# Particle Model part 2 AQA Triple Physics

Name: _____

Class: _____

Date: _____

Time: **67 minutes**

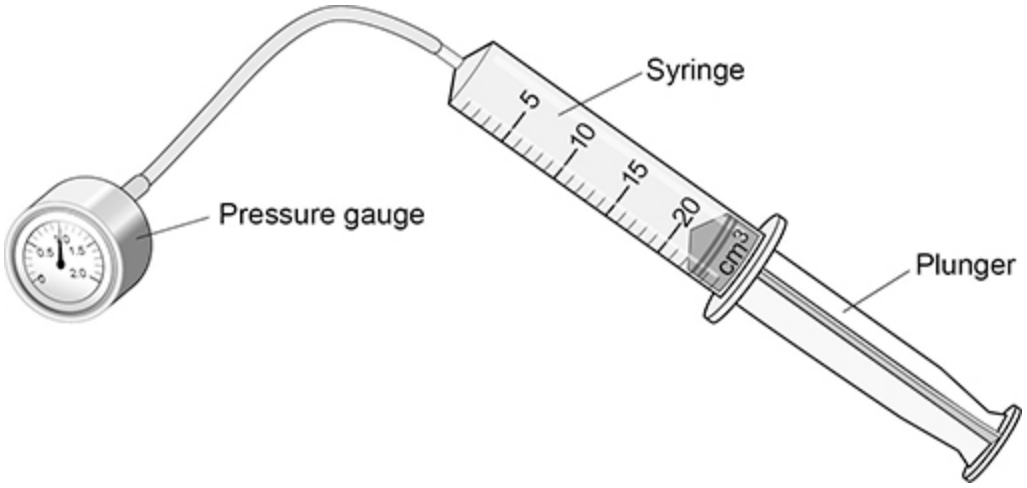
Marks: **64 marks**

Comments:

**1.** A student investigated how the pressure in a fixed mass of air varies with the volume of the air.

**Figure 1** shows the equipment used.

**Figure 1**




When the plunger was pushed slowly into the syringe, the temperature of the air stayed the same.

(a) How did pushing the plunger in affect the volume of air in the syringe?

Tick (✓) **one** box.

The volume decreased. ☐

The volume stayed the same. ☐

The volume increased. ☐

**(1)**

(b) How did pushing the plunger in affect the distance between the air particles in the syringe?

Tick (✓) **one** box.

The distance decreased. ☐

The distance stayed the same. ☐

The distance increased. ☐

**(1)**

(c) How did pushing the plunger in affect the frequency of collisions between the air particles and the syringe walls?

Tick (✓) **one** box.

The frequency of collisions decreased. ☐

The frequency of collisions stayed the same. ☐

The frequency of collisions increased. ☐

**(1)**

(d) How did pushing the plunger in affect the air pressure in the syringe?

Tick (✓) **one** box.

The air pressure decreased. ☐

The air pressure stayed the same. ☐

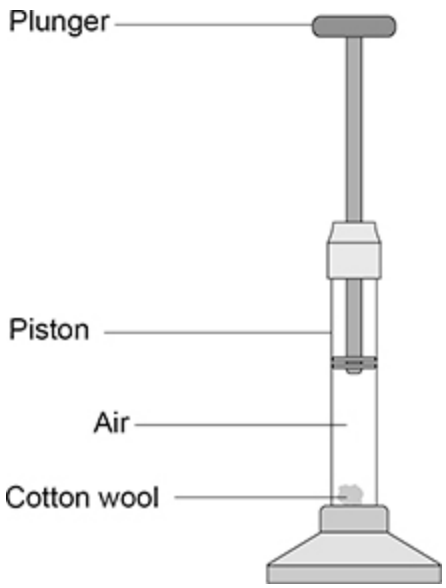
The air pressure increased. ☐

**(1)**

A fire piston is a special type of syringe that can be used to start fires.

**Figure 2** shows a fire piston.

**Figure 2**




The plunger is pushed quickly downwards and compresses the air.

