Neap:

Trial Examination 2007

VCE Physics Unit 2

Written Examination

Question and Answer Booklet

Reading time 15 minutes
Writing time 1 hour 30 minutes

Student's Name: ______________________________

Teacher's Name: ______________________________

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Number of marks
A Core – Areas of study			
1. Movement	16	16	35
2. Electricity	15	15	30
B Detailed studies			
1. Astrophysics	13	13	25
OR			
2. Aerospace	12	12	25
OR			
3. Alternative energy sources	11	11	25
			Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, up to two pages (one A4 sheet) of pre-written notes (typed or handwritten) and one scientific calculator. Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

Question and answer booklet of 24 pages with a detachable data sheet in the centrefold.

Instructions

Detach the data sheet from the centre of this booklet during reading time.
Please ensure that you write your **name** and your **teacher's name** in the space provided above on this page.
Answer all questions in the spaces provided.
Always show your working where space is provided.
Where an answer box has a unit printed in it, give your answer in that unit.
All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other electronic communication devices into the examination room.

SECTION A – CORE

Instructions for Section A

Answer **all** questions **for both** Areas of study in this section of the paper.

You should take the value of *g* to be 10 m s^{-2}.

Area of study 1 – Movement

Theo rides his skateboard down the street. By kicking with his foot, he maintains a constant velocity of 5 m s^{-1}. During the first part of the ride, he travels 60 m along a flat, straight part of the street.

Question 1

How long will it take Theo to cover the first 60 m of his journey?

s

1 mark

Question 2

The average force exerted by Theo when he kicks must be

A. zero newtons.

B. equal to the total resistive forces acting on Theo and his skateboard.

C. greater than the total resistive forces acting on Theo and his skateboard.

D. less than the total resistive forces acting on Theo and his skateboard.

1 mark

Theo then stops for five seconds at the top of a downward-sloping section of the street, before allowing himself to roll freely down the hill. It takes him 10 s to get to the bottom, and he reaches a maximum speed of 15 m s^{-1}.

Question 3

Assuming that Theo accelerates uniformly, calculate the length (in metres) of this downward section of his journey.

m

2 marks

At the bottom of the hill, Theo coasts without any further kicking. He is travelling along a horizontal part of the path, and he comes to a stop in a further 5 s.

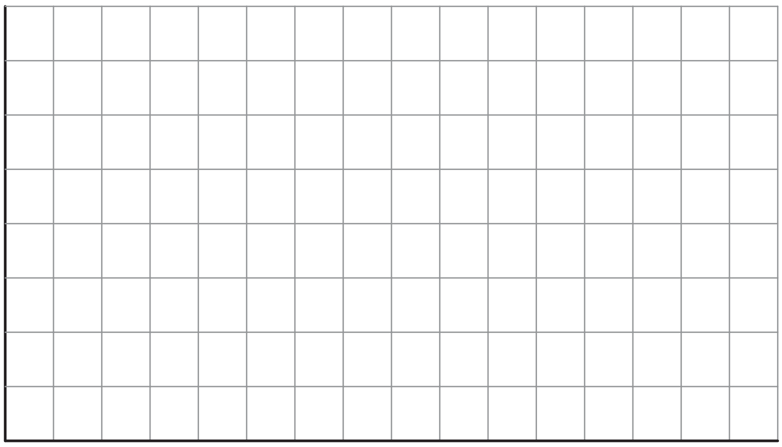
Question 4

Explain, using Newton's first **and** second laws, why Theo eventually comes to a stop.

2 marks

Question 5

On the axes below, draw a velocity–time graph of Theo's journey as described above. Include the values and units on the horizontal and vertical axes.



3 marks

Figure 1 shows Theo coming down a **different** hill.

