# DOT POINT

## NSW PHYSICS MODULES 5 TO 8

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# Contents



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# Words to Watch

**account, account for** State reasons for, report on, give an account of, narrate a series of events or transactions.

**analyse** Interpret data to reach conclusions.

**annotate** Add brief notes to a diagram or graph.

**apply** Put to use in a particular situation.

**assess** Make a judgement about the value of something.

**calculate** Find a numerical answer.

**clarify** Make clear or plain.

**classify** Arrange into classes, groups or categories.

**comment** Give a judgement based on a given statement or result of a calculation.

**compare** Estimate, measure or note how things are similar or different.

**construct** Represent or develop in graphical form.

**contrast** Show how things are different or opposite.

**create** Originate or bring into existence.

**deduce** Reach a conclusion from given information.

**define** Give the precise meaning of a word, phrase or physical quantity.

**demonstrate** Show by example.

**derive** Manipulate a mathematical relationship(s) to give a new equation or relationship.

**describe** Give a detailed account.

**design** Produce a plan, simulation or model.

**determine** Find the only possible answer.

**discuss** Talk or write about a topic, taking into account different issues or ideas.

**distinguish** Give differences between two or more different items.

**draw** Represent by means of pencil lines.

**estimate** Find an approximate value for an unknown quantity.

**evaluate** Assess the implications and limitations.

**examine** Inquire into.

**explain** Make something clear or easy to understand.

**extract** Choose relevant and/or appropriate details.

**extrapolate** Infer from what is known.

**hypothesise** Suggest an explanation for a group of facts or phenomena.

**identify** Recognise and name.

**interpret** Draw meaning from.

**investigate** Plan, inquire into and draw conclusions about.

**justify** Support an argument or conclusion.

**label** Add labels to a diagram.

**list** Give a sequence of names or other brief answers.

**measure** Find a value for a quantity.

**outline** Give a brief account or summary.

**plan** Use strategies to develop a series of steps or processes.

**predict** Give an expected result.

**propose** Put forward a plan or suggestion for consideration or action.

**recall** Present remembered ideas, facts or experiences.

**relate** Tell or report about happenings, events or circumstances.

**represent** Use words, images or symbols to convey meaning.

**select** Choose in preference to another or others.

**sequence** Arrange in order.

**show** Give the steps in a calculation or derivation.

**sketch** Make a quick, rough drawing of something.

**solve** Work out the answer to a problem.

**state** Give a specific name, value or other brief answer.

**suggest** Put forward an idea for consideration.

**summarise** Give a brief statement of the main points.

**synthesise** Combine various elements to make a whole.



## What the book includes

This book provides questions and answers for each dot point in the NSW Physics Stage 6 Syllabus for each module in the Year 12 Physics course:

- Module 5 Advanced Mechanics
- Module 6 Electromagnetism
- Module 7 The Nature Of Light
- Module 8 From the Universe To the Atom

### Format of the book

The book has been formatted in the following way:

**1.1 Subtopic from syllabus.**

**1.1.1 Assessment statement from syllabus.**

**1.1.1.1** First question for this assessment statement.

**1.1.1.2** Second question for this assessment statement.

The number of lines provided for each answer gives an indication of how many marks the question might be worth in an examination. As a rough rule, every two lines of answer might be worth 1 mark.

### How to use the book

Completing all questions will provide you with a summary of all the work you need to know from the syllabus. You may have done work in addition to this with your teacher as extension work. Obviously this is not covered, but you may need to know this additional work for your school exams.

When working through the questions, write the answers you have to look up in a different colour to those you know without having to research the work. This will provide you with a quick reference for work needing further revision.

# Module 5 Advanced Mechanics

Module 5 Advanced Mechanics

**Dot Point** — **Page**

## Projectile Motion

**INQUIRY QUESTION**

How can models that are used to explain projectile motion be used to analyse and make predictions?



**Dot Point** — **Page**

## Motion In Gravitational Fields

**INQUIRY QUESTION**

How does the force of gravity determine the motion of planets and satellites?

Module 5 Advanced Mechanics



## Circular Motion

**INQUIRY QUESTION**

Why do objects move in circles?

Module 6 Electromagnetism

# Module 6 Electromagnetism

Module 6 Electromagnetism

**Dot Point** **Page**

## Electromagnetic Induction

**INQUIRY QUESTION**

How are electric and magnetic fields related?



**Dot Point** **Page**

## Applications Of the Motor Effect

**INQUIRY QUESTION**

How has knowledge about the motor effect been applied to technological advances?

# Module 7 The Nature Of Light

Module 7 The Nature Of Light

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## Electromagnetic Spectrum

**INQUIRY QUESTION**

What is light?



**Dot Point** **Page**

## Light: Wave Model

**INQUIRY QUESTION**

What evidence supports the classical wave model of light and what predictions can be made using this model?


Module 7 The Nature Of Light

**Dot Point** **Page**

## Light: Quantum Model

**INQUIRY QUESTION**

What evidence supports the particle model of light and what are the implications of this evidence for the development of the quantum model of light?



## Light and Special Relativity

**INQUIRY QUESTION**

How does the behaviour of light affect concepts of time, space and matter?

# Module 8 From the Universe To the Atom

Module 8 From the Universe To the Atom

Module 8 From the Universe To the Atom

| Dot Point | | Page |
|---|---|---|

## Deep Inside the Atom

**INQUIRY QUESTION**

How is it known that human understanding of matter is still incomplete?


