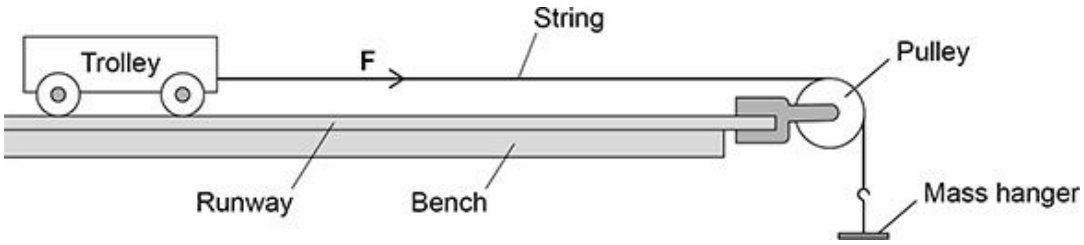
Questions are for both separate science and combined science students unless indicated in the question

Q1.

A student investigated how the acceleration of a trolley varies with the resultant force on the trolley.

Figure 1 shows some of the equipment used.

Figure 1



(a) **Figure 1** shows the force **F** which acts through the string.

What name is given to force **F**?

_____

(1)

(b) Give **one** variable that should have been a control variable in this investigation.

_____

(1)

(c) The student held the trolley stationary and then released it.

The trolley moved along the runway with a constant acceleration.

The student recorded the time taken for the trolley to travel a measured distance along the runway.

Describe how the acceleration of the trolley can be calculated using the time taken and distance travelled by the trolley.

_____

_____

_____

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_____

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_____

(3)

For one set of results, the force acting through the string was 2.0 N.

(d) The student released the trolley three times and determined the following values for acceleration:

1.36 m/s^2 1.39 m/s^2 1.33 m/s^2

Calculate the uncertainty in the values of acceleration.

_____

_____

_____

Uncertainty = ± _____ m/s^2

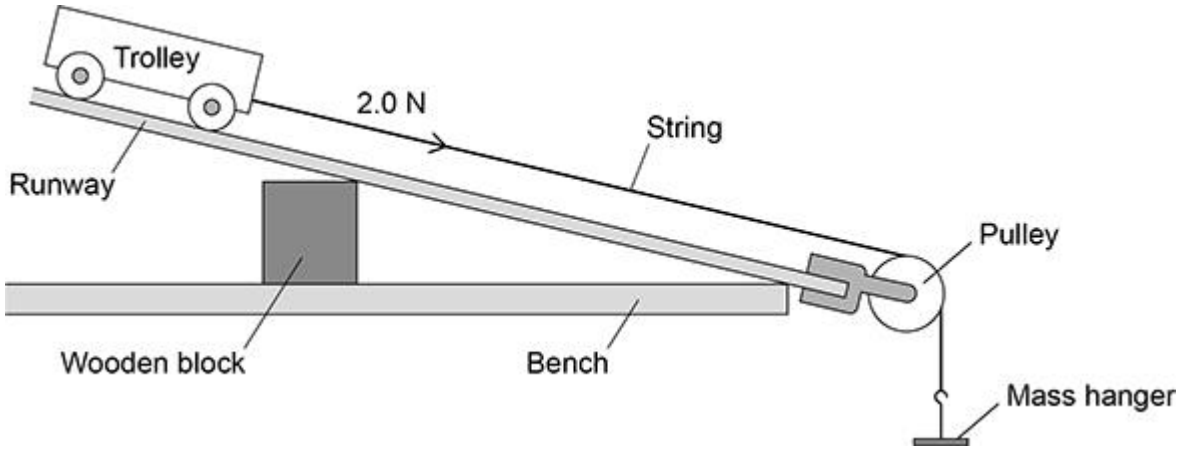
(2)

(e) The runway was then raised at one end.

The force acting through the string remained the same.

Figure 2 shows this.

Figure 2



Explain how the acceleration was affected by raising the end of the runway.

