Section A

1) Which of these is the equation for calculating speed from distance and time?

- ☐ **A:** speed = time × distance
- ☐ **B:** speed = distance × time
- ☐ **C:** speed = time ÷ distance
- ☐ **D:** speed = distance ÷ time

2) A typical speed for a car in a built-up area is

- ☐ **A:** 1.4 m/s
- ☐ **B:** 6 m/s
- ☐ **C:** 10.5 m/s
- ☐ **D:** 31 m/s

3) The speed of sound in air is typically

- ☐ **A:** 340 000 000 m/s
- ☐ **B:** 340 m/s
- ☐ **C:** 3.4 m/s
- ☐ **D:** 0.34 m/s

4) What is the correct unit for weight?

- ☐ **A:** g
- ☐ **B:** kg
- ☐ **C:** J
- ☐ **D:** N

5) What is the correct value and unit for gravitational field strength?

- ☐ **A:** 10 N/kg
- ☐ **B:** 10 g
- ☐ **C:** 10 m/s
- ☐ **D:** 10 N

6) Which of Newton's laws of motion states 'for every action there is an equal and opposite reaction'?

- ☐ **A:** Newton's 1st Law
- ☐ **B:** Newton's 2nd Law
- ☐ **C:** Newton's 3rd Law

Sort the quantities from the box into the correct column of the table

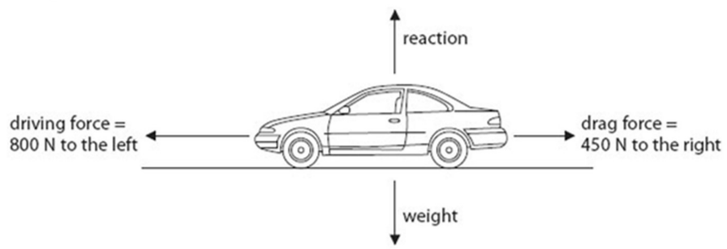
mass **distance** **acceleration** **speed** **velocity** **energy** **time** **power** **force** **displacement**

Scalar	Vector

Key Word: ***scalar***
a quantity with magnitude only

Key Word: ***vector***
a quantity with magnitude AND direction

The diagram shows the forces acting on a car which is travelling along a flat straight road.



Fill the gaps in the following statement

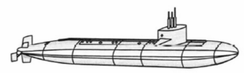
There is a resultant force of ..... N acting on the car. This means that the car's motion can be described as ..... in the direction of the resultant force. If the magnitude of the weight is 19000 N then the reaction force must be ..... N

Section B

A submarine is travelling at a constant depth in the sea. It starts to move forwards. Draw a free-body force diagram for all the forces acting on the submarine. Label these forces. **(2 marks)**

Newton's 1st Law
A resultant force larger than zero causes acceleration in the direction of the resultant force

The lengths of the arrows on a free body force diagram should be proportional to the sizes of the forces.



A speed skater is standing on the ice waiting for the start of a race.

Newton's 3rd Law
If one object pushes another (an action force), the second object pushes back just as hard in the opposite direction (a reaction force)

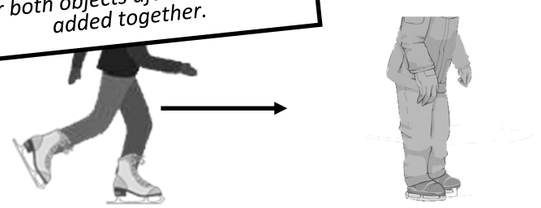
(a) Describe the action and reaction forces acting between the skater and the ground.

The action is the .....and the reaction is ..... **(2 marks)**

momentum = mass × velocity	$p = m \times v$

(b) Another skater collides with the standing one. They become tangled and slide forwards together.
Calculate the speed that they slide forwards at.
Mass of standing skater = 80 kg
Mass of skater that collides with them = 65 kg
Speed of skater that collides with them = 6 m/s

Conservation of Momentum
The momentum of both objects before a collision added together must be the same as the momentum for both objects after a collision added together.



