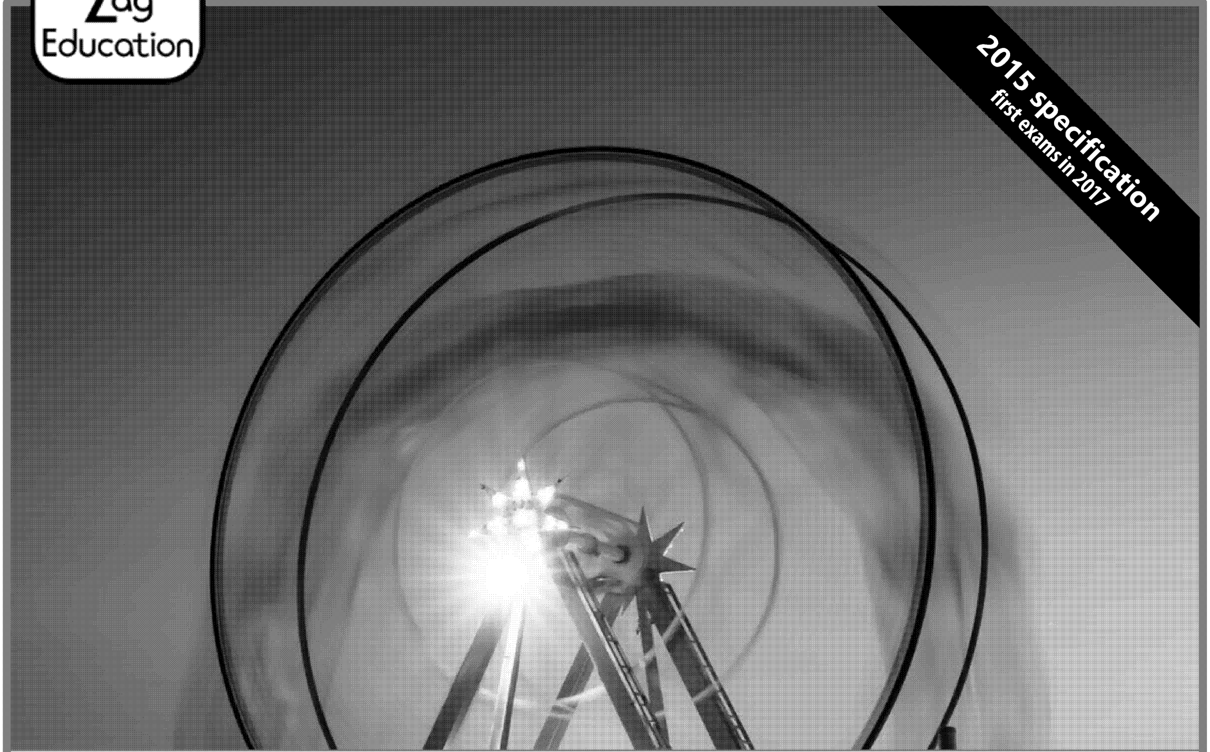
Physics

A Level | AQA | 7408



Revision Grids for A Level AQA Physics

Section 6: Further Mechanics and Thermal Physics

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POD 8585

Contents

Teacher's Introduction

These learning grids are designed to help your students independently learn cont knowledge during teaching of each section of Section 6 – Further mechanics and t A Level Year 2 Physics specification. The concept is that your students are assigne relevant book and then are asked to complete the relevant learning grids, possibl for a topic. These activities are particularly useful for students who need more su thought-provoking reasoning questions which will stimulate highly engaged stude

Each learning grid is closely mapped to the AQA 2015 specification and to the approved textbooks. Relevant textbook page numbers are provided at the top of each worksheet to allow easy cross-referencing. Separate resources cover Units 7 and 8.

Each learning grid contains a range of question styles, including:

- **Quick-testing questions** – these may be a phrase, a definition or a numeric response.
- **Missing-information/Match-terms-to-definitions questions** – test key knowledge quickly.
- **Explain-a-process questions** – encourage students to recognise cause and effect in physical processes.
- **Graph questions** – will require understanding of how to draw graphs, use log scales and interpret data.
- **Applied knowledge questions** – challenge students to apply knowledge in unfamiliar situations.
- **Practical questions** – covering the method and analysis of required practicals

Learning grids in this section will on average take 20–30 minutes each. However, t substantial opportunities to develop mathematics skills, and students who find m these resources take longer to complete.