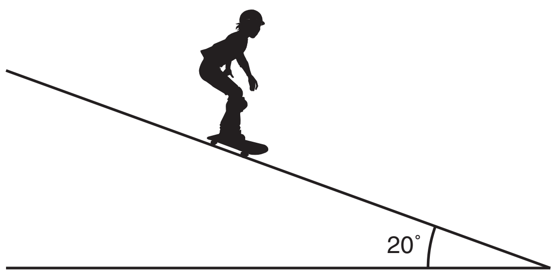


Figure 1

Question 6

Using arrows drawn on Figure 1, label and identify all of the forces acting on Theo while he is coming down the hill. Assume that friction and air resistance can be ignored for this question.

2 marks

Question 7

Use a vector diagram to find the magnitude and direction of the net force acting on Theo and his skateboard. The combined mass of Theo and his skateboard is 60 kg and the incline of the hill is 20°.

N

3 marks

Flora, who is nine years old, loves going down waterslides. On one slide, she reaches a speed of 12 m s^{-1} at the bottom of the slide.

Question 8

Assuming that there is negligible friction on the slide, at what height above the bottom of the slide did Flora start sliding?

m

2 marks

Flora is looking forward to the time when she is older, because, she says, "I'll be heavier, and therefore I will go down the slide even faster!"

Question 9

Discuss the validity of Flora's statement for both a non-friction slide and a slide with friction.

Slide without friction

Slide with friction

4 marks

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At the end of the waterslide there is a horizontal section that brings Flora to a stop. Remember that Flora's maximum speed was 12 m s^{-1}.

Question 10

What is the work done by resistive forces over this section of the slide? Assume that Flora's mass is 35 kg.

J

2 marks

The horizontal section of the slide is seven metres long.

Question 11

Calculate the average resistive force acting on Flora over this section of the slide.

N

2 marks

Aristotle, Galileo and Newton would each have given a different explanation of why Flora came to a halt during the final section of the slide.

Question 12

Three different explanations of why Flora came to a halt are shown below. For each one, write the name of the scientist most likely to have given that explanation in the box below it.

Explanation 1

Flora experienced a net force equal to the friction force, which caused her to accelerate and change her velocity until she was stationary. The rate of acceleration is proportional to the net force and inversely proportional to Flora's mass.

Scientist:

Explanation 2

It is Flora's natural state to be stationary, so in the absence of a force acting on her she will stop moving.

Scientist:

Explanation 3

Flora will slow down because a force is slowing her down. If there were no force acting, Flora's inertia would cause her to keep on going at a constant speed.

Scientist:

3 marks

Nuala is a physics student who wants to investigate the physics of a slingshot. She stretches the elastic of the slingshot to a length of 25 cm before releasing it and shooting a 20 g rock straight up into the air.

When it is stretched to 25 cm, the force exerted by the elastic is 40 N. The unstretched length of the slingshot is 5 cm.

Question 13

Calculate the spring constant for the elastic band.

$\boxed{\quad\quad\quad \text{N m}^{-1}}$

2 marks

Question 14

Calculate the maximum height above the slingshot that would be reached by the rock. Ignore air resistance.

