

★ **UNITS 1&2** ★  
**NEW FOR 2021**

 **Edrolo**

INTRODUCING THE  
**UNITS 1-4**  
**EDROLO PHYSICS**  
TEXTBOOKS

# VCE PHYSICS

## Units 1-4

- **VCAA-style questions** based on a thorough analysis of over 900 exam questions
- **Previous lessons questions** that cover concepts from previous lessons to promote recognition of theory out of context (like in an exam) and to consolidate concepts through spaced repetition
- **Exemplar answers** with a **checklist** and **video solution** for every exam-style question
- **Chapter and AOS review tests** for valuable SAC & exam practice
- **Concise theory** covers the core knowledge required within the scope of the VCAA Study Design
- **Theory summaries** concisely reiterate the key points from the lesson.
- **Key Science Skills & Practical Investigations** covered in a dedicated chapter, with Key Science Skills questions in every subsequent lesson
- **Units 1&2 revision lessons** to ensure all students start with a foundational knowledge of physics
- **Edrolo Theory Master videos aligned** directly to textbook chapters
- **Full lessons dedicated to difficult concepts:** deep dive into areas of the Study Design students find most challenging:
  - Oscillating springs
  - Key science skills
  - Electrical power transmission
  - The photoelectric effect

# AT THE BEGINNING OF EACH LESSON YOU WILL FIND:

Key Knowledge dot-points from the study design provide explicit links to the syllabus.

Key Knowledge units show a breakdown of the lesson.

Key terms and definitions are listed at the beginning of the lesson. All key terms are collated in the glossary in the back of the book.

Knowledge Unit overview provides a brief description of what will be covered next using basic terminology to introduce concepts.

Problem-solving process introduces new methods of problem-solving, relevant to the lesson.

Useful tips provide important insights into what VCAA assessors look for in exam responses and bring students' attention to common mistakes.

Worked examples guide students through the analysis of a question, the steps required, and a thorough work-through of how to reach the answer.

# QUESTIONS, SOLUTIONS, & EXPERIMENTS

## 2E BANKED CIRCULAR MOTION

Have you ever wondered why cycling events at the Olympics take place on banked tracks in a velodrome? This lesson explores the physics of circular motion on banked tracks and circular motion with conical pendulums.

Lesson overview summarises the key points being covered.

2A Kinematics recap	2B Forces recap	2C Inclined planes and connected bodies	2D Basic circular motion	2E Banked circular motion	2F Vertical circular motion	2G Projectile motion
<b>Study design key knowledge dot point</b>						
investigate and analyse theoretically and practically the uniform circular motion of an object moving in a horizontal plane:						
$F_{net} = \frac{mv^2}{r}$ , including:						
- a vehicle moving around a circular road						
- a vehicle moving around a banked track						
- an object on the end of a string						
<b>Key knowledge units</b>						
Banked tracks						3.3.2.3.1
Conical pendulums						3.3.2.3.2

Formulas for this lesson	
Previous lessons	New formulas
2B $F_g = mg$	$F_N = \sqrt{F_{net}^2 + F_g^2}$
2D $F_{net} = \frac{mv^2}{r}$	$F_{net} = F_N \sin(\theta) = F_g \tan(\theta)$
	$v = \sqrt{rg \tan(\theta)}$

### Definitions for this lesson

**conical pendulum** a mass on the end of a string which undergoes horizontal circular motion  
**design speed** the speed on a banked track for which there is no sideways frictional force acting on the vehicle

### Banked tracks 3.3.2.3.1

#### OVERVIEW

Banked tracks are curved sections of a track for a vehicle commonly used in races. They are useful because of a phenomenon called the 'design speed'. A vehicle travelling at the design speed of a banked track does not require a friction force between the tyres and the road to provide the centripetal force.

#### THEORY DETAILS

##### Forces

In most real-world circumstances, a vehicle undergoing circular motion on a banked track

Final total momentum:  
 $p_f = p_i \therefore p_f = -3000 \text{ kg m s}^{-1}$  (negative value indicates direction is to the left)  
 Final velocity:  
 $p_f = (m_A + m_B) \times v_f \therefore -3000 = (3000 + 3000) \times v_f$   
 $v_f = \frac{-3000}{(3000 + 3000)} = -0.500 \text{ m s}^{-1}$  (negative value indicates direction is to the left)

b Initial total kinetic energy:  
 $KE_A = \frac{1}{2} m_A v_A^2 = \frac{1}{2} \times 3000 \times 3.00^2 = 13\,500 \text{ J}$   
 $KE_B = \frac{1}{2} m_B v_B^2 = \frac{1}{2} \times 3000 \times 4.00^2 = 24\,000 \text{ J}$   
 $KE_{tot} = KE_A + KE_B = 13\,500 + 24\,000 = 37\,500 \text{ J}$   
 Final total kinetic energy:  
 $KE_{tot} = KE_f = \frac{1}{2} m_A v_f^2 + \frac{1}{2} m_B v_f^2 = 2 \times \frac{1}{2} \times 3000 \times 0.500^2 = 750 \text{ J}$   
 Compare initial and final total kinetic energy:  
 $KE_i \neq KE_f$  therefore it is an inelastic collision.