_____

_____

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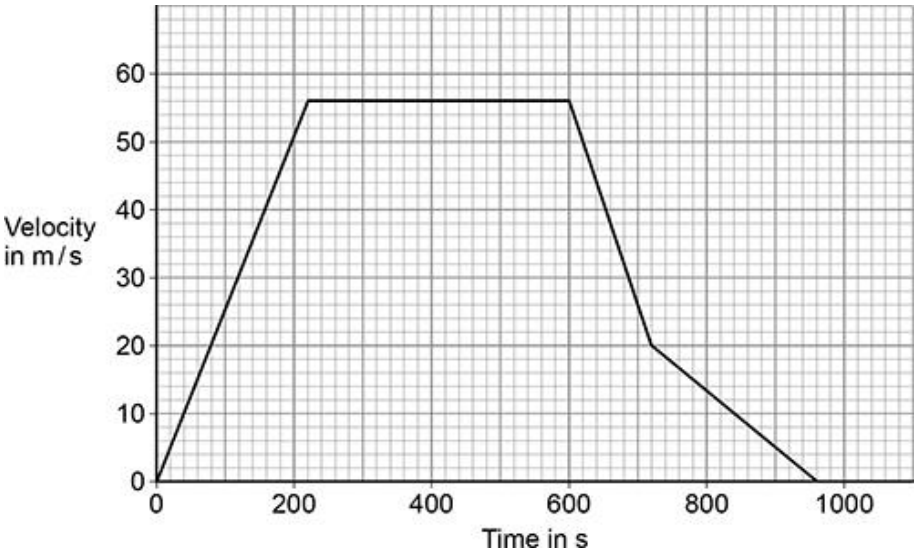
_____

(2)

(Total 9 marks)

Q2.

The figure below shows a velocity–time graph for a train travelling between two stations. **(HT only)**



(a) Determine the distance travelled by the train in the first 600 s of the journey.

Distance = _____ m

(3)

(b) Explain what happens to the braking force as the train decelerates.

Use information from the figure above.

(3)

(c) Determine the maximum deceleration of the train.

Deceleration = _____ m/s^2

(3)

(d) Another train travels at a speed of 60 m/s.

A constant braking force of 270 000 N causes the train to decelerate and stop.

mass of train = 240 000 kg

Calculate the distance travelled while the braking force is applied.

Use the Physics Equations Sheet. **(Physics only)**

Distance travelled = _____ m

(6)

(e) It is illegal for train drivers to drink alcohol before driving a train.

Explain how drinking alcohol would affect the stopping distance of a train.

_____

_____

_____

_____

_____

_____

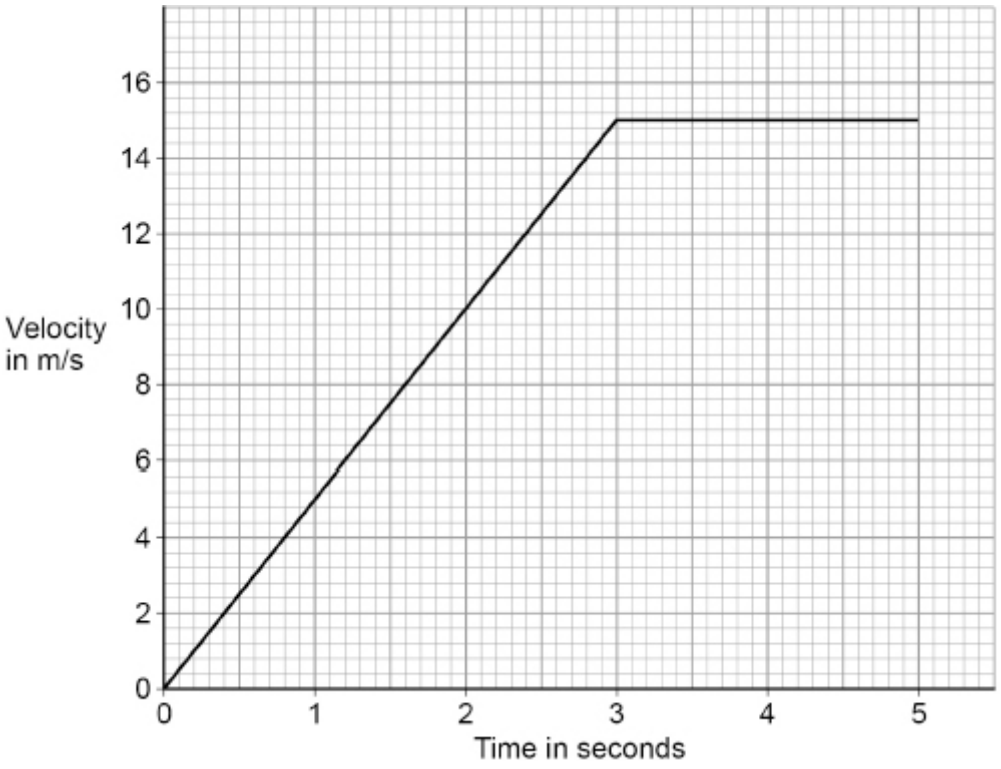
(3)

(Total 18 marks)

Q3.