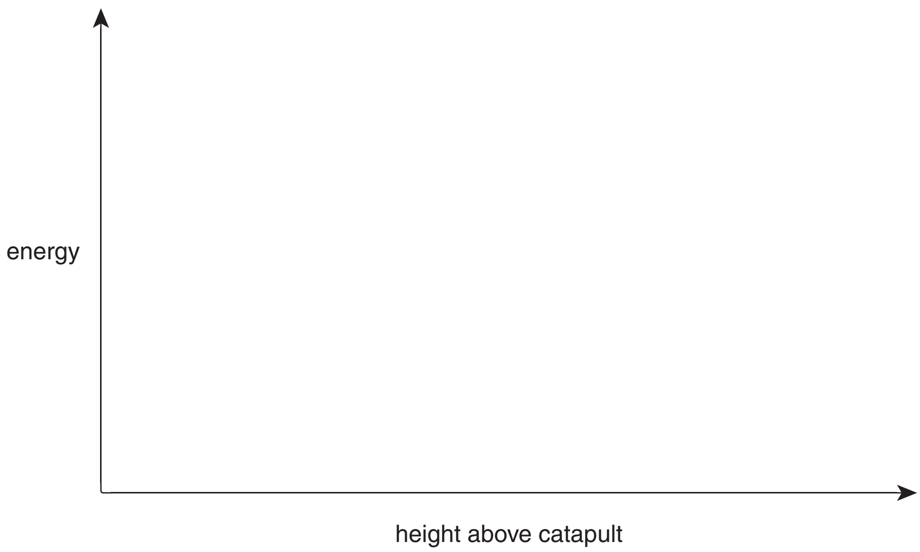
$\boxed{\quad\quad\quad \text{m}}$

2 marks

During most of its flight upwards, the rock possesses both kinetic energy and gravitational potential energy.

Question 15

On the axes below, sketch how the value of each of these forms of energy changes for the rock as it rises through the air and falls back down. Label each of the two lines you draw carefully. No calculations are required.



2 marks

Question 16

Using your knowledge of the physics of the situation, explain why Nuala should take safety precautions when performing this experiment and what the precautions should be.

2 marks

END OF AREA OF STUDY 1

Area of study 2 – Electricity

Households have AC electrical systems. In this section, household electricity will be modelled as DC.

Question 1

What is a model, as used in science?

2 marks

A household device contains two components, of resistance 40 Ω and 80 Ω respectively, wired in series with a 240 V DC power supply. This circuit is shown in Figure 1.

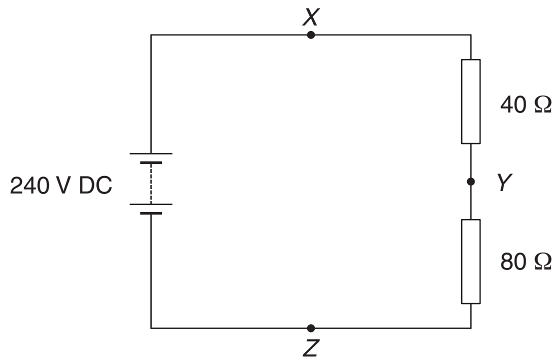


Figure 1

X, *Y* and *Z* are points on the circuit.

Question 2

Determine the current at point *X*.

A

3 marks

Consider the current in the circuit in Figure 1.

Question 3

Which of the options below (**A**–**D**) describes the situation correctly?

A. The current at *Y* is less than the current at *X*.
B. The current at *Y* is equal to the current at *X*.
C. The current at *Y* is larger than the current at *X*.
D. The current at *Y* is two-thirds of the current at *X*.

2 marks

Question 4

Determine the power dissipated in the 80 Ω resistor.

W

2 marks

A third resistor with resistance 120 Ω is added in parallel to the resistors in the circuit in Figure 1. The new circuit is shown in Figure 2.

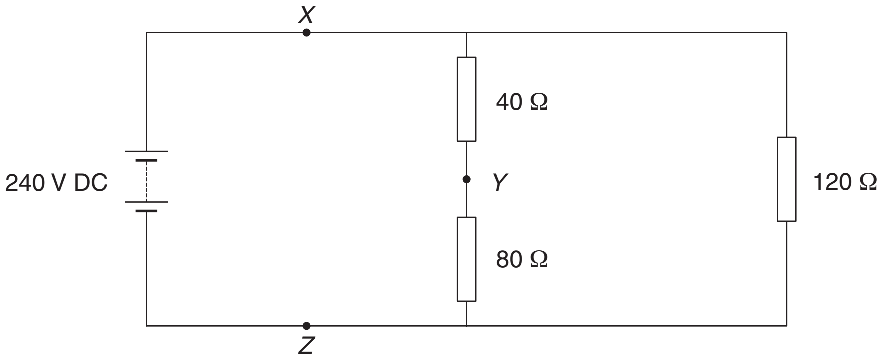


Figure 2

Compare the current in the circuit in Figure 1 to the current in the circuit in Figure 2.

Question 5

Which of the options below (**A**–**D**) describes the situation correctly?

A. The current at *X* has decreased.

B. The current at *X* has increased.

C. The current at *X* has stayed the same.

D. The current at *X* has halved.

2 marks

Question 6

Explain the reasoning behind your choice in Question 5.

