1(a). A student wants to estimate a typical value for the accelerating force on a car.

The student writes down **three** possible values for the car's acceleration.

3 m / s^2 **50 m / s^2** **100 m / s^2**

i. Put a (ring) around the value the student should use as the car's acceleration.

[1]

ii. The car has a mass of 1800 kg.

Use the value for the acceleration you chose in **(i)** to estimate the accelerating force on a car.

Use the equation: force = mass × acceleration

Force = ...N **[2]**

(b). In a crash, the change in velocity of a car is 18 m / s.

The time for the crash is 0.15 s.

Calculate the deceleration of the car.

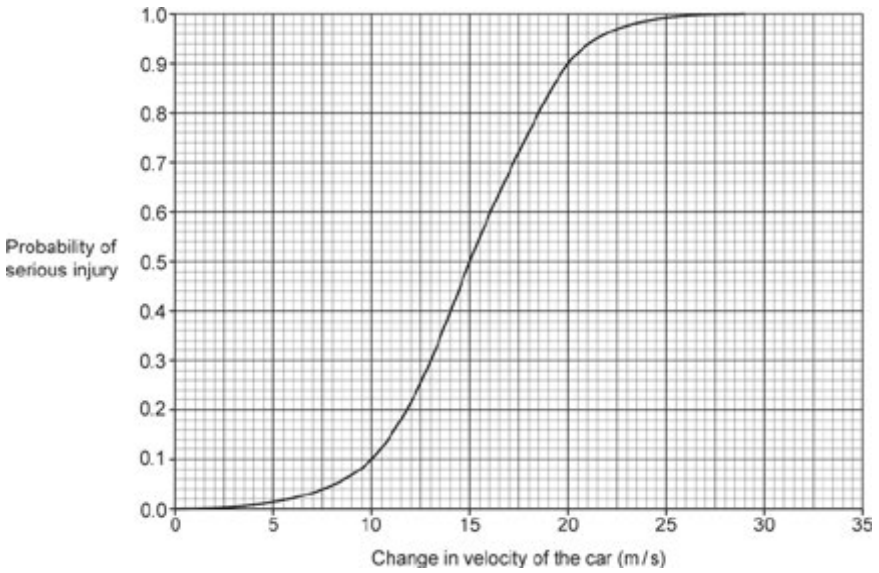
Use the equation: $\text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$

Deceleration = ... m / s^2 **[2]**

(c). In America, many cars have a 'black box' fitted.

The 'black box' records the change in velocity of the car if it crashes and comes to a stop.

The graph shows how the probability of serious injury to passengers in the car varies with the change in velocity of the car.



i. Describe how the probability of serious injury changes as the change in velocity of the car increases from 10 m / s to 20 m / s.

Use values from the graph.

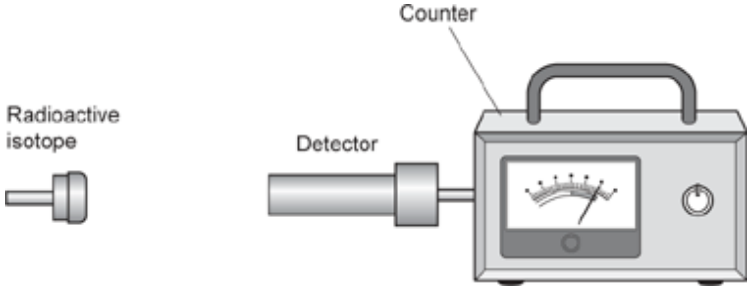
[3]

ii. Use the graph to estimate the minimum change in velocity which **definitely** causes serious injury.

Change in velocity = ... m / s **[1]**

2. A scientist measures the activity, in counts per minute (cpm), of different radioactive isotopes.

The diagram shows the equipment the scientist uses.



The scientist:

- Records the activity on the counter before the detector is switched on.
- Switches on the detector and records the activity with the radioactive isotope nearby.

The table shows the scientist's results.

	Activity (cpm)
Detector switched off	5
Detector switched on	420

i. How can the scientist make the results more accurate?

Tick (✓) **one** box.

Handle the radioactive isotope using tongs. ☐

Move the radioactive isotope further away from the detector. ☐

Place lead in front of the radioactive isotope. ☐

Zero the counter and take another reading. ☐

[1]

ii. The activity of a different radioactive isotope is 480 counts per minute (cpm).

Calculate the activity in counts per second.

Activity = ... counts per second **[1]**

3. Since 2009, filament lamps in the home have often been replaced by other lamps, called LED lamps.

The table compares a filament lamp and an LED lamp which produce the **same** intensity of light.

