Table of Contents

Forces

Whole topic summary https://youtu.be/Rz4XBSKNGXg in only 16 minutes!

Equation	Symbols	Units
$W = mg$	W = weight m = mass g = gravitational field strength	W = N (newton's) m = kg (kilograms) g = N/kg (newtons per kilogram)
$W = Fs$	W = work done F = force s = distance	W = J (joules) F = N (newtons) s = m (meters)
$F = ke$	F = force k = spring constant e = extension	F = N (newtons) k = N/m (newtons per meter) e = m (meters)
$E_e = \frac{1}{2} ke^2$ Given in the exam	E_e = elastic potential energy k = spring constant e = extension	E_e = J (joules) k = N/m (newtons per meter) e = m (meters)
$M = Fd$ Physics only	M = moment F = force d = distance	M = Nm (newton-meters) F = N (newtons) d = m (meters)
$p = \frac{F}{A}$ Physics only	p = pressure F = force A = area	p = Pa (pascals) F = N (newtons) A = m^2 (meters squared)
$p = h\rho g$ Physics only Higher tier only Given in the exam	p = pressure h = height ρ = density g = gravitational field strength	p = Pa (pascals) h = m (meters) ρ = kg/m^3 (kilograms per meter cubed g = N/kg (newtons per kilogram)
$s = vt$	s = distance v = speed t = time	s = m (meters) v = m/s (meters per second) t = s (seconds)

$a = \frac{\Delta v}{t}$	a = acceleration Δv = change in velocity t = time	a = m/s^2 (meters per second squared) Δv = m/s (meters per second) t = s (seconds)
$v^2 - u^2 = 2as$ Given in the exam	v = final velocity u = initial velocity a = acceleration s = distance	v = m/s (meters per second) u = m/s (meters per second) a = m/s^2 (meters per second squared) s = m (meters)
F = ma	F = force m = mass a = acceleration	F = N (newtons) m = kg (kilograms) a = m/s^2 (meters per second squared)
p = mv Higher tier only	p = momentum m = mass v = velocity	p = kg m/s (kilograms metre per second) m = kg (kilograms) v = m/s (meters per second)
$F = \frac{m \Delta v}{\Delta t}$ Physics only Higher tier only Given in the exam	F = force m = mass v = velocity t = time	F = N (newtons) m = kg (kilograms) v = m/s (meters per second) t = s (seconds)

Scalar, Vector and Contact Forces

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can define the terms scalar and vector quantities	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	https://youtu.be/5Xcie8V-UTw
I can give examples of contact and non-contact forces	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can recall the difference between weight and mass	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can recall how to measure weight	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can recall the units needed for W = mg	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can rearrange W = mg	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can use W = mg	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can describe distance as a scalar quantity	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	https://youtu.be/5Xcie8V-UTw
I can describe displacement as a vector quantity	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

1. State whether the forces below are **contact** or **non-contact** forces.

   a. Air resistance: _____
   [1]

   b. Normal contact force: _____
   [1]

   c. Electrostatic force: _____
   [1]

   d. Friction: _____
   [1]

   e. Magnetic force: _____
   [1]

f. Tension: _____

[1]

g. Gravitational force: _____

[1]

2. Describe each of the forces below as either a **scalar** or a **vector**.

a. Mass: _____

[1]

b. Distance: _____

[1]

c. Displacement: _____

[1]

d. Speed: _____

[1]

e. Velocity: _____

[1]

f. Energy: _____

[1]

g. Time: _____

[1]

h. Power: _____

[1]

i. Current: _____

[1]

j. Force: _____

[1]

3. In the spaces provided, draw a basic vector diagram to show the named force acting on the object.
   a. A car moving to the right at 50m/s.

[2]

b. A child with a weight of 100N standing on the floor.

[2]

c. A parachutist accelerating towards the ground at 9.8m/s^2.

[2]

d. A person pushing a rock up a hill with a force of 50N.

[2]

4. Explain what is meant by the mass of an object.

_____

_____

[1]

5. State the units for the weight of an object.

_____

[1]

6. Calculate the weight of a 2kg mass on Earth.
The gravitational field strength on Earth, g, is 9.8N/kg.
Give your answer to 2 decimal places.

_____

_____

_____

Weight _____ N

[3]

7. Calculate the mass of an object that weighs 10N on Earth.
Give your answer to 2 significant figures.

_____

_____

_____

Weight _____ N

[2]

8. A steel block has a weight of 30N on Earth.
The same object on the moon weighs 4.8N.
Calculate the gravitational field strength on the moon.
Give your answer to 3 significant figures.
Give a unit in your answer.

_____

_____

_____

_____

_____

_____

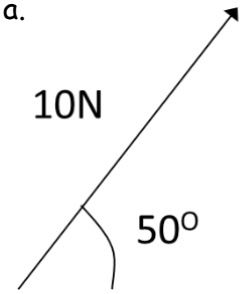
Gravitational field strength of the Moon _____

Unit _____

[6]

9. For the forces below, calculate the horizontal and vertical components acting to produce the overall force.

a.



_____

_____

_____

_____

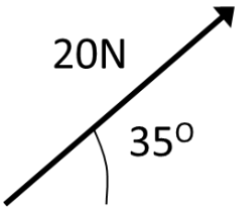
_____

Horizontal component _____N

Vertical component _____N

[4]

b.



Horizontal component _____N

Vertical component _____N

[4]

Balanced and Unbalanced Forces

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can represent the forces acting on an object as vectors	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can calculate the resultant force on an object	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	https://youtu.be/Oa9LglsNm2o

1. Find the resultant force that is acting on each of the objects below.

a. _____

_____

Resultant force _____

Direction _____

[2]

b. _____

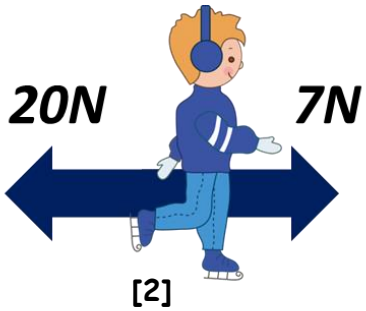
_____

_____

Resultant force _____

Direction _____

[3]



