

# Mechanics – Lesson Outline

## Syllabus References

- 8.4.2.2.7 - Define the terms 'mass' and 'weight' with reference to the effects of gravity
- 8.4.2.2.9 – Interpret Newton's Second Law of Motion and relate it to the equation:

$$\Sigma F = ma$$

- 8.4.2.2.10 – Identify the net force in a wide variety of situations involving modes of transport and explain the consequences of the application of that net force in terms of Newton's Second Law of Motion

- 8.4.2.3.6 - solve problems and analyse information using:

$$\Sigma F = ma$$

for a range of situations involving modes of transport

- 9.2.1.3.3 - analyse information using the expression:

$$F = mg$$

to determine the weight force for a body on Earth and for the same body on other planets

## Resources

Video: Newton's First and Second Laws of Motion  
<http://www.hscphysics.edu.au/resource/Dialogue.flv>

Video: Object Drop  
<http://www.hscphysics.edu.au/resource/Drop.flv>

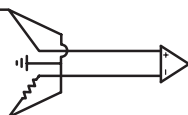
## Pre-video Activities

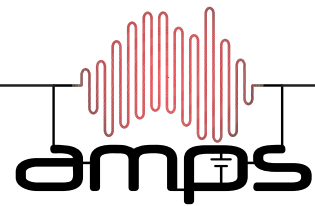
Split the class into pairs and hand out butcher's paper and markers to each pair. Pairs complete a concept map with the following:

- Force
- Acceleration
- Mass
- Newton
- Meters per second per second
- Kilogram

## View Video

Video: Newton's First and Second Laws of Motion  
<http://www.hscphysics.edu.au/resource/Dialogue.flv>





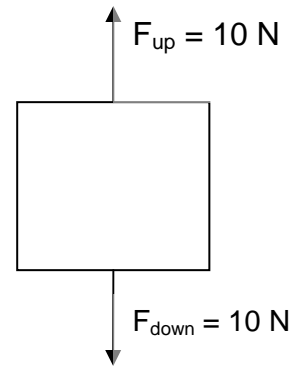
## Activities

Lead a class discussion about what student's saw and heard in the videos. Who was wrong? Who was right?

Draw the following diagram up on the board.

Introduce students to the idea of free-body diagrams and briefly discuss the forces acting on the object.

Ask the students whether the object is moving. Encourage discussions and questioning. Could the object be a book on a table? Could the object be a sled moving on ice with no friction?



In pairs again, students add more words to their concept map.

Including:

Newton's second law of motion

$F = ma$

Net force

Unbalanced forces

## View Video

Video: Object Drop

<http://www.hscphysics.edu.au/resource/Drop.flv>

## Activities

Lead a class discussion about the videos with the following questions:

Did the objects hit the ground at the same time?

Why?

Who was wrong?

Why were they wrong?

In pairs, students add more to their concept map, including:

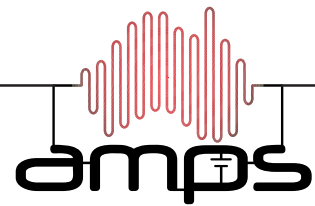
$F = mg$

Weight

Gravity

Post-video Activity: Concepts in Mechanics quiz

Students complete quiz individually.



# Mechanics – Concepts

**Q1.** The standard unit of force is the Newton. One Newton is equal to:

- A. One  $\text{kg m s}^{-2}$                       B. One  $\text{kg m s}^{-1}$                       C. One  $\text{kg m}^{-1} \text{s}^{-2}$   
D. One  $\text{m s}^{-2}$                       E. One  $\text{m}^{-1} \text{s}^{-1}$

**Q2.** If unbalanced forces are acting on an object, then:

- A. the object must be moving in a circle  
B. the object must be moving in a straight line  
C. the object must be stationary  
D. the object must be accelerating  
E. the object must be moving with constant velocity

**Q3.** Ashley pushes a box across frictionless tiles with a force of 95 N, causing the box to accelerate at  $2.5 \text{ m s}^{-2}$ . The mass of the box is:

- A. 15.2 kg                      B. 38 kg                      C. 237.5 kg  
D. 19 kg                      E. 0.003 kg

**Q4.** Alex pushes a 500-gram puck across the ice with a hockey stick, which accelerates at  $8.2 \text{ m s}^{-2}$ . What force is Alex applying to the puck?