This resource can be used to engage students and allow those who have missed le learning grids can be used as the basis for a homework exercise, and the answer s used in cover lessons. Students could also use the worksheets as an independent All resources can be photocopied in black and white. We hope you and your stude

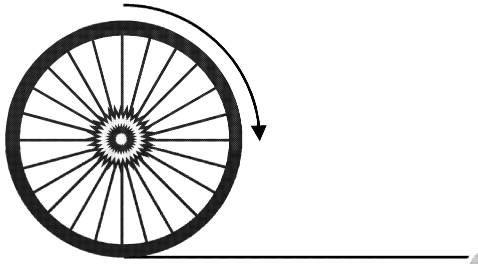
Topic 6.1.1: Circular motion

	Questions	
6.1.1 Circular motion	Fill in the gaps to describe the circular motion of Earth around the Sun.	Earth travels around t… ________________. This… always changing so Ea… This requires a ______
	A ball on a string is spun around. State the force that keeps the ball moving in a circle.	
	The diagram opposite shows the path of an object moving anticlockwise in a circle at a speed of v and an angular speed of ω, being acted on by a centripetal force, F. Complete the diagram to show v, ω and F.	
	State the number of degrees and radians in: a) a full circle b) half a circle c) two circles	

	Questions	
6.1.1 Circular motion	**State the equations used to convert radians to degrees and degrees to radians.**	
	Convert: **a) 1 rad to degrees** **b) $\frac{5\pi}{2}$ rad to degrees** **c) 2.781 rad to degrees**	
	Convert: **a) 270° to radians** **b) 41° to radians** **c) 92.[illegible] to radians**	
	Two equations for angular speed are shown opposite. **Label the variables and state a unit for each.** **Hint: In an exam, these will be given in the data booklet.**	

	Questions	
6.1.1 Circular motion	**A tractor tyre moves with linear velocity of 8.2 m s⁻¹ and has a radius of 1.4 m.** **Calculate the angular speed of the tyre.**	
	Rearrange an equation for angular speed to find radius.	
	A plate spins with an angular speed of 16 rad s^{-1} and a single point on the outside of the plate moves with a speed of 1.3 m s^{-1}. **Calculate the radius of the plate.**	
	For a rotating wheel, how can the distance the wheel moves, *s*, be related to the angular velocity of the wheel, *ω*, and the time taken, *t*?	

6.1.1 Circular motion

Questions	
A bicycle wheel has a radi[illegible].0 cm and rotates with an [illegible] of 14.2 rad s^{-1} along the [illegible]. **[illegible] the distance that the wheel covers in [illegible].** 	
A ball is thrown [illegible] 7.1 times a second. Calculat[illegible] [illegible]ar speed of the ball.	
Rearrange an equation for angular speed to find frequency.	
A spinning top spins with an [illegible] of 52 rad s^{-1}. Calculate th[illegible] of the spinning top's [illegible].	

	Questions	
6.1.1 Circular motion	The equation for the frequency of rotation of an object is shown opposite. Label the variables and state a unit for each. In an exam, these will be given in the data booklet.	
	A Ferris wheel takes 240 s to complete a revolution. Calculate the angular speed of the Ferris wheel.	
	On a turntable, a record has a radius of 30.5 cm and spins at 45 rpm (revolutions per minute). Calculate the linear speed of a point on the outside of the record.	

	Questions	
6.1.1 Circular motion	Two equations for centripetal acceleration are shown opposite. Label the variables and state a unit for each. Hint: In an exam, these will be given in the data booklet.	
	A Frisbee has a radius of 9.3 cm and spins with a linear speed of 2.5 m s^{-1}. Calculate the centripetal acceleration of the edge of the Frisbee.	
	Rearrange an equation for centripetal acceleration to find linear speed.	
	A car travels around a roundabout with a radius of 17.1 m at a centripetal acceleration of 4.67 m s^{-2}. Calculate the linear speed of the car.	

	Questions	
6.1.1 Circular motion	A student does a cartwheel. Their hands and feet move in a circle with a radius of 1.7 m and an angular speed of 0.4[illegible] rad s^{-1}. Calculate the centripetal acceleration of the student's hands and feet.	
	Rearrange and merge equations for centripetal acceleration and angular speed to find frequency.	
	A washing machine's drum has a radius of 22.0 cm and turns with a centripetal acceleration of 1540 m s^{-2}. Calculate the number of times the washing machine's drum rotates in one minute.	