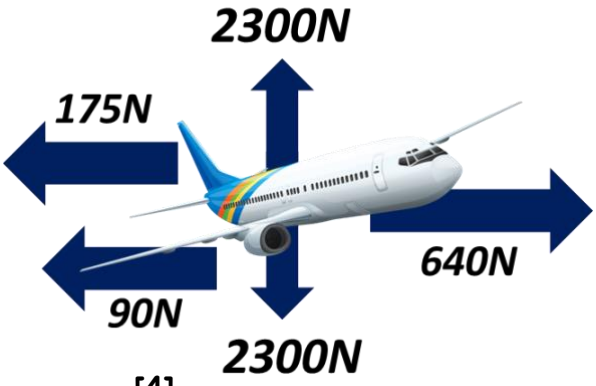
[2]

c. _____

_____

Resultant force _____

Direction _____



[4]

d. _____

_____

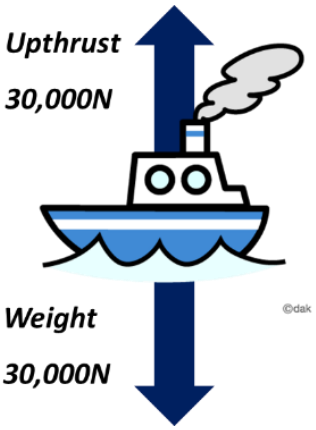
_____

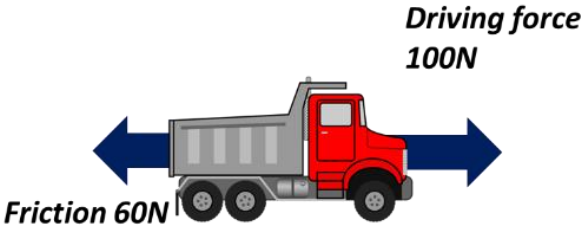
_____

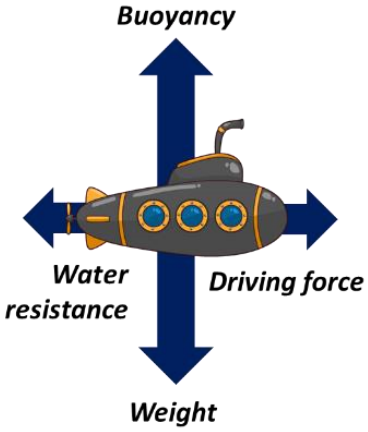
Resultant force _____

Direction _____

2. Draw a free body diagram for the three scenarios shown below.

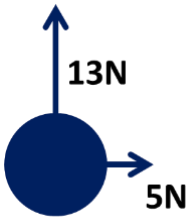






[3]

3. The free body diagram below shows the forces acting on an object.



Using Pythagoras theorem to calculate the magnitude of the resultant force that is acting on the object.

_____

_____

_____

_____

Resultant force _____ N

[4]

Distance-Time graphs and Velocity

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can recall the units needed for s = vt	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can rearrange s = vt	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can use s = vt	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can draw and interpret distance-time graphs	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	https://youtu.be/7OEL6bupk8A
I can calculate the speed of an object from a distance time graph	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

1. A car travels at 10m/s for 10 seconds. Calculate the distance travelled by the car.

_____

_____

Distance travelled _____ m

[2]

2. A plane travels 3000m in 15s. Calculate the average speed of the plane in this time.

_____

_____

Average speed _____ m/s

[2]

3. A person walked for 5000m at 2.5m/s. Calculate the time they were walking for.

_____

_____

Time _____ s

[2]

4. A toy boat travels 0.2km in 1 minute and 30 seconds. Calculate the average speed of the toy. Give your answer to 3 significant figures.

_____

_____

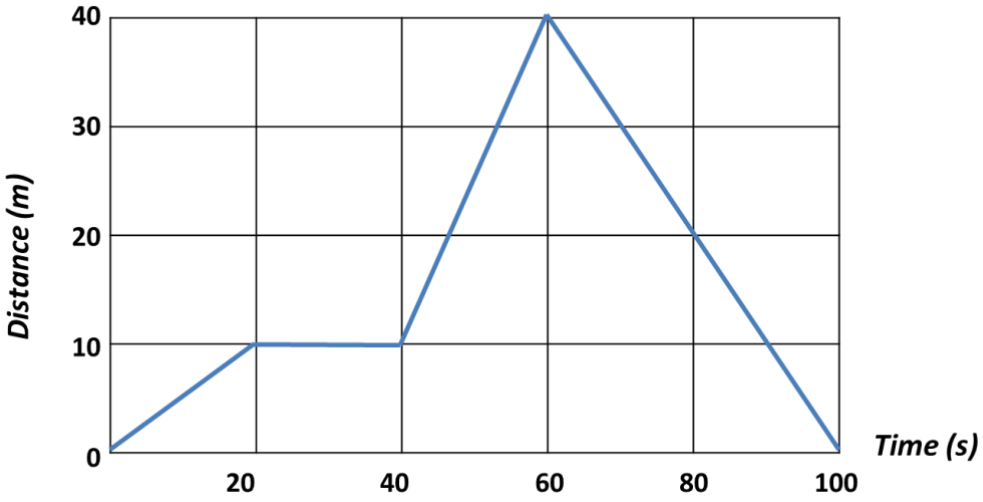
_____

_____

Average speed _____ m/s

[5]

Look at the distance-time graph below.



Answer the questions using the distance-time graph.

5. Calculate the average speed of the object during the first 20 seconds.

_____

_____

Average speed _____ m/s

[3]

6. State the distance from the starting point to the object after the first 60 seconds.

Distance _____ m

[1]

7. Calculate the average speed during the final 40 seconds.

_____

_____

Average speed _____ m/s

[2]

8. Below shows a table of the time taken for some athletes to complete a race.
   a. Complete the table by converting the times in minutes and seconds to find the average speed of the athletes in their races.

Distance (m)	***Athlete***	***Time***	***Time (s)***	***Speed (m/s)***
100	Usain Bolt	9.69s		
200	Micheal Johnson	19.32s		
400	Marita Koch	47.60s		
800	Wilson Kipketer	1min 41.11s		
1500	Yunxia Qu	3min 50.46s		
5000	Meseret Defar	14min 16.63s		
10000	Kenenisa Bekele	26min 17.53s		

[12]

   b. Describe the pattern shown in the table between the distance of the race and the average speed of the athletes.

_____

_____

[1]

9. The national speed limit for cars in the UK is 70mph (miles per hour).
   There are 1600m in one mile and 3600s in one hour.
   Use this information to convert 70mph into m/s (meters per second).

_____

_____

_____

_____

_____

70mph = _____ m/s

[4]

Velocity-Time graphs and Acceleration

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can describe situations where an object has a constant speed but is accelerating	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can draw and interpret velocity-time graphs	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	https://youtu.be/ZTwy8BYOhCs
I can calculate the distance travelled by an object from a velocity-time graph	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can define acceleration	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can calculate the acceleration of an object from a velocity-time graph	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	https://youtu.be/ZTwy8BYOhCs
I can recall the units needed for $a = \frac{\Delta v}{t}$	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can rearrange $a = \frac{\Delta v}{t}$	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can use $a = \frac{\Delta v}{t}$	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can recall that an object free falling due to the force of gravity has an acceleration of $9.8 m/s^2$	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can describe speed as a scalar quantity	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	https://youtu.be/5Xcie8V-UTw https://youtu.be/Nfm0a1Ui5pw
I can describe velocity as a vector quantity	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

I can describe the difference between speed and velocity	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

1. A motorbike can reach 30m/s in 3s. Calculate the acceleration of the motorbike.

_____

_____

Acceleration _____ m/s^2

[2]

2. A car can increase its velocity from 0m/s to 20 m/s in 5s. Calculate the acceleration of the car.

_____

_____

Acceleration _____ m/s^2

[2]

3. A car has a maximum acceleration of $5m/s^2$. Calculate the time it would take for the car to accelerate from rest to 30m/s.

