

# PROPERTIES OF MATTER

## QUANTITIES FOR THE PROPERTIES OF MATTER UNIT

For this unit copy and complete the table.

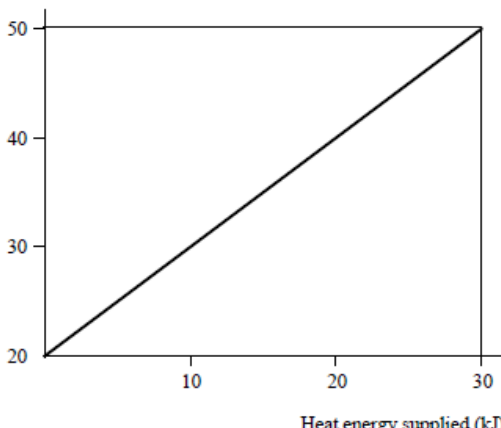
Quantity	Symbol	Unit	Unit Symbol	Scalar / Vector
Pressure				
Force				
Specific Heat Capacity				
Mass				
Change in Temperature				
Specific Latent Heat				
Volume				
Temperature				
Area				
Energy				
Work done				

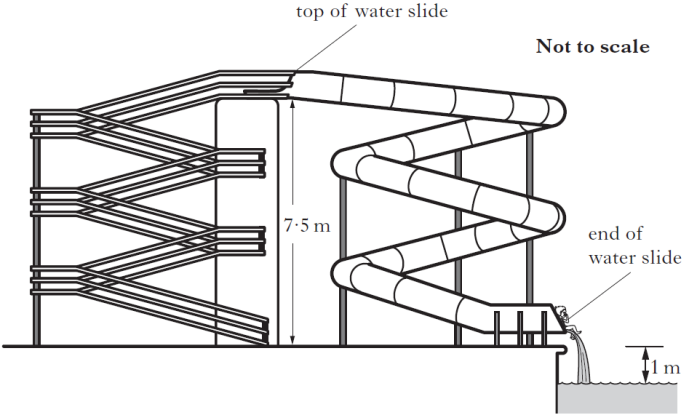
## THE PROPERTIES OF MATTER UNIT IN NUMBERS

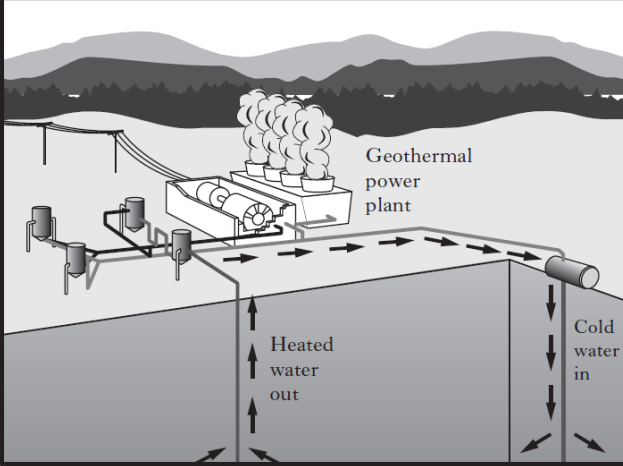
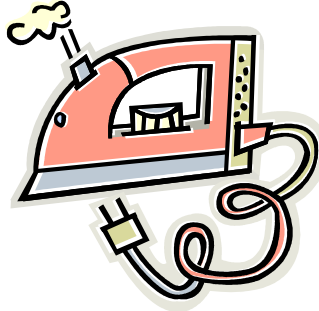
Quantity	Value
State the Specific Heat Capacity of Water.	
State the specific Latent heat of fusion of ice.	
State the specific latent heat of vaporisation of water.	
State the average Atmospheric Pressure.	
State the equivalent temperature of 0 °C in Kelvin.	
State the temperature of 0 Kelvin in °C.	
State the equivalent temperature of 100 °C in Kelvin.	
State the equivalent of 100 Kelvin in °C.	
State the equivalent temperature change in kelvin of a one degree Celsius temperature change	
State the conversion factor to change °C into Kelvin.	
State the conversion factor to change a temperature in Kelvin into °C	

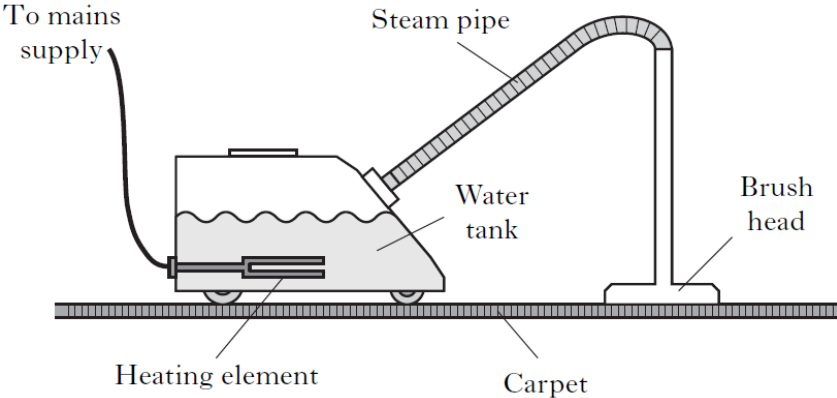
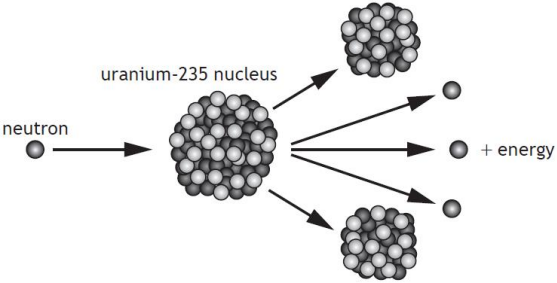
Quantity	Value
State the melting and boiling point of water.	
State the melting and boiling point of alcohol.	

No.	CONTENT
<b>Specific heat capacity</b>	
14.1	I know that the same mass of different materials require different quantities of heat energy to raise their temperature by 1 degree Celsius.
14.1.1	Explain the term <i>Specific Heat Capacity</i> .
14.1.2	When eating a cheese, pineapple, ham and tomato pizza the pineapple and tomato is much hotter when you bite into it than the ham, explain the reason for this.
14.1.3	State the formula linking energy, mass, specific heat capacity, and change in temperature. State what each letter means.
14.1.4	Using the data sheet, state the specific heat capacity of (a) ice                      (b) copper                      (c) iron
14.1.5	From the list of materials given in the Data sheet, state the material that would take (a) most energy to heat up the material by 10 °C (b) least energy to heat up the material by 10 °C
14.2	I am able to use $E_h = cm\Delta T$ to carry out calculations involving: mass, heat energy, temperature change and specific heat capacity.
14.2.1	Explain the difference between temperature and heat.
14.2.2	10000 J of energy raises the temperature of 1 kg of liquid by 2 °C. Calculate the specific heat capacity of the material.
14.2.3	The specific heat capacity of concrete is about $800 \text{ Jkg}^{-1}\text{ }^\circ\text{C}^{-1}$ . Calculate the heat stored in a storage heater containing 50 kg of concrete when it is heated through 100 °C.
14.2.4	1.344 MJ of heat energy are used to heat from 20 °C to 100 °C. Calculate the mass of water.
14.2.5	9600 J of heat energy is supplied to 1 kg of methylated spirit in a polystyrene cup. Calculate the rise in temperature produced. Take the specific heat capacity of methylated spirit to be the same as alcohol.

