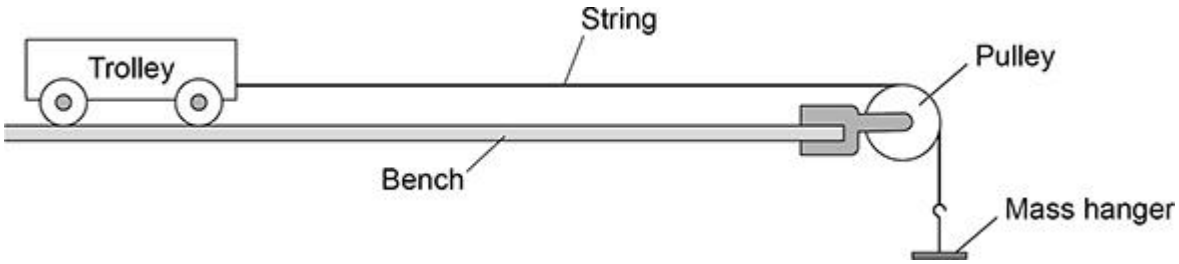
Questions are for both separate science and combined science students unless indicated in the question

Q1.

A student investigated how changing the mass of a trolley affects the acceleration of the trolley.

Figure 1 shows some of the equipment used.

Figure 1



(a) The trolley in **Figure 1** is not moving.

Which force prevents the trolley from moving?

Tick (✓) **one** box.

Friction	☐
Tension	☐
Weight	☐

(1)

The force pulling on the trolley was increased so that the trolley accelerated.

The force was then kept constant and different masses were put on the trolley.

For each different mass the acceleration of the trolley was measured.

(b) Draw **one** line from each variable to the correct quantity.

Variable	Quantity
	Acceleration of the trolley
Independent variable	
	Length of the bench
	Total mass of the trolley
Dependent variable	
	Force pulling on the trolley

(2)

(c) For one of the masses put on the trolley, the student recorded three values of acceleration.

1.58 m/s^2 1.53 m/s^2 1.54 m/s^2

Calculate the mean acceleration of the trolley.

_____

_____

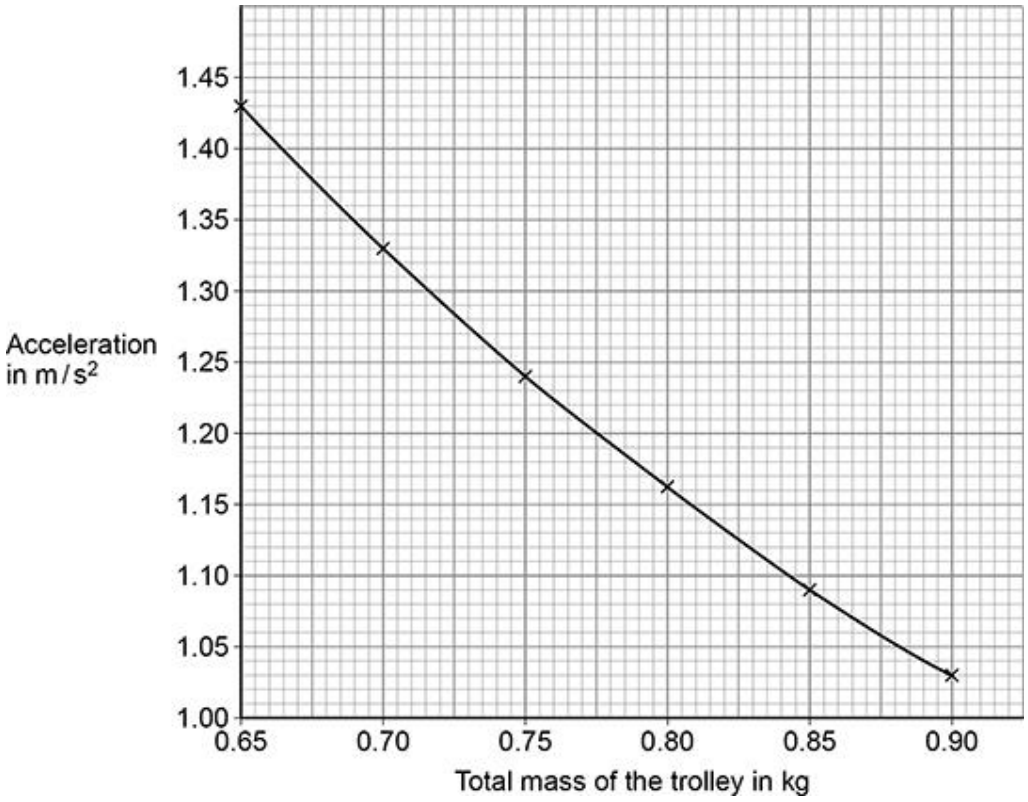
_____

Mean acceleration = _____ m/s^2

(2)

Figure 2 shows some of the results.