When the air is compressed quickly, the temperature of the air increases.

(e) How does an increase in temperature affect the mean speed of the air particles inside the syringe?

Tick (✓) **one** box.

The mean speed of the particles decreases. ☐

The mean speed of the particles does not change. ☐

The mean speed of the particles increases. ☐

**(1)**

(f) When the air is hot enough, a small piece of cotton wool in the piston catches fire.

The energy transferred to the air in the piston is 0.0130 J.

The mass of air in the piston is $2.60 \times 10^{-8}$ kg.

specific heat capacity of air = 1010 J/kg °C

Calculate the temperature change of the air.

Use the Physics Equations Sheet.

Temperature change = _____ °C

**(3)**

**(Total 8 marks)**

**2.** The figure below shows a wind turbine.

Wind turbines may generate electricity when the electricity is not needed.

Two methods that can be used to store the energy from the turbine are:

**Method A**: Heating water to a high temperature.

**Method B**: Pumping water uphill into a reservoir.

(a) Which energy store increases when water is heated?

_____

**(1)**

(b) Which energy store increases when water is pumped uphill into a reservoir?

_____

**(1)**

(c) The table below shows information about the two methods of storing energy.

| Method | Energy stored per 100 kg of water in kJ | Percentage of stored energy wasted | Installation |
|---|---|---|---|
| **A**: Increasing water temperature by 80 °C | 33 600 | 40% | Anywhere |
| **B**: Pumping water uphill to a height of 500 m | 490 | 25% | High mountains |

Compare the advantages and disadvantages of the two methods of storing energy.

Include calculations in your answer.

**(4)**

(d) Decreasing the amount of carbon dioxide released by different activities will help slow down climate change.

Transport and generating electricity are the two activities that released the largest amounts of carbon dioxide in the UK in 2018.

Explain **one** change that would reduce the amount of carbon dioxide released by **each** activity.

Transport _____

_____

_____

_____

_____

Generating electricity _____

_____

_____

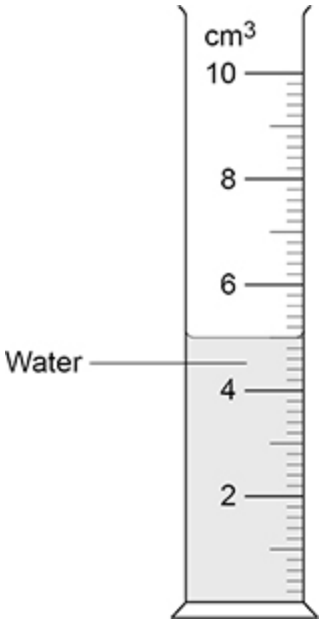
_____

_____

**(4)**

**(Total 10 marks)**

**3.** The figure below shows a measuring cylinder containing some water, which a student used to measure the volume of a metal ring.



(a) When measuring the volume, the student s eye was in line with the level of the water.

Which type of error would have been caused if the student s eye was **not** in line with the level of the water?

Tick (✓) **one** box.

Random error ☐

Systematic error ☐

Zero error ☐

**(1)**

(b) The student tied a piece of thick string to the metal ring and lowered the ring into the water.

Suggest **one** reason why the student should have used thin string instead of thick string.

_____

_____

_____

**(1)**

The table below shows the results.

| **Volume of water in $cm^3$** | **Volume of water and ring in $cm^3$** | **Volume of ring in $cm^3$** |
|---|---|---|
| 5.0 | 5.4 | 0.4 |

(c) The true volume of the ring was 0.44 $cm^3$.

Even without using the string, the measuring cylinder could not give an accurate value for the volume of the ring.

Give **one** reason why.

_____

_____

_____

**(1)**

(d) The student used a balance to measure the mass of the ring.

After the ring was removed from the balance, the reading on the balance was 0.02 g.

How could the student use the readings from the balance to determine the correct mass of the ring?

_____

_____

_____

_____

**(1)**

(e) The student determined that the density of the ring was 21 500 kg/m$^3$.