No.	CONTENT
14.2.6	<p>When <math>2.0 \times 10^4</math> J of heat is supplied to 4.0 kg of paraffin at <math>10^\circ\text{C}</math> in a container the temperature increases to <math>14^\circ\text{C}</math>.</p> <p>a) Calculate the specific heat capacity of the paraffin.</p> <p>b) Explain why the result in part a) is different from the theoretical value of <math>2200 \text{ Jkg}^{-1} \text{ }^\circ\text{C}^{-1}</math>.</p>
14.2.7	<p>Calculate the energy supplied to heat up 1.20 kg of water from <math>20.0^\circ\text{C}</math> to <math>100.0^\circ\text{C}</math>. Assume all the energy goes in to heating the water.</p>
14.2.8	<p>If 5000J of energy is used to heat up 0.80 kg of iron,</p> <p>(i) calculate the rise in temperature of the iron</p> <p>(ii) If its initial temperature is <math>30^\circ\text{C}</math>, determine the final temperature of the iron.</p>
14.2.9	<p>A kettle is used to heat up water from <math>20^\circ\text{C}</math> to boiling point. It has a power of 2000W and takes 120 seconds to boil.</p> <p>(i) Calculate the energy supplied to the water.</p> <p>(ii) If all of this energy is used to heat the water, Determine the mass of water in the kettle.</p>
14.2.10	<p>If a kettle containing 2 kg of water cools from <math>40^\circ\text{C}</math> to <math>25^\circ\text{C}</math>, calculate the heat given out by the water.</p>
14.2.11	<p>The temperature of a 0.8 kg metal block is raised from <math>27^\circ\text{C}</math> to <math>77^\circ\text{C}</math> when 4200 J of energy is supplied. Find the specific heat capacity of the metal.</p>
14.2.12	<p>The tip of the soldering iron is made of copper with a mass of 30 g. Calculate how much heat energy is required to heat up the tip of a soldering iron by <math>400^\circ\text{C}</math>.</p>
14.2.13	<p>5.0 kg of a plastic is heated from <math>10^\circ\text{C}</math> to <math>66^\circ\text{C}</math> using 36000 J of energy. Calculate the specific heat capacity of the plastic.</p>
14.2.14	<p>The graph below represents how the temperature of a 2 kg steel block changes as heat energy is supplied. From the graph calculate the specific heat capacity of the steel.</p> <div style="display: flex; align-items: center; justify-content: center;"> <div style="margin-right: 20px;"> <p>Temperature of steel block (<math>^\circ\text{C}</math>)</p> </div>  </div>
14.3	<p>I am able to explain how temperature of a substance is related to kinetic energy</p>
14.3.1	<p>Explain how the temperature of a substance relates to the particle speed.</p>

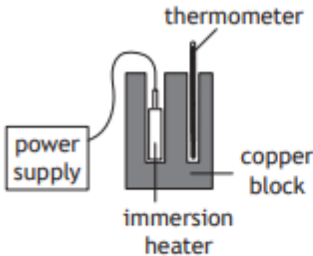
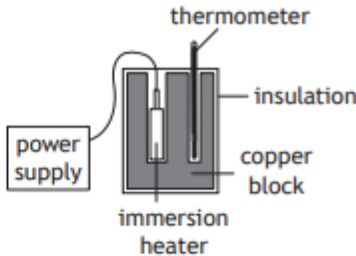
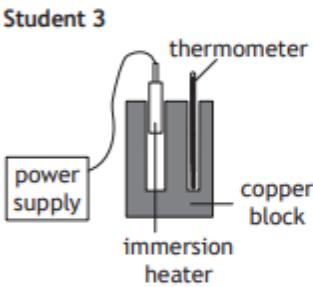
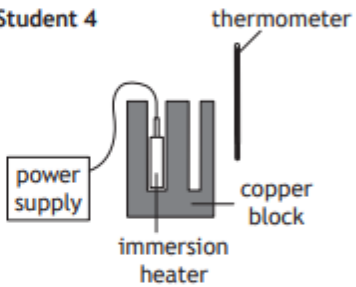
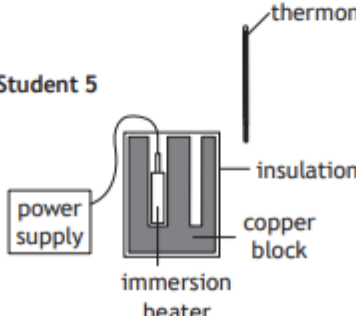
No.	CONTENT
14.3.2	<p>(a) If the speed of the particles in a substance increases state what happens to the kinetic energy of the particles in the substance.</p> <p>(b) Hence, state the link between temperature of a substance and the kinetic energy of its particles.</p>
14.4	<b>I can use the principle of conservation of energy to determine heat transfer.</b>
14.4.1	<p>GG Energy Notes</p> <p>A kettle works on the UK mains (230 V) and a current of 12.0 A flows when it is switched on.</p> <p>(a) Calculate the power rating of the kettle.</p> <p>(b) Calculate the energy transformed by the kettle if it was switched on for 2 minutes.</p> <p>(c) Calculate the maximum mass of water at 20 °C which could be heated to 99 °C in this time.</p> <p>(d) State any assumptions you made in part c.</p>
14.4.2	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;">  </div> <div style="width: 45%;"> <p>SQA SG C 2013</p> <p>A child of mass 42.0 kg is playing on a water slide at a water park.</p> <p>(a) The child climbs 7.50 m to the top of the slide.</p> <p>Calculate the gain in potential energy of the child.</p> <p>(b) When sliding down, an average frictional force of 15.0 N acts on the child. This causes 1050 J of heat energy to be produced. Calculate the length of the slide.</p> <p>(c) Calculate the speed of the child at the end of the slide.</p> </div> </div>