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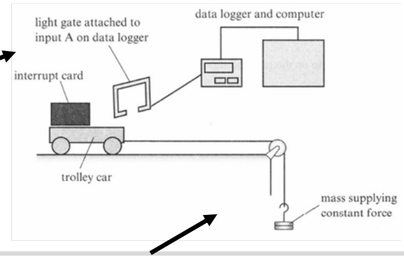
Section C

distance travelled = average speed × time

weight = mass × gravitational field strength | $W = m \times g$

Light gates are used to record how long it takes for the interrupt card to pass through.
Light gate reading 200 ms. Interrupt card length 10 cm.
What was the speed of the trolley through the light gate?
(hint: convert the values to standard units first)

..... m/s



The force pulling on the trolley is equal to the weight hanging from the string.
What was the force is a total mass of 300 g was hanging from the string?

.

..... N

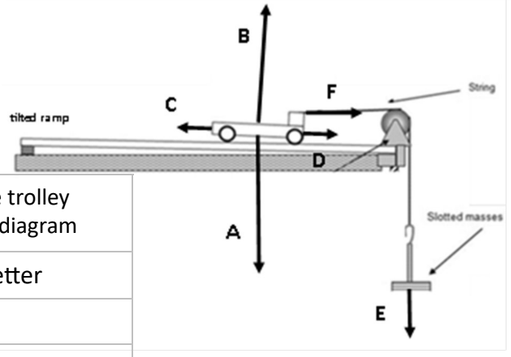
Why is a light gate used rather than a stopwatch?

acceleration = change in velocity ÷ time taken | $a = \frac{(v-u)}{t}$

In experiments where a force is being applied to accelerate a trolley the ramp is tilted a small amount. Why?

Light gates can be used to record the speed at two places on the ramp. If the time taken for the trolley to move between the light gates is also recorded then the acceleration can be calculated.
Speed at top of ramp = 0.4 m/s. Speed at bottom of ramp = 1.2 m/s
Time from top to bottom = 1.25 s. What was the acceleration of the trolley?

..... m/s²



Match the forces involved in the trolley experiment to the letters in the diagram	
Force	Letter
Weight of trolley	
Weight of masses	
Normal reaction force	
Friction	
Tension of string	
Horizontal component of weight of trolley	

How would the results of the experiment differ if the ramp was covered in cooking oil?

To use the equipment to investigate the effect of force on acceleration masses must be moved from between the hook and the trolley rather than simply adding or removing them from the hook.

Why?

Section D

force = mass × acceleration | $F = m \times a$

force = change in momentum ÷ time | $F = \frac{(mv-mu)}{t}$

A girl takes 20 s to walk between two lamp posts that are 30 m apart. What was the girl's average speed?	What is the average acceleration of a book that undergoes a change of velocity of 5 m/s during a 0.5 s fall?	A trolley has a mass of 2 kg and accelerates at 2.5 m/s² when a force is applied to it. What is the magnitude of the force?
A 1500 kg car is moving at 31 m/s on a motorway. What is the car's momentum?	An astronaut on the moon experiences a gravitational field strength of 1.6 N/kg. If they have a mass of 80 kg what is their weight?	What force would be required to change the momentum of a tennis ball by 1.5 kgm/s in a time of 0.2 s?
How long would it take someone to walk 5 km if they were travelling at 1.4 m/s?	If a bullet has a momentum of 0.8 kgm/s when it is travelling at 400 m/s what is its mass?	A 1025 kg robot on Mars experiences a weight of 3790 N. What is the gravitational field strength at the surface of Mars?
A force of 300 N is applied to an object with a mass of 550 g. What acceleration does the object experience?	Calculate the initial velocity of a skydiver if they accelerate at an average rate of 8 m/s² for 5 seconds to reach a speed of 50 m/s.	A 2 kg brick accelerates from 2 m/s to 10 m/s when a force of 100 N is applied. How long must the force have been acting on the brick for?

Answers						
	128	0.16	5	545	1.5	0.002
	3.7	10	10	3571	7.5	46500