Figure 2



(d) Describe the relationship shown in **Figure 2**.

_____

_____

(1)

(e) When the total mass of the trolley was 1.5 kg, the acceleration of the trolley was 0.62 m/s².

Calculate the resultant force acting on the trolley.

Use the equation:

resultant force = mass × acceleration

_____

_____

_____

Resultant force = _____ N

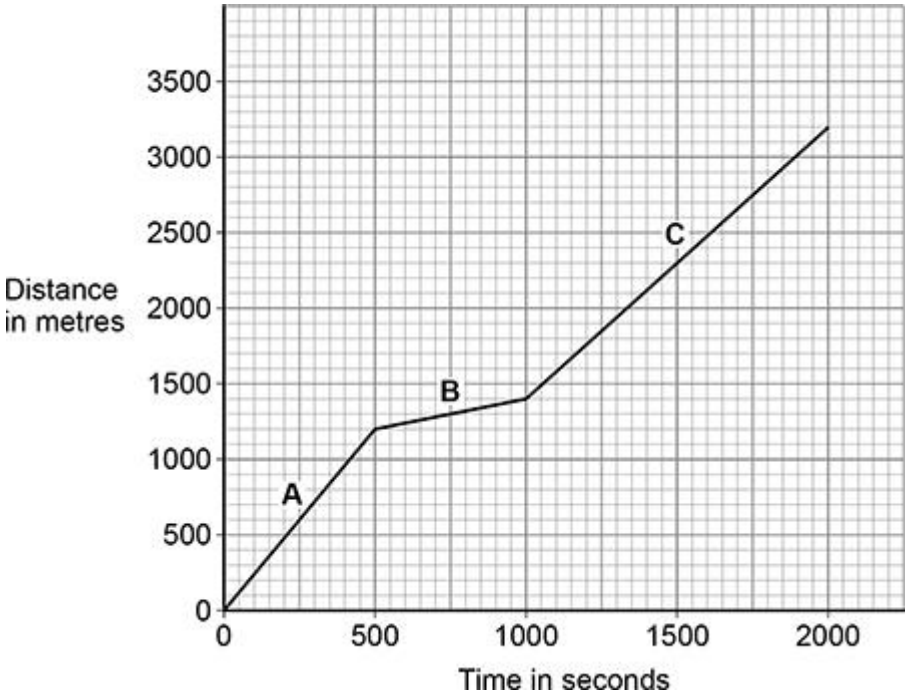
(2)

(Total 8 marks)

Q2.

A person has been for a walk.

The figure below shows the distance–time graph for the walk.



(a) Some quantities are scalar quantities and others are vector quantities.

Which of the following are scalar quantities?

Tick (✓) **two** boxes.

Displacement	☐
Distance	☐
Force	☐
Speed	☐
Velocity	☐

(2)

(b) What was the total distance walked by the person in 2000 seconds?

Total distance = _____ m

(1)

(c) Calculate the average speed of the person during the 2000 seconds.

Use your answer to part (b)

Use the equation:

$$\text{average speed} = \frac{\text{total distance}}{\text{total time}}$$

_____

_____

_____

Average speed = _____ m/s

(2)

(d) Which section of the figure above shows the person walking the slowest?

Give a reason for your answer.

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐

Reason _____

_____

(2)

(e) The person walked slowest when going up some steps.

Complete the sentence.

Choose the answer from the box.

air resistance	**friction**	**gravity**

When walking up the steps, the person did more work against the force of _____ .

(1)

(f) On another day, the person ran the same route.

What is a typical speed for a person running?

Tick (✓) **one** box.

0.3 m/s ☐

3.0 m/s ☐

30 m/s ☐

(1)

(Total 9 marks)

Q3.

A swimming pool is being filled with water. **(Physics only)**

(a) Calculate the weight of the water in the swimming pool when the mass of the water is 25 000 kg.

gravitational field strength = 9.8 N/kg

Use the equation:

weight = mass × gravitational field strength

Weight = _____ N

(2)

(b) When the swimming pool is full, the weight of the water is 1 960 000 N.

The bottom of the swimming pool has an area of 49 m^2.

Calculate the pressure at the bottom of the swimming pool when it is full.