# MODULE 5

## Advanced Mechanics


In this module you will:

- Describe and analyse qualitatively and quantitatively circular motion and motion in a gravitational field, in particular, the projectile motion of particles.
- Explain and analyse motion in one dimension at constant velocity or constant acceleration.
- Extend your study of motion into examples involving two or three dimensions that cause the net force to vary in size or direction.
- Develop an understanding that all forms of complex motion can be explained by analysing the forces acting on a system, including the energy transformations taking place within and around the system.
- Apply new mathematical techniques to model and predict the motion of objects within systems. You will examine two-dimensional motion, including projectile motion and uniform circular motion, along with the orbital motion of planets and satellites, which are modelled as an approximation to uniform circular motion.
- Engage with all the Working Scientifically skills for practical investigations involving the focus content to examine trends in data and to solve problems related to advanced mechanics.

# Projectile Motion

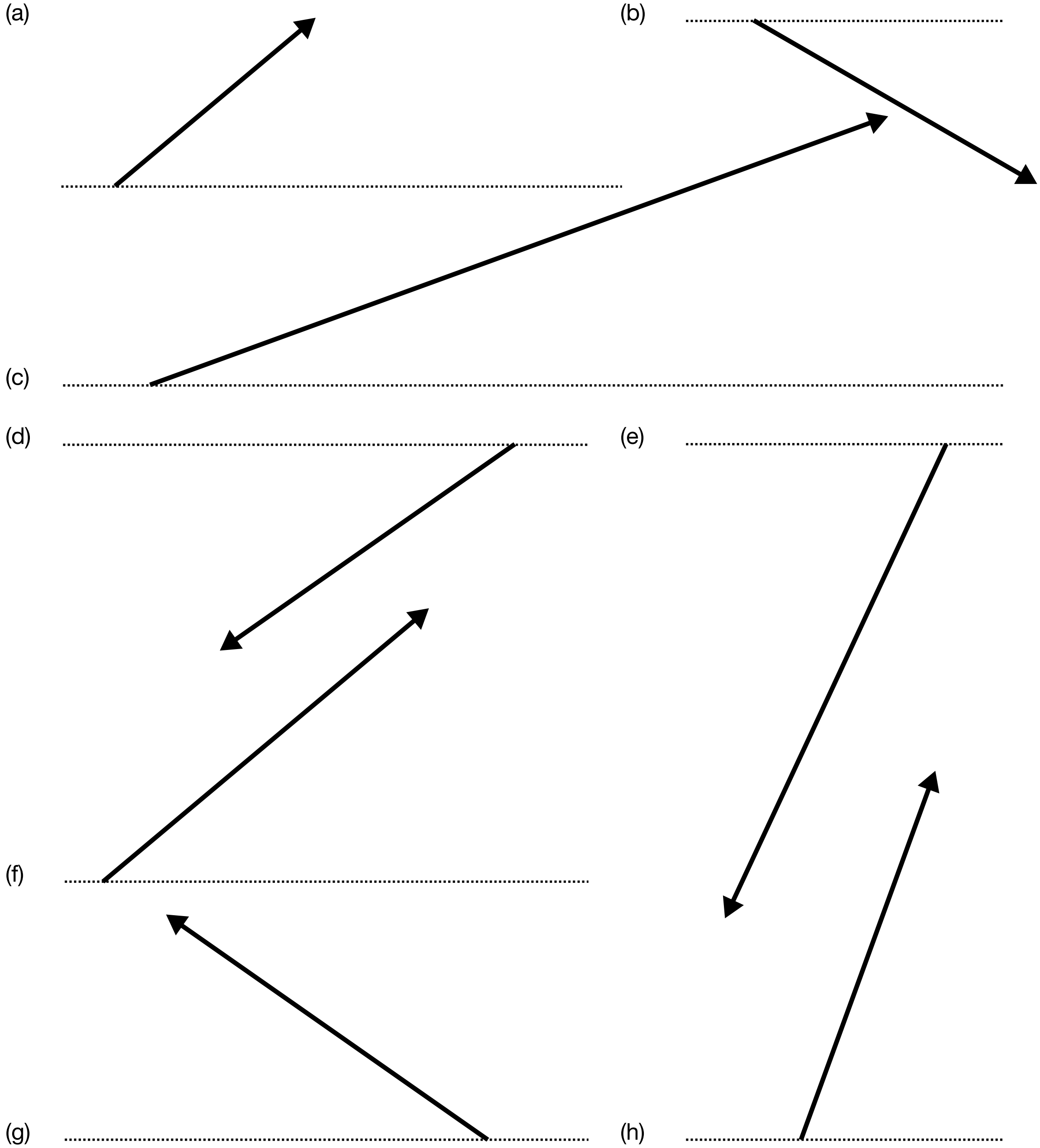
**5.1 Analyse the motion of projectiles by resolving the motion into horizontal and vertical components, making the following assumptions: a constant vertical acceleration due to gravity and zero air resistance.**

**INQUIRY QUESTION**

How can models that are used to explain projectile motion be used to analyse and make predictions?

### 5.1.1 Resolution of vectors – Revision.

**5.1.1.1** Find the horizontal and vertical components of each of the following vectors. All vectors are drawn to a scale where 1 cm = 10 m.

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### 5.1.2 Analysing projectile motion 1.

Use the following information to answer the next TEN questions.

Some students rolled a ball down a ramp from different heights and then let it roll across a frictionless benchtop for a distance of 1.0 m. They launched the ball from the end of the bench which was 1.2 m above the floor and the horizontal range of each ball was measured. The table shows their average results.

| Projectile | Height up the ramp (m) | Time to roll 1.0 metre (s) | Time of flight (s) | Launch velocity (m s$^{-1}$) | Range (m) |
|---|---|---|---|---|---|
| P | 0.30 | 0..86 | *W* | | |
| Q | 0.45 | 0.72 | | *X* | |
| R | 0.60 | 0.61 | | | *Y* |
| S | 0.90 | 0.45 | *Z* | | |

**5.1.2.1** What is the independent variable?
(A) Horizontal range.
(B) Launch velocity.
(C) Time to roll over the bench.
(D) Time of flight.