3 marks

The 120 Ω device is a hand-held kitchen blender. The blender is used for 10 s.

Question 7

How much energy is transferred by the blender in 10 s? Give your answer in joules and in kW h.

J	kW h

4 marks

The circuit in Figure 2 is provided again in Figure 3.

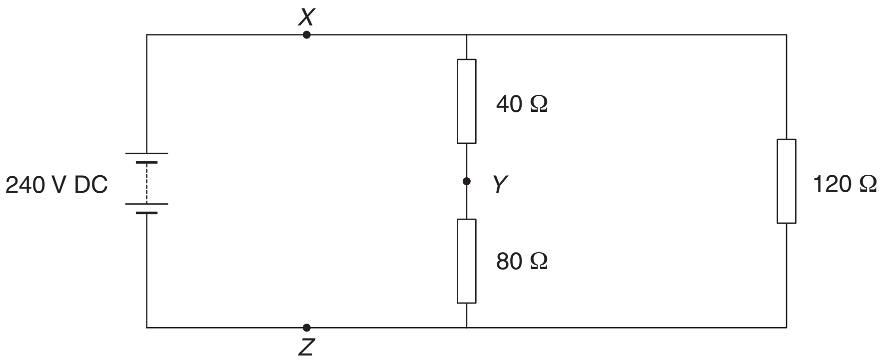


Figure 3

Margaret has been employed to make this circuit safe. She has earthed the circuit at point *Z*.

Question 8

Draw in the 'earth' at *Z*.

1 mark

Question 9

What does earthing the circuit at *Z* do to the voltage at *Z*?

1 mark

Margaret would like to include a fuse in her circuit as a safety feature.

Question 10

How does a fuse work to improve the safety of the circuit?

2 marks

Question 11

On Figure 3 draw a fuse in the circuit in a position where it is best placed to protect users.

1 mark

Question 12

Justify your choice of position indicated in Question 11.

____

____

2 marks

Figures 4 and 5 show current–voltage characteristic curves for two devices.

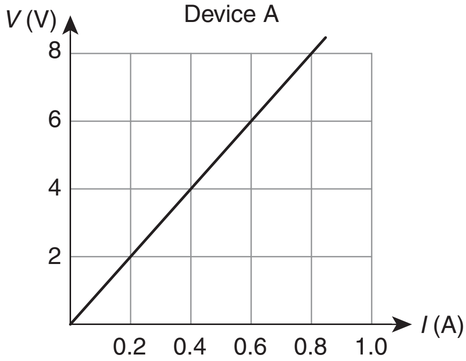


Figure 4

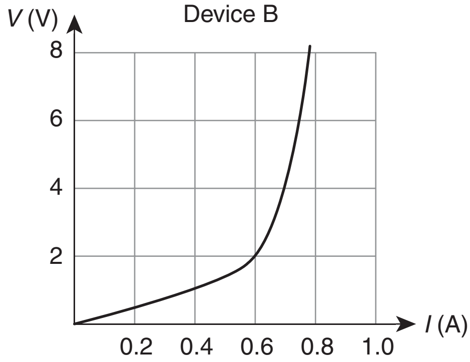


Figure 5

Question 13 **Question 13**

Which of the devices (A, B, both or neither) is ohmic?

1 mark

Device A is connected in series with Device B as shown in Figure 6.

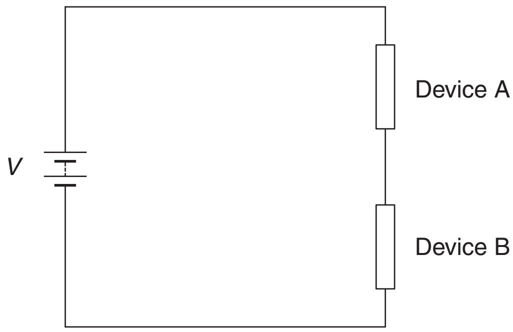


Figure 6

The potential difference across Device A is measured to be 6 V.

