Work through each question – you can use the previous lesson resources to help and then check your answers with the answer document. You do not have to complete the (physics only) questions but you can give them a go as an extension task.

Part 1

1. Quantities that we measure can be grouped into scalars and vectors.

a. Describe the difference between scalars and vectors. (2)

Scalars have magnitude only.

Vectors have magnitude and direction.

b. Complete the table by putting the following quantities in the correct place. (2)

acceleration	**mass**	**speed**	**time**	**displacement**

Scalar Quantities	Vector Quantities
mass	acceleration
time	displacement
speed	

c. Describe the difference between speed and velocity. (2)

Speed is a scalar - it has magnitude only.

Velocity is a vector - it has magnitude and direction.

Part 2

1. A person watches a rocket explode at a firework display. The person hears the explosion 2.5 seconds after seeing the rocket explode.

a. Work out how far away the rocket was when it exploded. (3)

Speed of sound in air = 330m/s

Distance = speed x time

Distance = 330 x 2.5

Distance = 825 m

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b. Children are often told that the time difference, in seconds, between seeing lightning and hearing the thunder is the distance the lightning strike was away, in miles.

The speed of sound is 330 m/s.

One mile is 1604 m.

Explain whether children are told the distance correctly. (3)

Children not told correctly

Sound will travel 330 m every second whereas one mile is 1604 m

It will take sound 4.9 seconds to travel one mile (or other suitable calculation)

2 Boats use sonar to find the depth of water where they are.
They measure the time taken to receive the echo of the sound wave that is sent out from the boat.
If it takes 4.7 s to receive the echo. The speed of sound in water is 1498 m/s.
Work out the depth of the sea at that point. (4)

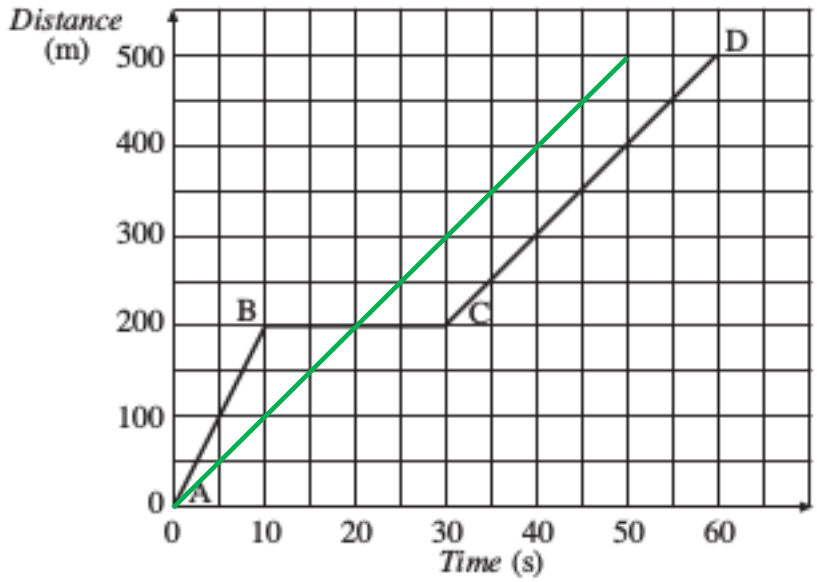
Distance = speed x time

Distance = 1498 x 4.7

Total distance to the sea floor and back = 7 041 m

Depth of the sea = 3 520 m

3 The motion of a car is shown in the distance-time graph below.



a. i) Describe fully the motion of car. (5)