No.	CONTENT	
14.4.3		<p>SQA SG C 2013</p> <p>An experimental geothermal power plant uses heat energy from deep underground to produce electrical energy. A pump forces water at high pressure down a pipe. The water is heated and returns to the surface. At this high pressure the boiling point of water is <math>180\text{ }^{\circ}\text{C}</math>.</p> <p>The plant is designed to pump <math>82.0\text{ kg}</math> of heated water, to the surface, each second. The specific heat capacity of this water is <math>4320\text{ J kg}^{-1}\text{ }^{\circ}\text{C}^{-1}</math>.</p> <p>(a) The water enters the ground at <math>20\text{ }^{\circ}\text{C}</math> and emerges at <math>145\text{ }^{\circ}\text{C}</math>. Calculate the heat energy absorbed by the water each second.</p> <p>The hot water is fed into a heat exchanger where <math>60\%</math> of this heat energy is used to vaporise another liquid into gas. This gas is used to drive a turbine which generates electrical energy. The specific latent heat of vaporisation for this liquid is <math>3.42 \times 10^5\text{ J kg}^{-1}</math>.</p> <p>Calculate the mass of this liquid which is vaporised each second.</p>
14.4.4	<p>SQA SG C 2012A</p> <p>A manufacturer has developed an iron with an aluminium sole plate. A technician has been asked to test the iron. The technician obtains the following data for one setting of the iron.</p> <p>Starting temperature of sole plate: <math>24\text{ }^{\circ}\text{C}</math></p> <p>Operating temperature of the sole plate: <math>200\text{ }^{\circ}\text{C}</math></p> <p>Time for iron to reach the operating temperature: <math>35\text{ s}</math></p> <p>Power rating of the iron: <math>1.5\text{ kW}</math></p> <p>Operating voltage: <math>230\text{ V}</math></p> <p>Specific Heat Capacity of Aluminium: <math>902\text{ J kg}^{-1}\text{ }^{\circ}\text{C}^{-1}</math></p> <p>(a) Calculate how much electrical energy is supplied to the iron in this time.</p> <p>(b) Calculate the mass of the aluminium sole plate.</p> <p>(c) The actual mass of the aluminium sole plate is less than the value calculated in part (b) using the technician's data. Give one reason for this difference.</p> 	

No.	CONTENT
14.4.5	<p>A steam cleaner rated at 2.0 kW is used to clean a carpet. The water tank is filled with 1.60 kg of water at 20.0 °C. This water is heated until it boils and produces steam. The brush head is pushed across the surface of the carpet and steam is released.</p>  <p>(a) Calculate how much heat energy is needed to bring this water to its boiling point of 100 °C.</p> <p>(b) After the steam cleaner has been used for a period of time, 0.90 kg of boiling water has changed into steam.</p> <p>(i) Calculate how much heat energy was needed to do this.</p> <p>(ii) Calculate how long it would take to change this water into steam.</p>
14.4.6	<p>SQA N5 2017</p> <p>In a nuclear reaction a uranium-235 nucleus is split by a neutron to produce two smaller nuclei, three neutrons, and energy.</p>  <p>One nuclear reaction releases <math>3.2 \times 10^{-11}</math> J.</p> <p>In the reactor, <math>3.0 \times 10^{21}</math> reactions occur each minute.</p> <p>Determine the maximum power output of the reactor.</p>

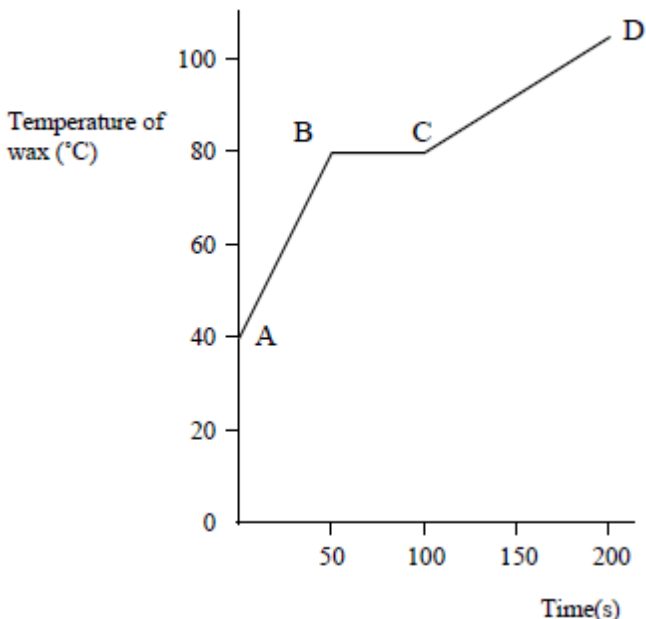
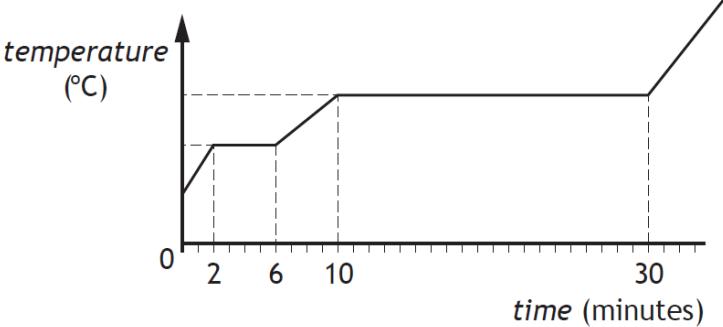
## Specific Latent Heat

15.1	I know that different materials require different quantities of heat to change the state of unit mass.
15.1.1	State what is meant by <i>change of state</i> .
15.1.2	Define the term <i>specific latent heat</i> .
15.1.3	State what is meant by <i>latent heat of fusion</i> .
15.1.4	State what is meant by <i>latent heat of vaporisation</i> .

No.	CONTENT
15.1.5	Using the information in the data sheet, state the energy required to melt 1 kg of the following substances: a) ice      b) copper      c) aluminium
15.2	<b>I know that the same material requires different quantities of heat to change the state of unit mass from solid to liquid (fusion) and to change the state of unit mass from liquid to gas (vaporisation)</b>
15.2.1	State which requires more energy, melting 1 kg of ice or boiling 1 kg of water. <i>You must justify your answer.</i>
15.2.2	State whether 1 kg of water or 1 kg of molten copper will give out more energy as they change to a solid, you must justify your answer.
15.2.3	State what happens to the temperature of a substance when it changes from a solid to a liquid.
15.2.4	Copy and complete this sentence: <i>When a substance changes state, its temperature . . .</i>
15.2.5	State what you have to do to a material to make it turn from (a) a liquid to a gas, and (b) from a liquid to a solid.
15.2.6	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p><b>Student 1</b></p>  </div> <div style="text-align: center;"> <p><b>Student 2</b></p>  </div> <div style="text-align: center;"> <p><b>Student 3</b></p>  </div> <div style="text-align: center;"> <p><b>Student 4</b></p>  </div> <div style="text-align: center;"> <p><b>Student 5</b></p>  </div> </div> <p style="margin-left: 650px;">Draw the diagram of the student's setup that would allow the most accurate value for the specific heat capacity of copper to be determined.</p>