	Questions	
6.1.1 Circular motion	A conker is attached to a string and spun around with a radius of [illegible] cm. The conker has a mass of 88 g and moves at a linear velocity of 0.91 m s^{-1}. Calculate the tension in the string.	
	A car with a mass of 1800 kg drives around a circular track with a radius of 39 m. The car makes a complete loop of the track in 11 s. Only frictional forces keep the car moving in a circular path. Calculate the magnitude of the frictional force acting on the car.	
	A car drives over a bridge, moving in a circle with a radius of 6.2 m. a) Complete the diagram to show the directions of the forces acting on the car as it drives over the bridge. b) Calculate the maximum speed at which the car can travel at the top of the bridge without losing contact with the bridge.	a) b)

6.1.1 Circular motion

Questions	
Saturn orbits the Sun at a radius of 1.43 billion km. The force due to gravity between two objects is given by $$F_{gravity} = \frac{Gm_1m_2}{r^2}$$ a) Complete the diagram to show the forces acting on Saturn as it orbits the Sun. b) Calculate the length of one of Saturn's years. The Sun has a mass of 1.99×10^{30} kg.	a) b)

6.1.1 Circular motion

Questions	
A 3170 kg car drives around a curve, without slipping, with a radius of 67.2 m, around a banked slope which is raised at an angle of 21.3° to the horizontal. **a) Draw a free body diagram to show the forces acting on the car as it drives around the curve.** **b) Calculate the speed at which the car drives.**	**a)** **b)**

6.1.1 Circular motion

Questions

A pendulum swings in a circle, making an angle θ to the vertical. The pendulum swings with a frequency of 0.664 s^{-1} and at a radius of 13.5 cm.

a) Complete the diagram to show the forces acting on the pendulum as it swings.

b) Calculate the angle θ.

Hint: You might have to use

$$\frac{\sin\theta}{\cos\theta} = \tan\theta$$

a)

b)

Topic 6.1.2: Simple harmonic motion (SHM)

	Questions	
6.1.2 Simple harmonic motion (SHM)	For each of the following cases, state the restoring force, resulting in simple harmonic motion. a) A pendulum swinging. b) A mass oscillating on a spring. c) A negative charge oscillating at the exact centre between two negative charges.	
	Fill in the gaps to describe the restoring force and velocity of an object in simple harmonic motion over time.	When displacement is linear velocity is ____ maximum, the restori ________________ direc restoring force alway
	Write a proportionality between the acceleration of an object in simple harmonic motion and its displacement.	

6.1.2 Simple harmonic motion (SHM)	Questions	
	A ball on a spring undergoes simple harmonic motion. At time t_1, the ball has a displacement of [illegible] cm and an acceleration of -34 m s^{-2}. Calculate the acceleration of the ball at t_2, when the ball has a displacement of -7.0 cm.	
	An equation for the acceleration of an object in simple harmonic motion is shown opposite. Label the variables and state units for each. Hint: In an exam these will be given in the data booklet.	
	A mass on a spring oscillates with an angular speed of 0.88 rad s^{-1}. Calculate the acceleration of the mass when it is 6.2 cm away from the central position.	
	As a pendulum swings, at one point the displacement of the pendulum is [illegible] m, and the acceleration is [illegible]. Calculate the angular speed of the pendulum.	

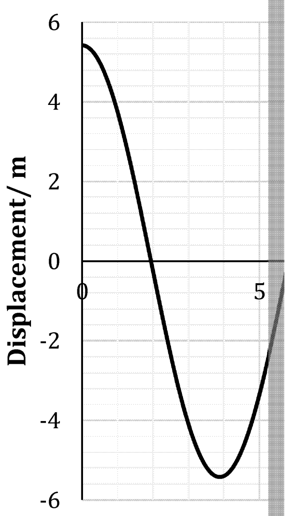
6.1.2 Simple harmonic motion (SHM)	Questions	
	An equation for the displacement of an object undergoing simple harmonic motion is shown opposite. [illegible] the variables and state a unit for each. Hint: In an exam, these will be given in the data booklet.	
	A ball sits on the surface of the water, and is set bobbing up and down with simple harmonic motion. The amplitude of the ball's simple harmonic motion is 9.6 mm. The angular speed is 7.1 rad s^{-1}. Calculate the displacement of the ball 3.2 s after it is first set in motion, in mm.	

6.1.2 Simple harmonic motion (SHM)

Questions

The graph opposite shows the simple harmonic motion over time of a particle.

Determine the amplitude and angular speed of the particle's motion.



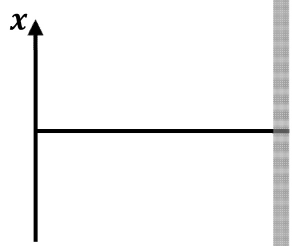
Rearrange the equation for the displacement of an object in simple harmonic motion for the object's angular speed.