The volume of the ring was 0.44 cm$^3$.

Calculate the mass of the ring.

Use the Physics Equations Sheet.

Give your answer in kg.

_____

_____

_____

_____

_____

_____

_____

Mass = _____ kg

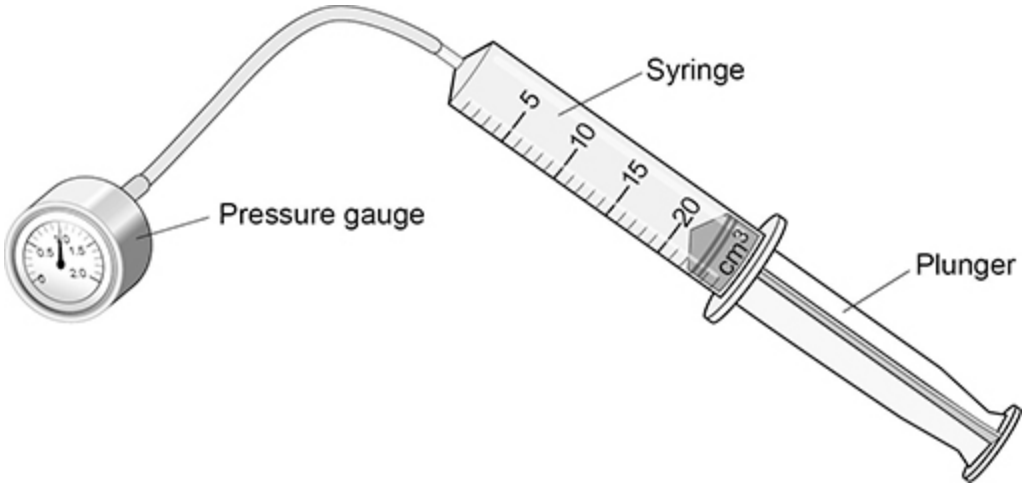
**(4)**

**(Total 8 marks)**

**4.** A student investigated how the pressure in a fixed mass of air varies with the volume of the air.

**Figure 1** shows the equipment used.

**Figure 1**




(a) When the plunger was pushed slowly into the syringe, the pressure in the syringe increased.

The temperature of the air remained constant.

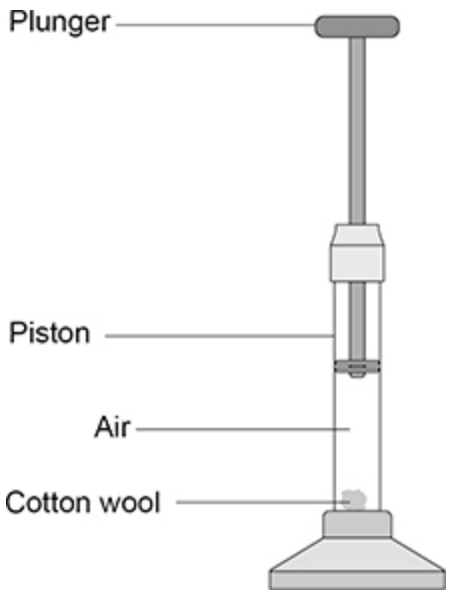
Explain why the pressure increased.

**(3)**

A fire piston is a special type of syringe that can be used to start fires.

**Figure 2** shows a fire piston.

**Figure 2**




The plunger is pushed quickly downwards and compresses the air.

When the air is compressed quickly, the temperature of the air increases.

(b) How does an increase in temperature affect the air particles inside the piston?

Tick (✓) **one** box.

The mean kinetic energy of the particles increases. ☐

The mean potential energy of the particles increases. ☐

The mean separation of the particles increases. ☐

**(1)**

(c) When the air is hot enough, a small piece of cotton wool in the piston catches fire.

The energy transferred to the air in the piston is 0.0130 J.

The mass of air in the piston is $2.60 \times 10^{-8}$ kg.

specific heat capacity of air = 1.01 kJ/kg °C

Calculate the temperature change of the air.