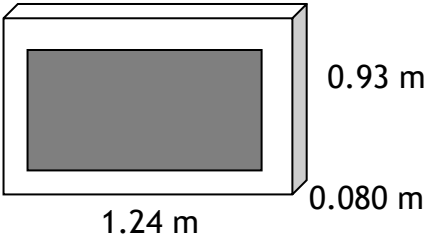
No.	CONTENT
15.3	I can solve problems involving mass, heat energy and specific latent heat.
15.3.1	State the formula linking mass energy and specific latent heat. State the units of each quantity.
15.3.2	Calculate the specific latent heat of fusion of naphthalene given that $6 \times 10^5$ J of heat is given out when 4.0 kg of naphthalene at its melting point changes to a solid.
15.3.3	Calculate the mass of water changed to steam if 10.6 kJ of heat energy is supplied to the water at $100^\circ\text{C}$ .
15.3.4	Ammonia is vaporised in order to freeze an ice rink. a) Calculate the heat energy required to vaporise 1 g of ammonia. b) Assuming this heat is taken from water at $0^\circ\text{C}$ , find the mass of water frozen for every gram of ammonia vaporised. (Specific latent heat of vaporisation of ammonia = $1.34 \times 10^6$ Jkg <sup>-1</sup> Specific latent heat of fusion of ice = $3.34 \times 10^5$ Jkg <sup>-1</sup> ).
15.3.5	(a) Explain how evaporation can be used to cool objects. (b) Describe how (i) evaporation and (ii) melting can be used to keep things cool.
15.3.6	Calculate the amount of heat energy required to melt 0.3 kg of ice at $0^\circ\text{C}$ .
15.3.7	Calculate the specific latent heat of fusion of naphthalene given that $6 \times 10^5$ J of heat are given out when 4.0 kg of naphthalene at its melting point changes to a solid.
15.3.8	Calculate what mass of water can be changed to steam if 10.6 kJ of heat energy is supplied to the water at $100^\circ\text{C}$ .
15.3.9	Ammonia is vaporised in order to freeze an ice rink. a) Find out how much heat it would take to vaporise 1.0 g of ammonia. b) Assuming this heat is taken from water at $0^\circ\text{C}$ , find the mass of water frozen for every gram of ammonia vaporised. (Specific latent heat of vaporisation of ammonia = $1.34 \times 10^6$ Jkg <sup>-1</sup> )
15.3.10	State what is meant by <i>Specific Heat Capacity</i> State the formula linking Energy, mass, specific heat capacity, and change in temperature. State what each letter means.
15.3.11	Calculate the energy required to melt 4.0 kg of ice.
15.3.12	Using the information in the data sheet, state the energy required to boil 1kg of the following substances: b) water      b) alcohol      c) glycerol

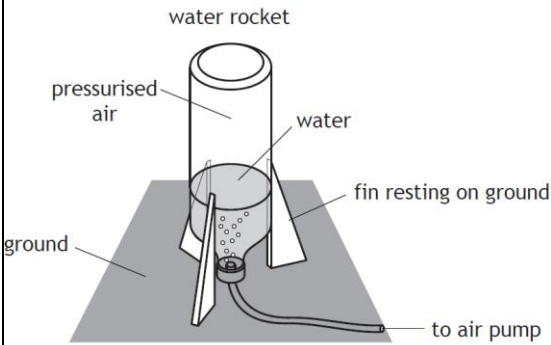
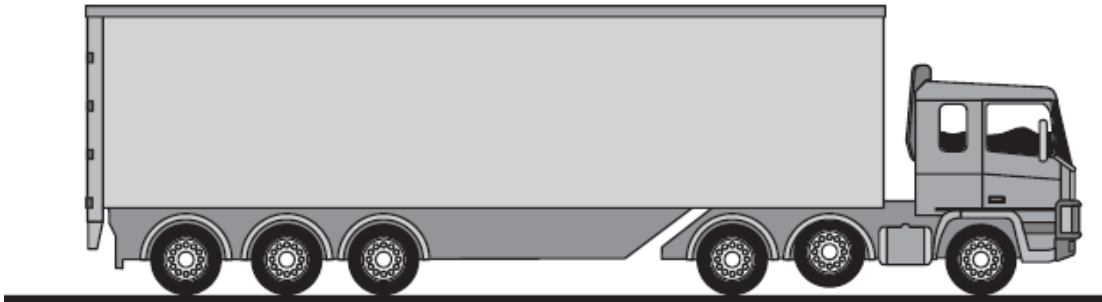
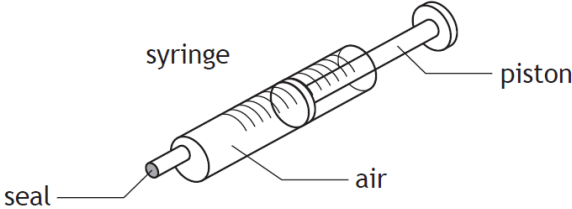


No.	CONTENT
15.3.13	<p>The graph below shows how the temperature of a 2.0 kg lump of solid wax varies with time when heated.</p>  <p>a) Explain what is happening to the wax in the regions AB, BC and CD.</p> <p>b) If a 200 W heater was used to heat the wax, calculate the specific latent heat of fusion of the solid wax.</p>
15.3.14	<p>A heater transfers energy to boiling water at the rate of 1130 joules every second. Calculate the maximum mass of water converted to steam in 2 minutes.</p>
15.3.15	<p>A kettle is rated at 230 V 10 A.</p> <p>(a) Calculate the power rating of the kettle</p> <p>(b) Calculate the time it will take to heat 1.3 kg of water from 10 °C to boiling point using the kettle, <i>assume all the energy goes into the water.</i></p> <p>(c ) The kettle in part (a) is faulty and does not switch its self off when it boils. If it boils the water for 5 minutes before it is noticed, determine the mass of water turned into steam.</p>
15.3.16	<p>(i) From the data sheet, state the melting point of aluminium.</p> <p>(ii) Calculate the energy needed to melt 5kg of aluminium at its melting point.</p>
15.3.17	<p>A solid substance is placed in an insulated flask and heated continuously with an immersion heater.</p> <p>The graph shows how the temperature of the substance in the flask changes in time.</p>  <p>State in which state(s) the substance is after being heated for 5 minutes</p>