6.1.2 Simple harmonic motion (SHM)

Questions	
A particle undergoing simple harmonic motion has a maximum displacement of 6.2 cm. At a [illegible], the particle has a displacement [illegible] cm. Calculate the angular speed of the particle.	
An equation for the linear velocity of an object undergoing simple harmonic motion is shown opposite. Label the variables and state the unit for each.	
[illegible] equation for the velocity of an object undergoing simple harmonic motion has a $\pm$ sign. What is the physical significance of this sign?	
A particle moves with simple harmonic motion, with an amplitude of 76 cm and an angular speed of 5.3 rad s^{-1}. Calculate the linear velocity of the particle when the displacement of the particle is -21 cm.	

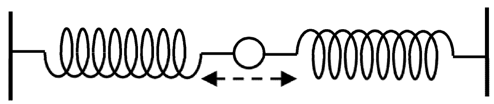
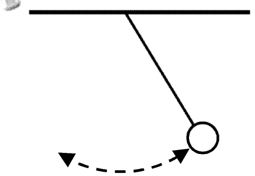
	Questions	
6.1.2 Simple harmonic motion (SHM)	Rearrange the equation for the velocity of an object in simple harmonic motion for the object's displacement.	
	A particle undergoes simple harmonic motion. The motion has an amplitude of 14.5 cm and an angular speed of 9.22 rad s^{-1}. At what displacement will the particle have a linear velocity of 0.850 m s^{-1}?	

6.1.2 Simple harmonic motion (SHM)

Questions	
Expand the equation for the linear velocity of a particle undergoing motion by substituting in the equation for the displacement of the particle.	
A particle undergoes simple harmonic motion. The amplitude of the motion is 38 μm and the frequency of oscillation is 21 kHz. Calculate the speed of the particle after one minute.	
The diagram below shows a particle in simple harmonic motion at the exact centre of an oscillation at $t = 0$. Draw displacement–time, velocity–time and acceleration–time graphs for the particle. 	

	Questions	
6.1.2 Simple harmonic motion (SHM)	A student is given the displacement–time graph of an object undergoing simple harmonic motion. Describe how the student could determine the velocity–time and acceleration–time graphs from the displacement–time graph.	
	Write equations that give the maximum speed and maximum acceleration of an object undergoing simple harmonic motion.	
	Derive the equation for maximum speed from the equation for the linear velocity of an object in simple harmonic motion.	
	Derive the equation for maximum acceleration from the equation for the acceleration of an object in simple harmonic motion.	

Topic 6.1.3: Simple harmonic systems

	Questions	
6.1.3 Simple harmonic systems	The equation for the period of oscillation for a mass-spring system is shown opposite. Label the variables and state a unit for each. 	
	The equation for the period of oscillation for a simple harmonic is shown opposite. Label the variables and state a unit for each. 	
	Foucault's pendulum is a 67 m long pendulum in the Panthéon in Paris, which is used to show the rotation of Earth as the oscillation of the pendulum changes direction as Earth turns beneath it. Calculate the period of Foucault's pendulum.	

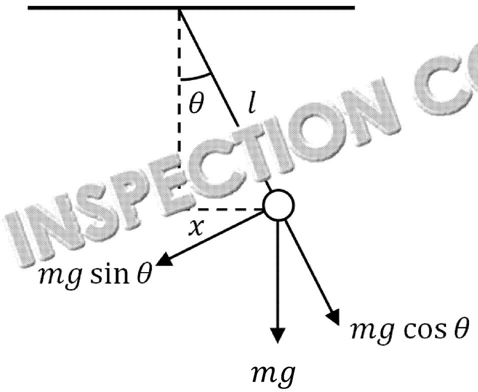
	Questions	
6.1.3 Simple harmonic systems	Rearrange the equation for the period of a mass-spring system to find the spring constant, k.	
	A 28.2 g mass is oscillating between two springs. The time period of the oscillation is 0.541 s Calculate the spring constant of the springs.	

6.1.3 Simple harmonic systems

Questions

Use the diagram below to find the linear acceleration of the mass at the end of the pendulum, and then compare this to the defining equation of simple harmonic motion to prove the equation for the period of a pendulum.

Hint: You will have to use the small-angle approximation $sin\theta \approx \theta$



Describe an experiment that could be used to show that the period of a pendulum depends only on the length of the pendulum, and not its mass.

6.1.3 Simple harmonic systems	Questions	
	State the variables for an experiment investigating the period of a pendulum with varying length, as described in the question above.	
	For the experiment described above, describe how the results could be analysed	

6.1.3 Simple harmonic systems

Questions

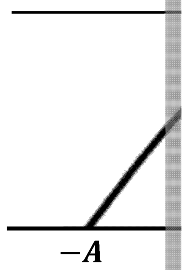
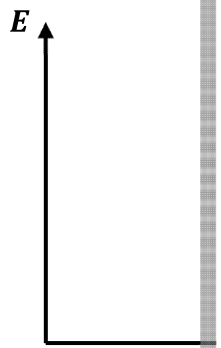
[illegible]udent carries out an experiment where they measure the periods of pendulums of different lengths.