Figure 2 shows how the velocity of the car changes during the first 5 seconds of a journey.

Figure 2



(a) After 3 seconds, the momentum of the car is 24 000 kg m/s.

Calculate the mass of the car.

Use the Physics Equations Sheet. **(HT only)**

Mass = _____ kg

(4)

(b) Determine the distance travelled by the car during the first 5 seconds of the journey.

Use **Figure 2**. **(HT only)**

Distance travelled by the car = _____ m

(3)

(c) In an emergency the driver needs to apply the brakes suddenly to stop the car quickly.

The driver of the car is distracted.

Explain why the distraction will increase the stopping distance.

(3)

(d) Explain why the temperature of the brakes increases as they are used.

(2)

(Total 12 marks)

Q4.

The figure below shows some bumper cars. **(Physics only)**

Bumper cars are designed to withstand collisions at low speeds.

(a) How does Newton's Third Law of motion apply to the collision between the bumper car and the barrier?

_____

_____

_____

(1)

(b) During the collision, the change in momentum of the bumper car is 700 kg m/s.

The time taken for the collision is 0.28 s.

Calculate the force on the bumper car during the collision.

Use the Physics Equations Sheet. **(HT only)**

_____

_____

_____

_____

Force = _____ N

(2)

(c) The bumper car has a flexible bumper.

Explain how the flexible bumper reduces the risk of injury to the people in the bumper car during the collision.

_____

_____

_____

_____

_____

_____

(3)

(d) A bumper car moved with an initial constant velocity and then accelerated at 2.0 m/s^2.

While accelerating, the bumper car travelled a distance of 1.5 m.

The final velocity of the bumper car was 2.5 m/s.

Calculate the initial constant velocity of the bumper car.

Use the Physics Equations Sheet.

_____

_____

_____

_____

_____

Initial constant velocity = _____ m/s

(3)

(Total 9 marks)

Q5.

Speed limits on roads increase safety. **(Physics only)**

(a) The braking distance of a car increases as the speed of the car increases.

Give two **other** factors that **increase** the braking distance of a car.

1. _____

2. _____

(2)

(b) Explain why the driver's reaction time affects the thinking distance of a car.