_____

_____

Time _____ s

[2]

4. A falling object accelerates due to gravity at a rate of $10m/s^2$.
   Calculate the velocity of the object after it has been falling for:
   a. 10s

_____

_____

Velocity _____ m/s

   b. 20s

_____

_____

Velocity _____ m/s

   c. 50s

_____

_____

Velocity _____ m/s

5. State whether the following quantities are examples of speed or velocity.
   a. 30 mph due east _____

[1]

   b. 50 mph _____

[1]

c. 5 mm/s _____

[1]

d. 200 m/s _____

[1]

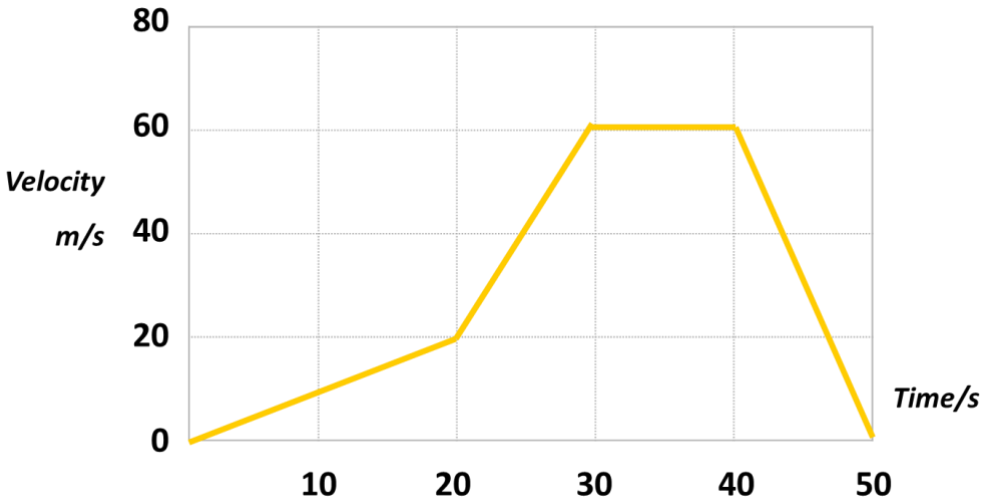
e. 10 cm/s 045° _____

[1]

f. 12km/hr North _____

[1]

6. Look at the velocity time graph below.



Use the graph to answer the questions below.

a. State the velocity of the object after 10 seconds.

_____

[1]

b. Calculate the acceleration of the object between 20 and 30 seconds.
Give your answer a unit.

_____

_____

_____

Acceleration_____

Unit _____

[5]

c. Calculate the deceleration of the object between 40 and 50 seconds.

_____

_____

_____

d. Use the graph to find the distance travelled by the object in the 50s it was moving.

_____

_____

_____

_____

_____

_____

Distance travelled _____ m

[7]

7. State the value that scientists use for the acceleration of an object due to gravity.

_____

[1]

8. Describe what is meant when an object is said to be in freefall.

_____

_____

[1]

9. An object is dropped from a building and accelerates due to gravity.
Calculate the velocity that the object hits the ground if it is in freefall for 2 seconds.

_____

_____

_____

Velocity _____ m/s

[2]

10. An object falls to the ground due to gravity.
The object hits the floor with a velocity of 11.4 m/s.
If the object was released at 2m/s, calculate the time the object was in free fall.
Give your answer a unit.

_____

_____

_____

Time _____

Unit _____

[4]

11. A parachutist jumps from an aeroplane and accelerates due to gravity for 6 seconds.
Calculate the speed the parachutist is moving at after 4 seconds.

_____

_____

_____

Velocity _____ m/s

[2]

12. A pen falls from a table and hits the floor 0.5s later. The pen was in freefall for the 0.5s.
Calculate the speed that the pen hits the floor at.

_____

_____

_____

Velocity _____ m/s

[2]

13. An object is thrown up in the air at 25m/s.
Calculate the time taken for the ball to reach its maximum height.

_____

_____

_____

Velocity _____ m/s

[2]

14. On the moon, it takes 3.5 seconds for an object to hit the floor.
The object hits the floor at 5.5m/s.
Calculate the acceleration due to gravity on the moon.
Give your answer a unit.
Calculate your answer to 3 decimal places.

_____

_____

_____

Acceleration due to gravity on the moon _____

Unit _____

[4]

Equations of Motion

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can recall the units needed for $v^2 - u^2 = 2as$	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can rearrange $v^2 - u^2 = 2as$	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can use $v^2 - u^2 = 2as$	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

1. A car accelerates uniformly from 5m/s to 15m/s taking 7.5 seconds. Calculate the distance travelled during this period.

Distance _____ m

[2]

2. A runner starts from rest, runs for 30 seconds at a uniform acceleration of $2m/s^2$. Calculate the runner's final velocity.

Final velocity _____ m/s

[3]

3. A particle is accelerated from 1m/s to 5m/s over a distance of 15m. Find the acceleration and the time taken.

Final velocity _____ m/s

[5]

4. A car accelerates uniformly from rest and after 12 seconds has covered 40m. Calculate the final velocity and acceleration.

Final velocity _____ m/s

Acceleration _____ m/s^2

[5]

5. A new car is being tested. Its Initial velocity is measured to be 5m/s, and has a final velocity 36km/hr whilst accelerating at1.25m/s/s. Calculate the distance travelled by the car.

Distance travelled _____ m

[4]

6. A train travels along a straight piece of track between 2 stations A and B. The train starts from rest at A and accelerates at 1.25m/s^2 until it reaches a speed of 20m/s. It then travels at this speed for a distance of 1560m and then decelerates at 2m/s^2 to come to rest at B. Find:

    1. Distance from A to B

Distance between A and B _____ m

[6]

2. Total time taken for the journey

Time taken for the journey _____ s

[7]

3. Average speed for the journey

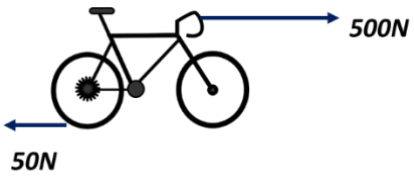
Average velocity _____ m/s

[2]

Newton's 1st Law

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can describe the forces on a moving object	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can describe how an object is moving if the resultant force on it is 0	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	https://youtu.be/Oa9LglsNm2o
I can apply Newton's First Law to explain the motion of objects	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can describe situations where an object has a constant speed but is accelerating	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can state that the speed of an accelerating object is constantly changing	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

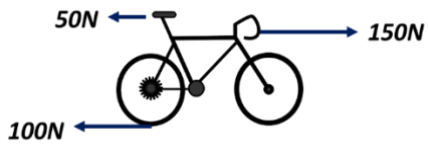
1. Calculate the vector values of each of the resultant force acting in the following scenarios.



a. _____
_____
_____

Resultant force _____ N

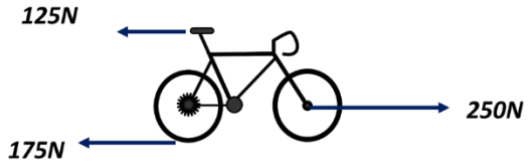
[1]



b. _____
_____
_____

Resultant force _____ N

[2]



c. _____

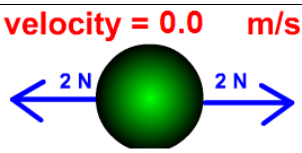
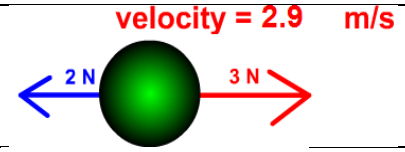
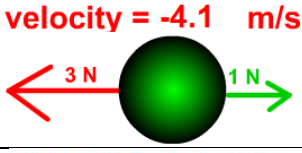
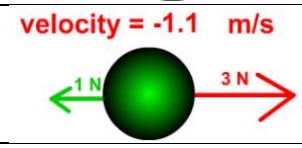
_____

_____

Resultant force _____ N

[3]

2. Complete the table below by stating the overall size of the resultant force, direction of the resultant force, and the effect on the ball.
   Values that are positive mean that they are acting to the right.