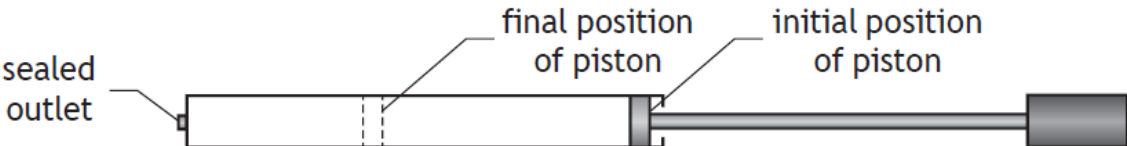
**Gas laws and the kinetic model**

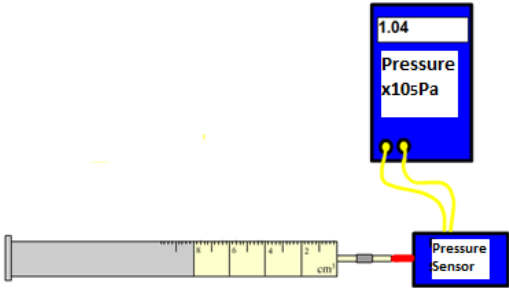
16.1	I can explain pressure
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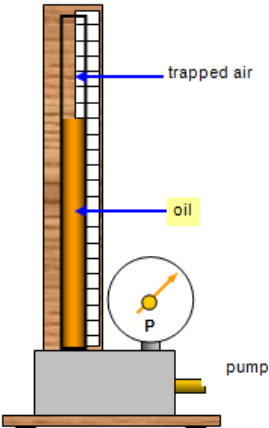
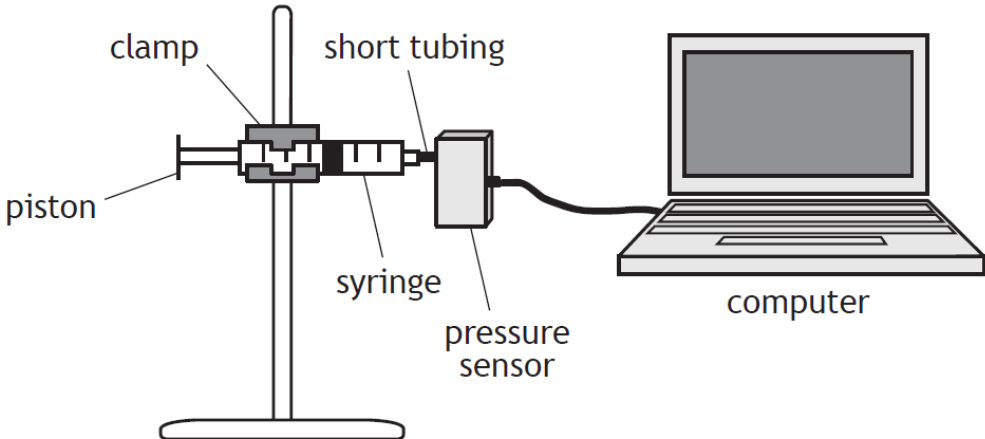
No.	CONTENT
16.1.1	State the meaning of the term pressure.
16.1.2	State the equation linking force and pressure, define each term.
<b>16.2</b>	<b>I am able to use the correct equation to calculate pressure, force and area</b>
16.2.1	<p>A television has a length of 1.24 m, a height of 0.93 m and a depth of 0.080 m. If it has a mass of 30 kg.</p>  <p>(a) Calculate the maximum pressure that the television can exert on a surface</p> <p>(b) Calculate the minimum pressure that the television can exert on a surface.</p>
16.2.2	<p>The mass of a spacecraft is 1200 kg.</p> <p>The spacecraft lands on the surface of a planet.</p> <p>The gravitational field strength on the surface of the planet is <math>5.0 \text{ N kg}^{-1}</math>.</p> <p>The spacecraft rests on three pads. The total area of the three pads is <math>1.5 \text{ m}^2</math>.</p> <p>Determine the pressure exerted by these pads on the surface of the planet.</p>
16.2.3	<p>The pressure of the air outside an aircraft is <math>0.40 \times 10^5 \text{ Pa}</math>.</p> <p>The air pressure inside the aircraft cabin is <math>1.0 \times 10^5 \text{ Pa}</math>.</p> <p>The area of an external cabin door is <math>2.0 \text{ m}^2</math>.</p> <p>Calculate the outward force on the door due to the pressure difference.</p>
16.2.4	<p>A 0.480 kg tin of baked beans is a cylinder with a radius of 0.032 m. It is placed on a kitchen counter. Calculate the pressure on the counter caused by the tin.</p>
16.2.5	<p>A car of mass 1250 kg is driven on to a bridge. The pressure on the surface of the bridge when all four tyres are on the ground is 39.0 kPa. Calculate the contact area of one tyre on the bridge.</p>
16.2.6	<p>By measuring your weight and the area of your feet, calculate the pressure that you exert on the floor when:</p> <p>(a) You are standing normally.</p> <p>(b) You are standing on one foot.</p>
16.2.7	<p>Are you more likely to fall through an icy lake if you are on your tip toes or lying flat on your back with your arms and legs stretched out? Explain your answer.</p>

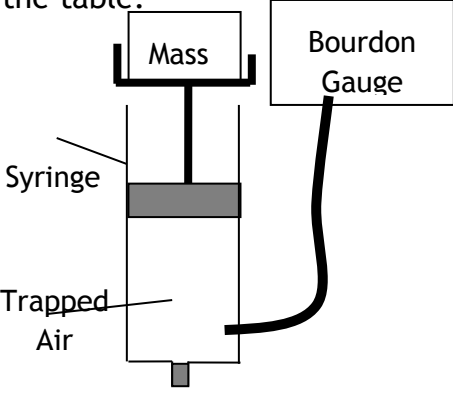
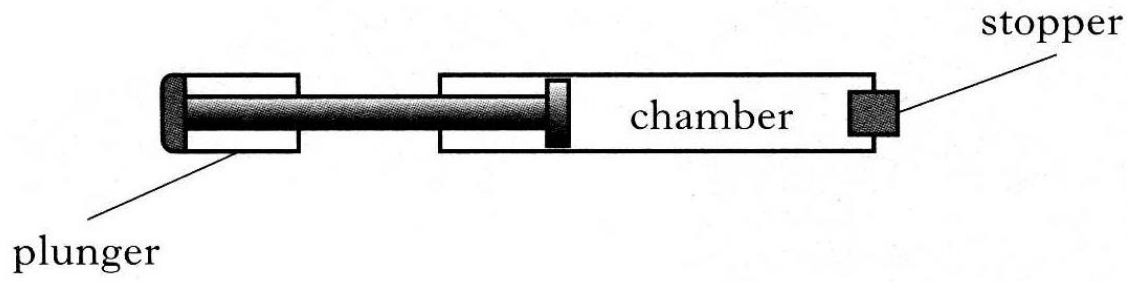
No.	CONTENT
<p>16.2.8</p>	<p style="text-align: right;">SQA N5 2014</p> <div style="display: flex; align-items: center;">  <div style="margin-left: 20px;"> <p>A student is investigating the motion of water rockets. The water rocket is made from an upturned plastic bottle containing some water. Air is pumped into the bottle. When the pressure of the air is great enough the plastic bottle is launched upwards.</p> <p>The mass of the rocket before launch is 0.94 kg.</p> <p>a) Calculate the weight of the water rocket.</p> <p>b) Before launch, the water rocket rests on three fins on the ground. The area of each fin in contact with the ground is <math>2.0 \times 10^{-4} \text{ m}^2</math>. Calculate the total pressure exerted on the ground by the fins.</p> </div> </div>
<p>16.2.9 OEQ</p>	<p>An articulated lorry has six pairs of wheels. One pair of wheels can be raised off the ground.</p> <div style="text-align: center;">  </div> <p>Using your knowledge of physics, comment on situations in which the wheels may be raised or lowered.</p>
<p>16.3</p>	<p>I can describe the kinetic model of a gas.</p>
<p>16.3.1</p>	<p>A syringe containing air is sealed at one end as shown. The piston is pushed in slowly. There is no change in temperature of the air inside the syringe.</p> <div style="text-align: center;">  </div> <p>Copy the statement which describes and explains the change in pressure of the air in the syringe.</p> <p>A The pressure increases because the air particles have more kinetic energy.</p> <p>B The pressure increases because the air particles hit the sides of the syringe more frequently.</p> <p>C The pressure increases because the air particles hit the sides of the syringe less frequently.</p> <p>D The pressure decreases because the air particles hit the sides of the syringe with less force.</p> <p>E The pressure decreases because the air particles have less kinetic energy.</p>

