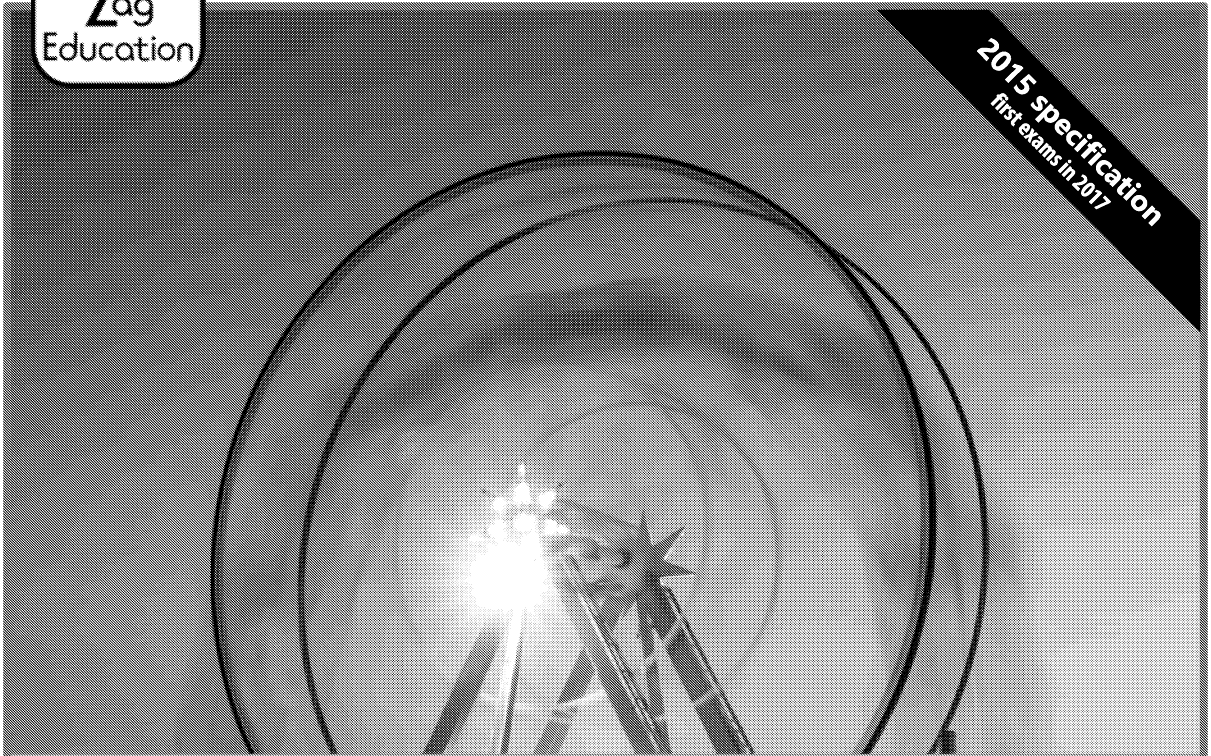
Physics

A Level | AQA | 7408



Revision Grids
for A Level AQA Physics
Section 6: Further Mechanics and Thermal Physics

zigzageducation.co.uk

POD 8585

Contents

Teacher's Introduction

These learning grids are designed to help your students independently learn content and help you to assess their knowledge during teaching of each section of Section 6 – Further mechanics and thermal physics, within the AQA A Level Year 2 Physics specification. The concept is that your students are assigned a set of pages to read from the relevant book and then are asked to complete the relevant learning grids, possibly for homework or as a refresher for a topic. These activities are particularly useful for students who need more support, but they contain some thought-provoking reasoning questions which will stimulate highly engaged students.

Each learning grid is closely linked 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.

> This resource directly references:
> AQA A Level Physics Year 2, 2nd Edition;
> Breithaupt;
> Oxford, 2015
>
> and
>
> AQA A-Level Physics Year 2;
> Pharaoh, Bishop & Gidzewicz;
> Collins, 2016
>
> AQA A level Physics 2;
> England, Davenport, Pollard & Thomas;
> Hodder Education, 2015

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 on the specification.

Learning grids in this section will on average take 20–30 minutes each. However, this resource includes substantial opportunities to develop mathematics skills, and students who find maths challenging may find that these resources take longer to complete.

This resource can be used to engage students and allow those who have missed lessons to catch up quickly. The learning grids can be used as the basis for a homework exercise, and the answer scheme allows them to be easily used in cover lessons. Students could also use the worksheets as an independent learning and revision resource. All resources can be photocopied in black and white. We hope you and your students enjoy this resource!