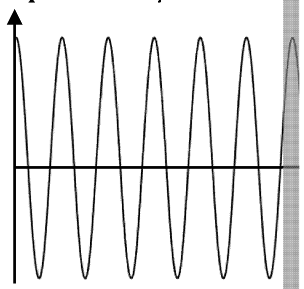
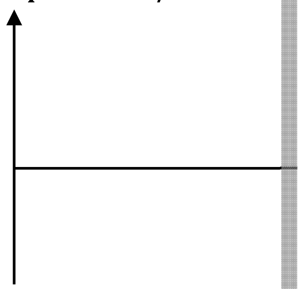
They collect the following data.

Length/ m	Period/ s	Period²/ s²
0.1	0.61 ± 0.02	0.372 ± 7 %
0.2	0.93 ± 0.02	[illegible] ± 4 %
0.3	1.16 ± 0.0[illegible]	1.[illegible] ± 3 %
0.4	1.[illegible] ± 0.0[illegible]	1.51 ± 3 %
0.5	[illegible] ± 0.02	2.19 ± 3 %
[illegible]	1.56 ± 0.02	

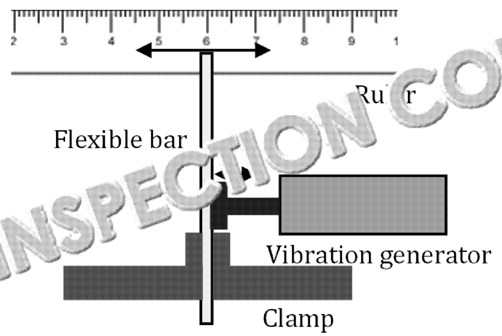
[illegible]ulate the value for period² for the 0.6 m pendulum, including uncertainty, and use a graph to show that the length and pendulum approximately follow the rule

$$T = 2\pi\sqrt{\frac{l}{g}}$$

	Questions	
6.1.3 Simple harmonic systems	The graph to the right shows the kinetic energy, E_k, of a pendulum as it swings in terms of its displacement from its equilibrium position. On the same graph, sketch the gravitational potential energy, E_p, and total energy, E_{total}, of the pendulum as it swings.	
	A mass-spring system is pulled taut and then released. On the axes opposite, draw the kinetic energy, E_k, potential energy, E_p, and total energy, E_{total}, of the system, as it oscillates over time.	
	Describe the effect of damping on a simple harmonic oscillator.	

	Questions	
6.1.3 Simple harmonic systems	The graph opposite shows displacement against time for an undamped oscillator. Draw the effect on the oscillator in the case of light damping, heavy damping and critical damping.	Undamp Displacement/ m  Heavy dam Displacement/ m 
	What type of damping could be used to slow a door closing? Explain your answer.	
	What type of damping is best for the suspension in a car? Explain your answer.	
	A clock's bell has been ringing for a long time after it is struck. The owners want the bell to ring for a shorter period of time, but still want the bell to ring several times. What type of damping should they use? Explain your answer.	

Topic 6.1.4: Forced vibrations and resonance

	Questions	
6.1.4 Forced vibrations and resonance	Describe the difference between free vibrations and forced vibrations.	
	What is meant by the term 'natural frequency'?	
	Describe the effect of resonance on an oscillating system.	
	Explain how resonance occurs.	
	Describe how the apparatus below can be used to investigate the resonant frequency of a system. 	

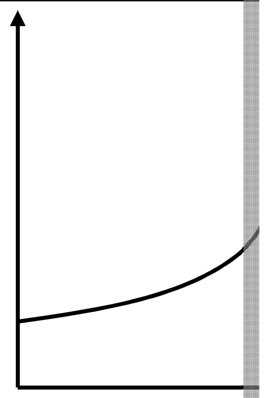
6.1.4 Forced vibrations and resonance

Questions

The graph to the right shows the amplitude of a given system compared to driving frequency.

Draw on the graph what you would expect to see for the same system after it has been damped.

Amplitude / m



In the summer of 2000 the Millennium Bridge in London was opened. When pedestrians crossed the bridge began to sway dangerously.

The footbridge was temporarily closed and engingeers fitted damping to the bridge, which solved the problem.

Suggest why the bridge began to sway when people crossed, and explain why adding damping to the bridge stopped the phenomenon.

A harp has many strings of different length. When each string is plucked, a different note is heard.

Explain why different notes are heard when plucking different harp strings.