**5.1.2.2** Which statement about the time of flight for these projectiles is correct?
(A) Time for P will be the least.
(B) Time for Q will be the least.
(C) Time for S will be the least.
(D) They will all have the same time of flight.

**5.1.2.3** What will be the launch speed for P?
(A) 0.72 m s$^{-1}$
(B) 0.86 m s$^{-1}$
(C) 1.16 m s$^{-1}$
(D) 1.40 m s$^{-1}$

**5.1.2.4** What is the best value for *W*?
(A) 0.45 s
(B) 0.86 s
(C) 1.16 s
(D) 1.39 s

**5.1.2.5** What is the best value for *X*?
(A) 0.60 m s$^{-1}$
(B) 0.74 m s$^{-1}$
(C) 1.39 m s$^{-1}$
(D) 2.70 m s$^{-1}$

**5.1.2.6** What is the best value for *Y*?
(A) 0.74 m
(B) 0.88 m
(C) 1.64 m
(D) 2.36 m

**5.1.2.7** What is the best value for *Z*?
(A) 0.45 s
(B) 0.50 s
(C) 0.86 s
(D) 2.22 s

**5.1.2.8** What is the range of Z?
(A) 0.2 m
(B) 1.0 m
(C) 1.2 m
(D) 2.67 m

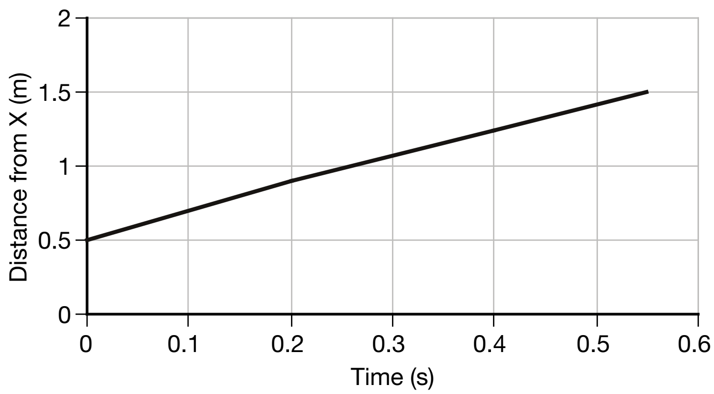
**5.1.2.9** What is the best estimate for the speed of R at the bottom of the ramp?
(A) 0.98 m s$^{-1}$
(B) 1.02 m s$^{-1}$
(C) 1.64 m s$^{-1}$
(D) 1.96 m s$^{-1}$

**5.1.2.10** The experiment is repeated with a ball with twice the mass. How is each range affected?
(A) Ranges will be quartered.
(B) Ranges will be halved.
(C) Ranges will be doubled.
(D) Ranges will be the same.

### 5.1.3 Analysing projectile motion 2.

Use the following information to answer the next FIVE questions.

A ball was rolled from X, 1.5 m across a horizontal table to the table's edge. The time and its distance from X as it rolled across the table were measured. The results are shown in the graph.




**5.1.3.1** What was the ball's speed at the edge of the table?

(A) 0.54 m $s^{-1}$

(B) 1.50 m $s^{-1}$

(C) 1.82 m $s^{-1}$

(D) 2.78 m $s^{-1}$

**5.1.3.2** If the ball landed 0.75 m out from the edge of the table, what was the time of flight?

(A) 2.47 s

(B) 1.0 s

(C) 0.8 s

(D) 0.4 s

**5.1.3.3** If the ball landed 0.75 m out from the edge of the table, what was the height of the table?

(A) 0.4 m

(B) 0.5 m

(C) 0.6 m

(D) 0.8 m

**5.1.3.4** The experiment was repeated on the Moon. How would the range of the projectile compare?

(A) It would be the same on Earth and the Moon.

(B) It would be larger on the Moon.

(C) It would be larger on Earth.

(D) It would still depend on the horizontal speed of the ball.

**5.1.3.5** The experiment was repeated using a ball with half the mass of the original ball. Indicate, for each of the questions above, how the results would be different.

(a) For 5.1.3.1 ....................

(b) For 5.2.3.2 ....................

(c) For 5.1.3.3 ....................

(d) For 5.1.3.4 ....................

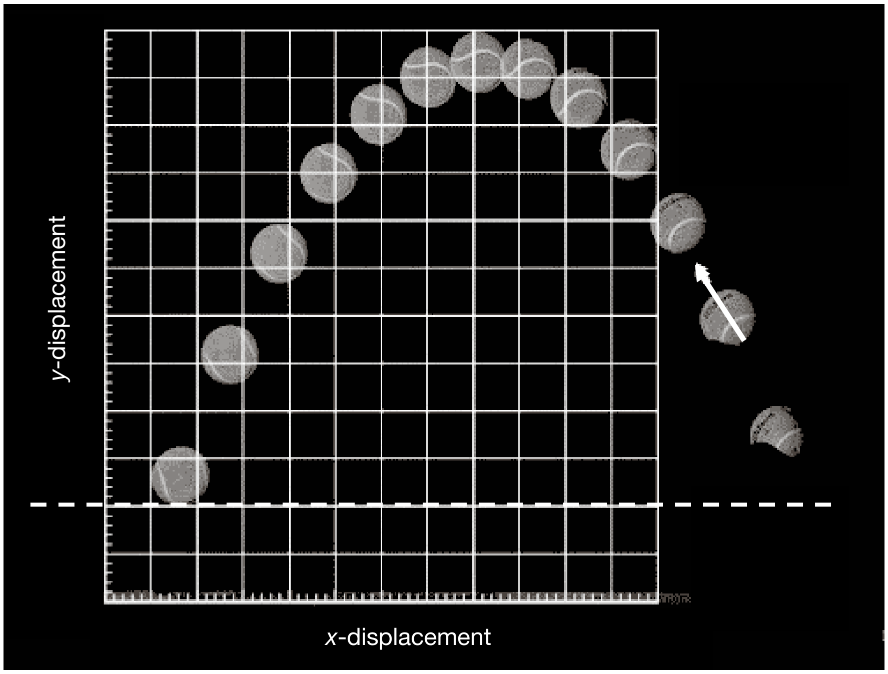
## 5.1.4 Analysing projectile motion 3.