	Filament lamp	**LED lamp**
Power	60 W	0.01 kW
Lifetime	2000 hours	26 000 hours
Cost to buy	£1.00	£5.00
Cost to run over 1 year	£22.00	£3.65
Dimmable	Yes	No
Structure	Glass	Plastic

State the power of the filament lamp in kW.

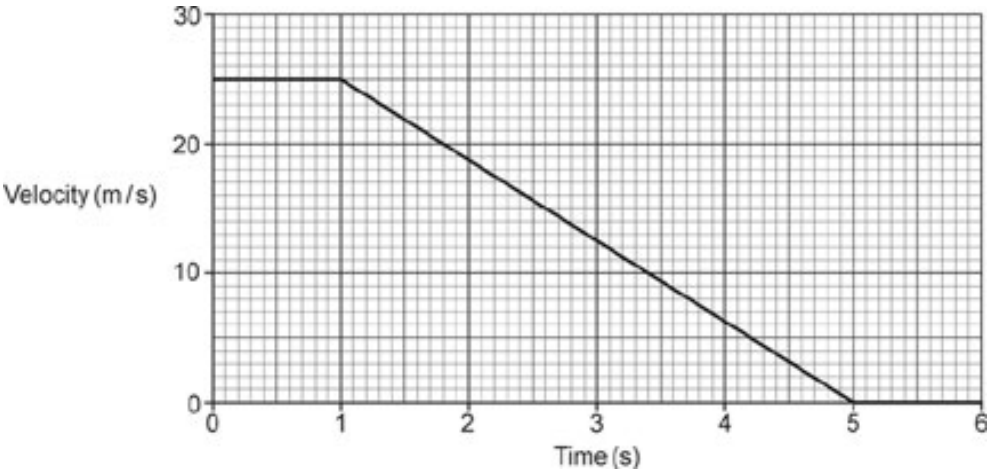
_____ kW **[1]**

4. Which statement about some typical values of speed is correct?

A The speed of a car is greater than the speed of a jet plane flying.
B The speed of a car is greater than the speed of sound in air.
C The speed of a runner is greater than the speed of a jet plane flying.
D The speed of sound in air is greater than the speed of the wind.

Your answer ☐ **[1]**

5. The graph shows how the velocity of a car changes when the driver sees a hazard in the road at time = 0 seconds.



Which statement is correct?

A The driver brakes for 1 second.
B The driver brakes for 5 seconds.
C The driver takes 1 second to react.
D The driver takes 5 seconds to react.

Your answer ☐ **[1]**

6(a). A student pedals a bicycle on a level surface.

They start from rest and reach a velocity of 6 m / s.

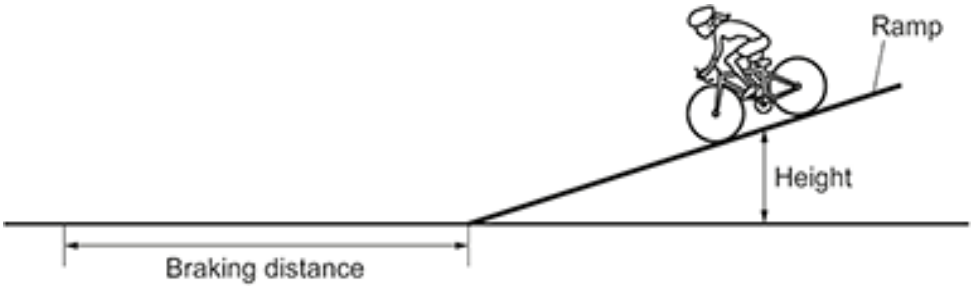
Estimate the acceleration of the student on the bicycle.

Use the equation: acceleration = $\frac{\text{change in velocity}}{\text{time}}$

Acceleration = ... m / s^2 **[3]**

(b). Student **A** is investigating braking distance using a bicycle. This is their method:

- Freewheel down a ramp **without** pedalling.
- At the bottom of the ramp, press the brakes until the bicycle comes to a stop.
- Measure the braking distance of the bicycle from the bottom of the ramp.



Student **A** repeats the investigation three times. Each time they start at the same height. Their results are shown in the table.

Measurement number	Braking distance (m)
1	4.4
2	8.0
3	5.6

i. Suggest what equipment student **A** can use to measure the braking distance.

---

[1]

ii. Use the results from the table to calculate the **mean** braking distance.