Question 14

Determine the current in Device A.

A

1 mark

Question 15

Find the voltage supplied by the battery.

V

3 marks

END OF AREA OF STUDY 2

Neap:

Trial Examination 2007

VCE Physics Unit 2

Written Examination

Data Sheet

Directions to students

Detach this data sheet before commencing the examination.
This data sheet is provided for your reference.

MOVEMENT

1	velocity; acceleration	$v = \frac{\Delta x}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$
2	equations for constant acceleration	$v = u + at$ $x = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2ax$ $x = \frac{1}{2}(v + u)t$
3	Newton's second law	$F = ma$
4	gravitational potential energy near the surface of the Earth	mgh
5	kinetic energy	$\frac{1}{2}mv^2$
6	mechanical work	$W = Fx$
7	power	$P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t}$
8	acceleration due to gravity	$g = 10 \text{ m s}^{-2}$

ELECTRICITY

1	electrical charge	$Q = It$
2	electrical work	$W = QV$
3	voltage	$V = IR$
4	power	$P = VI$
5	resistors in series	$R_T = R_1 + R_2 \ldots$
6	resistors in parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \ldots$

ASTROPHYSICS

speed of light in vacuum	$c = 3.0 \times 10^8 \text{ m s}^{-1}$

ALTERNATIVE ENERGY SOURCES

$$\text{Efficiency (\%)} = \frac{\text{Useful energy output}}{\text{Energy input}} \times 100$$

PREFIXES

Prefix	Abbreviation	Value
giga	G	10^9
mega	M	10^6
kilo	k	10^3
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}

END OF DATA SHEET

SECTION B – DETAILED STUDIES

Instructions for Section B

Choose **one** of the following **Detailed studies**. Answer **all** the questions on the Detailed study you have chosen. You should take the value of g to be 10 m s^{-2}.

Detailed study 1 – Astrophysics

Question 1

In the text below, options are given in bold. Indicate your choice of the best option by circling it. (3 marks)

It is now widely accepted that the structures and objects we observe in the Universe around us have been formed by the gradual accumulation and concentration of matter through the action of **[gravitational / nuclear / electromagnetic]** forces. This process ultimately concentrates matter so strongly that **[fission / fusion / chemical]** reactions are initiated. When this happens, **[galaxies / stars / planets]** are born.

3 marks

At the beginning of the year 2007, for several weeks, a bright comet (Comet McNaught) was observed in the southwestern sky in the early evening.

Question 2

Suggest a method and explain how it could be used to determine the fact that the comet was about 140 million km away from us during this time. You are encouraged to draw a diagram in support of your answer.

___

___

___

2 marks

Question 3

During the start of 2007 Comet McNaught was about the same distance away from us as

A. the Moon.
B. the International Space Station.
C. the Sun.
D. the nearest star to Earth, Alpha Centauri.
E. Pluto.

1 mark

Edwin Hubble estimated the distance between us and other galaxies by assuming that they had roughly equal luminosity.

Question 4

What is meant here by the word 'luminosity'?

1 mark

Hubble already knew how far away a few of our nearest neighbouring galaxies are. By measuring how bright other, more distant, galaxies appeared in his telescope, Hubble was able to estimate the distances to each galaxy.

Question 5

Explain how Hubble did this, and give at least one assumption he had to make.

3 marks

One of the most important results of Hubble's work was the conclusion that the universe is not static, it is expanding.

Question 6

Apart from the distances to many galaxies, what other data did Hubble need to come to this conclusion?

2 marks

Hubble represented his information about the galaxies he had observed in the form of a graph. Below is a sketched representation of this graph.