Use the equation:

$$\text{pressure} = \frac{\text{weight}}{\text{area}}$$

Choose the unit from the box.

m^2	**m^3**	**N**	**Pa**

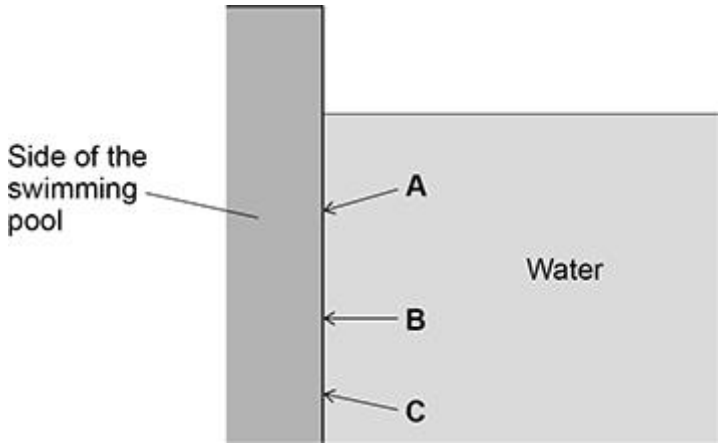
Pressure = _____ Unit _____

(3)

(c) There is a force acting on the side of the swimming pool because of the water pressure.

Figure 1 shows the side of the swimming pool.

Figure 1



Which arrow shows the direction of the force acting on the side of the swimming pool?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐

(1)

(d) A child is swimming in the pool. The velocity of the child is 0.70 m/s.

The child then accelerates for 5.0 s, reaching a final velocity of 1.3 m/s.

Calculate the acceleration of the child.

Use the equation:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

_____

_____

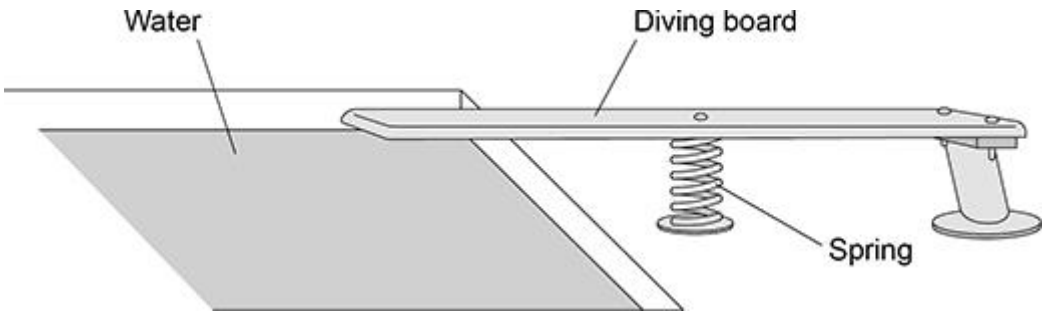
_____

Acceleration = _____ m/s^2

(2)

Figure 2 shows a diving board at the side of the swimming pool.

Figure 2



(e) The original length of the spring is 0.84 m.

When the child stands on the diving board, the length of the spring decreases by 0.21 m.

Calculate the percentage change in the length of the spring.

_____

_____

_____

Percentage change in length = _____ %

(2)

Use the Physics Equations Sheet to answer parts (f) and (g).

(f) Write down the equation which links extension (*e*), force applied to a spring (*F*) and spring constant (*k*).

_____

(1)

(g) The force applied to the spring by the weight of the child is 336 N.

The change in length of the spring is 0.21 m.

Calculate the spring constant of the spring.

Spring constant = _____ N/m

(3)

(h) The child steps off the diving board and falls into the swimming pool.

The initial velocity of the child is 0 m/s.

acceleration due to gravity = 9.8 m/s^2

Calculate the final velocity when the child has fallen a distance of 0.95 m through the air.

Give your answer to 2 significant figures.

Use the Physics Equations Sheet.

Final velocity of child (2 significant figures) = _____ m/s

(4)

(Total 18 marks)

Q4.

Figure 1 shows a young child using a baby walker.

Figure 1

(a) The child is standing still.

What is the resultant **vertical** force on the child?

Give a reason for your answer.

Resultant vertical force = _____ N

Reason _____

_____

(2)

Use the Physics Equations Sheet to answer parts (b) and (c).

(b) Write down the equation which links distance (*s*), force (*F*) and work done (*W*).

_____

(1)

(c) The child pushed the baby walker 2.8 m across a horizontal floor.

The work done by the child was 35 J.