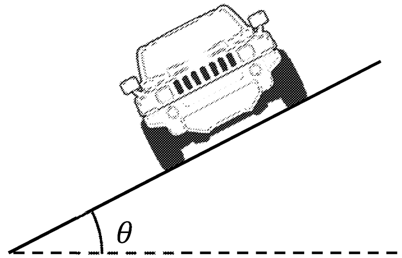
Selected Question and Answer Pages

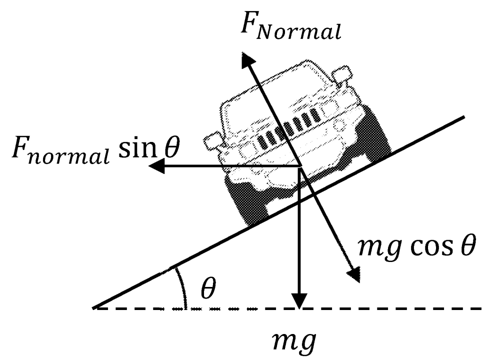
For demonstration only, the sample answer pages immediately follow their corresponding question pages

	Questions	Answers
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) 922° 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.**	$\omega = \frac{v}{r}$ $\omega = 2\pi f$

6.1.1 Circular motion

Questions	Answers
State the equations used to convert radians to degrees, and degrees to radians.	$\text{degrees} = 360 \times \frac{\text{radians}}{2\pi}$ $\text{radians} = 2\pi \times \frac{\text{degrees}}{360}$
Convert: **a) 1 rad to degrees** **b) $\frac{5\pi}{2}$ rad to degrees** **c) 2.781 rad to degrees**	**a)** $\text{degrees} = 360 \times \frac{1}{2\pi} = 57.3°$ **b)** $\text{degrees} = 360 \times \frac{5\pi}{2} \times \frac{1}{2\pi} = 450°$ **c)** $\text{degrees} = 360 \times \frac{2.781}{2\pi} = 159.3°$
Convert: **a) 270° to radians** **b) 41° to radians** **c) 922° to radians**	**a)** $\text{radians} = 2\pi \times \frac{270}{360} = \frac{3}{2}\pi$ rad **b)** $\text{radians} = 2\pi \times \frac{41}{360} = 0.72$ rad **c)** $\text{radians} = 2\pi \times \frac{922}{360} = 16.1$ rad
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.**	$\boldsymbol{\omega = \frac{v}{r}}$ $\boldsymbol{\omega = 2\pi f}$ Angular speed rad s^1 Linear speed m s^{-1} Rad m

	Questions	Answers
6.1.1 Circular motion	**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)**

<table>
<tr><th></th><th>Questions</th><th>Answers</th></tr>
<tr><td rowspan="2">6.1.1 Circular motion</td><td rowspan="2">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.</td><td>a)


Note: In an exam, only $\boldsymbol{mg}$ and $\boldsymbol{F_{Normal}}$ would be needed. The resolved components are shown here to help with the working in b).</td></tr>
<tr><td>b) $\boldsymbol{F_{normal}\sin\theta = F_{centripetal} = \frac{mv^2}{r}}$
$\boldsymbol{F_{normal} = mg\cos\theta}$
$\boldsymbol{\frac{mv^2}{r} = mg\cos\theta\sin\theta}$
$\boldsymbol{v = \sqrt{rg\cos\theta\sin\theta}}$
$\boldsymbol{v = \sqrt{67.2 \times 9.81 \times \cos 21.3 \times \sin 21.3}}$
$\boldsymbol{v = 14.9}$ m s^{-1}</td></tr>
</table>

	Questions	Answers
6.2.3 Molecular kinetic theory	**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 2.2 m^3 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	Answers
Molecular kinetic theory	**Use the fact that, generally, $(u_{rms})^2 = (v_{rms})^2 = (w_{rms})^2$ to derive the final form of the kinetic theory equation, $pV = \frac{1}{3}Nm(c_{rms})^2$.**	$(u_{rms})^2 = (v_{rms})^2 = (w_{rms})^2$ and $c_1^2 = u_1^2 + v_1^2 + w_1^2$ $(c_{rms})^2 = 3(u_{rms})^2$ $(u_{rms})^2 = \frac{1}{3}(c_{rms})^2$ $p = \frac{1}{3} \times \frac{Nm(c_{rms})^2}{V}$ $pV = \frac{1}{3}Nm(c_{rms})^2$
	The root mean square velocity of oxygen molecules in a container is 460 m s^{-1}. The container has a volume of 2.2 m^3 and contains 9.4 moles of oxygen. **The molar mass of oxygen is 32 g.** **Calculate the pressure of the gas.**	$pV = \frac{1}{3}Nm(c_{rms})^2$ $p = \frac{1}{3}\frac{Nm(c_{rms})^2}{V}$ We don't need to work out N or m, because Nm just equals the total mass of the gas in the sample, which is also equal to the molar mass times the number of moles. $p = \frac{1}{3} \times \frac{0.032 \times 9.4 \times 460^2}{2.2}$ $p = 9600$ Pa
	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.**	$pV = \frac{1}{3}Nm(c_{rms})^2$ $c_{rms} = \sqrt{\frac{3pV}{Nm}}$ Density gives the mass (Nm) in 1 m^3, so we can ι $c_{rms} = \sqrt{\frac{3 \times 101.3 \times 10^3}{1.225}}$ $c_{rms} = 498.1$ m s^{-1}

Additional Selected Question Pages

Topic 6.2.1: Thermal energy transfer

Oxford: pp. 36–45
Collins: pp. 40–50
Hodder: pp. 56–64

	Questions	Answers
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	Answers
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.	

	Questions	Answers
6.2.1 Thermal energy transfer	**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.** ***Hint: Make sure your units are consistent!***	
	Rearrange the equation for the heat required for a temperature change to find the final temperature.	

	Questions	Answers
6.2.1 Thermal energy transfer	**32.1 cm³ of boron is heated from an initial temperature of 14.5 °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.**	