Use the Physics Equations Sheet.

Temperature change = _____ °C

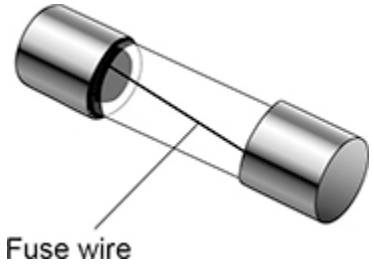
**(4)**

**(Total 8 marks)**

**5.** The live wire in a three-core cable is connected to a fuse inside a plug.

A fuse contains a wire that is designed to melt when the current gets too great.

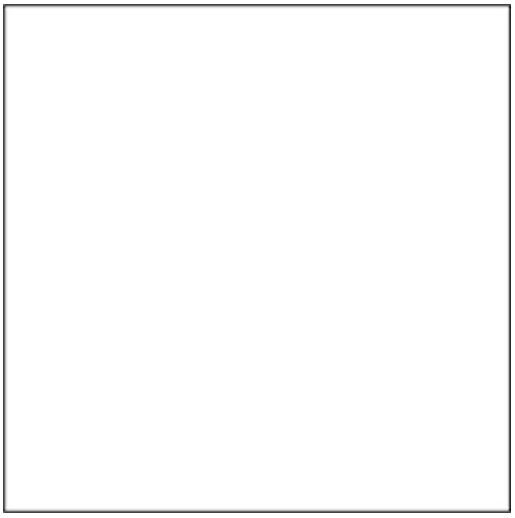
The figure below shows a fuse.




(a) What colour is the insulation covering the live wire in a three-core cable?

**(1)**

(b) Draw the circuit symbol for a fuse in the box below.



**(1)**

(c) The fuse wire melts when there is a charge flow of 2.0 C for 400 ms.

Calculate the current in the fuse wire.

Use the Physics Equations Sheet.

Current = _____ A

**(4)**

(d) When the fuse wire is at its melting point, the additional energy needed to melt the wire is 1.02 J.

specific latent heat of fuse wire = 60 kJ/kg

Calculate the mass of the fuse wire.

Use the Physics Equations Sheet.

Mass = _____ kg

**(4)**

(e) The calculation in part (d) assumes there is no energy transferred to the surroundings.

How would the time taken for the wire to melt be affected if some energy was transferred to the surroundings?

Give a reason for your answer.

Tick (✓) **one** box.