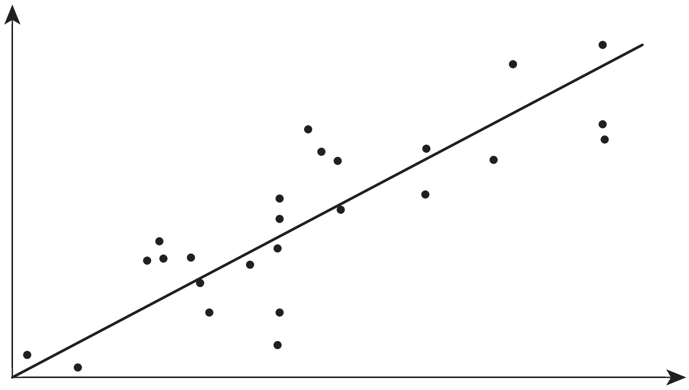


Figure 7

Question 7

Label the vertical and horizontal axes of the graph. There is no need to include units.

2 marks

Question 8

What is the name given to the value of the gradient of this graph and what is its significance?

____

____

2 marks

Our own Milky Way galaxy is a type of galaxy called a ‘spiral’ galaxy. Figure 8 shows an example of a spiral galaxy.

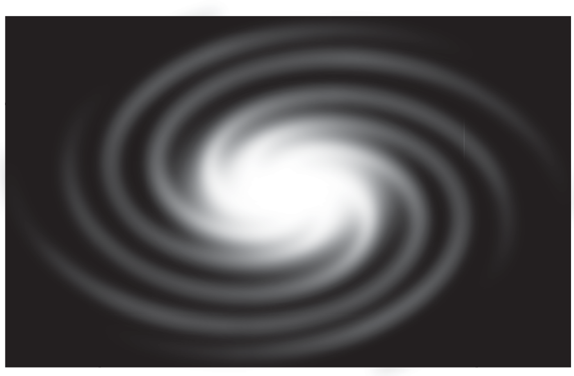


Figure 8

Question 9

What property of our galaxy explains its appearance with its ‘swirling’ spiral arms?

____

1 mark

Our Sun can be described a typical main sequence star.

Question 10

Explain what is meant by the term ‘main sequence’. Use a diagram in your answer.

3 marks

The surface temperature of the Sun is about 6000 K.

Question 11

Explain how astrophysicists can acquire such information.

2 marks

All stars contain mostly hydrogen. However, small amounts of other elements are also present, especially helium.

Helium was discovered in the Sun’s atmosphere (corona) in 1863, before it was found on Earth.

Question 12

Explain how an element could be found on the Sun in 1863, well before the era of space travel.

2 marks

The presence of hydrogen and helium gives an important clue to the source of the Sun’s almost limitless energy.

Question 13

What is this source of energy?

1 mark

END OF DETAILED STUDY 1

Detailed study 2 – Aerospace

A helicopter is rising vertically into the air with a uniform velocity, as shown in Figure 1 below.

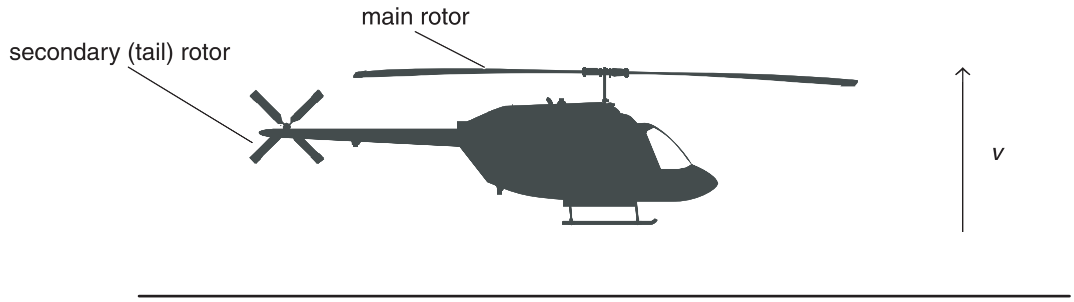


Figure 1

Question 1

Draw and label the forces acting on the helicopter in the diagram. Ignore the forces resulting from the secondary tail rotor for this question.

2 marks

The helicopter stays perfectly horizontal while it is rising.