Note that kinetic energy is **not** a vector quantity. No matter the direction objects are travelling before or after a collision, kinetic energy is always added to find the total.

### Energy dissipation 3.3.15.5

#### OVERVIEW

During inelastic collisions, the kinetic energy lost is dissipated from the objects in the form of heat, sound, and the deformation of the objects.

#### THEORY DETAILS

During collisions where kinetic energy is not conserved (inelastic collisions), the energy lost must be transformed into other forms of energy, since energy cannot just vanish. Imagine a tennis ball bouncing along the floor. With each bounce, the tennis ball loses kinetic energy, which can be seen by the ball bouncing lower each time. We know that there will be a sound produced as the ball bounces, and the energy required to produce this sound comes from the kinetic energy of the ball. Additionally, there will be friction between the tennis ball and the ground, which generates heat. This heat energy is also transformed from the initial kinetic energy of the ball. Finally, with each bounce energy is transformed into deformation of the tennis ball (changing its shape).

Due to processes like the ones seen in the tennis ball bounce, kinetic energy is dissipated into other forms during inelastic collisions. To observe energy dissipation yourself, try rubbing your hands together. The kinetic energy of your hands will be transformed into heat energy due to friction.

#### Theory summary

- The total momentum is conserved in all collisions
- Kinetic energy is conserved in elastic collisions
- Kinetic energy is not conserved (decreases) in inelastic collisions
- When energy is not conserved, it is dissipated in the form of heat, sound or object deformation

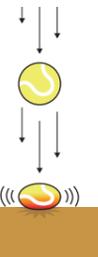


Figure 2 Energy is dissipated as sound, heat, and deformation of the tennis ball when it collides with the ground.

#### KEEN TO INVESTIGATE?

- oPhysics 'Momentum & Energy: Elastic and Inelastic Collisions' simulation <https://ophysics.com/e2.html>
- oPhysics 'Momentum & Energy: Explosive Collisions' simulation <https://ophysics.com/e2a.html>
- PHET 'Collision Lab' simulation [https://phet.colorado.edu/sims/collision-lab/collision-lab\\_en.html](https://phet.colorado.edu/sims/collision-lab/collision-lab_en.html)

Theory summary summarises all the information into a small paragraph, table, or diagram to reiterate the key points to students.

Keen to investigate provide links to simulations and videos demonstrating the theory in each lesson.

### Elastic collisions

In elastic collisions, **kinetic energy is conserved**. This means that the total kinetic energy of the colliding objects before the collision is equal to the total kinetic energy of the objects after the collision. As in all collisions, momentum is also conserved.

Not many everyday collisions are elastic: true elastic collisions only occur at a subatomic level. However, collisions between very rigid objects like billiard balls are often close to elastic collisions.

### Inelastic collisions

During inelastic collisions, **kinetic energy is not conserved**. This means that the total kinetic energy of the colliding objects before the collision is not equal to the total kinetic energy of the objects after the collision, despite momentum still being conserved. Since kinetic energy cannot be gained in a collision, the total kinetic energy after an inelastic collision will be less than before the collision. This is because the kinetic energy lost in the collision is transformed into other types of energy.

Most collisions in the real world are inelastic collisions, such as a car crash or football players tackling each other.

### Problem solving process

To solve common VCAA collision questions:

- Calculate total momentum before collision.
- Using the conservation of momentum and information provided, calculate the final velocity of the colliding objects.
- Calculate the total kinetic energy before and after the collision.
- From the change in kinetic energy, determine if the collision conserved kinetic energy (elastic) or did not (inelastic).

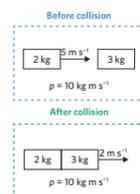


Figure 1 The total momentum of objects involved in a collision is the same before and after the collision occurs.

**USEFUL TIP**  
 If the final total kinetic energy is larger than the initial total kinetic energy, you have made a mistake in your working.

### 1 Worked example

Two 3000 kg train cars, car A and car B, are moving toward each other head on. Before they collide, car A is travelling to the right at  $3.00 \text{ m s}^{-1}$  and car B is travelling to the left at  $4.00 \text{ m s}^{-1}$ .



After the collision, the cars are joined together and move off as one.



- Calculate the final velocity of the joined cars.
- Is the collision elastic or inelastic? Justify your answer with calculations.

a Define the right direction as positive.