Calculate the horizontal force the child applied to the baby walker.

_____

_____

_____

_____

_____

Horizontal force = _____ N

(3)

(d) The child pushed the baby walker from a carpet onto a hard floor.

The child applied the same horizontal force to the baby walker.

Explain why the speed of the baby walker increased.

_____

_____

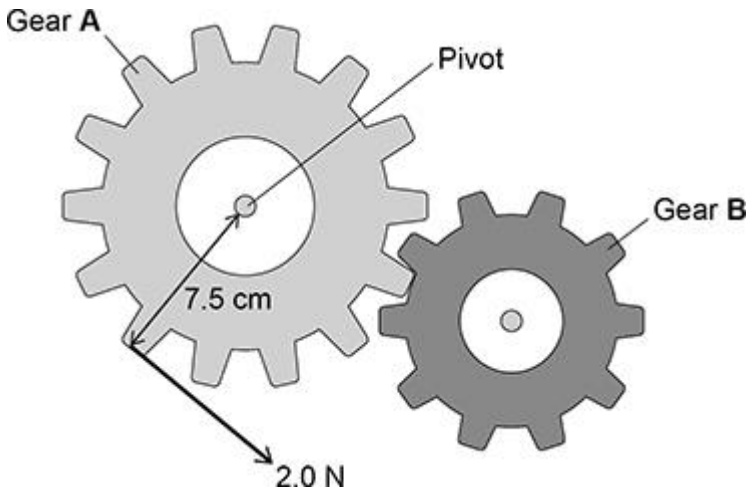
_____

(2)

There are some toy gears on the front of the baby walker.

Figure 2 shows the gears.

Figure 2



The child applies a force to gear **A**.

This causes a moment about the pivot, so gear **A** rotates.

Use the Physics Equations Sheet to answer parts (e) and (f).

(e) Write down the equation which links distance (*d*), force (*F*) and moment of a force (*M*). **(Physics only)**

_____

(1)

(f) The child applies a force of 2.0 N on gear **A**.

The perpendicular distance between the force and the pivot is 7.5 cm.

Calculate the moment of the force about the pivot. **(Physics only)**

_____

_____

_____

_____

_____

Moment of force = _____ N m

(3)

(g) Explain what happens to gear **B** when the child applies the force to gear **A**.

_____

_____

_____

_____

(2)

(Total 14 marks)

Q5.

The stopping distance of a car is the braking distance added to the thinking distance. **(Physics only)**

(a) Complete the sentences.

Choose answers from the box.

chemical	**electrostatic**	**kinetic**
nuclear	**thermal**	

A driver applies the brakes to a moving car.

As the car slows down, there is a decrease in the _____

energy of the car.

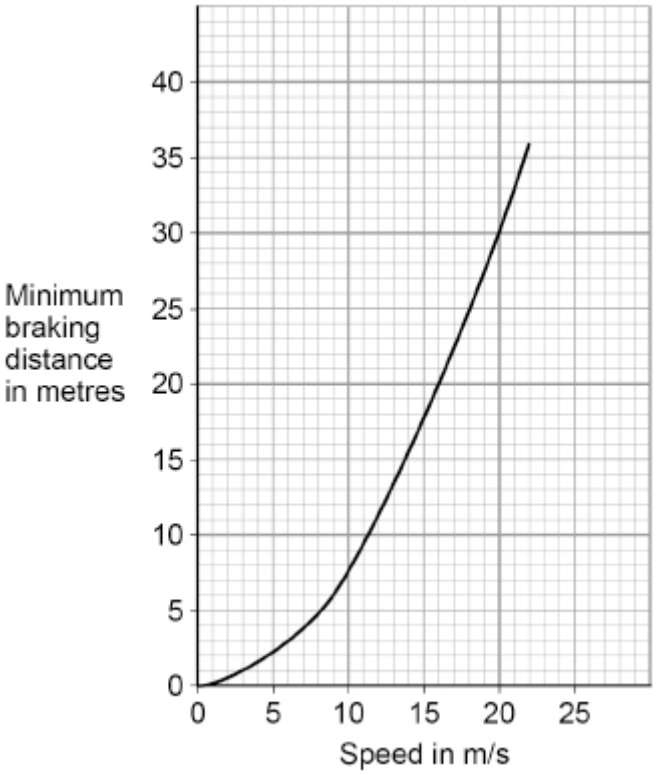
The work done by friction causes an increase in the _____

energy store of the brakes.

(2)

(b) **Figure 1** shows how the speed of the car affects the minimum braking distance of the car.