_____

_____

_____

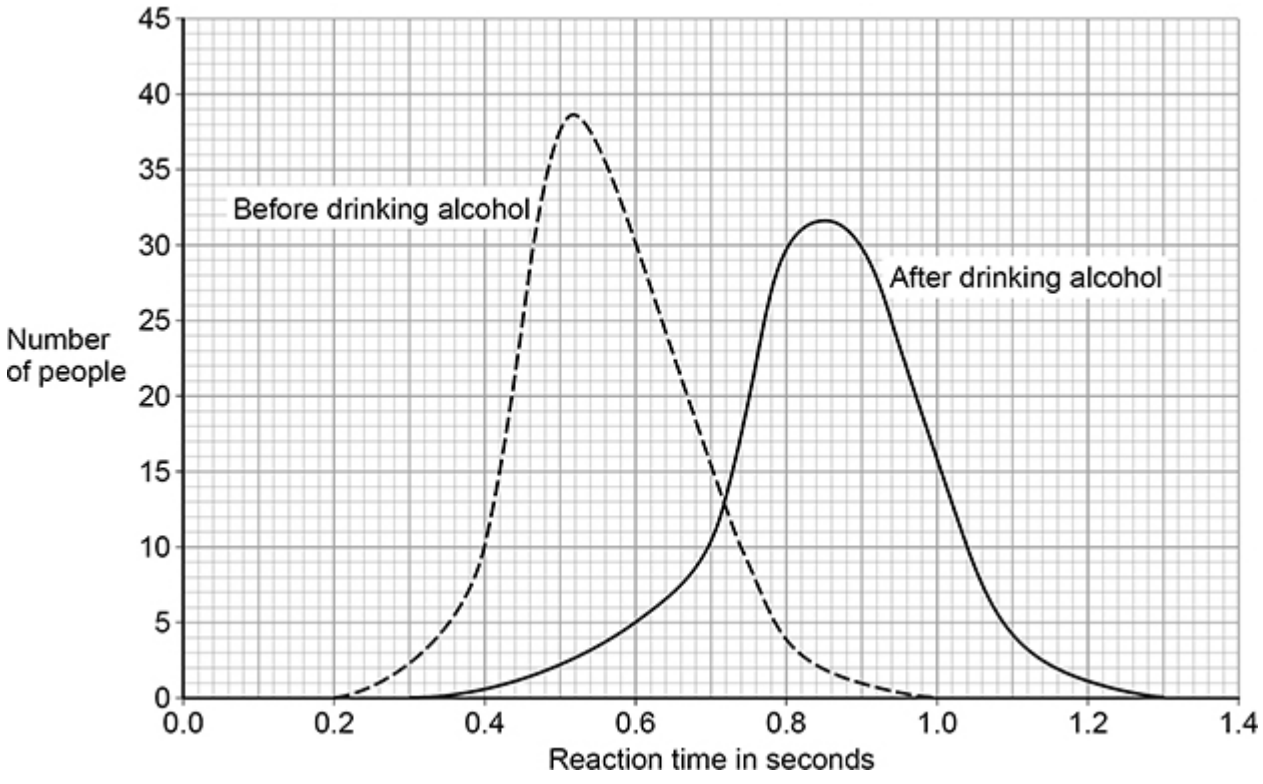
_____

(2)

(c) Scientists have investigated how drinking alcohol affects a person's reaction time.

Figure 1 shows the results of the investigation.

Figure 1



Which of the following conclusions can be made using **Figure 1**?

Tick (✓) **two** boxes.

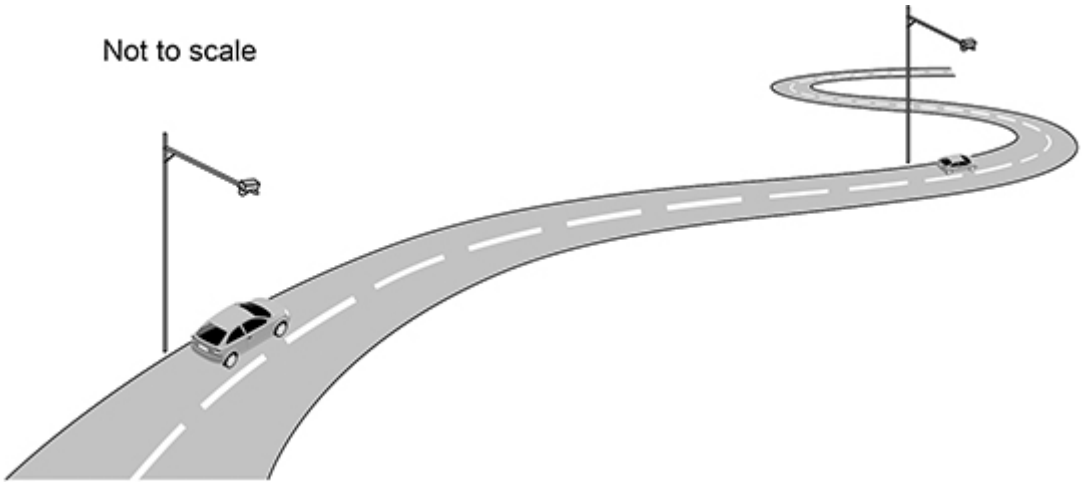
Every person's reaction time increases after drinking alcohol.	☐
Mean reaction time increases after drinking alcohol.	☐
Some people's reaction time is not affected by drinking alcohol.	☐
The change in reaction time is not the same for all people after drinking alcohol.	☐
There is a smaller range of reaction times after drinking alcohol.	☐

(2)

Figure 2 shows some speed cameras on a road.

The speed cameras determine the average speed of cars on the road.

Figure 2



(d) The speed limit on the road in **Figure 2** is 20 m/s.

The cameras in **Figure 2** are 1.5 km apart.

Calculate the minimum time it takes to travel 1.5 km without breaking the speed limit.