If the ball at the start is…	***The force applied***	***Size of Resultant force***	***Direction of resultant force***	***Effect on the object?***
Stationary				
Moving to the right				
Moving left				
Moving left				

[12]

3. Complete the sentences below using the words in box.

Force ***Velocity*** ***Centre*** ***Accelerates*** ***Changing*** ***Centripetal***

   a. For an object moving in a circle, its _____ is along a tangent to a circle bit it is constantly _____ .
   b. The change of velocity is towards the _____ of the circle
   c. There must be a resultant _____ acting on the object towards the centre of the circle. This is called the _____ force.
   d. For an object moving in a circle at constant speed, the object _____ continuously towards the centre of the circle.

4. For each of the scenarios below, state the name of the force that causes the centripetal force to act.

   a. A car travelling around a bend _____

   [1]

   b. A stone being whirled around on the end of a string _____

   [1]

   c. A planet moving around the sun _____

   [1]

   d. An electron orbiting the nucleus in an atom _____

   [1]

Newton's 2nd Law

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can describe inertia	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can describe the relationship between the mass of an object and its acceleration	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can recall the units needed for F = ma	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can rearrange F = ma	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can use F = ma	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

1. A car has a mass of 1750kg. The car's engine provides a driving force of 5200N. When the car reaches 70mph, there is a drag force of 5150N acting on the car.
   a. Sketch a free body diagram to show the forces acting on the car at 70mph. You do not have to write any values on your diagram.

[3]

   b. Calculate the acceleration of the car as it moves from rest. Assume that there are no frictional forces acting.

_____

_____

_____

Acceleration = _____ m/s^2

[2]

c. Calculate the acceleration of the car at 70mph.

Acceleration = _____ m/s^2

[2]

2. A cyclist has a mass of 60kg. She rides a bike that has a mass of 20kg.
When starting off, the cyclist provides a force of 200N.
Calculate the acceleration of the cyclist. Give your answer to 2 significant figures.

Acceleration = _____ m/s^2

[3]

3. A car of mass 500kg is travelling at 20m/s. The driver sees a red light ahead and slows to a halt in 10s.
   a. Calculate the force that the brakes must provide to produce this deceleration.

Force required _____ N

[4]

   b. Calculate the distance that the car travels during this time.

Distance _____ m

[3]

4. A rocket has a mass of 5000kg. It has 4 engines, each providing a thrust of 50,000N.
   a. Calculate the acceleration of the rocket.

_____

_____

_____

Acceleration _____ m/s^2

[2]

   b. Explain what will happen to the acceleration as the rocket progresses into its flight.

_____

_____

_____

_____

_____

_____

[4]

Newton's 3rd Law

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can describe what happens when two objects interact	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

1. Describe in words Newton's third law.

_____

_____

_____

_____

[2]

2. In each of the diagrams below, name the forces that are acting on each of the objects.

The moon and the Earth.

a.

[2]

A teapot on a table.

b.

[4]

An accelerating car.

c.

[5]

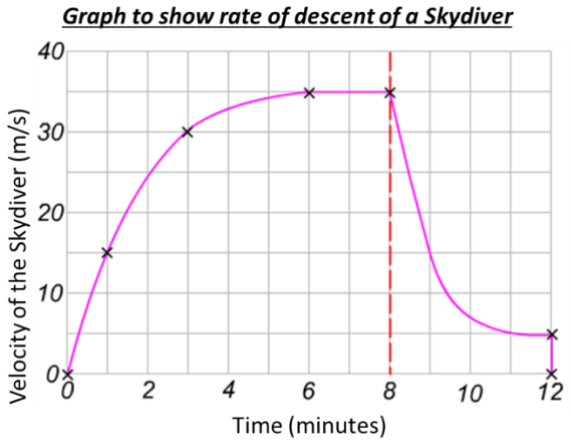
Terminal Velocity

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can describe how an object reaches terminal velocity	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can draw and interpret velocity-time graphs for objects that have reached terminal velocity	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

1. Complete the sentences using the words provided below.
   a. At the start of a parachute jump the air resistance is _____ so the parachutist _____ downwards.
   b. As the speed of the parachutist increases, the air resistance will _____.
   c. Eventually, the air resistance will be big enough to _____ the skydiver's weight. At this point the forces are balanced so the speed becomes _____ - this is referred to as terminal velocity.
   d. When the parachutist opens their parachute, the air resistance suddenly _____ causing them to start _____ _____.
   e. Because they are slowing down the air resistance will _____ again until it balances their _____. The skydiver has now reached a new, lower _____ _____.

[10]

2. Look at the graph below before attempting the questions.



a. State the initial velocity of the skydiver.

Initial velocity _____ m/s

[1]

b. State the maximum constant velocity of the skydiver.

Maximum velocity _____ m/s

[1]

c. State the name given to this maximum velocity reached by the parachutist.

_____

[1]

d. State the time that the parachutist's velocity begins to decrease.

Time _____ s

[1]

e. Explain, in terms of balanced forces, why the parachutist begins to slow down after 8 minutes.

_____

_____

_____

_____

_____

_____

[3]

f. Calculate the average acceleration of the parachutist between 2 and 6 minutes.

_____

_____

_____

Acceleration _____ m/s^2

[3]

g. Calculate the deceleration of the parachutist from the time the parachute opens until they touch the ground.

_____

_____

_____

Acceleration _____ m/s^2

[3]

Momentum

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can recall the units needed for p = mv **Higher Tier Only**	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can rearrange p = mv **Higher Tier Only**	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can use p = mv **Higher Tier Only**	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can calculate momentum when two objects collide **Physics only**	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

1) State the equation that links together mass, velocity, and momentum.

_____

[1]

2) Calculate the momentum of a 5kg object travelling at 2m/s.

_____

_____

_____

_____

Momentum = _____ kg.m/s

[2]

3) Calculate the mass of an object that is travelling at 3m/s with 36kg.m/s momentum?

Mass = _____ kg

[2]

4) Calculate the momentum of a 2000g object travelling at 4m/s

Momentum = _____ kg.m/s

[2]

5) A hockey ball at rest has a mass of 250g. A player hits the ball with 0.35kN of force.

a. Calculate the acceleration of the ball.