Figure 1



Describe the relationship between the speed of the car and the minimum braking distance of the car.

_____

_____

(1)

(c) Complete the sentence.

Choose the answer from the box.

decreases	**stays the same**	**increases**

When the road becomes icy, the braking distance _____.

(1)

A car driver applies the brakes to decelerate the car as it approaches a road junction.

The car decelerates at 0.25 m/s^2.

mass of the car = 1600 kg

(d) Calculate the time taken for the velocity of the car to decrease from 12.5 m/s to 5.0 m/s.

Use the equation:

$$\text{time taken} = \frac{\text{change in velocity}}{\text{deceleration}}$$

_____

_____

_____

_____

_____

Time taken = _____ s

(3)

(e) Calculate the resultant force causing the car to decelerate.

Use the equation:

resultant force = mass × deceleration

_____

_____

_____

_____

Resultant force = _____ N

(2)

Thinking distance is affected by the reaction time of the driver.

Figure 2 shows how a student tested a person's reaction time.

Figure 2

The student held a ruler and then released it.

The person being tested closed his hand to catch the ruler as quickly as possible.

The further the ruler fell the greater the person's reaction time.

(f) The student wanted to test the reaction time of the people in her class.

Which of the following could have been a control variable in this investigation?

Tick (✓) **one** box.

Distance fallen by the ruler before being caught ☐

Initial height of the ruler above the person's hand ☐

Reaction time of the person being tested ☐

(1)

(g) The student tested three people in her class.

The mean distance that the ruler fell before being caught was 18.2 cm.

If all of the people in her class were tested, the mean distance may not be 18.2 cm.

Suggest why.

_____

_____

(1)

(h) Describe how this investigation could be changed to find out how listening to music affects reaction time.

_____

_____

_____

_____

(2)

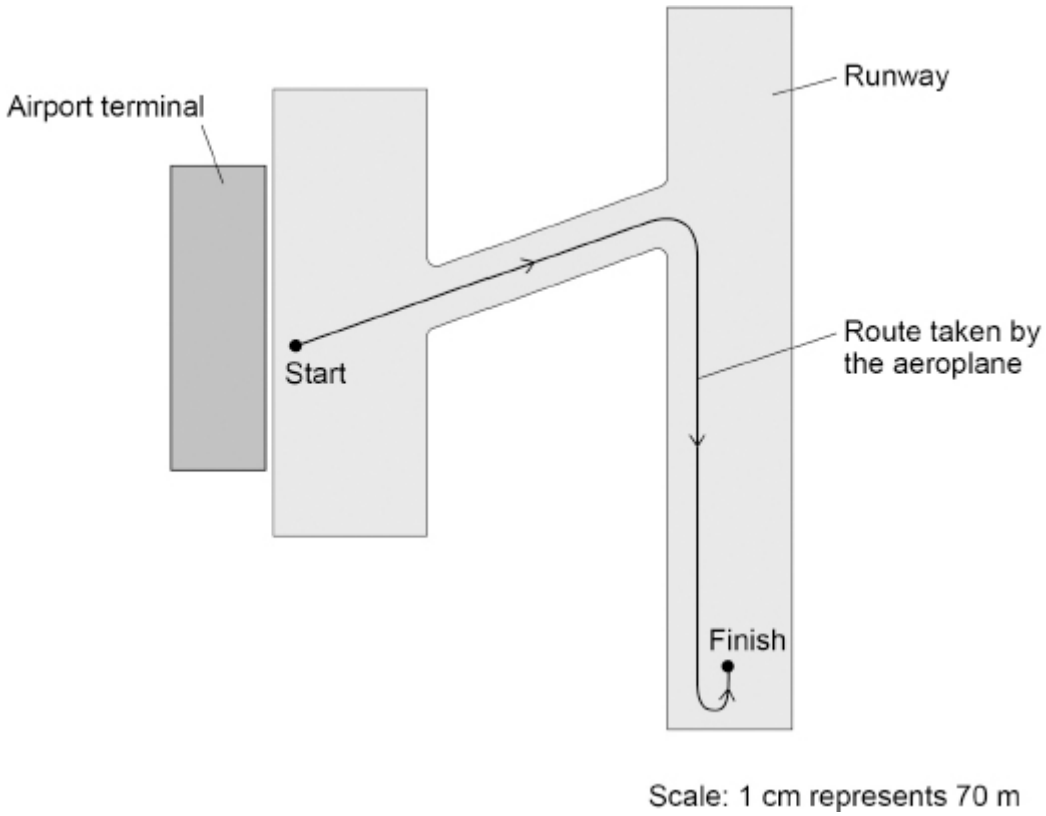
(Total 13 marks)

Q6.