Use the Physics Equations Sheet.

Minimum time = _____ s

(4)

(e) The average speed of a car between the cameras and the average velocity of the car between the cameras are different.

Explain why.

(3)

(Total 13 marks)

Q6.

Hailstones are small balls of ice. Hailstones form in clouds and fall to the ground.

Figure 1 shows different-sized hailstones.

Figure 1

A hailstone falls from a cloud and accelerates.

(a) Why does the hailstone accelerate? **(Physics only)**

_____

_____

(1)

(b) The hailstone stops accelerating and reaches terminal velocity.

Explain why the hailstone reaches terminal velocity. **(Physics only)**

_____

_____

_____

_____

_____

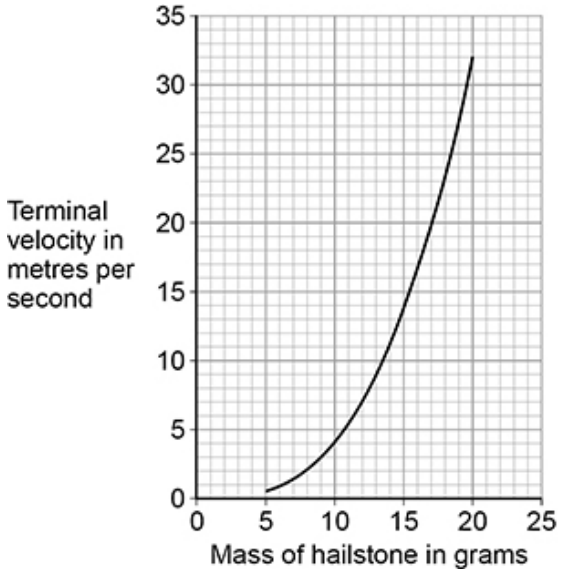
_____

(3)

A scientist investigated how the mass of hailstones affects their terminal velocity.

Figure 2 shows the results.

Figure 2



(c) Why does terminal velocity increase with mass?

Tick (✓) **one** box.

As mass increases the cross-sectional surface area of a hailstone increases.	☐
As mass increases the volume of a hailstone increases.	☐
As mass increases the weight of a hailstone increases.	☐

(1)

(d) Explain the difference in the maximum kinetic energy of a hailstone with a mass of 10 g and a hailstone with a mass of 20 g.

_____

_____

_____

_____

_____

_____

(3)

(e) The kinetic energy of a hailstone is measured in joules.

Which of the following is the same as 1 joule?

Tick (✓) **one** box.

1 N m ☐

1 N/m ☐

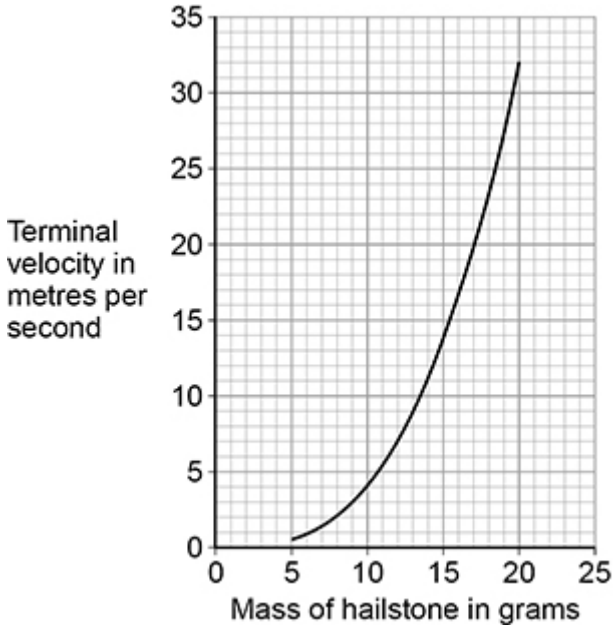
1 N/m^2 ☐

1 N m^2 ☐

(1)

Figure 2 is repeated below.

Figure 2



(f) A hailstone hit the ground at its terminal velocity of 25 m/s.

The hailstone took 0.060 s to stop moving.

Determine the average force on the hailstone as it hit the ground.

Use information from **Figure 2**.

Use the Physics Equations Sheet. **(Physics only) (HT only)**

_____

_____

_____

_____

_____

Average force = _____ N

(3)

(Total 12 marks)