Acceleration = _____ m/s^2

[2]

b. The ball accelerates for 0.5s. Find the final velocity of the ball, and hence find the final momentum of the ball

Momentum = _____ kg.m/s

[4]

6) A school bus has twice the mass of a car. Explain how both the lorry and the can have the same magnitude of momentum.

[2]

Conservation of Momentum

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can state the law of conservation of momentum **Higher Tier Only**	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can describe momentum as a property of moving objects **Higher Tier Only**	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

1. A 1000kg wagon moving at a velocity of 5.0m/s collides with a 1500kg stationary wagon. The two wagons move together after the collision.

   a. State the equation that links together momentum, velocity, and mass together.

   _____

   [1]

   b. Calculate the momentum of the 1000kg wagon before the collision.

   _____

   _____

   Momentum _____ kg.m/s

   [1]

   c. Calculate the velocity of the wagons after the collision.

   _____

   _____

   _____

   _____

   Velocity _____ m/s

   [4]

2. A 1500kg car is travelling at 2.5m/s and collides with a 2000kg car travelling at 1.5m/s in the same direction. The two cars move together in the same direction after the collision. Calculate the velocity of the 2 vehicles after the collision.

Velocity _____ m/s

[5]

3. A 1kg snowball is rolling down a hill at 1m/s. A snowball with mass 0.5kg is rolled towards the snowball at 1m/s. Explain what you expect to happen to the velocity of the two snowballs be after the collision. Calculate the final velocity of the snowballs.

Velocity _____ m/s

[5]

4. A 2kg mass is moving at 8m/s to the right and sticks to a 3kg mass that is moving to the left at 2m/s. Calculate the final velocity of the objects after the collision.

Velocity _____ m/s

[4]

5. A 6kg mass moving at 4m/s to the right collides with a 2kg mass moving at 6m/s to the left. Calculate the velocity of the combined mass after the collision.

Velocity _____ m/s

[4]

6. A 3kg mass moving at 7m/s to the right hits a 2kg mass which is moving at 3m/s in the opposite direction. After the collision the 3kg mass moves to the right with a velocity of 1m/s. Calculate the velocity of the 2kg mass and state the direction it is moving in.

_____
_____
_____
_____
_____

Velocity _____ m/s

Direction _____

[6]

7. A 600kg cannon recoils at a speed of 0.5m/s when a 12kg cannon ball is fired from it. Calculate the velocity of the cannon ball when it leaves the cannon.

_____
_____
_____
_____

Velocity _____ m/s

[4]

8. A 30kg skater and a 40kg skater standing in the middle of an ice rink push apart. Complete the following sentences using the words *force*, *momentum*, and *velocity*.

   a. They skaters move apart with equal and opposite _____

   [1]

   b. The 30kg skater moves away with a greater _____ than the 40kg skater.

   [1]

   c. They push each other with equal and opposite… _____

   [1]

d. The 30kg skater moves away at 2m/s.

What is her momentum?

_____

_____

Momentum _____ kg.m/s

[1]

e. Calculate the velocity that the other skater moves away with.

_____

_____

_____

_____

Velocity _____ m/s

[3]

Stopping Distances

These are the bits the exam board wants you to know, make sure you can do all of these…	Self-assessment			Bits to help if you don't understand
	First review	Second review	Final review	
I can describe stopping distance as a combination of reaction time and breaking distance	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can describe the factors that affect reaction time	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	
I can describe the factors that affect breaking distance	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	

1. State what factors stopping distance is divided into.

_____

[1]

2. Sketch a simple graph to show the relationship between speed and stopping distance.

[2]

3. The thinking distance of a normal driver travelling at 40 mph is 12 m.

   a. Calculate the thinking distance for a driver whose reaction time is 25% longer than that of a normal driver.

_____

_____

_____

Thinking distance _____ m

[2]

b. Name 3 factors that could cause the thinking distance of a driver to increase.

_____

_____

_____

[3]

4. State what will happen to the braking distance of a car if the velocity of the car doubles.

_____

_____

[1]

5. A vehicle with mass 1800kg is travelling at a constant velocity along a flat road. A constant braking force of 15,000N is applied over a distance of 120m to bring the car to a stop.

   a. Calculate the work done in bringing the car to a stop.

_____

_____

_____

Work done _____ J

[2]

   b. Use your answer to part a. to calculate the velocity of the car before the brakes were applied.

_____

_____

_____

Velocity _____ m/s

[4]

   c. The brakes are made from a special ceramic material with a specific heat capacity of 1700J/kg.°C. Each brake has a mass of 0.75kg and transfers 25% of the kinetic energy into thermal energy. Calculate the change in temperature of each of the brakes fitted to the car.
   Give your answer to 2 significant figures.
   Give your answer a unit.

_____

_____

_____

_____

_____

Change in temperature _____

Unit _____

[6]

Answers

Scalar, Vector and Contact Forces Answers

1.

a. Contact **[1]**
b. Contact **[1]**
c. Non-contact **[1]**
d. Contact [**1**]
e. Non-contact **[1]**
f. Contact **[1]**
g. Non-contact **[1]**

2.

a. **Scalar** **[1]**
b. Scalar **[1]**
c. Vector **[1]**
d. Scalar **[1]**
e. Vector **[1]**
f. Scalar **[1]**
g. Scalar **[1]**
h. Scalar **[1]**
i. Scalar **[1]**
j. Vector **[1]**

3.

a. Arrow pointing to the right **[1]**
   Labelled as 50m/s **[1]**
b. Arrow pointing downwards **[1]**
   Labelled with 100N **[1]**
c. Arrow pointing downwards **[1]**
   Labelled with 9.8m/s^2 **[1]**
d. Arrow at an angle pointing in an upward direction **[1]**
   Labelled with 50N

4. The amount of matter in an object **[1]**

5. Kilograms **[1]**

6. Weight = 2 x 9.8 **[1]**
   = 19.6N **[1]**

7. Mass = 10 / 9.8 **[1]**
   = 1.020408... kg **[1]**
   OR = 1.02kg **[2]**

8. Mass on Earth = 30 / 9.8 **[1]**
   = 3.06… kg **[1]**
   Mass on Earth = Mass on Moon **[1]**
   GFS on moon = 4.8 / 3.06
   = 1.57…. **[1]**
   OR = 1.57 **[2]**
   N/kg (Newtons per Kilogram) **[1]**

9. .
   a. ***Horizontal component***
      10cos(50) **[1]**
      6.43 N **[1]**

      Vertical component
      10sin(50) **[1]**
      7.66N **[1]**

   b. ***Horizontal component***
      20cos(35) **[1]**
      16.38 N **[1]**

      Vertical component
      20sin(35) **[1]**
      11.47N **[1]**

Resultant Forces Answers

1.
   a. 700 – 200 = 500N **[1]**
      To the right

   b. 70 + 45 = 115N acting to the left **[1]**
      230 – 115 = 115N resultant force **[1]**
      Acting to the right **[1]**

   c. 20 – 7 =13N **[1]**

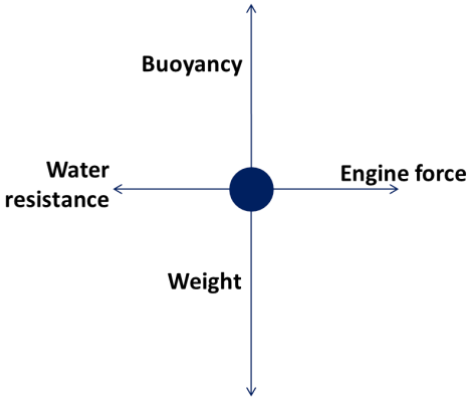
To the right **[1]**

d. 0N force is acting in vertical direction **[1]**
175 +90 = 365N acting to the left **[1]**
640 – 265 = 375N Resultant force **[1]**
Acting to the right **[1]**

2.