Use the following information to answer the next SIX questions.

Students studying projectile motion fired a tennis ball into the air and photographed its flight using a stroboscopic camera which photographed the position of the ball every 0.1 s.

They did several runs of the experiment, launching the ball at different velocities to determine the maximum heights reached at each velocity.

In the photograph, the dotted horizontal line represents the surface of the benchtop. One set of their results are shown in the photograph.




**5.1.4.1** What was the time of flight of the ball?

(A) 0.1 s
(B) 1.1 s
(C) 1.2 s
(D) 1.3 s

**5.1.4.2** What was the frequency of the stroboscope used to record these results?

(A) 0.1 Hz
(B) 1.2 Hz
(C) 1.3 Hz
(D) 10 Hz

**5.1.4.3** Which choice correctly identifies the dependent and independent variables in this experiment?

| | Dependent variable | Independent variable |
|---|---|---|
| (A) | Time to rise | Launch velocity |
| (B) | Time to rise | Time to rise |
| (C) | Maximum height | Launch velocity |
| (D) | Maximum height | Time to rise |

**5.1.4.4** What is the maximum height of the ball (measured from its bottom) above the benchtop?

(A) 1.76 m
(B) 3.53 m
(C) 9 m
(D) 10 m

**5.1.4.5** What is the best estimate of the scale of the grid in the photograph?

(A) 1 grid square = 0.2 m
(B) 1 grid square = 0.4 m
(C) 1 grid square = 1.11 m
(D) 1 grid square = 1.12 m

**5.1.4.6** What was the magnitude of the velocity of the tennis ball at its maximum height above the benchtop?

(A) 0
(B) 1.0 m $s^{-1}$
(C) 2.1 m $s^{-1}$
(D) 4.2 m $s^{-1}$

## 5.2 Apply the modelling of projectile motion to quantitatively derive the relationships between the following variables: initial velocity, launch angle, maximum height, time of flight, final velocity, launch height and horizontal range.

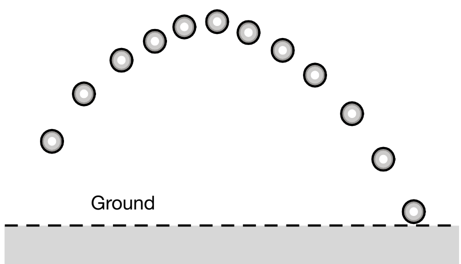
**5.2.1 Projectile motion 1.**

**5.2.1.1** Outline the characteristics of the motion of a projectile.

**5.2.1.2** A projectile is launched at 40 m $s^{-1}$ at 75° to the horizontal. Calculate the components of its launch velocity.

**5.2.1.3** List the three characteristics of projectile motion as cited by Galileo.

**5.2.1.4** A tennis ball is hit into the air and follows the path shown in the diagram.

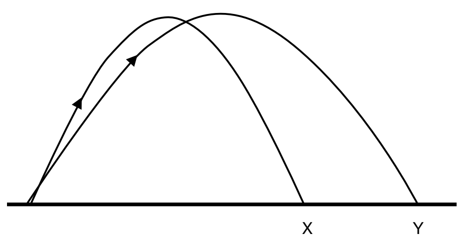



(a) Which statement regarding the flight of the ball is correct?

(A) The velocity of the ball at its highest point is zero.
(B) The velocity of the ball is always changing.
(C) The direction of the ball's acceleration changes when it reaches the highest point.
(D) The acceleration of the ball at its highest point is zero.

(b) The final displacement of this projectile could be described as being negative. Explain this.

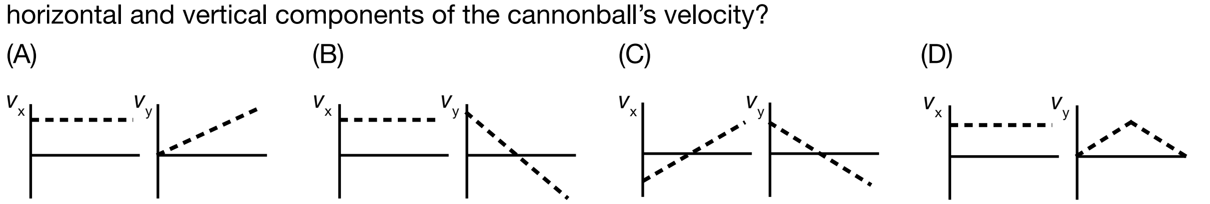
**5.2.1.5** The diagram shows the paths of the flights of two projectiles, X and Y.




Which of the following is different for X and Y?

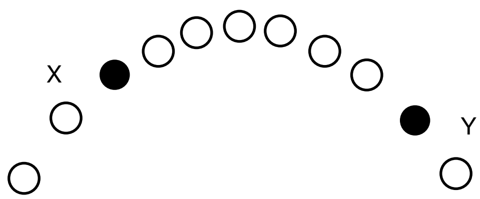
(A) Their accelerations.
(B) Their times of flight.
(C) Their maximum *y*-displacements.
(D) Their initial velocities.