Question 2

This must mean that the forces you identified in Question 1

A. are equal in magnitude but opposite in direction.
B. are not equal in magnitude.
C. both act on the helicopter's centre of mass.
D. provide a non-zero net torque around the helicopter's centre of mass.

2 marks

Apart from the main rotor providing vertical lift, the helicopter also has a secondary rotor on its tail.

Question 3

Explain the role of this secondary rotor by describing what would happen if it weren't there and why this would happen.

2 marks

In the helicopter above the secondary rotor is 5.0 m from the centre of mass of the helicopter.

Question 4

If the maximum torque provided by the main rotor is 6.0×10^5 N m, calculate the maximum force that the tail rotor must be able to produce.

N

2 marks

Question 5

Use Bernoulli's principle to explain how a helicopter creates lift. Use a diagram in your answer.

3 marks

The Wright brothers used bicycle-mounted experimental wing profiles to investigate lift.

In one such experiment, Wilbur Wright mounted a flat board on his bicycle at a 30° angle to the horizontal as shown on Figure 2 below. The bicycle is moving to the right.

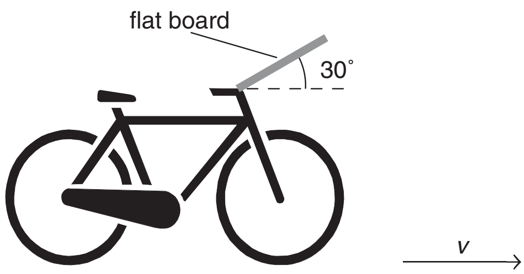


Figure 2

Question 6

Explain how a board on the bicycle can provide lift. Your answer must make reference to the change of momentum of air.

2 marks

Wilbur now measured the lift produced by his board at various speeds.

Question 7

On the axes below, sketch a graph of Wilbur's results. Label the axes (a scale is not required).

Figure 3

2 marks

Question 8

Justify the shape of your graph.

2 marks

Question 9

What other continuous, independent variable could Wilbur investigate using this experimental set-up?

1 mark

Question 10

Describe the results that Wilbur can expect when he changes the variable that you have named in Question 9.

2 marks

The Wright brothers were eventually the first to achieve real flight in a motorised aircraft, the *Wright Flyer*, in 1903. The engine used in the *Wright Flyer* generated about 15 kW of power. The first flight was 30 m long and lasted 12 seconds.

Question 11

Calculate the average friction force that the *Wright Flyer* experienced during the first flight.

N

2 marks

Question 12

In the text below, options are given in bold. Indicate your choice of the best option by circling it.

An aircraft can turn around **[one axis / two axes / three axes]** as it flies. When the aircraft lifts its right wing and lowers its left wing, the motion is referred to as **[roll / yaw / pitch]**.
This movement almost always occurs together with **[roll / yaw / pitch]** when the aircraft changes its horizontal direction.

3 marks

END OF DETAILED STUDY 2

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Detailed study 3 – Alternative energy sources

Question 1

In the text below, options are given within the brackets. Only one of the options will be correct. Circle the best option.

> Recent Victorian government initiatives have proposed charging a fee for the emission of **[pollution / carbon dioxide / radioactivity]**. It is hoped that this will discourage the use of **[cheap / renewable /non-renewable]** energy sources such as **[solar / nuclear / coal]**.

3 marks

Over the next three years it is hoped that Victoria can phase out the use of incandescent light bulbs, which have an efficiency of 3%, and replace them with low-energy fluorescent lights with an efficiency of 15%.

Consider an average house containing 15 incandescent lights that are on for an average of 20 minutes per day. Each light uses energy at a rate of 80 W.

Question 2

How much energy does one light use in 1 s?

J

1 mark

Question 3

If the incandescent light is 3% efficient, how much light energy does it produce in 1 s?

J

1 mark

Question 4

How much energy would a low-energy light with an efficiency of 15% use to produce the same amount of light as the incandescent light in 1 s?

J

2 marks

Question 5

Assuming that on average the 15 lights in a house are on for about 20 minutes each day, calculate the amount of energy saved in one year if all of the incandescent lights were replaced by low energy lights. Give your answer in J and kW h.