Initial total momentum:

$$p = mv \therefore p_A = m_A \times v_A = 3000 \times 3.00 = 9000 \text{ kg m s}^{-1}$$

$$p_B = m_B \times v_B = 3000 \times -4.00 = -12\,000 \text{ kg m s}^{-1}$$

$$p_{tot} = p_A + p_B = 9000 - 12\,000 = -3000 \text{ kg m s}^{-1} \text{ (negative value indicates direction is to the left)}$$

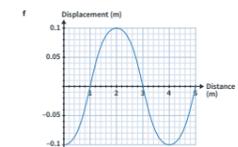
### 9A Wave fundamentals

Theory review questions		
1 C	2 C	3 D
4 B	5 D	6 A
7 C	8 C	9 B

### Exam-style questions

#### This lesson

- A, A is the only particle for which displacement increases from 0 cm just after  $t = 0$ s.
- $T = 5$  s (1 MARK)  
 $f = \frac{1}{T} = \frac{1}{5} = 0.2 \text{ Hz}$  (1 MARK)  
 $f = \frac{1}{T} = \frac{1}{5} = 0.2 \text{ Hz}$  (1 MARK)  
 $f = \frac{1}{T} = \frac{1}{5} = 0.2 \text{ Hz}$  (1 MARK)
- A: not moving, B: up, C: up, D: down  
 b Distance = 2.5 cm. Displacement = -2 cm
- A: left, B: right, C: right, D: right  
 b Distance = 5.5 m. Displacement = -0.2 cm  
 $f = \frac{1}{T} = \frac{1}{0.2} = 5 \text{ Hz}$  (1 MARK)



- I have plotted a sinusoidal line going through the points: (0, -0.1), (1, 0), (2, 0.1), (3, 0), (4, -0.1), and (5, 0).
- I have used a consistent and appropriate scale on each axis so that the space between each grid line represents a consistent value and the data takes up at least half the space on the axis.
- I have included appropriate units on each axis.

- a  $\lambda = 20 \text{ cm}$   
 b  $f = 0.20$  (1 MARK)  
 $f = \frac{1}{T} = \frac{1}{5} = 0.2 \text{ Hz}$  (1 MARK)

#### Previous lessons

- $y = \frac{1}{\sqrt{1-0.8^2}} = \frac{1}{\sqrt{1-0.64}} = 2.294$   
 $L = \frac{1}{2} \times \frac{4.52 \times 10^{18}}{2.294} = 9.75 \times 10^{17} \text{ m}$  (1 MARK)  
 $f = \frac{c}{\lambda} = \frac{3.00 \times 10^8}{9.75 \times 10^{17}} = 3.08 \times 10^{-10} \text{ Hz}$  (1 MARK)  
 $f = 6.47 \times 10^7 \text{ s}^{-1} = 2.3 \text{ years}$  (1 MARK)
- The coil begins to rotate because forces act on the current-carrying wires WX and YZ in opposite directions which creates a torque (turning effect).<sup>1</sup> The forces are due to current flowing perpendicular to the magnetic field.<sup>2</sup> By the right hand palm rule, as the current flows from W to X and the magnetic field is from left to right, the force on the left side of the coil is directed down. Similarly, the force on the right side of the coil is directed upwards.<sup>3</sup>
- I have explicitly addressed the question.<sup>1</sup>
- I have used the relevant theory: conditions for magnetic force.<sup>2</sup>
- I have used the relevant theory: application of right hand palm rule.<sup>3</sup>
- I have related my answer to the content of the question.

#### Key science skills

- Izzy has more accurate data and Emma has more precise data.<sup>1</sup> Izzy's average (106.2 nm) is closer than Emma's average (106.8 nm) to the actual wavelength (105 nm).<sup>2</sup> The range of Emma's measurements (5 nm) is smaller than Izzy's range (12 nm).<sup>3</sup>

### TEXTBOOK QUESTIONS:

- Previous lessons questions** provide spaced repetition for students to revise all concepts throughout the year.
- Theory review questions** assess a student's comprehension of the theory covered in the lesson
- Exam-style questions** provide frequent, valuable exam practise with questions covering content from within the lesson and also from previous lessons to reinforce the interconnected nature of the curriculum.
- Key Science Skills questions** assess skills outlined in the VCAA Study Design through experimental design or data analysis questions.

### TEXTBOOK SOLUTIONS:

- Exemplar responses** are written responses to every exam-style question, providing students with an example of a full-mark answer.
- Checklists** provide a breakdown of the exemplar response for worded questions and draw questions to guide students when self-marking their answers.
- Video solutions** in your Edrolo account explain and deconstruct every single exam-style question.