**5.2.1.6** A cannonball is fired into the air towards a distant castle. Which graphs below correctly describe the horizontal and vertical components of the cannonball's velocity?



**5.2.1.7** The diagram shows the path of a projectile. Which choice correctly shows the directions of the velocity and acceleration of the projectile at points X and Y?

| | Velocity at X | Acceleration at X | Velocity at Y | Acceleration at Y |
|---|---|---|---|---|
| (A) | → | ↓ | → | ↓ |
| (B) | ↗ | ↑ | ↘ | ↓ |
| (C) | ↗ | ↓ | ↘ | ↓ |
| (D) | ↑ | → | ↓ | → |




**5.2.1.8**

(a) A projectile is launched into the air at 60° to the horizontal. Which statement about the projectile is true when it is at its maximum height?

(A) $a_x = 0$ (B) $a_y = 0$ (C) $v_x = 0$ (D) $\Delta x = 0$

(b) At what angle should a projectile be launched so that its range is maximum?

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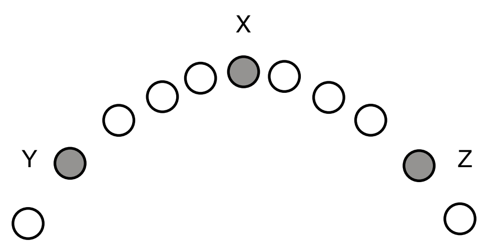
**5.2.1.9** Consider three positions, X, Y and Z in the path of a projectile as shown by the darkened circles in the diagram.




(a) Which statement about the acceleration of the projectile at these three positions is correct?

(A) The acceleration at Y is less than the acceleration at X.
(B) The acceleration at X is the same as the acceleration at Z.
(C) The acceleration at X is greater than the acceleration at Y.
(D) The acceleration at Y is in the opposite direction to the acceleration at Z.

(b) Three projectiles are launched at 20°, 40° and 60° to the horizontal at 20, 30 and 40 m $s^{-1}$ (in that order). Calculate the ratio of their accelerations.

..........................................................................................

**5.2.1.10** A ball is thrown upwards from point P and follows a parabolic path. Its highest point is point X. Which statement about the acceleration of the ball is correct?

(A) It is zero at X. (B) It is maximum at X.
(C) It is maximum at P and minimum at X. (D) It is the same at X as it is at P.

**5.2.1.11**

(a) Which of the following statements was *not* one of Galileo's descriptions of projectile motion?

(A) Horizontal motion is constant. (B) Horizontal acceleration is zero.
(C) Vertical motion is accelerated. (D) Vertical acceleration is negative.

(b) Explain the concept of positive and negative velocity in physics. ..........................................

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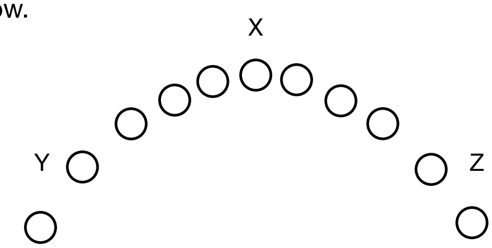
**5.2.2** **Projectile motion 2.**

**5.2.2.1** Consider the path of a projectile as shown in the diagram below.




(a) Which statement about the projectile is correct?

(A) The speed at X is the same as the speed at Z.

(B) The speed at Y is zero.

(C) The velocity at X is equal to the velocity at Z but in the opposite direction.

(D) The velocity at X, Y and Z is constant.

(b) Write a question which would make choice (c) correct. ..........

..........

..........

**5.2.2.2** Which of the following statements about projectile motion is correct?

(A) The horizontal distance a projectile travels is proportional to the time of travel squared.

(B) The rate at which a projectile rises and falls is proportional to its mass.

(C) The square of the distance a projectile travels is proportional to the time of flight.

(D) The rate at which a projectile rises and falls is independent of its velocity.

**5.2.2.3** Which of the following statements is in agreement with Galileo's analysis of projectile motion?

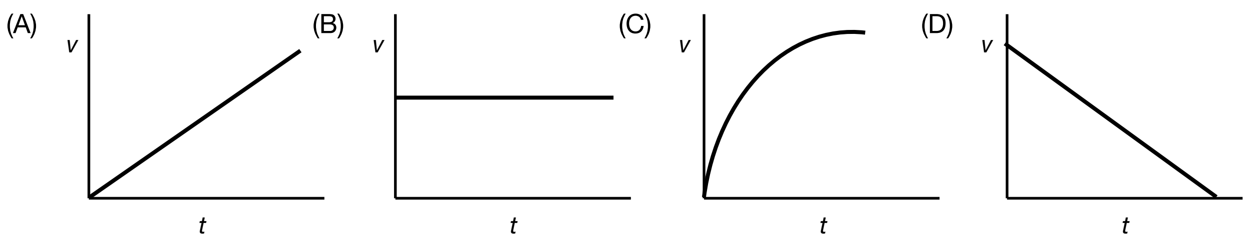
(A) The rate at which a projectile falls is proportional to its mass.

(B) The range of the projectile is proportional to the time elapsed.

(C) The range of the projectile is proportional to its initial vertical speed.

(D) The speed of the projectile is the vector sum of the vertical and horizontal components of that speed.

**5.2.2.4** A ball is rolled at different speeds along a horizontal benchtop until it falls over the edge towards the floor. Which graph best shows the velocity of the ball as it falls to the floor?




**5.2.2.5** Several balls are rolled at different speeds along a benchtop until they fall over the edge towards the floor. Which statement about these balls is correct?

(A) All four balls will hit the floor at the same time.

(B) The slowest ball will hit the floor first; the fastest will hit it last.

(C) The fastest ball will hit the floor first; the slowest will hit it last.

(D) All balls will land in the same position at the same time.