[1]

[1]



[1]

3. $a^2 + b^2 = c^2$ **[1]**
$13^2 + 5^2 = c^2$ **[1]**
169 + 25 = 194 **[1]**
Resultant force = √194 = 12.8N **[1]**

Distance-Time graphs Answers

1. Distance = time x speed = 10s x 10m/s **[1]**
   = 100m **[1]**
2. Average speed = Distance / time = 3000m/15s **[1]**
   = 200 m/s **[1]**
3. Time = Distance / Avg. speed = 5000m/2.5m/s **[1]**
   = 2000s **[1]**
4. 0.2km = 200m **[1]**
   1min 30seconds = 90s **[1]**
   Average speed = Distance / time = 200m / 90s **[1]**
   = 2.222222222…. m/s **[1]**
   OR
   =2.22 m/s **[2]**
5. Distance travelled = 10m **[1]**
   Average speed = Distance / time = 10m / 20s **[1]**
   = 0.5 m/s **[1]**
6. 40m **[1]**
7. Distance travelled = 40m **[1]**
   Average speed = Distance / time = 40m / 40s **[-]**
   = 1 m/s **[1]**

8.

Distance (m)	Athlete	Time	Time (s)	Speed (m/s)
100	Usain Bolt	9.69s	9.69	10.32
200	Micheal Johnson	19.32s	19.32	10.35
400	Marita Koch	47.60s	47.60	8.40
800	Wilson Kipketer	1min 41.11s	101.11	7.91
1500	Yunxia Qu	3min 50.46s	230.46	6.51
5000	Meseret Defar	14min 16.63s	970.63	5.15
10000	Kenenisa Bekele	26min 17.53s	1577.53	6.34

   b. The greater the distance, the slower the average speed. **[1]**

9. 70mph = 70 x 1600m (meters per hour) **[1]**
   = 112,000 meters per hour **[1]**
   112,000 meters ph = 112,000 / 3600 (m/s) **[1]**
   = 31.1 m/s **[1]**

Acceleration and Velocity-time graphs Answers

1. Acceleration = change of velocity / time = 30 m/s / 3s **[1]**
   = 10 m/s^2 **[1]**
2. Acceleration = change of velocity / time = 20 m/s / 5s **[1]**
   = 4 m/s^2 **[1]**
3. Time = Change of velocity / acceleration = 30 m/s / 5 m/s^2 **[1]**
   = 6 s **[1]**
4. a. Velocity = Acceleration x time = 10s x 10m/s^2 **[1]**
   =100m/s **[1]**
   b. Velocity = 200m/s **[1]**
   c. Velocity = 500m/s **[1]**

5. a. Velocity **[1]**
   b. Speed **[1]**
   c. Speed **[1]**
   d. Speed **[1]**
   e. Velocity **[1]**
   f. Velocity **[1]**

6. a. 10 m/s **[1]**
   b. Starting velocity = 20 m/s Final velocity = 60 m/s **[1]**
   Change in velocity = 40 m/s **[1]**
   Acceleration = velocity / time = 40 m/s / 10 s **[1]**
   = 4 **[1]**
   Unit m/s^2 **[1]**
   c. Change in velocity = 60 m/s **[1]**
   Acceleration = Change in velocity / time = 60 m/s / 10 s **[1]**
   = 6 (m/s^2) **[1]**
   d. 0 -20 s
   Distance covered = $\frac{1}{2}$ x 20 x 20 **[1]**
   = 200m **[1]**
   20-30 s
   Distance covered = $\frac{1}{2}$ (20 +60) x 10 **[1]**
   = 400 m **[1]**
   30-40 s
   Distance covered = 10 x 60 **[-]**
   = 600 m **[1]**

40-50s

Distance covered = ½ x 60 x 10 **[-]**

= 300 m **[1]**

Combined distance = 1500 m **[1]**

7. 10 m/s^2 (9.8 m/s^2)
8. When an object is accelerating towards the ground due to gravity. **[1]**
9. Velocity = Acceleration x time = 10 m/s^2 x 2s **[1]**

   = 20 m/s **[1]**
10. Change in velocity = 11.4 m/s – 2m/s = 9.4 m/s **[1]**

    Time = Change in velocity / acceleration = 9.4 m/s / 10m/s^2 **[1]**

    = 0.94 **[1]** seconds **[1]**
11. Change in velocity = acceleration x time= 10 m/s^2 x 4 s **[1]**

    = 40 m/s **[1]**
12. Change in velocity = acceleration x time = 10 m/s^2 x 0.5s **[1]**

    = 5 m/s **[1]**
13. Velocity at the maximum height = 0 m/s **[1]**

    Change in velocity = 25 – 0 = 25 m/s **[1]**

    Time = Velocity / acceleration = 25m/s / 10 m/s^2 **[1]**

    = 2.5s
14. Acceleration = velocity / time = 5.5m/s / 3.5s **[1]**

    = 1.5714… **[1]**

    OR

    = 1.571 **[2]**

    m/s^2 **[1]**

Equations of Motion Answers

1. Distance = ½ (u + v) x t = ½ (5m/s + 15m/s) x 7.5s **[1]**

   =75m **[1]**
2. Acceleration = (v – u)/t -> (a x t) + u = velocity **[1]**

   velocity = (a x t) + u = (2 x 30) + 0 **[1]**

   = 60 m/s **[1]**
3. 2 x a x s = v^2 – u^2 -> acceleration = (v^2 – u^2)/(2 x s) **[1]**

   Acceleration = (v^2 – u^2)/(2 x s) = (5^2 – 1^2) / (2 x 15) **[1]**

   = 0.8m/s^2 **[1]**

   Acceleration = (v – u)/t -> time = (v – u)/a **[1]**

   Time = (v-u)/a = (5 – 1)/0.8 **[1]**

   = 5s **[1]**

4. Distance = $\frac{1}{2}$ (u + v) x t -> (2s – u)/t = final velocity **[1]**
   (2s – u)/t = final velocity = (2 x 40 - 0)/12 **[1]**
   = 6.67 m/s **[1]**

   Acceleration = (v – u)/t = (6.67 – 0)/12 **[1]**
   = 0.56 m/s^2 **[1]**
5. Final velocity = 36km/hr = 36,000m/hr **[1]**
   36,000m/hr / 3600s = 10m/s **[1]**