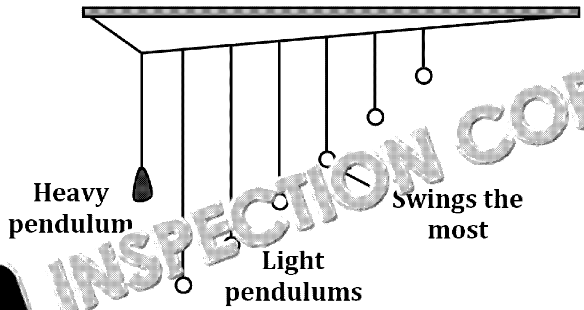
6.1.4 Forced vibrations and resonance

Questions

Barton's pendulums is a physics experiment. A large, heavy pendulum is hung from the same string as several lighter pendulums with a variety of different lengths.

When the large pendulum is swung, energy is transferred to the lighter pendulums.

Explain why the light pendulum which is the same length as the heavy pendulum swings the most.



Topic 6.2.1: Thermal energy transfer

	Questions	
6.2.1 Thermal energy transfer	Write an equation in words for the internal energy of a system.	
	Explain why a system with a higher temperature has a higher sum of kinetic energy.	
	Explain why two particles which are more separated have higher potential energy.	
	Does a mug of cold water or an identical mug of warm water have a higher internal energy? Explain your answer.	
	Which has a higher internal energy: a beaker of water, or the same mass of water vapour, at the same temperature? Explain your answer.	

	Questions	
6.2.1 Thermal energy transfer	What is required for an increase in the internal energy of a system?	
	Write down the first law of thermodynamics.	
	A student blocks the end of an empty syringe and then pushes the plunger down. The internal energy of the air in the syringe increases. The student lets go of the plunger and the air in the syringe pushes the plunger back to its original position. Explain why the internal energy increases when the student pushes the plunger, but decreases when the air pushes the plunger.	
	In a refrigerator cooling system, gas is allowed to expand. This causes the gas to cool, which then cools the interior of the refrigerator. Explain why expanding gas cools down, in terms of the first law of thermodynamics.	
	Explain why a heat input is required to boil a liquid, in terms of energy of the particles in the liquid.	

6.2.1 Thermal energy transfer

Questions	
Write an equation for the heat inputted to an object, causing a change in temperature. **Label the variables and state a unit for each.**	
A copper cube has a mass of 0.054 kg. The cube is heated to 48 °C and then allowed to cool to 22 °C. The specific heat capacity of copper is 0.39 J g^{-1} K^{-1}. **Calculate the heat lost from the system.** ***Make sure your units are consistent!***	
Rearrange the equation for the heat required for a temperature change to find the final temperature.	

6.2.1 Thermal energy transfer

Questions

32.1 cm³ of boron is heated from an initial temperature of [illegible] °C by an electric heater. The heater registers an input of power to the boron of 236 W for three minutes.

The density of boron is 2370 kg m⁻³ and the specific heat capacity of boron is 1030 J kg⁻¹ K⁻¹.

Calculate the temperature of the boron after heating. Give your answer in kelvin.

Water flows through an immersion heater and increases in temperature by 19 K.

The power of the immersion heater is 12 kW. Calculate the rate that water flows through the immersion heater.

The specific heat capacity of water is 4200 J kg⁻¹ K⁻¹.

Write an equation for the heat inputted to an object, causing a change of state.

Label the variables and state a unit for each.

	Questions	
6.2.1 Thermal energy transfer	How much energy is released when [illegible] g of chlorine gas condenses? The specific latent heat of vaporisation for chlorine is [illegible] kJ/kg.	
	A beaker of 241 g of propanol is heated from 18.1 °C to propanol's boiling point at 97.3 °C. A total of 98.2 kJ is used to heat the propanol. The specific heat capacity of propanol is 2390 J kg^{-1} K^{-1} and the specific latent heat of propanol is 690 kJ kg^{-1}. Calculate the mass of propanol that evaporated in grams.	
	Describe how the method of mixtures can be used to determine the specific heat capacity of a substance.	

	Questions	
6.2.1 Thermal energy transfer	The mass of a block of copper is measured and heated by a hotplate. The temperature of the block is recorded as it is heated for a set amount of time. The power that the hotplate provides at a given temperature is listed in its user manual. List the potential sources of random errors and systematic errors in the experiment.	**Random**
	An iron ball has a mass of 840 g and is heated to 610 K. The ball is dropped into [illegible].3 kg of water, which is initially at a temperature of 290 K. The final temperature of the water is 297 K. The specific heat capacity of water is [illegible] J kg^{-1} K^{-1}. Calculate the specific heat capacity of iron.	