No.	CONTENT
16.3.2	State the properties of an ideal gas.
16.3.3	Explain the kinetic theory of an ideal gas.
<b>16.4</b>	<b>I can describe the kinetic model of a gas and how this accounts for pressure</b>
16.4.1	Explain the term pressure.
16.4.2	Explain how the kinetic model of a gas accounts for pressure.
16.4.3	Explain what happens to the particles of a gas as the temperature of the gas increases.
<b>16.5</b>	<b>I can convert temperatures between kelvin and degrees Celsius and understand the term absolute zero of temperature.</b>
16.5.1	Convert the following temperatures into kelvin a) 0 °C, b) 20 °C, c) -273 °C, d) 100 °C
16.5.2	Convert the following temperatures into degrees Celsius a) 0 K, b) 20 K, c) 273 K, d) 100 K, e) 500 K
16.5.3	The average temperature of the surface of the Sun is 5778 K. Determine the average temperature of the surface of the Sun in degrees Celsius.
16.5.4	A liquid is heated from 17 °C to 50 °C. Determine the temperature rise in kelvin.
16.5.5	A solid at a temperature of -20 °C is heated until it becomes a liquid at 70 °C. Calculate the temperature change in kelvin.
16.5.6	State the freezing and boiling points of water at standard pressure on the degree Celsius scale and kelvin scale
<b>16.6</b>	<b>I know the link between kelvin and the degrees Celsius °C scale</b>
16.6.1	State the link between kelvin and the degree Celsius scale.
16.6.2	Copy and complete this sentence A change of temperature of 1°C is equal to a change of temperature of _____ K
16.6.3	Copy and complete this sentence To convert between kelvin and degrees Celsius _____ To convert between degrees Celsius and kelvin _____
16.6.4	Explain in terms of moving particles what occurs at a temperature of zero kelvin.

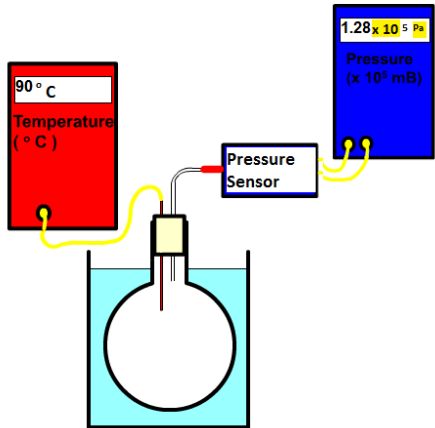
No.	CONTENT
16.7	I can explain the relationship between the volume, pressure and temperature of a fixed mass of gas using qualitative (info) in terms of kinetic theory.
16.7.1	Explain how the kinetic theory suggests that as the temperature of a fixed mass of gas increases the pressure increases.
16.7.2	Explain how the kinetic theory suggests that as the temperature of a fixed mass of gas increases the volume increases for constant pressure.
16.7.3	Explain how the kinetic theory suggests that as the volume of a fixed mass of gas increases the pressure decreases.
16.7.4	When completing an experiment to find the relationship between volume and pressure, explain why it is important to change the volume slowly.
16.7.5 A	<p>SQA N5 2017</p> <p>A bicycle pump with a sealed outlet contains <math>4.0 \times 10^{-4} \text{ m}^3</math> of air. The air inside the pump is at an initial pressure of <math>1.0 \times 10^5 \text{ Pa}</math>. The piston of the pump is now pushed slowly inwards until the volume of air in the pump is <math>1.6 \times 10^{-4} \text{ m}^3</math> as shown.</p>  <p>Using the kinetic model, explain what happens to the pressure of the air inside the pump as its volume decreases.</p>
16.7.5 B	<p>(continued from above)</p> <p>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. Sketch a graph to show how the pressure of the air in the pump varies as its volume increases.</p> <p><i>Numerical values are not required on either axis.</i></p>
16.8	<p>I can use appropriate relationships to calculate the volume, pressure and temperature of a fixed mass of gas</p> $p_1V_1/T_1(K) = p_2V_2/T_2(K)$ $p_1V_1 = p_2V_2 \quad p_1/T_1(K) = p_2/T_2(K) \quad V_1/T_1(K) = V_2/T_2(K) \quad pV/T(K) = \text{constant}$
16.8.1	<p>The pressure of a fixed mass of gas is 150 kPa at a temperature of 27 °C.</p> <p>The temperature of the gas is now increased to 47 °C.</p> <p>The volume of the gas remains constant. Determine the new pressure of the gas.</p>