FOR MORE INFO SEE THE **TEXTBOOK TRAINING VIDEO** IN YOUR **EDROLO ACCOUNT**.

# NAVIGATING YOUR EDROLO TEXTBOOK ONLINE

PLANNING  
AHEAD

## VCE PHYSICS UNITS 3&4 [2020 TEXTBOOK]

Bookmarks All videos View printable unit plan

To assist with planning, there is an editable and downloadable **unit plan** available for your course.

ACCESSING THE  
TEXTBOOK PDFS,  
DIGITAL TEXTBOOK  
QUESTIONS AND  
SOLUTIONS

Unit 4, AOS 3 - Practical investigation (key science skills)			
Chapter 1: Practical investigations - Edrolo - Textbook PDF			
1A Asking questions, identifying variables, and making predictions	41 min video	<a href="#">Class progress</a>	13 questions
1B Scientific conventions	22 min video	<a href="#">Class progress</a>	8 questions
1C Collecting data	19 min video	<a href="#">Class progress</a>	32 questions
1D Representing and analysing data	6 min video	<a href="#">Class progress</a>	14 questions
1E Gradients of lines of best fit	17 min video	<a href="#">Class progress</a>	10 questions

All questions found in the text are also available as interactive digital questions. To access these, click on the **X questions** button next to the corresponding theory lesson.

### Q1

A student proposes the following statement as a hypothesis: 'The time taken for a height of 1.0 metre is 1.0 second.'

Which of the following best explains why this is a bad hypothesis?

- A It is incorrect.
- B It does not provide an explanation or predicted relationship between variables.
- C It does not make a prediction.
- D It does not start with 'It is predicted that...'

For multiple-choice questions, students receive immediate feedback.

Click the **Additional Resources** icon beside each **Area of Study** to find your **Textbook PDFs**.

**I'm confident in my understanding**  
If I came across this question again I'm confident I can answer it.

**I need help, or more study**  
I'm not confident enough with the concepts to succeed on this question in future.

- I have stated a predicted relationship between the DV (final speed) and the IV (slope angle).<sup>1</sup>
- I have explicitly addressed the effect on the DV (final speed) when the IV (slope angle) increases.<sup>2</sup>
- I have used an 'if...then...when...' statement.

#### Exemplar Response

[ If the final speed varies with the slope angle, <sup>1</sup> then the final speed will increase when the slope angle increases. <sup>2</sup> ]

For short-answer questions, students self-mark their work using the exemplar response and digital checklist.

CHECKING STUDENT  
RESPONSES

### 13C Master genes

20 questions

#### Q11c

I have explained the molecular mechanism for *BMP4* in jaw formation in cichlids. 6/8

I have explained that *BMP4* expression varies within cichlids. 4/8

I have explained how variation in *BMP4* expression led to adaptive radiation in cichlids. 2/8

Controversial Caterpillar	<input checked="" type="checkbox"/>	Balanced Badger	<input type="checkbox"/>
Senior Sheep	<input checked="" type="checkbox"/>	Classical Crocodile	<input type="checkbox"/>
		Long Leopard	<input type="checkbox"/>
		Recent Reindeer	<input type="checkbox"/>
		Wrong Walrus	<input type="checkbox"/>
		Zany Zebra	<input type="checkbox"/>

#### Balanced Badger's response

The *BMP4* gene is a regulatory master gene, that is a signaling protein. This gene can cause major phenotypic changes in a short period of time. This explains how speciation has occurred much quicker throughout evolution rather than the theory that different mutations occur slowly over time. This gene alters beak size in galapagos finches and jaws in cichlid fish, high levels producing a short robust jaw or beak with great width and depth.

I have referred to the scenario in my answer. 3/8

**Extended response:** see how each student self-assessed against the checklist. Click on any of the **checklist items** and click a student's name to view their response.

**Multiple-choice results:** see each student's answer and reflection on their understanding as well as a summary of your whole class.

### 1A Data Types

28 questions

#### Q2dii

Responses	Understands?	Understand
12/12		11/12
Name	Understands?	A
Ashamed Antelope	<input checked="" type="checkbox"/>	
Casual Caribou	<input checked="" type="checkbox"/>	
Comfortable Chimpanzee	<input checked="" type="checkbox"/>	
Global Gerbil	<input checked="" type="checkbox"/>	
Material Monkey	<input checked="" type="checkbox"/>	
Main Mosquito	<input type="checkbox"/>	
Misleading Mouse	<input checked="" type="checkbox"/>	
Ready Rabbit	<input checked="" type="checkbox"/>	
Small Sheep	<input checked="" type="checkbox"/>	
Separate Sow	<input checked="" type="checkbox"/>	
Swift Sow	<input checked="" type="checkbox"/>	
Written Wallaby	<input checked="" type="checkbox"/>	