Time taken would decrease ☐

Time taken would stay the same ☐

Time taken would increase ☐

Reason _____

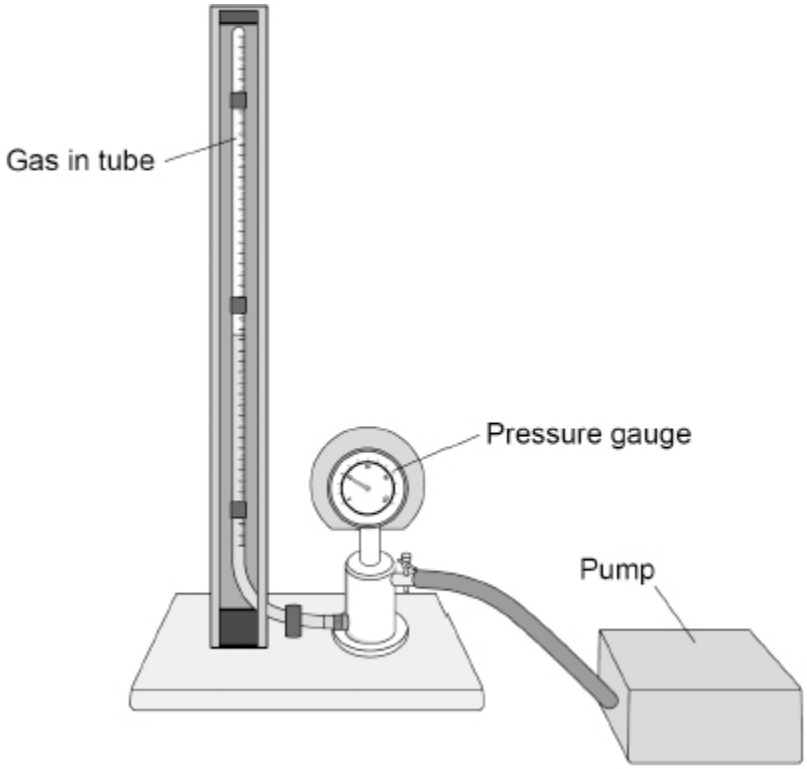
**(2)**

**(Total 12 marks)**

**6.** A teacher demonstrated the relationship between the pressure and the volume of a fixed mass of gas at a constant temperature.

**Figure 1** shows the equipment used.

**Figure 1**




(a) Complete the sentence.

Choose the answer from the box.

| | | |
|---|---|---|
| **circular paths** | **random directions** | **the same direction** |

Particles in a gas move in _____.

**(1)**

(b) Complete the sentence.

Choose the answer from the box.

| | | |
|---|---|---|
| **a constant speed** | **a constant velocity** | **a range of speeds** |

Particles in a gas move with _____.

**(1)**

(c) The table below shows some of the results.

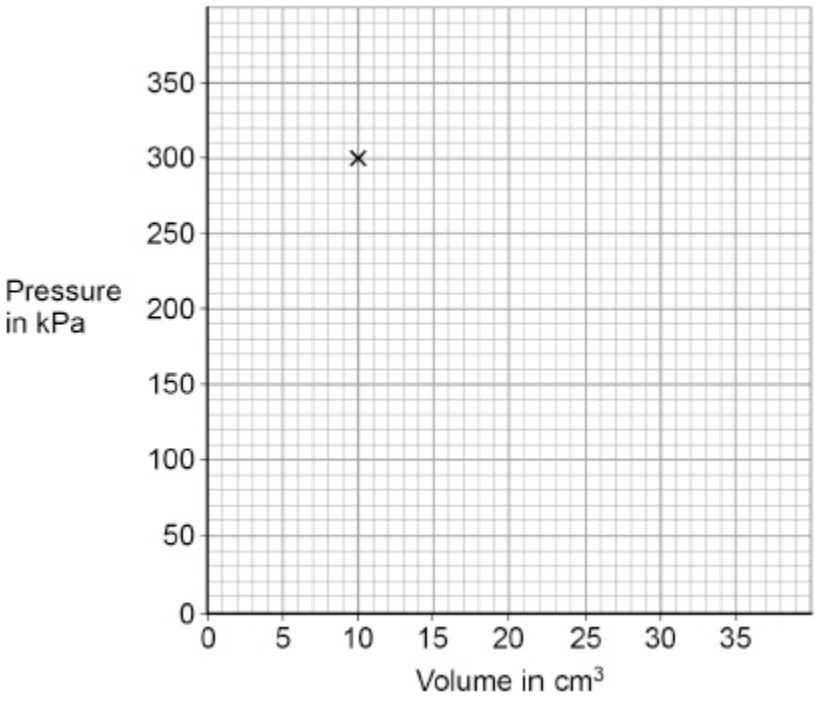
| Pressure in kPa | Volume in $cm^3$ |
|---|---|
| 300 | 10 |
| 200 | 15 |
| 150 | 20 |
| 120 | 25 |
| 100 | 30 |

Complete **Figure 2**. The first point has been plotted for you.

You should:

- plot the points from the table above
- draw the line of best fit.

**Figure 2**




**(3)**

(d) The relationship between the pressure and the volume of a gas is given by the equation:

pressure × volume = constant

Calculate the constant when the pressure of the gas was 300 kPa.

Use the table above.

_____

_____

_____

_____

Constant = _____ kPa $cm^3$

**(2)**

(e) When the volume of the gas increases, the pressure in the gas decreases.

The temperature of the gas stays the same.