Topic 6.2.2: Ideal gases

	Questions	
6.2.2 Ideal gases	Gas laws are experimental relationships. Explain what this means.	
	Define the term 'absolute zero'.	
	Convert: a) 0 K to Celsius b) 273.15 K to Celsius c) 460 K to Celsius	
	Convert: a) 0 °C to kelvin b) [illegible]5 °C to kelvin c) -155 °C to kelvin	
	Write the ideal gas equation in two forms, and explain the difference.	

	Questions	
6.2.2 Ideal gases	**Write Boyle's law, which describes an ideal gas at constant temperature.**	
	Write Charles's law, which describes an ideal gas at constant pressure.	
	2.5 moles of an ideal gas is at a temperature of 450 K and has a volume of 6.7 m^3. **Calculate the pressure of the ideal gas.**	
	An ideal gas has a pressure of 861 Pa, a volume of 4.94 m^3 and a temperature of -77.6 °C. **Calculate the number of particles in the ideal gas.**	

	Questions	
6.2.2 Ideal gases	At constant temperature, an ideal gas expands from 0.0941 m³ to 0.116 m³. The initial pressure of the gas is 5.31 kPa. Calculate the final pressure of the ideal gas.	
	An ideal gas is heated from 18.9 °C to 50.1 °C, causing it to expand to a volume of 6.22 m³. The pressure of the gas is constant. Calculate the initial volume of the gas.	

	Questions	
6.2.2 Ideal gases	**A box contains an ideal gas at a pressure of 26.7 kPa and a temperature of 72.5 °C. The gas cools to a temperature of 49.4 °C.** **The walls of the box are inflexible, so the volume is constant.** **Calculate the pressure of the gas after it cools.**	
	[illegible] an equation for the work done by a gas during a change in volume at constant pressure.	
	A piston has a cross-sectional area of 25.3 [illegible] The gas in the piston expands, doing [illegible] of work and pushing the piston [illegible] so that the height of the piston [illegible] increases from 11.1 cm to 19.5 [illegible] **Calculate the pressure of the gas.**	

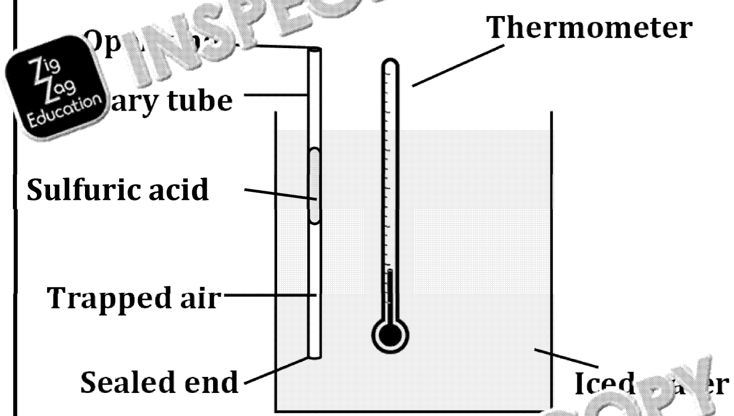
	Questions	
6.2.2 Ideal gases	Water vapour is allowed to expand, with no [illegible] of work or heat. The water vapour cools due to the expansion, and liquid water condenses. At a constant pressure of 950 Pa, the water vapour expands from 1.2 m^3 to 7.1 m^3. Calculate the mass of water that condenses. The specific latent heat of vaporisation of water is 2230 J/g.	
	How many molecules are in 1 mol of a substance?	
	Write equations for the number of molecules in a sample and the number of moles in a sample, in terms of the sample's molar mass.	

6.2.2 Ideal gases	Questions	
	The molar mass of difluoroethane is 66.05 g. Calculate: a) The number of moles in 1.00 kg of difluoroethane. b) The number of molecules in 444 g of difluoroethane. c) The mass of 25.7 moles of difluoroethane. d) The molecular mass of difluoroethane in kilograms.	
	Describe how Boyle's law may be investigated.	

6.2.2 Ideal gases

Questions

The following apparatus is used to investigate Charles's law.



Warm water is slowly added to the iced water so that its temperature increases.

Explain why the apparatus can be used to investigate Charles's law and describe how the experiment shown can be used to determine absolute zero, including a sketch of any graphs you would use.

Random

For the experiment used to investigate Charles's law and determine absolute zero, list potential sources of random errors and systematic errors.

Questions

6.2.2 Ideal gases

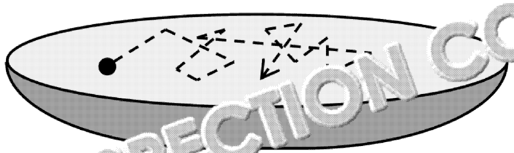
The following data is collected in an experiment investigating Boyle's law.