Figure 1 shows the route an aeroplane takes as it travels from an airport terminal to the runway.

Figure 1 has been drawn to scale.

Figure 1



(a) Determine the magnitude of the aeroplane's displacement from the start point to the finish point on **Figure 1**.

_____

_____

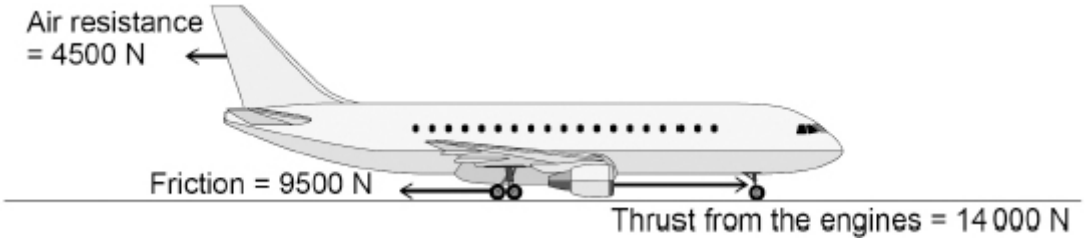
_____

Displacement = _____ m

(2)

Figure 2 shows the direction of the horizontal forces acting on the aeroplane as it moves in a straight line towards the runway.

Figure 2



(b) Determine the magnitude of the resultant horizontal force on the aeroplane.

_____

_____

Resultant horizontal force = _____ N

(1)

(c) Describe the motion of the aeroplane as it moves towards the runway.

_____

_____

(1)

(d) Air resistance and friction are contact forces.

Give **one** other example of a contact force.

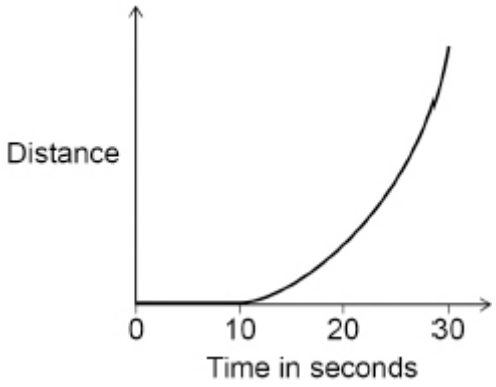
_____

(1)

(e) The aeroplane stops for a short time and then accelerates along the runway.

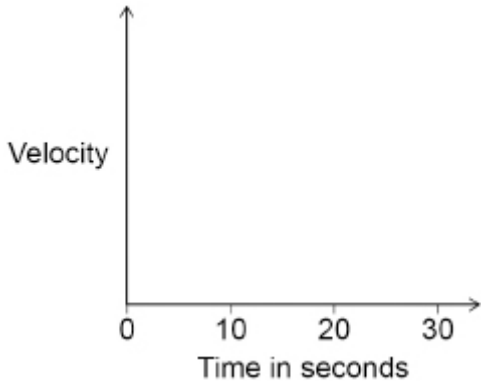
Figure 3 shows a distance–time sketch-graph for this stage of the journey.

Figure 3



Draw the velocity–time sketch-graph for this stage of the journey on **Figure 4**.