- A. 4.1N                      B. 0.02 N                      C. 4100 N  
D. 16.4 N                      E. none of the above.

**Q5.** A force of  $F$  causes a mass of  $M$  to accelerate at  $7 \text{ m s}^{-2}$ . What would the acceleration be on a mass of  $2M$  with a force of  $0.5F$ ?

- A.  $1.75 \text{ m s}^{-2}$                       B.  $28 \text{ m s}^{-2}$                       C.  $7 \text{ m s}^{-2}$   
D.  $14 \text{ m s}^{-2}$                       E. There is not enough information to work this out.

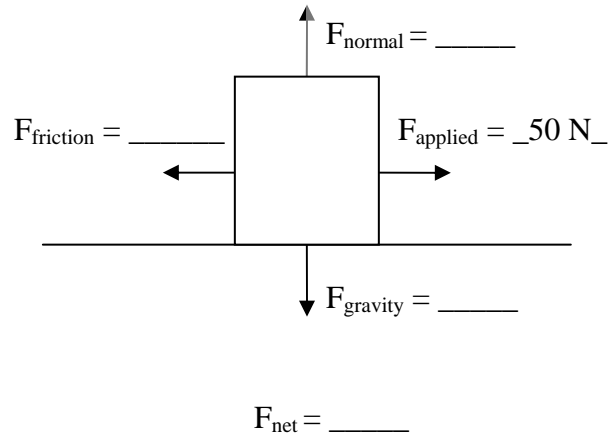
**Q6.** A box is moving across the floor to the left, this time with friction. The force of friction is:

- A. so small it can be ignored                      B. pulling down on the object                      C. to the right  
D. to the left                      E. to both the left and the right.

**Q7.** A 2 kg book encounters a 5 N frictional force when being pushed across a horizontal surface. What force do you have to apply in order to maintain a constant velocity?

- A. More than 5 N                      B. Less than 5 N                      C. 5 N  
D. 2 N                      E. 10 N

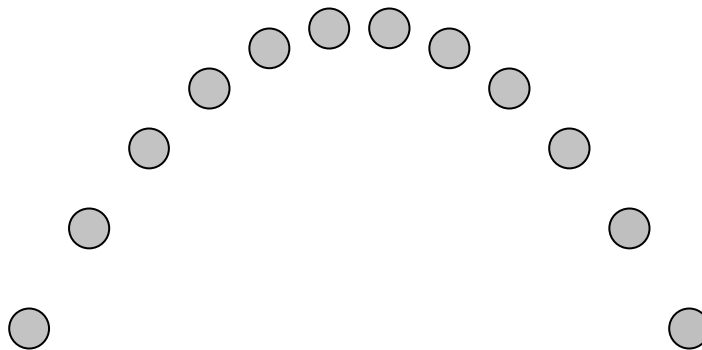
**Q8.** After reading the information, fill in the blanks on the following diagram. A 20-kg block is pushed across a table with a force of 50 N. This accelerates the block at  $0.5 \text{ m s}^{-2}$  to the right.



**Q9.** A small child throws a ball straight up into the air. After the child releases the ball, what forces are acting on it?