A to B **Constant speed of 20 m/s**

B to C **Stationary (for 20s)**

C to D **Constant speed of 10 m/s**

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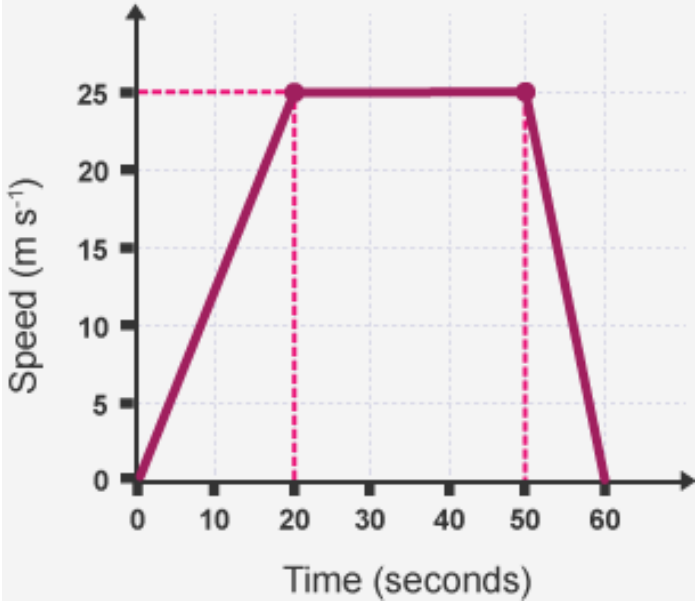
ii) A motorbike completes the same journey at a greater average speed.

On the graph, above, add a second line to show the motion of the motorbike. (1)

Line drawn that gets to 500m before 60 s

4 A car has its speed analysed over a period of one minute. The graph, below, shows the motion of the car.



a. i) State the times when the car was stationary. (1)

0s and 60 s

ii) During which times did the car have the greatest acceleration?

Explain how the graph shows this. (2)

50 to 60 s

The line on the graph is the steepest

iii) Work out the acceleration of the car for the first 20 seconds of its journey. (2)

acceleration = change in velocity / time taken or a = 25 / 20

acceleration = 1.25 m/s^2

iv) Work out the total distance travelled by the car. (3)

Distance travelled = area under the line

Distance travelled = (0.5 x 25 x 20) + (25 x 30) + (0.5 x 25 x 10)

Distance travelled = 1125 m

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5 A stone is dropped off a cliff.
The stone hits the floor at a speed of 21.2 m/s.

The acceleration due to gravity on Earth is 9.8 m/s^2.

a. Work out the height of the cliff. (3)

$$v^2 - u^2 = 2 \times a \times s$$

As the stone is dropped the initial velocity = 0 m/s

$21.2^2 - 0^2 = 2 \times 9.8 \times s$

s = 22.9 m

b. The stone **did not** reach terminal velocity as it fell.

What conditions are required for an object to fall at terminal velocity? (2)

Weight is equal in size

But opposite in direction to drag / air resistance

Part 3

1 This question is about Newton's Laws of Motion.

a. i) State Newton's First Law of Motion. (1)

A body will continue with uniform motion unless a resultant force acts upon it

ii) State the equation used to commonly show Newton's Second Law of motion. (1)

Force = mass x acceleration

iii) A car crashes into a crash barrier.

The car experiences a force of 27 000 N.

Describe the force acting on the crash barrier. (2)

The force acting on the crash barrier is 27 000 N

But acting in the opposite direction

b. A motorbike and rider have a combined mass of 320 kg. The driving force supplied by the motorbike's engine is 6700 N.

Work out the acceleration of the motorbike and rider. (2)

Acceleration = force / mass

Acceleration = 20.9 m/s^2

c. Give the property of matter that gives an object the tendency to continue at rest or at a steady speed in a straight line. (1)

Inertia

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d. A car accelerates from rest until it reaches its top speed along a test track.

Explain how the acceleration of the car changes during its journey. (4)

Maximum acceleration at the start as no drag force initially

As drag increases the acceleration of the car is reduced

At top speed driving and resistive forces are balanced, so no resultant force

Therefore, no acceleration

2 A ball of mass 0.6 kg is kicked with a force of 38 N.

Work out the acceleration of the ball. (2)

Acceleration = force / mass or acceleration = 38 / 0.6

Acceleration = 63.3 m/s^2

3. This question is about weight and mass.

a. State the equation that links gravitational field strength, mass and weight. (1)

Weight = mass x gravitational field strength

b. i) An astronaut has a weight of 750 N on Earth, where the gravitational field strength is 9.8 N/kg.