Figure 4

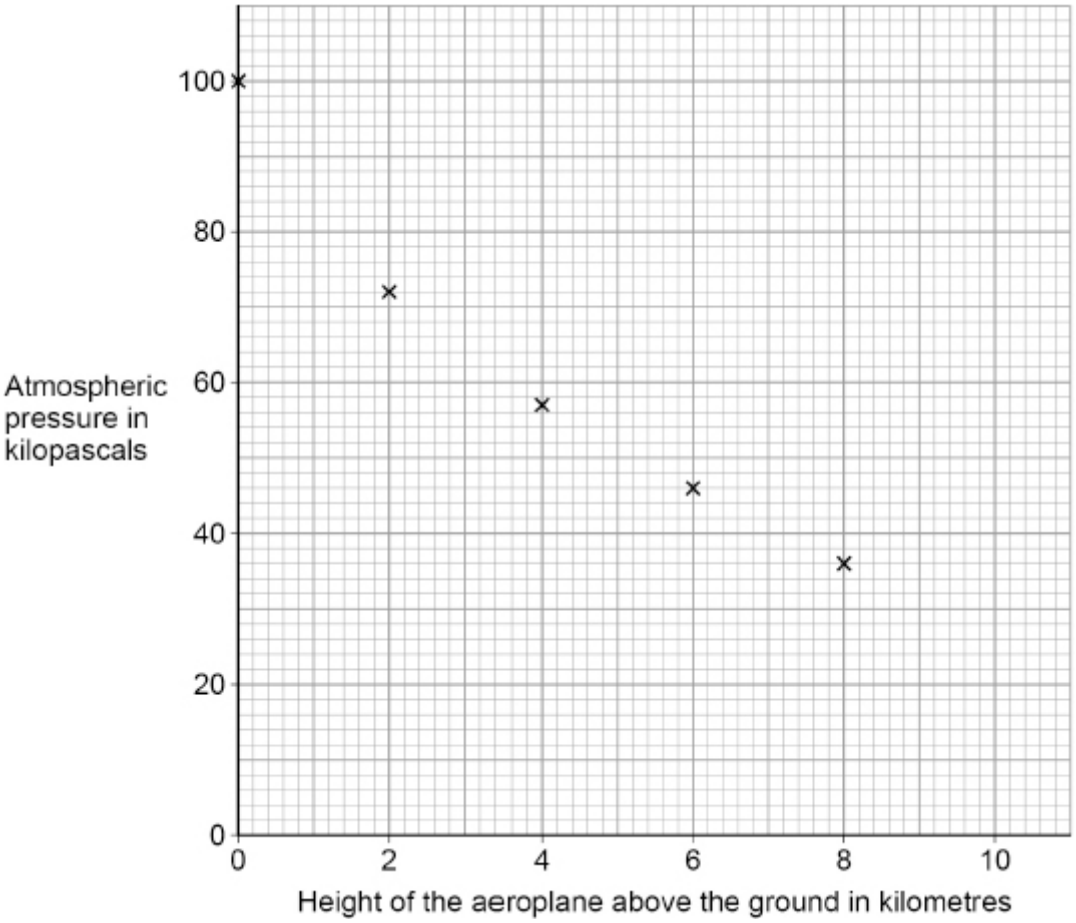


(2)

(f) The aeroplane takes off from the runway, so its height above the ground increases. **(Physics only)**

Figure 5 shows how atmospheric pressure varies with the height of the aeroplane above the ground.

Figure 5



Estimate the atmospheric pressure when the height of the aeroplane above the ground is 10 km.

Atmospheric pressure = _____ kPa

(2)

(g) What happens to the air surrounding the aeroplane as the height of the aeroplane above the ground increases? **(Physics only)**

Tick (✓) **one** box.

The average density of the air above the aeroplane decreases.	☐
The mass of air above the aeroplane increases.	☐
The temperature of the air increases.	☐
The volume of air below the aeroplane decreases.	☐

(1)

(Total 10 marks)

Q7.

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

Figure 1 shows different-sized hailstones.

Figure 1

(a) Which force causes the hailstones to fall to the ground?

Tick (✓) **one** box.

Air resistance	☐
Gravitational force	☐
Magnetic force	☐
Tension	☐

(1)

(b) As the hailstones begin to fall they accelerate.

Which force increases as the hailstones accelerate?

Tick (✓) **one** box.

- Air resistance ☐
- Gravitational force ☐
- Magnetic force ☐
- Tension ☐

(1)

(c) After a short time hailstones fall at terminal velocity.

Which of the following statements is true at terminal velocity?

Tick (✓) **one** box.