How does increasing the volume affect each of the following quantities?

Tick (✓) **one** box in **each** row.

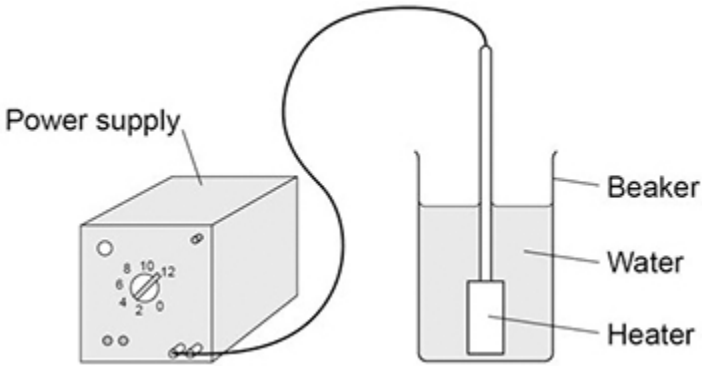
| **Quantity** | **Decreases** | **Stays the same** | **Increases** |
|---|---|---|---|
| Mean time between collisions of the particles with the tube | | | |
| Mean distance between the particles | | | |
| Mean speed of the particles | | | |

**(3)**

**(Total 10 marks)**

**7.** A student determined the specific latent heat of vaporisation of water.

The figure shows some of the equipment used.




(a) The student measured a mass of water and put it into the beaker.

What measuring instrument should the student have used to measure the mass of the water?

Tick (✓) **one** box.

balance ☐

joulemeter ☐

newtonmeter ☐

thermometer ☐

**(1)**

(b) The power output of the heater stayed the same throughout the experiment.

What type of variable was the power output of the heater?

Tick (✓) **one** box.

| | |
|---|---|
| Categoric variable | ☐ |
| Control variable | ☐ |
| Dependent variable | ☐ |
| Independent variable | ☐ |

**(1)**

(c) The student turned on the heater and heated the water until it reached boiling point.

The student continued to heat the water so that it boiled for several minutes.

The mass of the water remaining in the beaker was measured again.

Give **one** way the beaker of boiling water could be moved safely to measure its new mass.

_____

_____

_____

**(1)**

(d) The mass of water that turned into steam was 0.0090 kg.

The heater transferred 25 200 J of energy to the water to turn it into steam.

Calculate the specific latent heat of vaporisation of water given by the student s data.

Use the Physics Equations Sheet.

Choose the unit from the box.

| J | kg | J/kg |
|---|---|---|

Specific latent heat of vaporisation = _____ Unit _____

**(4)**

(e) What was a source of error in the student s experiment?

Tick (✓) **one** box.

The transfer of thermal energy from the heater to the water ☐

The transfer of thermal energy from the surroundings to the water ☐

The transfer of thermal energy from the water to the heater ☐

The transfer of thermal energy from the water to the surroundings ☐

**(1)**

**(Total 8 marks)**

**1.**

(a) the volume decreased

**1**

(b) the distance decreased

**1**

(c) the frequency of collisions increased

**1**

(d) the air pressure increased

**1**

(e) the mean speed of the particles increases

**1**

(f) $0.0130 = 2.60\times10^{-8} \times 1010 \times \Delta\theta$

**1**

$$\Delta\theta = \frac{0.0130}{(2.60 \times 10^{-8} \times 1010)}$$

**1**

$\Delta\theta = 495$ (°C)

*allow a correct answer given to more than 3 s.f.*

**1**

**[8]**

**2.**

(a) thermal / internal (energy)
**or**
kinetic (energy of the water particles)

*ignore heat*

*allow $E_k$*

**1**

(b) gravitational potential (energy)

*allow $E_p$ / GPE*

*allow kinetic / $E_k$*

**1**

(c) **Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.