J	kW h

4 marks

Tidal energy is a form of renewable energy that relies on the gravitational attraction of the Moon. A narrow region of a bay or estuary is dammed and valves in the dam are opened and closed to control the flow of water from one side of the dam to the other. This flow of water is passed through a turbine within the dam and the turbine generates electricity.

As the tide comes in, the valves are opened and the water is directed to flow through the turbine producing electricity. This is shown in Figure 1.

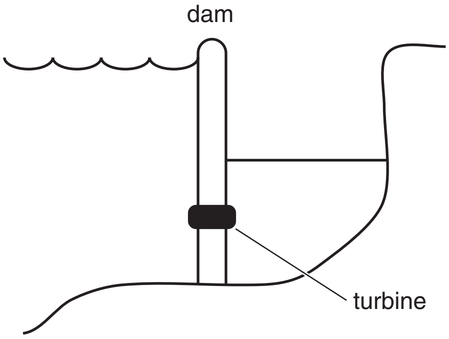

Figure 1

When the water is level on either side of the dam the valves are closed and as the tide goes out water is trapped behind the dam. At low tide the valves are opened and the trapped water is allowed to pass through the turbine again producing electricity. This is shown in Figure 2.

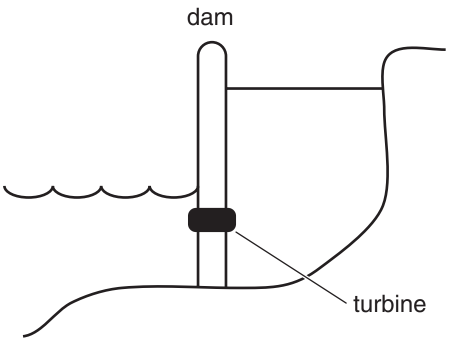

Figure 2

Question 6

List the energy transformations in the production of electricity from tidal energy by listing the type of energy and where it is located.

3 marks

Samm and Bradley design a model to test this system. They place a hole near the bottom of a bucket and place a water wheel in front of the hole. The water wheel is attached to an electricity generator. The generator is wired in series with a 100 Ω resistor. The set-up is shown in Figure 3.

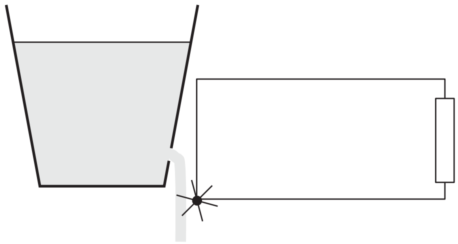

Figure 3

Sam puts 8 kg of water in the bucket and lets it run through the water wheel. Bradley monitors the current through the resistor and the voltage across the resistor.

Question 7

Assuming the average height of the water above the water wheel is 10 cm, determine the gravitational potential energy of the water.

J

2 marks

It takes 95 s for the bucket to empty. Bradley records an average current of 14 mA and an average voltage of 1.5 V.

Question 8

Determine the electrical energy transferred at the resistor.

J

2 marks

Question 9

Compare your answers to Questions 7 and 8, and account for any energy differences between your answers.

___

___

___

___

2 marks

Question 10

Outline two limitations of Samm and Bradley's model.

2 marks

Question 11

Table 1 contains three sources of energy available in Victoria. Complete Table 1 by choosing from the list of advantages and disadvantages in Table 2 that most correctly describes the major advantage and disadvantage for each energy source. You may only use each advantage and disadvantage once.
You may use the labels A1–A3 and D1–D3.

Energy source	Advantage	Disadvantage
Coal		
Hydroelectricity		
Wind		

Table 1

Advantage		Disadvantage	
A1	Readily switched on and off	D1	Dependent on climatic conditions, so less reliable than other sources
A2	Provides renewable and clean energy that can be installed in many locations	D2	A major source of greenhouse gases
A3	Already set up, so easy to keep running	D3	Requires a particular site

Table 2

3 marks

END OF QUESTION AND ANSWER BOOKLET