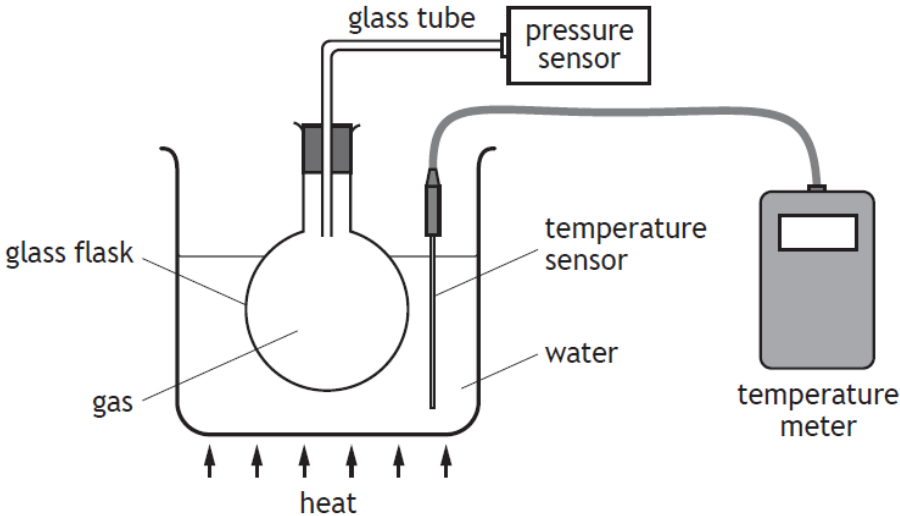
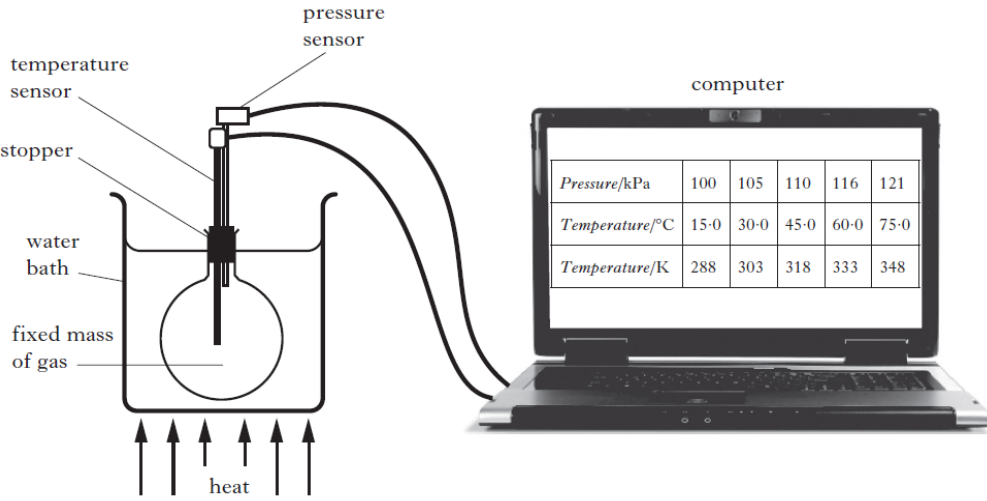
No.	CONTENT
16.8.2	<p>The pressure of a fixed mass of gas is <math>6.0 \times 10^5</math> Pa.</p> <p>The temperature of the gas is <math>27^\circ\text{C}</math> and the volume of the gas is <math>2.5\text{ m}^3</math>.</p> <p>The temperature of the gas increases to <math>54^\circ\text{C}</math> and the volume of the gas increases to <math>5.0\text{ m}^3</math>. Determine the new pressure of the gas.</p>
16.8.3	<p>A mass of gas at a pressure of 20 kPa has a volume of <math>3.0\text{ m}^3</math>. Calculate the new volume if the pressure is doubled but the temperature remains constant.</p>
16.8.4	<p>The volume of mass of a gas is reduced from <math>5.0\text{ m}^3</math> to <math>2.0\text{ m}^3</math>. If the pressure was initially 40 Pa, calculate be the new pressure if the temperature remains constant.</p>
16.8.5	<p>The pressure of a fixed volume of gas at 300 K is increased from 5.0 Pa to 10.0 Pa, calculate the new temperature.</p>
16.8.6	<p>If pressure of a fixed volume of gas at 200 K is 50.0 Pa, calculate the pressure if the temperature is increased to 300 K?</p>
16.8.7	<p>The temperature of <math>6.0\text{ m}^3</math> of gas is increased from <math>27^\circ\text{C}</math> to <math>127^\circ\text{C}</math>, calculate the new volume of the gas if the pressure remains constant.</p>
16.8.8	<p>The volume of a gas is increased from <math>10.0\text{ m}^3</math> to <math>20.0\text{ m}^3</math> at constant pressure. Calculate the new temperature if the initial temperature was 300 K.</p>
16.8.9	<p>A mass of gas has a volume of <math>5.0\text{ m}^3</math>, a pressure of 20.0 Pa and a temperature of <math>27^\circ\text{C}</math>. Calculate the new pressure if the volume is changed to <math>4.0\text{ m}^3</math> and the temperature to <math>27^\circ\text{C}</math>.</p>
16.8.10	<p>A sealed bicycle pump contains <math>4.0 \times 10^{-5}\text{ m}^3</math> of air at a pressure of <math>1.2 \times 10^5</math> Pa.</p> <p>The piston of the pump is pushed in until the volume of air in the pump is reduced to <math>0.80 \times 10^{-5}\text{ m}^3</math>.</p> <p>During this time the temperature of the air in the pump remains constant.</p> <p>Calculate the new pressure of the air in the pump.</p>
16.9	<p>I can describe an experiment to verify Boyle's Law (pressure and volume)</p>
16.9.1	<div style="display: flex; align-items: center;"> <div style="flex: 1;">  </div> <div style="flex: 2; padding-left: 20px;"> <p>Explain how the following equipment can be used to show the relationship between pressure and volume. State the measurements required and how the variable will be altered. include any assumptions made.</p> </div> </div>

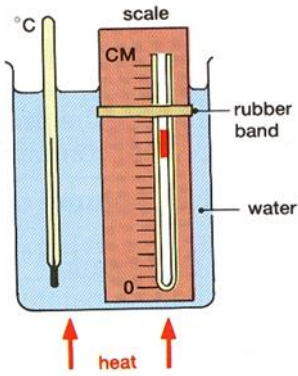
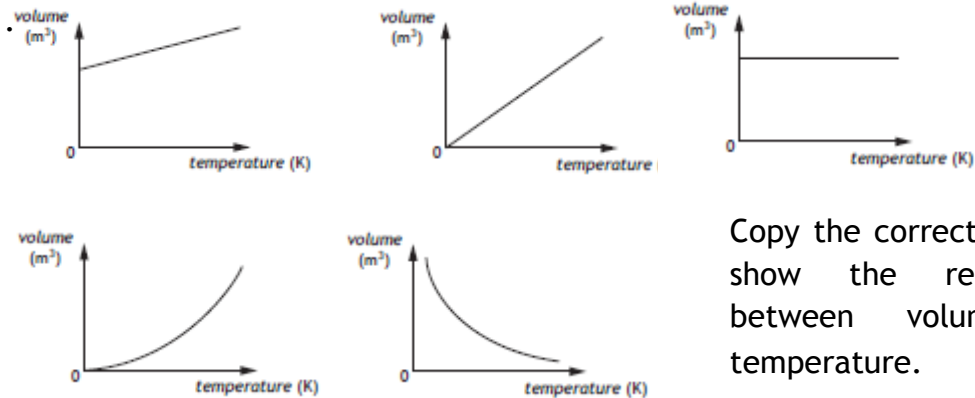
No.	CONTENT																					
16.9.2	 <p>Explain how the equipment is different from that in 16.9.2 in collecting data to find the relationship between pressure and volume.</p>																					
16.9.3	<p>SQA N5 2017 SP</p> <p>A student carries out an experiment to investigate the relationship between the pressure and volume of a fixed mass of gas using the apparatus shown.</p>  <p>The pressure <math>p</math> of the gas is recorded using a pressure sensor connected to a computer. The volume <math>V</math> 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.</p> <table border="1" data-bbox="411 1424 1315 1550"> <tbody> <tr> <td><math>p</math></td> <td>(kPa)</td> <td>100</td> <td>125</td> <td>152</td> <td>185</td> <td>200</td> </tr> <tr> <td><math>V</math></td> <td>(cm<sup>3</sup>)</td> <td>50</td> <td>40</td> <td>33</td> <td>27</td> <td>25</td> </tr> <tr> <td><math>1/V</math></td> <td>(cm<sup>-3</sup>)</td> <td>0.020</td> <td>0.025</td> <td>0.030</td> <td>0.037</td> <td>0.040</td> </tr> </tbody> </table> <p>(a) (i) Using square-ruled paper, draw a graph of <math>p</math> against <math>1/V</math>. You must start the scale on each axis from 0.</p> <p>(ii) Explain how the graph confirms that pressure is directly proportional to <math>1/\text{volume}</math>.</p>	$p$	(kPa)	100	125	152	185	200	$V$	(cm <sup>3</sup> )	50	40	33	27	25	$1/V$	(cm <sup>-3</sup> )	0.020	0.025	0.030	0.037	0.040
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No.	CONTENT														
<p>16.9.4</p>	<p>In an experiment, a mass with a weight of 1N is placed on top of a syringe filled with trapped air. A Bourdon Gauge is used to measure the air pressure inside the syringe. This is then repeated for different masses. The results are given in the table.</p>  <table border="1" data-bbox="750 347 1444 728"> <thead> <tr> <th><i>Force / N</i></th> <th><i>Pressure / x 10<sup>5</sup> Pa</i></th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1.01</td> </tr> <tr> <td>1</td> <td>1.03</td> </tr> <tr> <td>2</td> <td>1.05</td> </tr> <tr> <td>3</td> <td>1.07</td> </tr> <tr> <td>4</td> <td>1.09</td> </tr> <tr> <td>5</td> <td>1.11</td> </tr> </tbody> </table> <p>Use this data to construct a line graph of force against change in pressure, and use the gradient of the straight line to calculate the surface area of the syringe plunger inside the syringe.</p>	<i>Force / N</i>	<i>Pressure / x 10<sup>5</sup> Pa</i>	0	1.01	1	1.03	2	1.05	3	1.07	4	1.09	5	1.11
<i>Force / N</i>	<i>Pressure / x 10<sup>5</sup> Pa</i>														
0	1.01														
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3	1.07														
4	1.09														
5	1.11														
<p>16.9.5</p>	<p>The end of a bicycle pump is sealed with a stopper so that the air in the chamber is trapped.</p>  <p>The plunger is now pushed in slowly causing the air in the chamber to be compressed. As a result of this the pressure of the trapped air increases. Assuming that the temperature remains constant, copy our the statements wick correctly explain why the pressure increases.</p> <ul style="list-style-type: none"> <li>I The air molecules increase their average speed.</li> <li>II The air molecules are colliding more often with the walls of the chamber</li> <li>III Each air molecule is striking the walls of the chamber with greater force.</li> </ul>														