**3–4**

**Level 1:** Relevant features are identified and differences noted.

**1–2**

**No relevant content**

**0**

**Indicative content**

**Method A:**
- heated water needs insulating (to maintain high temperature)
- energy stored by heating water is much greater (per 100 kg)
- useful energy from heating 100 kg of water = 20 160 (kJ)
- energy wasted (per 100 kg) = 13 440 (kJ)
- efficiency = 60 %

**Method B:**
- suitable location needed to pump water uphill
- pumping water efficiency is higher
- useful energy from pumping 100 kg of water = 367.5 (kJ)
- energy wasted (per 100kg) = 122.5 (kJ)
- efficiency = 75 %

A level 2 answer should use the data in a relevant calculation that compares the two methods.

(d) **Transport examples:**
don't use (petrol / diesel) cars (for transport)
**or**
don't burn petrol / diesel (for transport)

*allow don't use other transport methods e.g. (diesel) buses*

*allow fossil fuels for petrol / diesel*

**1**

(instead) use electric cars
**or**
(instead) use hydrogen-fuelled cars
**or**
(instead) use a bicycle
**or**
(instead) use public transport
**or**
(instead) walk

**1**

**Generating Electricity examples:**
don't use coal / oil / gas (to generate electricity)

*allow fossil fuels for coal / oil / gas*

**1**

(instead) use renewable methods
**or**
(instead) use nuclear power

**OR**

don't use (electrical) appliances when not needed

to reduce the demand for electricity (generated) using coal / oil / gas

*allow specific examples of renewable energy resources*

*allow specific examples e.g. lights*

*allow fossil fuels for coal / oil / gas*

*accept other reasonable changes with valid alternative for 2 marks each*

**1**

**[10]**

**3.** (a) random error

**1**

(b) thin string would affect the volume measurement less (than thick string)

*allow thin string would displace less water (than thick string)*

*ignore absorption of water by string*

**1**

(c) the measuring cylinder could not be used to measure to 2 dp
**or**
the resolution of the measuring cylinder is 0.2 $cm^3$

*allow the resolution is 0.1 $cm^3$*

*ignore the resolution is too low*

**1**

(d) subtract 0.02 g from the measured value

*ignore zero the balance*

**1**

(e) $0.44\ cm^3 = 4.4 \times 10^{-7}\ m^3$

1

$$21\ 500 = \frac{m}{4.4 \times 10^{-7}}$$

*allow a correct substitution of an incorrectly / not converted value of V*

1

$m = 21\ 500 \times 4.4 \times 10^{-7}$

*allow a correct rearrangement of an incorrectly / not converted value of V*

1

$m = 0.00946$ (kg)

**or**

$m = 9.46 \times 10^{-3}$ (kg)

*allow an answer consistent with an incorrectly / not converted value of V*

1

**[8]**

**4.** (a) (air) particles are closer together

*ignore reference to kinetic energy of particles*

*ignore reference to concentration of air particles*

1

(so) frequency of collision between air particles and syringe walls increased

*do not credit MP2 if linked to an increase in kinetic energy*

1

larger (total) force on a smaller (surface) area

*allow larger force per unit area*

*if no other marks score allow 1 mark for pressure increases because volume decreases and pV = constant*

1

(b) the mean kinetic energy of the particles increases

1

(c) $c$ = 1010 (J/kg °C)

*allow full credit for a correct method using E = 0.0000130 (kJ)*

1

$0.0130 = 2.60\times10^{-8} \times 1010 \times \Delta\theta$

*allow a correct substitution of an incorrectly / not converted value of c*

1

$$\Delta\theta = \frac{0.0130}{(2.60 \times 10^{-8} \times 1010)}$$

*allow a correct rearrangement of an incorrectly / not converted value of c*

1

$\Delta\theta$ = 495 (°C)

*allow an answer consistent with an incorrectly / not converted value of c*

*allow a correct answer given to more than 3 sig figs*

1

**[8]**

**5.** (a) brown

1

(b)

1

(c) t = 0.400 (s)