Mean braking distance = ... m **[2]**

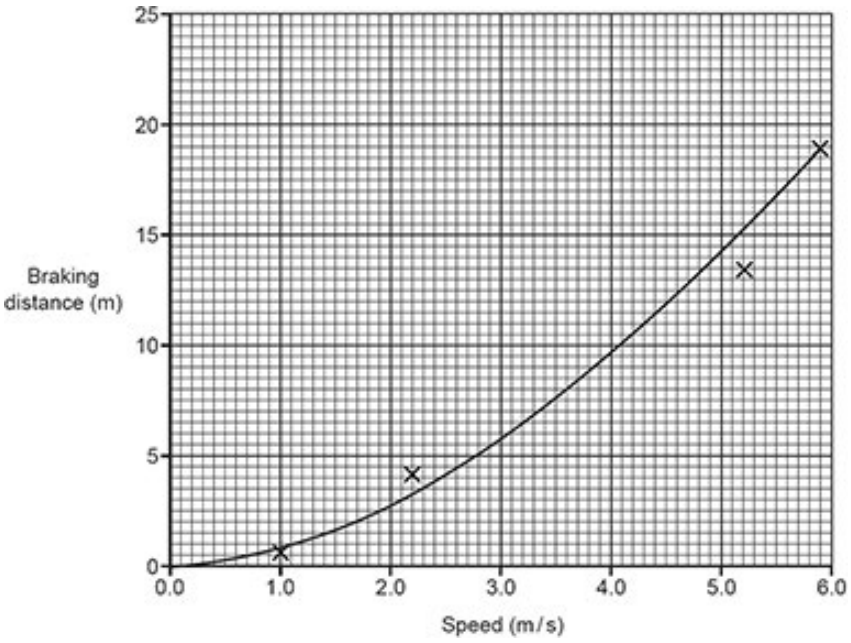
iii. Suggest why the values of the braking distance are **not** the same.

_____

_____ **[1]**

(c). Student **A** measures the braking distance for different speeds at the bottom of the ramp.

The graph shows student **A**'s results.



i. Use the graph to find the braking distance when the speed is 4.3 m / s.

Braking distance = ... m **[1]**

ii. It can be more dangerous to cycle quickly.

Use data from the graph to explain why.

_____

_____

_____

_____ **[2]**

iii. Suggest how student **A**'s investigation could be improved.

_____

_____ **[1]**

(d). Student A increases the mass of the bicycle.

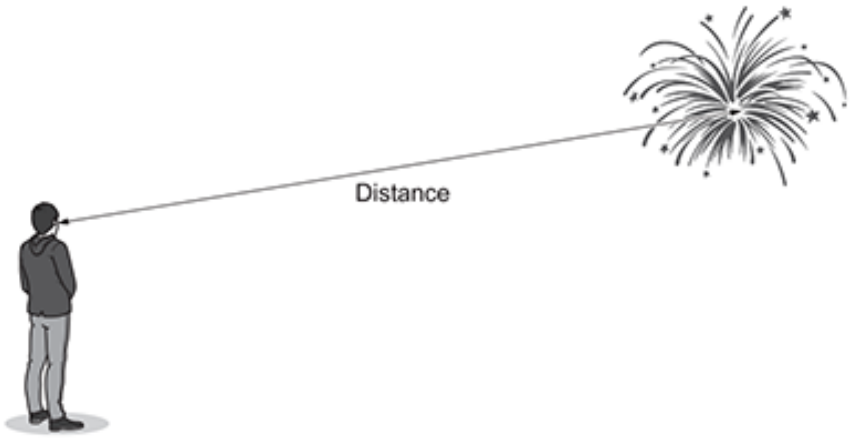
What happens to the braking distance?

Tick (✓) **one** box.

Decreases	☐
Increases	☐
Stays the same	☐

[1]

7(a). A child is watching a firework display.



The speed of light in air is 3×10^8 m / s.

Explain why the child sees the firework **before** they hear it.

---

[1]

(b). The child measures the time between seeing and hearing the firework.

The time they measure is 0.42 s.

The speed of sound in air is 330 m / s.

Calculate the distance from the child to the firework.

Give your answer to **2** significant figures.
Use the Data sheet_J249 01/02/03/04, June 2022.

Distance = ... m **[4]**

(c). Explain why the distance calculated above is not the actual distance.

_____

_____

_____

_____**[2]**

8. What is a good estimate for the speed of an Olympic sprinter?

A 1 m / s
B 3 m / s
C 10 m / s
D 30 m / s

Your answer ☐ **[1]**

9. When a car crashes, it undergoes a very large **deceleration**.

Which row describes the crash?

	Forces involved	Time for the car to decelerate
A	large	large
B	large	small
C	small	large
D	small	small

Your answer ☐ **[1]**

END OF QUESTION PAPER