No.	CONTENT										
16.9.6	<p>A student is training to become a diver.</p> <p>(a) The student carries out an experiment to investigate the relationship between the pressure and volume of a fixed mass of gas using the apparatus shown.</p> <p>The pressure of the gas is recorded using a pressure sensor connected to a computer. The volume of the gas 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.</p> <table border="1" data-bbox="518 562 1209 658"> <thead> <tr> <th>Pressure/kPa</th> <th>100</th> <th>105</th> <th>110</th> <th>115</th> </tr> </thead> <tbody> <tr> <th>Volume/cm<sup>3</sup></th> <td>20</td> <td>19</td> <td>18.2</td> <td>17.4</td> </tr> </tbody> </table> <p>(i) Using all the data, establish the relationship between the pressure and volume of the gas.</p> <p>(ii) Use the kinetic model to explain the change in pressure as the volume of gas decreases.</p>	Pressure/kPa	100	105	110	115	Volume/cm <sup>3</sup>	20	19	18.2	17.4
Pressure/kPa	100	105	110	115							
Volume/cm <sup>3</sup>	20	19	18.2	17.4							
16.10	I can describe an experiment to verify Gay-Lussac's Law (pressure and temperature)										
16.10.1	 <p>Explain how the following equipment can be used to show the relationship between pressure and temperature. State the measurements required and how the variable will be altered. include any assumptions made.</p>										
16.10.2	Discuss whether the thermometer should be placed in the round bottom flask or in the water.										
16.10.3	Sketch a graph of the expected results of pressure against temperature on the degrees Celsius scale.										
16.10.4	Sketch a graph of the expected results of pressure against temperature on the kelvin scale.										

No.	CONTENT										
16.10.5	<p>SQA N5 2018 Q9</p> <p>A student sets up an experiment to investigate the relationship between the pressure and temperature of a fixed mass of gas as shown.</p>  <p>(a) The student heats the water and records the following readings of pressure and temperature.</p> <table border="1" data-bbox="459 1003 1264 1099"> <tbody> <tr> <td>Pressure (kPa)</td> <td>101</td> <td>107</td> <td>116</td> <td>122</td> </tr> <tr> <td>Temperature (K)</td> <td>293</td> <td>313</td> <td>333</td> <td>353</td> </tr> </tbody> </table> <p>(i) Using all the data, establish the relationship between the pressure and the temperature of the gas.</p> <p>(ii) Predict the pressure reading which would be obtained if the student was to cool the gas to 253 K.</p> <p>(b) State one way in which the set-up of the experiment could be improved to give more reliable results.</p>	Pressure (kPa)	101	107	116	122	Temperature (K)	293	313	333	353
Pressure (kPa)	101	107	116	122							
Temperature (K)	293	313	333	353							
16.10.6	<p>A student carries out an experiment to investigate the relationship between the pressure and temperature of a fixed mass of gas. The apparatus used is shown.</p>  <p>The pressure and temperature of the gas are recorded using sensors connected</p>										

No.	CONTENT																		
	<p>to a computer. The gas is heated slowly in the water bath and a series of readings is taken.</p> <p>The volume of the gas remains constant during the experiment.</p> <p>The results are shown.</p> <table border="1" data-bbox="277 376 1209 510"> <thead> <tr> <th>Pressure/kPa</th> <th>100</th> <th>105</th> <th>110</th> <th>116</th> <th>121</th> </tr> </thead> <tbody> <tr> <th>Temperature/°C</th> <td>15.0</td> <td>30.0</td> <td>45.0</td> <td>60.0</td> <td>75.0</td> </tr> <tr> <th>Temperature/K</th> <td>288</td> <td>303</td> <td>318</td> <td>333</td> <td>348</td> </tr> </tbody> </table> <p>(a) Using all the relevant data, establish the relationship between the pressure and the temperature of the gas.</p> <p>(b) Use the kinetic model to explain the change in pressure as the temperature of the gas increases.</p> <p>(c) Explain why the level of water in the water bath should be above the bottom of the stopper.</p>	Pressure/kPa	100	105	110	116	121	Temperature/°C	15.0	30.0	45.0	60.0	75.0	Temperature/K	288	303	318	333	348
Pressure/kPa	100	105	110	116	121														
Temperature/°C	15.0	30.0	45.0	60.0	75.0														
Temperature/K	288	303	318	333	348														
16.11	I can describe an experiment to verify Charles' Law (volume and temperature)																		
16.11.1	 <p>Explain how the following equipment can be used to show the relationship between pressure and temperature. State the measurements required and how the variable will be altered. include any assumptions made.</p>																		
16.11.2	<p>A student is investigating the relationship between the volume and the kelvin temperature of a fixed mass of gas at constant pressure.</p> <p>Sketch a graph to shows this relationship.</p>																		
16.11.3	Explain why the set up in 16.11.1 requires the thin tube to be open at one end.																		
16.11.4	 <p>Copy the correct graph to show the relationship between volume and temperature.</p>																		

No.	CONTENT
16.11.5	State what must be kept constant to allow a relationship between volume of a gas and its temperature.