- A. gravity
- B. gravity and air resistance
- C. gravity, air resistance, and the force from the child's hand
- D. gravity and the force from the child's hand
- E. air resistance and the force from the child's hand

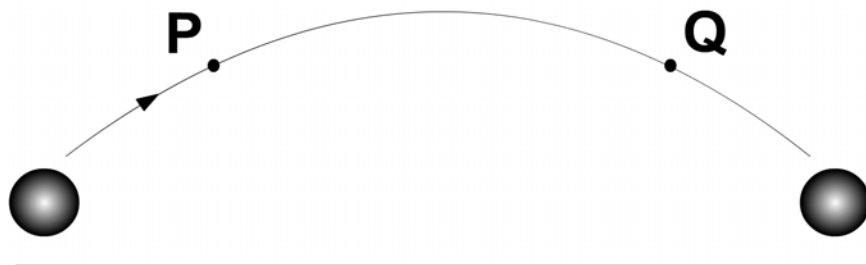
**Q10.** A ball thrown in the air traces a path as shown below.



Which of the following statements is true?

- A. The velocity of the ball keeps changing.
- B. The acceleration of the ball keeps changing.
- C. The velocity of the ball at the top of its motion is zero.
- D. The acceleration of the ball at the top of its motion is zero.
- E. All of the above

**Q11.** The diagram shows the trajectory of a golf ball.



Which set of arrows shows the direction of the acceleration of the ball at points *P* and *Q* respectively?

	At <i>P</i>	At <i>Q</i>
A.	↑	↓
B.	↓	↓
C.	↗	↘
D.	↙	↘

Questions 11- 13 refer to the following scenario:

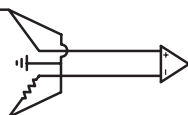
Ashley throws a 0.8 kg ball into the air. It moves upwards, stops and then falls back down to the ground. Air resistance is so small it can be ignored.

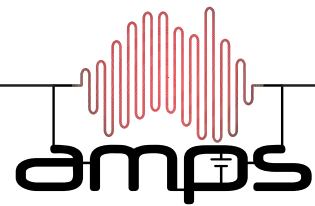
**Q11.** The net force acting on the ball at the top of its trajectory is:

- A. 0 N
- B. 0.8 N
- C. 1.6 N
- D. 8 N
- E. There is not enough information to work this out.

**Q12.** The net force acting on the ball as it travels towards the ground is:

- A. 0 N
- B. 0.8 N
- C. 1.6 N
- D. 8 N
- E. There is not enough information to work this out.





**Q13.** Which of the following statements accounts for the first part of the ball's trajectory, when it is moving upwards?

- A. The force from the ball's weight is constant and acts downwards, while the force upwards from Ashley's hand is steadily decreasing. So the ball slows to a stop.
- B. Air resistance slows the ball to a stop.
- C. The ball is accelerating downwards due to gravity. No other forces are acting, so the ball slows to a stop.
- D. The ball slows to a stop because the further it is from the Earth, the lower the gravitational attraction.
- E. The downward forces from air resistance and gravity are larger than the force upwards from Ashley's hand. Therefore the ball comes to a stop.

**Q14.** The weight of an astronaut on the Moon is  $\left(\frac{1}{6}\right)$  of her weight on Earth. What is the acceleration due to gravity on the Moon?

- A.  $\left(\frac{6}{9.8}\right) \text{ms}^{-2}$
- B.  $\left(\frac{9.8}{6}\right) \text{ms}^{-2}$
- C.  $9.8 \text{ms}^{-2}$
- D.  $(9.8 \times 6) \text{ms}^{-2}$
- E. None of the above

**Q15.** On the surface of Planet X a kangaroo with a mass of 100 kg would weigh 500N. What is the acceleration due to gravity on Planet X?

- A.  $0.2 \text{m s}^{-2}$
- B.  $5 \text{m s}^{-2}$
- C.  $1 \text{m s}^{-2}$
- D.  $400 \text{m s}^{-2}$
- E.  $50\,000 \text{m s}^{-2}$

**Q16.** The table shows the value of the acceleration due to gravity on the surface of Earth and on the surface of Mercury.

	Acceleration due to gravity ( $\text{ms}^{-2}$ )
Earth	9.8
Mercury	3.8

A person has a weight of 550 N on the surface of Earth. What would be the person's weight on the surface of Mercury?

- A. 56.1 N
- B. 213 N
- C. 550 N
- D. 1420 N
- E. None of the above