end and the piston pushed until the pressure of the trapped air is 4∙00 × 105 Pa.

trapped air

sealed end

piston

The area of the piston compressing the air is 5∙00 × 10−4 m2.

The force that the trapped air exerts on the piston is

* 1. 1∙25 × 10−9 N
  2. 8∙00 × 10−1 N
  3. 2∙00 × 102 N
  4. 8∙00 × 108 N
  5. 2∙00 × 1010 N.

1. A liquid is heated from 17 °C to 50 °C. The temperature rise in kelvin is
   1. 33 K
   2. 67 K
   3. 306 K
   4. 340 K
   5. 579 K.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *p* (kPa) | 100 | 125 | 152 | 185 | 200 |
| *V* (cm3) | 50 | 40 | 33 | 27 | 25 |
| 1/*V* (cm−3) | 0∙020 | 0∙025 | 0∙030 | 0∙037 | 0∙040 |

**MARKS**

computer

short tubing

clamp

piston

syringe

pressure

sensor

1. **.** A student carries out an experiment to investigate the relationship between the pressure and volume of a fixed mass of gas using the apparatus shown.

The pressure *p* of the gas is recorded using a pressure sensor connected to a computer. The volume *V* of the gas in the syringe is also recorded. The student pushes the piston to alter the volume and a series of readings is taken.

The temperature of the gas is constant during the experiment.

The results are shown.

(a) (i) Using the square-ruled paper on *page 23*, draw a graph of *p* against 1/*V*.

You must start the scale on each axis from 0. **3**

(Additional square-ruled paper, if required, can be found on *page 32*.)

(ii) Explain how the graph confirms that pressure is directly proportional

to 1/volume. **1**

*page 22*

**MARKS**

#### 8. (continued)

b Calculate the pressure of the gas in the syringe when its volume is 8∙0 cm3. **3** *Space for working and answer*

1. Using the kinetic model, explain the increase in the pressure of the gas

in the syringe as its volume decreases. **2**

1. (i) When carrying out the experiment, the student clamped the syringe rather than holding it in their hand.

Explain why this is better experimental practice. **2**

(ii) A second student suggests that replacing the short tubing between the syringe and the pressure sensor with one of longer length would improve the experiment.

Explain why this student’s suggestion is incorrect. **2**

1. The pressure of the air outside an aircraft is 0·40 × 105 Pa.

The air pressure inside the aircraft cabin is 1·0 × 105 Pa. The area of an external cabin door is 2·0 m2.

The outward force on the door due to the pressure difference is

* 1. 0·30 × 105 N
  2. 0·70 × 105 N
  3. 1·2 × 105 N
  4. 2·0 × 105 N
  5. 2·8 × 105 N.

1. A solid at a temperature of −20 °C is heated until it becomes a liquid at 70 °C. The temperature change in kelvin is
   1. 50 K
   2. 90 K
   3. 343 K
   4. 363 K
   5. 596 K.
2. A sealed bicycle pump contains 4·0 × 10−5 m3 of air at a pressure of 1·2 × 105 Pa.

The piston of the pump is pushed in until the volume of air in the pump is reduced to 0·80 × 10−5 m3.

During this time the temperature of the air in the pump remains constant.

The pressure of the air in the pump is now

* 1. 2·4 × 104 Pa
  2. 1·2 × 105 Pa
  3. 1·5 × 105 Pa
  4. 4·4 × 105 Pa
  5. 6·0 × 105 Pa.

1. **.** A student sets up an experiment to investigate the relationship between the pressure and temperature of a fixed mass of gas as shown.

temperature

sensor

temperature

meter

water

gas

glass flask

glass tube

pressure

sensor

heat

(a) The student heats the water and records the following readings of pressure and temperature.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Pressure* (kPa) | 101 | 107 | 116 | 122 |
| *Temperature* (K) | 293 | 313 | 333 | 353 |

(i) Using **all** the data, establish the relationship between the pressure

and the temperature of the gas. **3**

*Space for working and answer*

#### 20. (a) (continued) MARKS

1. Using the kinetic model, explain why the pressure of the gas

increases as its temperature increases. **3**

1. Predict the pressure reading which would be obtained if the

student was to cool the gas to 253 K. **1**

(b) State one way in which the set-up of the experiment could be improved to give more reliable results.

Justify your answer. **2**

1. The pressure *p* due to a liquid at a depth *h* is given by the relationship

where *ρ* is the density of the liquid and *g* is the gravitational field strength. Aliquid has a density of 990 kg m−3.

When the pressure due to the liquid is 1470 Pa, the depth in the liquid is

* 1. 0·069 m
  2. 0·15 m
  3. 0·67 m
  4. 1·5 m
  5. 6·6 m.

1. A car is parked in the sun for some time. During this time the air pressure inside the tyres increases.

The reason for this increase in pressure is

* 1. the volume occupied by the air particles in the tyres has increased
  2. the force produced by the air particles in the tyres acts over a smaller area
  3. the average spacing between the air particles in the tyres has increased
  4. the increased temperature has made the air particles in the tyres expand
  5. the air particles in the tyres are moving with greater kinetic energy.

1. The temperature of a sample of gas in a container is 20 °C.

The volume of the gas is 0·30 m3.

The container is free to expand in order to maintain a constant pressure.

The temperature of the gas is increased to 50 °C.

The volume now occupied by the gas is

* 1. 0·12 m3
  2. 0·27 m3
  3. 0·30 m3
  4. 0·33 m3
  5. 0·75 m3

1. A water rocket consists of a plastic bottle partly filled with water. Air is pumped in through the water. When the pressure is great enough, the tube detaches from the bottle. Water is forced out of the bottle, which causes the bottle to be launched upwards.

bicycle pump

pressurised

air

tube

water

At launch, the air in the bottle is at a pressure of 1·74 × 105 Pa.

(a) On the diagram below, show all the forces acting vertically on the bottle as it is launched.

You must name these forces **and** show their directions. **2**

1. The area of water in contact with the pressurised air in the bottle is

4·50 × 10−3 m2.

Calculate the force exerted on the water by the pressurised air at launch. **3** *Space for working and answer*

1. At launch, the air in the bottle has a volume of 7·5 × 10−4 m3.

At one point in the flight, the volume of air in the bottle has **increased by** 1·2 × 10−4 m3.

During the flight the temperature of the air in the bottle remains constant.

(i) Calculate the pressure of the air inside the bottle at this point in

the flight. **4**

*Space for working and answer*

(ii) Using the kinetic model, explain what happens to the pressure of the air inside the bottle as the volume of the air increases. **3**