**5.2.2.6** Four model rockets are launched with the velocity components shown in the table.

| Rocket | Horizontal component of velocity (m $s^{-1}$) | Vertical component of velocity (m $s^{-1}$) |
|---|---|---|
| (A) | 20 | 52 |
| (B) | 30 | 38 |
| (C) | 50 | 29 |
| (D) | 40 | 21 |

(a) Which rocket was launched closest to 30° to the horizontal?

..........

(b) What would be the time of flight of rocket (A)?

..........

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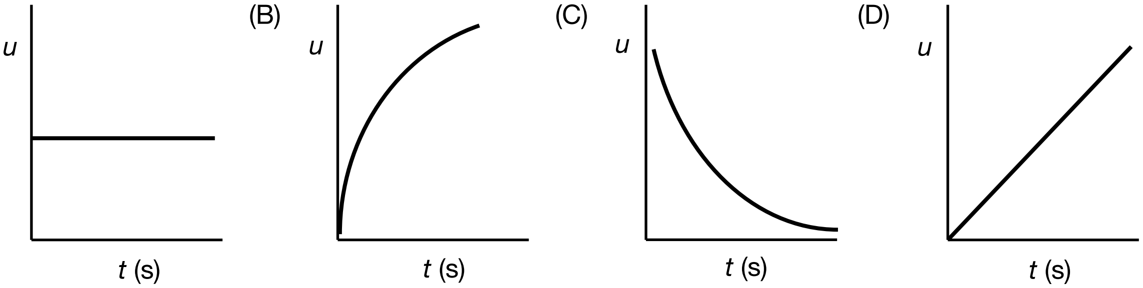
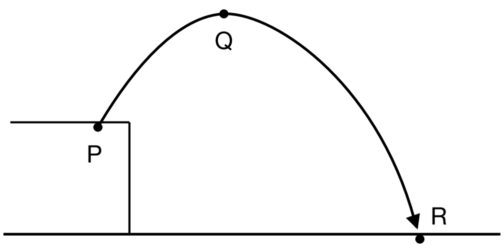
**5.2.2.7** Which graph best shows the relationship between the time of flight of a projectile ($t$) and its launch velocity ($u$)?




**5.2.2.8** A projectile follows the pathway shown in the diagram.

Which statement about this projectile is correct?



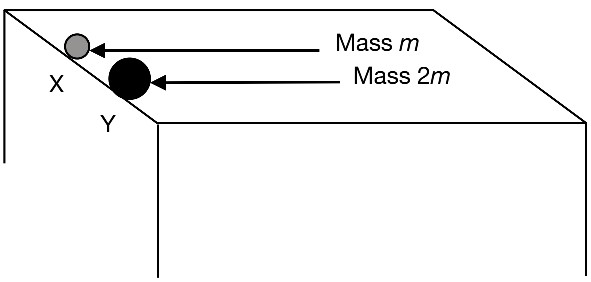

(A) The time of flight from P to R is twice the time from P to Q.

(B) The acceleration of the projectile is independent of its launch velocity.

(C) The vertical component of the velocity is the same at P, Q and R.

(D) The horizontal component of the velocity is greatest at Q.

**5.2.2.9** A student rolls two balls X and Y, X with mass $m$ and Y with mass $2m$ across a benchtop so that they leave the edge at the same time and with the same speed.




Four students made statements about the flight of the two balls.

Jacinta: Y hits the ground before X.

Chin: X and Y hit the ground at the same time.

Mario: X hits the ground twice as far away from the table compared to Y.

Pasqual: X hits the ground the same distance from the table as Y.

Whose statement about the two balls is correct?

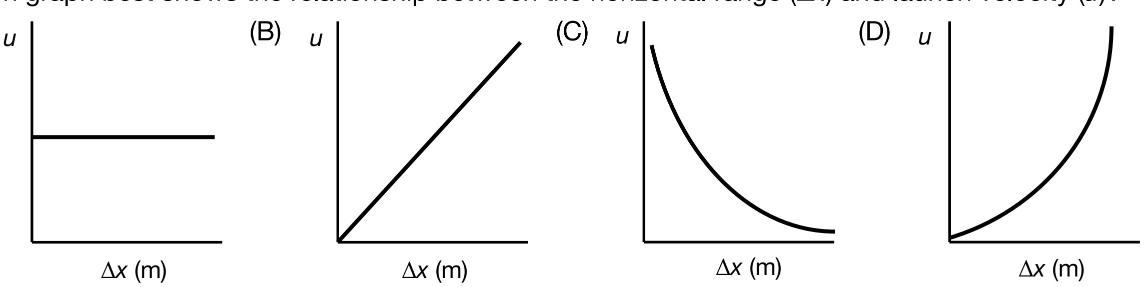
(A) Pasqual and Chin.

(B) Pasqual and Jacinta.

(C) Mario and Jacinta.

(D) Mario and Chin.

**5.2.2.10** Which graph best shows the relationship between the horizontal range ($\Delta x$) and launch velocity ($u$)?

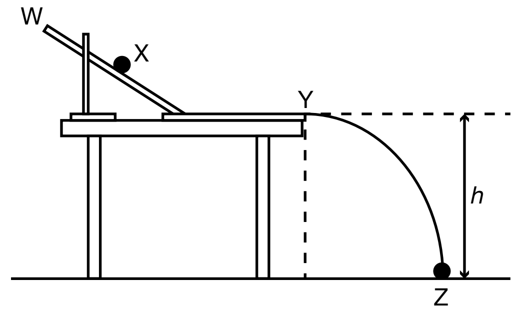


## 5.3 Solve problems, create models and make quantitative predictions by applying the equations of motion relationships for uniformly accelerated and constant rectilinear motion.