1

$2.0 = I \times 0.400$

*allow a correct substitution of an incorrectly / not converted value of t*

1

$$I = \frac{2.0}{0.400}$$

*allow a correct rearrangement using an incorrectly / not converted value of t*

1

$I$ = 5.0 (A)

*allow an answer consistent with an incorrectly / not converted value of t*

1

(d) $L$ = 60 000 (J/kg)

*allow full credit for a correct method using E = 0.00102 (kJ)*

1

1.02 = $m$ × 60 000

*allow a correct substitution of an incorrectly / not converted value of L*

1

$$m = \frac{1.02}{60\,000}$$

*allow a correct rearrangement using an incorrectly / not converted value of L*

1

$m = 1.7 \times 10^{-5}$ (kg)

*allow an answer consistent with an incorrectly / not converted value of L*

1

(e) time taken would increase

1

more energy would need to be transferred (in total)

*MP2 dependent on scoring MP1*

1

**[12]**

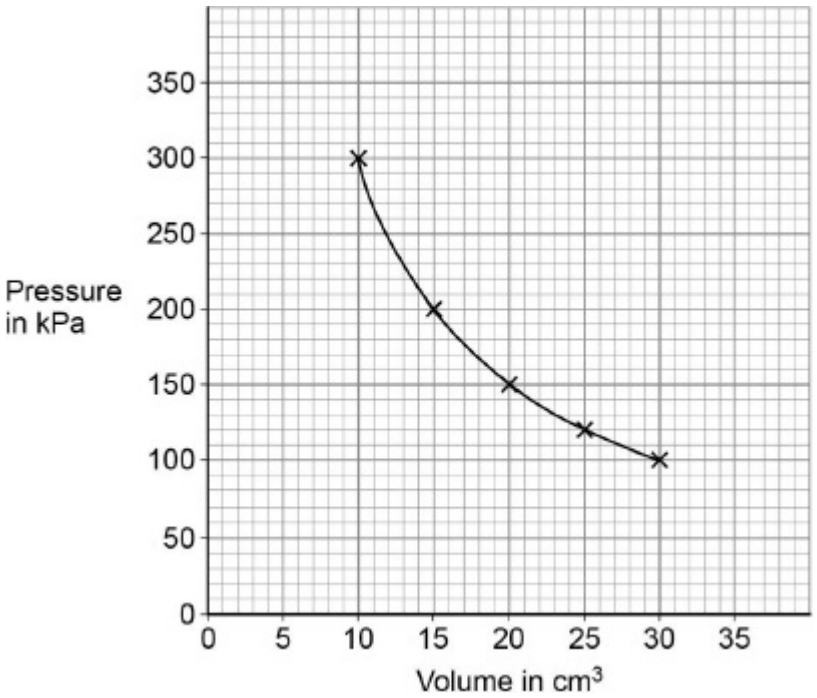
**6.** (a) random directions

1

(b) a range of speeds

1

(c)




*2 marks for plotting 4 points correctly*

*1 mark for plotting 2 or 3 points correctly*

*1 mark for line of best fit*

**3**

(d) 300 × 10 = constant

*allow use of any correct pair of values*

**1**

constant = 3000

**1**

(e)

| **Quantity** | **Decreases** | **Stays the same** | **Increases** |
|---|---|---|---|
| Mean time between collisions of the particles with the tube | | | ✓ |
| Mean distance between the particles | | | ✓ |
| Mean speed of the particles | | ✓ | |

additional tick in a row negates the mark for that row

**3**

**[10]**

**7.** (a) balance

**1**

(b) control variable

**1**

(c) use tongs / gloves
**or**
use a heatproof mat

*allow other sensible methods of avoiding contact with hot beaker eg using a cloth*

*allow wait for the beaker (and hot water) to cool down*

**1**

(d) 25 200 = 0.0090 *L*

**1**

$$L = \frac{25\,200}{0.0090}$$

**1**

*L* = 2 800 000
**or**
*L* = $2.8 \times 10^6$

**1**

J/kg

**1**

(e) the transfer of thermal energy from the water to the surroundings

**1**

**[8]**