Work out the mass of the astronaut. (2)

Mass = weight / gravitational field strength

Mass = 76.5 kg

ii) The astronaut goes to the Moon where the gravitational field strength is 1.6 N/kg.

Work out the weight of the astronaut on The Moon. (2)

Weight = 76.5 x 1.6

Weight = 122.4 N

iii) Give the mass of the astronaut on the Moon.

Explain your answer. (2)

Mass = 76.5 kg

Mass does not depend on where you are in the Universe

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Part 4 (PHYSICS ONLY)

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

Momentum = mass x velocity

b. Momentum is a vector quantity. Explain what is meant by a vector quantity. (1)

Vectors have both magnitude and direction

c. Momentum is a conserved quantity.

Describe what is meant by a momentum being a conserved quantity. (1)

The momentum before an event equals the momentum afterwards, in a closed system

2a. A ball of mass 0.75 kg is kicked and moves off with a speed of 14 m/s.

Work out the momentum of the ball. (2)

Momentum = 0.75 x 14

Momentum = 10.5 kgm/s

b. The ball is kicked again and moves off with half the speed.

State the new momentum of the ball. (1)

Momentum = 5.25 kgm/s

c. Describe how doubling the mass of an object will affect its momentum, at a given speed. (1)

Doubling the mass will double the momentum

3a. A car has a momentum of 33 000 kgm/s and a speed of 30 m/s.

Work out the mass of the car. (2)

Mass = 33 000 / 30

mass = 1100 kg

3b The car changes speed and now has a momentum of 4760 kgm/s.

Work out the new speed of the car. (2)

Velocity = momentum / mass or Velocity = 4760 / 1100

Velocity = 4.3 m/s

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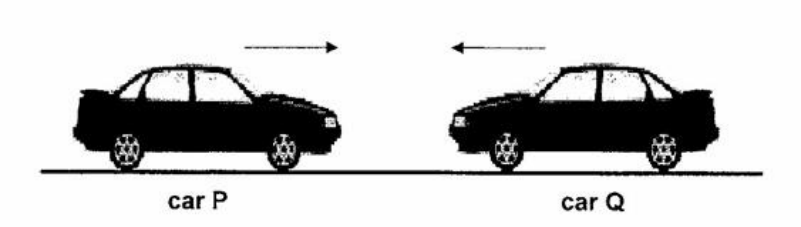
4 In a crash test two identical cars of mass 900 kg move towards each other.



Before impact, **Car P** has a speed of 14 m/s and **Car Q** has a speed of 18 m/s.

a. i) Work out the total momentum of the two cars before impact. (3)

Taking motion to the right to be positive:

Momentum = momentum of Car P + momentum of Car Q

Momentum = 900 x 14 - 900 x 18

Momentum = - 3600 kg m/s

ii) After impact the cars move off together to the left.

Work out the speed that the two cars move off at after impact. (3)

Combined mass = 1800 kg

Momentum = mass x velocity or - 3600 = 1800 x velocity

Velocity = - 2 m/s or 2 m/s from right to left

5 Cars have many features to reduce injury in case of a crash. Seatbelts and crumple zones are two safety features designed to reduce injury in a crash.

a. i) Give **one** other safety feature designed to reduce injury in a crash. (1)

One of:

Airbags Roll Cage Laminated Glass Head rest

ii) Explain how seatbelts reduce injury in a crash. (4)

Seatbelts increase the time of impact as they are designed to stretch a little

This reduces the acceleration as acceleration = change in velocity / time taken

The force is reduced as force = change in momentum / time taken

As the force of impact is reduced the injuries are also reduced

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iii) In a crash a car changes its velocity from 20 m/s to 0 m/s. It takes the car 0.2 s to stop.

The car had a mass of 1265 kg.

Work out the force acting on the car. (4)

Force = change in momentum / time taken

Change in momentum = 20 – 0 x 1265 = 25 300 kgm/s

Force = 25 300 / 0.2

Force = 126 500 N

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