### 5.3.1 Solving projectile problems.

**5.3.1.1** The diagram shows the apparatus used to do an experiment where a ball is rolled down the ramp from point X, across the benchtop to the edge Y, then allowed to fall onto the floor, landing at point Z.

What would the ball do if it was released from point W?




(A) Take a shorter time to fall from Y to the floor but land further out from the table.

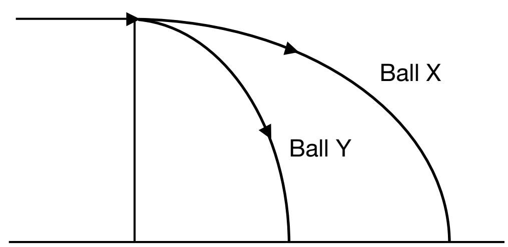
(B) Take the same time to fall from Y to the floor but land further out from the table.

(C) Take a shorter time to fall from Y to the floor but still land at Z.

(D) Take a longer time to fall from Y to the floor but land further out from the table.

**5.3.1.2** Ball X is projected horizontally from a 1.2 m high table at 2.6 m $s^{-1}$. Ball Y is projected vertically out from the edge of the table at 1.5 m $s^{-1}$.

How much further out from the edge of the table does ball X land compared to Y?




**5.3.1.3** A cannonball is fired at 80 m $s^{-1}$at an angle of 45° to the horizontal. Calculate the height at which the ball hits a vertical cliff 150 m away.

**5.3.1.4** A ball is hit into the air at 45 m $s^{-1}$ 30° to the horizontal. What is its speed 2 s later?

**5.3.1.5** A projectile is fired horizontally at 150 m $s^{-1}$ from the top of a 196 m high cliff. Calculate:

(a) Its time of flight.

(b) Its range.

(c) Its velocity on hitting the ground.

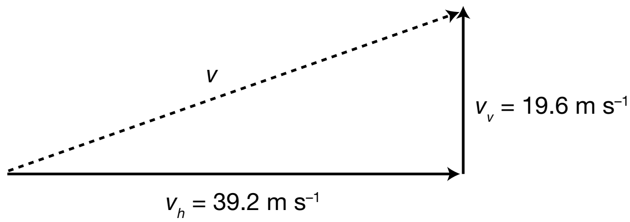
**5.3.1.6** A projectile has a time of flight of 7.5 s and a range of 1200 m. Calculate:

(a) Its horizontal velocity.

(b) Its maximum height.

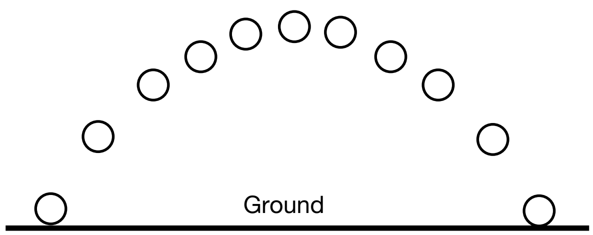
(c) The velocity with which it is projected.

**5.3.1.7** The velocity of a projectile 2.0 s after its launch can be found from the vector diagram shown. What was the launch velocity of the projectile?




**5.3.1.8** The diagram shows a stroboscopic photograph of a projectile which has a time of flight of 10.0 s.

(a) What was the initial vertical speed of the projectile?




(b) Calculate the maximum height of the projectile.

**5.3.1.9** A cannon was fired at an elevation of 40°. It was then loaded with an identical charge and ball and fired again at an elevation of 50°.

(a) Which cannonball will rise to the highest height and how much higher than the other ball is it?

(b) Which cannonball will have the largest range and how much further than the other ball does it go?

## 5.4 Conduct a practical investigation to collect primary data in order to validate the relationships derived for projectile motion.

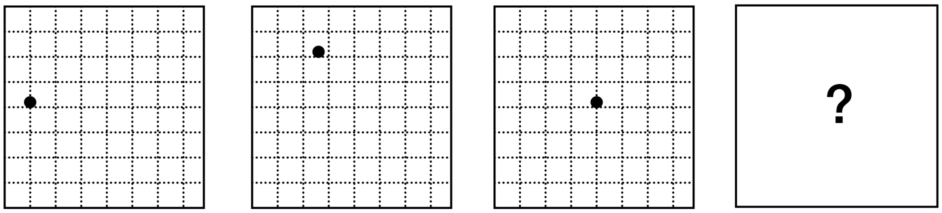
### 5.4.1 Analysing projectile data.

**5.4.1.1** The table shows the results of an experiment where a ball was rolled along a smooth, horizontal surface at 15 m s$^{-1}$ and then over the edge of a 150 m drop. The ball left the surface and started to fall at time zero.

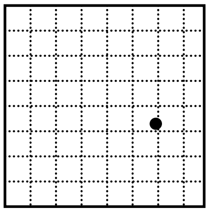
| Time (s) | Speed of ball (m s$^{-1}$) |
|---|---|
| 1 | 17.92 |
| 2 | 24.68 |
| 3 | 33.01 |
| 4 | 41.97 |

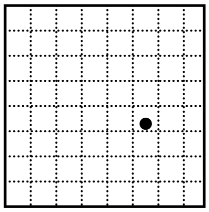
Assuming that the horizontal component of the motion of the projectile does not change, show that the vertical component is uniformly accelerated.

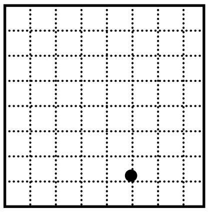
**5.4.1.2** Some photographs are taken of a ball moving in a parabolic path in front of a grid. The time interval between photographs is identical. The diagrams show the first three photographs of the ball's flight.