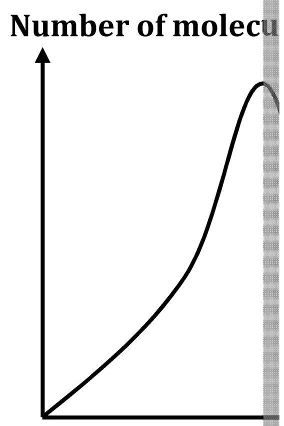
Pressure/ kPa	Length/ mm
80	4.7
90	[illegible]
100	[illegible]
110	3.4
120	3.2
[illegible]	2.9
140	2.7
150	2.6
160	2.3

Use the data to show that Boyle's law is followed.

Pressure/ kPa
80
90
100
110
120
130
140
150
160

Topic 6.2.3: Molecular kinetic theory

	Questions	
6.2.3 Molecular kinetic theory	What is Brownian motion?	
	A grain of pollen is placed in a bowl of water. The pollen is jostled about the surface of the water. Explain how this motion provides evidence for the particle model of matter. 	
	Use the simple particle model to explain the following observations of an ideal gas. a) When temperature increases at fixed volume, pressure increases. b) When the volume of a gas increases, its temperature increases, if pressure is constant. c) When the volume of a gas increases at constant temperature, its pressure decreases.	a) b) c)

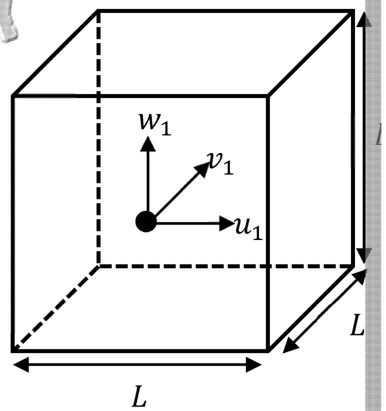
	Questions	
6.2.3 Molecular kinetic theory	The graph opposite shows the speed distribution of particles in a gas. Sketch how the graph would change if the gas were heated.	
	The ideal gas laws are empirical but the molecular kinetic theory is purely theoretical. Describe the differences between these approaches.	
	State the six assumptions made about ideal gases when deriving the kinetic theory equation, $pV = \frac{1}{3}Nm(c_{rms})^2$.	

6.2.3 Molecular kinetic theory	Questions	
	Explain how the following observations provide an experimental basis for the assumptions made about ideal gases.	Gases display Browni Gases aren't observed Gases can be compres

The following questions are all part of the same derivation, shown b

The entire derivation uses the diagram seen here, showing the velocit

There are N identical gas molecules in the box, with mass m.



From Pythagoras' theorum, the total velocity of the gas molecule is g

Derive an expression for the change in momentum as the gas molecule collides with the side of the container.	

	Questions	
6.2.3 Molecular kinetic theory	**Use the time taken for the molecule to travel from one side of the container to the other, and back, to determine the number of collisions the molecule makes with the wall of the container per second.**	
	By finding the change in momentum per second, derive the force exerted by the gas molecule on the wall of the container.	
	Calculate the force exerted by all *N* molecules of the gas. **Use** $(u_{rms})^2 = \frac{u_1^2 + u_2^2 + u_3^2 + \ldots + u_N^2}{N}$	
	Derive an expression for the pressure exerted by the molecules on the walls of the container.	

6.2.3 Molecular kinetic theory

Questions	
Use the fact that, generally, $(u_{rms})^2 = (v_{rms})^2 = (w_{rms})^2$ to derive the final form of the kinetic theory equation, $pV = \frac{1}{3}Nm(c_{rms})^2$.	
The root mean square velocity of oxygen molecules in a container is 460 m s^{-1}. The container has a volume of [illegible] and contains 9.4 moles of oxygen. The molar mass of oxygen is 32 g. Calculate the pressure of the gas.	
The density of air is 1.225 kg m^{-3} and the pressure at sea level is 101.3 kPa. Calculate the root mean square speed of air molecules.	

	Questions	
6.2.3 Molecular kinetic theory	What is the internal energy of an ideal gas?	
	Give an equation for the average kinetic energy of an ideal gas in terms of its temperature.	
	Using the kinetic theory equation and the ideal gas equation, derive the two forms of equation for the average kinetic energy of particles in a gas.	

	Questions	
6.2.3 Molecular kinetic theory	**Find the average kinetic energy of a gas that has a temperature of 153 °C.**	
	Find the root mean square speed of argon at a temperature of 44.8 K. **The molecular mass of argon is 39.9 u.**	