   $2 \times a \times s = v^2 - u^2$ -> $s = (v^2 - u^2)/2a$ **[1]**
   $s = (v^2 - u^2)/2a$ = $(10^2 - 5^2) / (2 \times 1.25)$ **[1]**
   = 30m **[1]**

6. .
   1. Distance travelled by the train whilst accelerating
      $2 \times a \times s = v^2 - u^2$ -> $s = (v^2 - u^2)/2a$ **[1]**
      $s = (v^2 - u^2)/2a$ = $(20^2 - 0^2)/(2 \times 1.25)$ **[1]**
      =160m **[1]**
      Then, the train travels 1560m at a constant speed.
      Distance travelled whilst train is decelerating
      $2 \times a \times s = v^2 - u^2$ -> $s = (v^2 - u^2)/2a$ **[-]**
      $s = (v^2 - u^2)/2a$ = $(0^2 - 20^2)/(2 \times -2)$ **[1]**
      =100m **[1]**
      Total distance travelled by the train = 160 + 1560 + 100 = 1820m **[1]**
   2. Time taken whilst the train is accelerating
      Acceleration = (v – u)/t -> time = (v – u)/a **[1]**
      Time = (v-u)/a = (20 – 0)/1.25 **[1]**
      = 16s **[1]**
      Time taken to travel 1560m at a constant speed
      Time = distance / velocity (speed distance time equation)
      Time = 1560 / 20 **[1]**
      = 78 s **[1]**

Time taken whilst train is decelerating

Acceleration = (v – u)/t -> time = (v – u)/a [-]

Time = (v-u)/a = (0 – 20)/-2 [-]

= 10s [1]

Total time taken = 16 + 78 + 10 = 104 s [1]

3. Average speed for journey = total distance travelled / Total time taken [1]

= 1820m (or answer to 1.) / 104s (or answer to 2.) [-]

= 17.5 m/s

Newton's 1st Law Answers

1. .

a. 500N – 50N = 450N [1]

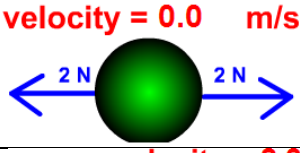
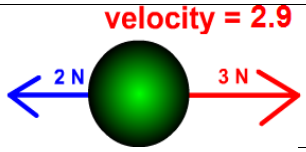
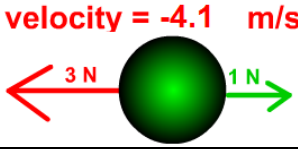
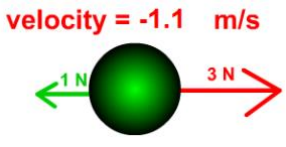
b. 100N + 50N = 150N [1]

150N – 150N = 0N [1]

c. 125N + 175N = 300N [1]

250N – 300N = - [1] 50N [1]

2. .

If the ball at the start is…	***The force applied***	***Size of Resultant force***	***Direction of resultant force***	***Effect on the object?***
Stationary		0 N	-	Does not move
Moving to the right		1 N	Right	Accelerates to the right
Moving left		2 N	Left	Accelerates to the left
Moving left		2 N	Right	Decelerates, then accelerates to the right

1 mark for each correct box

3. .

a. Velocity **[1]** Changing **[1]**
b. Centre **[1]**
c. Force **[1]** Centripetal **[1]**
d. Accelerates **[1]**

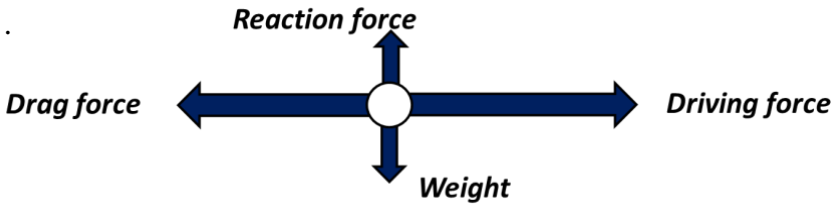
4. .

a. Friction **[1]**
b. Tension **[1]**
c. Gravity **[1]**
d. Electrostatic **[1]**

Newton's 2nd Law Answers

1. .

a. .



All forces labelled correctly **[1]**
Reaction force and driving force same size **[1]**
Drag force arrow smaller than driving force **[1]**

b. Resultant force = 5200N **[-]**
Acceleration = Force /mass = 5200N / 1750N **[1]**
= 3.0 m/s^2 **[1]**

c. Resultant force = 5200N – 5150N = 50N **[1]**
= Force / mass = 50N/1750kg **[1]**
= 0.029 m/s^2 **[1]**

2. Mass = 60kg + 20kg = 80kg **[1]**
Acceleration = force/mass = 200N/80kg **[1]**
=2.5 m/s^2 **[1]**

3. .

a. Acceleration = velocity / time = (20 - 0)/10 **[1]**
= 2 m/s^2 **[1]**
Force = mass x acceleration = 500kg x $2m/s^2$ **[1]**
= 1000N **[1]**

b. $v^2 - u^2 = 2 \times a \times s \rightarrow (v^2 - u^2)/2a = s$ **[1]**
$(v^2 - u^2)/2a = s = (20^2 - 0^2)/(2 \times 2)$ **[1]**
= 200m **[1]**

4. .

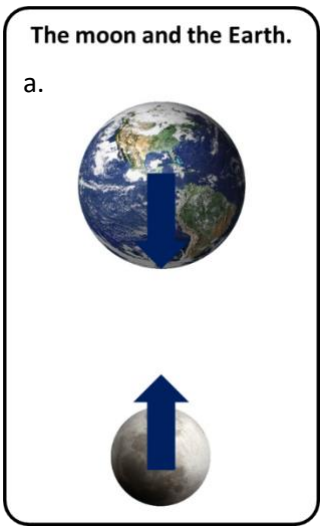
a. Force = 4 x 50,000N = 200,000N **[1]**
Acceleration = 200,000N/5000kg = $40m/s^2$ **[1]**

b. The acceleration will ***increase*** **[1]**
Atmosphere becomes thinner **[1]**
Causing less air resistance **[1]**
At far distances, the pull of gravity will be less **[1]**

Newton's 3rd Law Answers

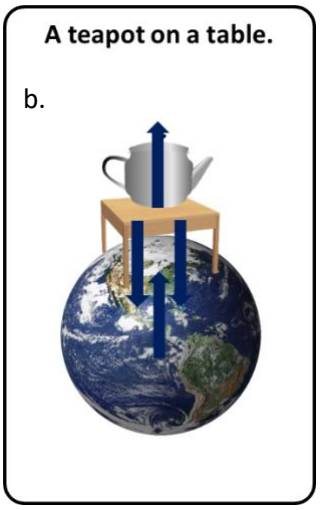
1. If object a exerts a force on object b, object b will exert a force on object a **[1]**
That is equal in size but opposite in direction **[1]**

2. .



1 mark for each correct arrow.

2 marks maximum.