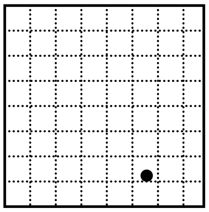



Which choice best shows the next photograph in the series?

(A) 

(B) 

(C) 

(D) 

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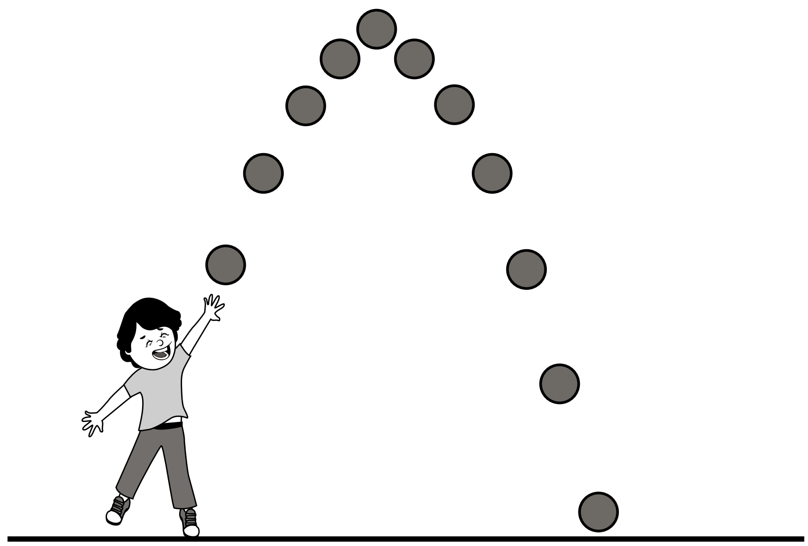
**5.4.1.3** The diagram shows a film clip of a ball projected into the air. The camera took the clip at 2.5 frames per second.



(a) What was the time of flight of the ball?

(b) How long did it take to reach its maximum height?

(c) What was its initial vertical velocity?

(d) How high did it rise?

(e) What was its range?

(f) What was its initial horizontal velocity?

(g) Using a vector diagram, determine its initial velocity.

(h) From what height was the ball projected?

# DOT POINT

# Answers

## Module 5 Advanced Mechanics

**5.1.1.1**

| | Horizontal component = vector cos $\theta$ | Vertical component = vector sin $\theta$ |
|---|---|---|
| (a) | 30.6 | 25.7 |
| (b) | 43.3 | 25.0 |
| (c) | 112.8 | 41.0 |
| (d) | 45.1 | 31.6 |
| (e) | 33.8 | 72.5 |
| (f) | 49.8 | 41.8 |
| (g) | 49.1 | 34.4 |
| (h) | 20.5 | 56.4 |

**5.1.2.1** B

**5.1.2.2** D

**5.1.2.3** C

**5.1.2.4** A

**5.1.2.6** C

**5.1.2.6** A

**5.1.2.7** A

**5.1.2.8** B

**5.1.2.9** C

**5.1.2.10** D

**5.1.3.1** C

**5.1.3.2** D

**5.1.3.3** D

**5.1.3.4** B

**5.1.3.5**
(a) Answer will be the same.
(b) Answer will be the same.
(c) Answer will be the same.
(d) Answer will be the same.

**5.1.4.1** C

**5.1.4.2** D

**5.1.4.3** C

**5.1.4.4** A

**5.1.4.5** A

**5.1.4.6** C

**5.2.1.1** Horizontal component of its motion is constant velocity (zero acceleration), while the vertical component is accelerated by gravity.

**5.2.1.2** Horizontal component is 10.35 m $s^{-1}$, vertical component is 38.64 m $s^{-1}$.

**5.2.1.3** Horizontal and vertical components of the motion of a projectile are independent of each other.

Horizontal component of its motion is constant velocity (zero acceleration).

Vertical component is constantly accelerated (by gravity).

**5.2.1.4**
(a) B
(b) Taking the upward direction as positive, then because the ball has landed vertically below its launch point, its final vertical displacement, and therefore its overall displacement is negative.

**5.2.1.5** D

**5.2.1.6** B

**5.2.1.7** C

**5.2.1.8**
(a) A
(b) 45°

**5.2.1.9**
(a) B
(b) The acceleration of each is the same, equal to gravitational acceleration directed downwards. (1 : 1 : 1)

**5.2.1.10** D

**5.2.1.11**
(a) D
(b) Positive and negative velocities refer to velocities in opposite directions to each other. Which one is taken as positive is purely up to the person doing the problem or analysis; there is no rule which defines this.

**5.2.2.1**
(a) A
(b) Which statement about the horizontal velocity of the projectile is correct?

**5.2.2.2** D

**5.2.2.3** B

**5.2.2.4** C

**5.2.2.5** A

**5.2.2.6**
(a) C
(b) 5.31 s

**5.2.2.7** B

**5.2.2.8** B

**5.2.2.9** A

**5.2.2.10** B

**5.3.1.1** B

**5.3.1.2** 54.5 cm

**5.3.1.3** 115.5 m

**5.3.1.4** 39.1 m $s^{-1}$

**5.3.1.5**
(a) 6.32 s
(b) 948.7 m
(c) 162 m $s^{-1}$ at 22.5° down from the horizontal

**5.3.1.6**
(a) 160 m $s^{-1}$
(b) 68.9 m
(c) Up at 164.2 m $s^{-1}$ at 12.9° to the horizontal

**5.3.1.7** 55.4 m $s^{-1}$ at 45° to the horizontal

**5.3.1.8**
(a) 49 m $s^{-1}$
(b) 122.5 m

**5.3.1.9**
(a) The ball fired at an elevation of 50° will rise higher but without actual figures, we are unable to determine by how much.
(b) Neither. They will both have a range of 251.2 m since the firing angles are complementary.