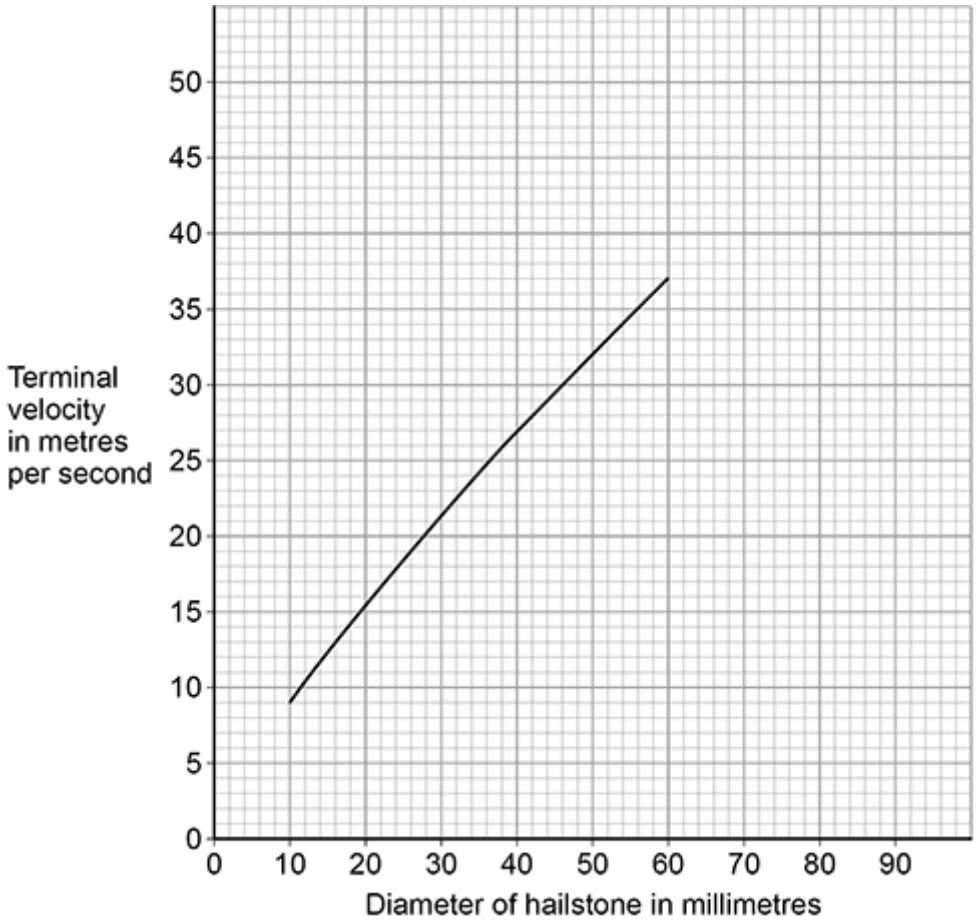
- The hailstones begin to slow down. ☐
- The mass of the hailstones increases. ☐
- The resultant force on the hailstones is zero. ☐

(1)

A scientist investigated how the terminal velocity of hailstones varies with their diameter.

Figure 2 shows the results.

Figure 2



(d) Estimate the terminal velocity for a hailstone with a diameter of 80 mm.

Show how you obtain your answer.

_____

_____

_____

Terminal velocity = _____ m/s

(2)

(e) Give **one** reason why a hailstone with a large diameter has a greater terminal velocity than a hailstone with a smaller diameter.

Tick (✓) **one** box.

It has a greater power. ☐

It has a greater pressure. ☐

It has a greater temperature. ☐

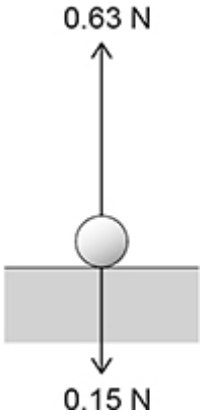
It has a greater weight. ☐

(1)

After falling, the hailstone hits the ground.

Figure 3 shows the forces acting on the hailstone at the moment it hits the ground.

Figure 3



(f) What is the magnitude of the resultant force on the hailstone in **Figure 3**?

Tick (✓) **one** box.

0.15 N ☐

0.48 N ☐

0.63 N ☐

0.78 N ☐

(1)

(g) What is the direction of the resultant force on the hailstone in **Figure 3**?

_____

(1)

(Total 8 marks)

Q8.

The figure below shows an electric super-car.

(a) The battery in an electric car needs to be recharged.

Suggest **two** factors that affect the distance an electric car can travel before the battery needs to be recharged.

1. _____

2. _____

(2)

Use the Physics Equations Sheet to answer parts (b) and (c).

(b) Write down the equation which links acceleration (*a*), change in velocity (Δv) and time taken (*t*).

_____

(1)

(c) The maximum acceleration of the car is 20 m/s^2.

Calculate the time taken for the speed of the car to change from 0 m/s to 28 m/s at its maximum acceleration.

_____

_____

_____

_____

_____

Time taken = _____ s

(3)

(d) In a trial run, the car accelerates at 10 m/s^2 until it reaches its final velocity.

distance travelled by the car = 605 m

initial velocity of the car = 0 m/s

Calculate the final velocity of the car.

Use the Physics Equations Sheet.

Final velocity = _____ m/s

(3)

Use the Physics Equations Sheet to answer parts (e) and (f).

(e) Write down the equation which links distance (*s*), force (*F*) and work done (*W*).

(1)

(f) When travelling at its maximum speed the air resistance acting on the car is 4000 N.

Calculate the work done against air resistance when the car travels a distance of 7.5 km at its maximum speed.

Work done = _____ J

(3)

(Total 13 marks)