1 mark for each correct arrow

4 marks maximum

1 mark for each correct arrow

Maximum of 4 marks

1 additional mark for driving force being larger to show acceleration

Terminal Velocity

1. .
    a. Small **[1]** Accelerates **[1]**
    b. Increase **[1]**
    c. Balance **[1]** Constant **[1]**
    d. Increases **[1]** Slowing down **[1]**
    e. Decrease **[1]** Weight **[1]** Terminal velocity **[1]**
2. .
    a. 0 m/s **[1]**
    b. 35 m/s **[1]**
    c. Terminal velocity **[1]**
    d. 8 minutes **[1]**

e. Large surface area **[1]**
Of parachute increases the air resistance **[1]**
Acting in an opposite direction to the parachutist's weight **[1]**

f. Velocity at 2 minutes (15 m/s) Velocity at 6 minutes (35 m/s) **[1]**
Change in time – 4 minutes change in time in seconds – 240s **[1]**
Acceleration = change in velocity / time = (35 – 15) / 240 **[1]**
= 0.083m/s^2 **[1]**

g. Change in velocity = - 35m/s **[1]**
Acceleration = change in velocity / time = -35 / 240 **[1]**
= - 0.15 m/s^2 **[1]**

Momentum Answers

1) Momentum = mass x velocity
2) p = 5kg x 2m/s **[1]**
= 10kg.m/s **[1]**
3) m = 36kg.m/s / 3m/s **[1]**
= 12kg **[1]**
4) p = 2kg x 4m/s **[1]**
= 8kg.m/s **[1]**
5)
a. a = F/m – a = 350N / 0.25kg **[1]**
= 1400m/s^2 **[1]**
b. Step 1 - Find the velocity
v = a x t – v = 1400 x 0.05 **[1]**
= 70 m/s **[1]**
Step 2 – Find the momentum
p = m x v – p = 0.25kg x 70m/s **[1]**
= 17.5kgm/s **[1]**
6) The lorry and car can have the same momentum because – momentum = mass x velocity
- Lorry has larger mass **[1]**
- So must have a lower velocity to have same momentum **[1]**

Conservation of Momentum Answers

1. .
a. Momentum = Mass x velocity **[1]**
b. momentum = 1000kg x 5.0m/s **[-]**
= 5000kg.m/s **[1]**

c. Mass after the collision = 1000kg + 1500kg = 2500kg **[1]**
Momentum before = momentum after
1000kg x 5.0m/s = 2500kg x v m/s **[1]**
v = (1000kg x 5.0m/s)/2500kg **[1]**
= 2 m/s **[1]**

2. Momentum before = momentum after
(1500kg x 2.5m/s) + (2000kg x 1.5m/s) = m_a x v_a **[1 mark per underlined part]**
Mass after collision = 1500kg + 2000kg = 3500kg **[1]**
[(1500kg x 2.5m/s) + (2000kg x 1.5m/s)]/3500kg = v_a **[1]**
v_a = 1.9m/s **[1]**

3. Momentum before = momentum after
(1kg x 1m/s) + (0.5kg x -1m/s) = m_a x v_a **[1 mark per underlined section]**
Mass after collision = 1kg + 0.5kg = 1.5kg **[1]**
((1kg x 1m/s) + (0.5kg x -1m/s))/1.5kg = v_a **[1]**
v_a = 0.33m/s (in the same direction as the 1kg snowball) **[1]**

4. Momentum before = momentum after
(2kg x 8m/s) + (3kg x -2m/s) = 5kg x v_a **[1 mark per underlined section]**
((2kg x 8m/s) + (3kg x -2m/s))/5kg = v_a **[1]**
v_a = +2m/s **[1]**

5. Momentum before = momentum after
(6kg x 4m/s) + (2kg x -6m/s) = 8kg x v_a **[1 mark per underlined section]**
((6kg x 4m/s) + (2kg x -6m/s))/8kg = v_a **[1]**
v_a = +1.5m/s **[1]**

6. Momentum before = momentum after
(3kg x 7m/s) + (2kg x -3m/s) = (3kg x 1m/s) + (2kg x v_a) **[1 mark per underlined section]**
((6kg x 4m/s) + (2kg x -6m/s) – (3kg x 1m/s))/2kg = v_a **[1]**
v_a = 4.5m/s **[1]**
To the right **[1]**

7. (cannon mass x recoil v) = -(shell mass x shell v)
600kg x 0.5m/s = -(12kg x v) **[1 mark for each side of the equation being correct]**
Shell velocity = (600 kg x 0.5 m/s)/-12kg **[1]**
= -25m/s **[1 – has to include negative symbol]**

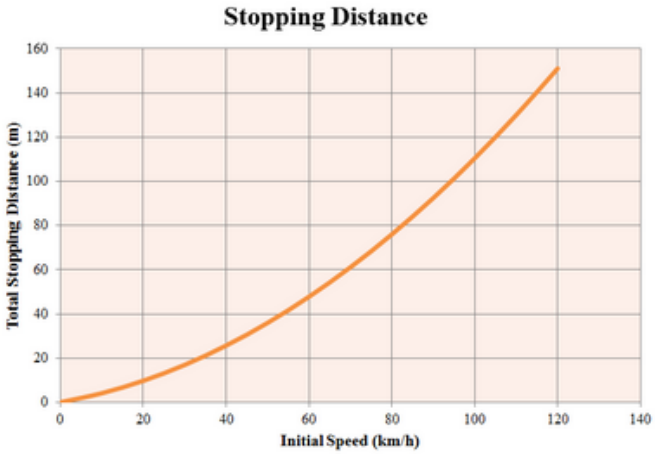
8.

a. Momentum **[1]**
b. Velocity **[1]**
c. Force **[1]**
d. p = 30kg x 2m/s **[-]**
= 60kg.m/s **[1]**

e. (skater 1 mass x velocity) = -(skater 2 mass x velocity)
40kg x velocity = -(30kg x 2m/s) **[1 mark for correct equation]**
-(30kg x 2m/s)/40kg**[1]**
= -1.5m/s **[1 – has to include negative symbol]**

Stopping Distances Answers

1. Stopping distance = thinking distance + braking distance. **[1]**



2.

1 mark for showing a curved line of best fit
1 mark for labelled axes (ignore units)

3. .

a. 12m + 25%
25% of 12 = 4m **[1]**
12m + 4m = 16m **[1]**

b. Any from: How fast the car is going, How intoxicated the person is (drink/drugs), Concentration of the person (tiredness), Poor visibility. **[1 mark each – 3 max]**

4. As the velocity of the car doubles, the braking distance will increase by 4x. **[1]**

5. .

a. Work done (J) = Force (N) x Distance (m)
Work done (J) = 15,000N x 120m **[1]**
= 1,800,000J **[1]**

b. $E_k = \frac{1}{2} \times m \times v^2$
Conservation of energy E_k = 1,800,000J **[1]**
(2 x 1,800,000J)/1800 = v^2 **[1]**
√2000 **[1]**
v = 44.7m/s **[1]**

c. Work done = 1,800,000J
25% of 1,800,000J = 450,000J **[1]**

E = m x c x ΔT
450,000 = 0.75 x 1700 x ΔT **[1]**
450,000 = ΔT **[1]**
0.75 x 1700
ΔT = 353 **[1]** **OR** 350 **[2]**
Unit - ^{O}C **[1]**