NAME: ……..……..……

SCHOOL:……

DATE: .....

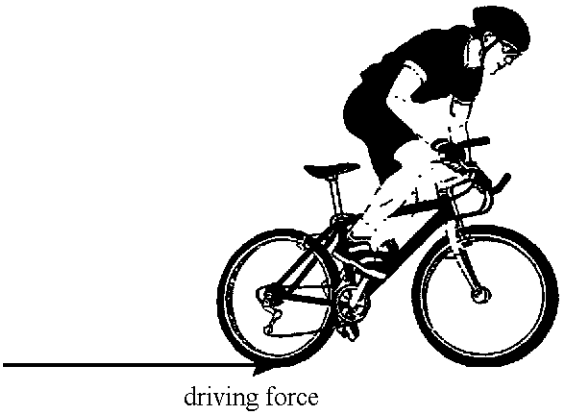
LINEAR MOTION

INSTRUCTIONS TO CANDIDATES

*Answer **ALL** questions in this paper in the spaces provided.*

1. Two forces that act on a moving cyclist are the **driving force** and the **resistive force.**

(a) The diagram shows a cyclist.



(i) Add an arrow to show the direction of the resistive force.

(1)

(ii) The cyclist is speeding up. Which is the correct statement about these two forces?

A The driving force is **greater** than the resistive force.

B The driving force is **smaller** than the resistive force.

C The driving force is the **same** as the resistive force.

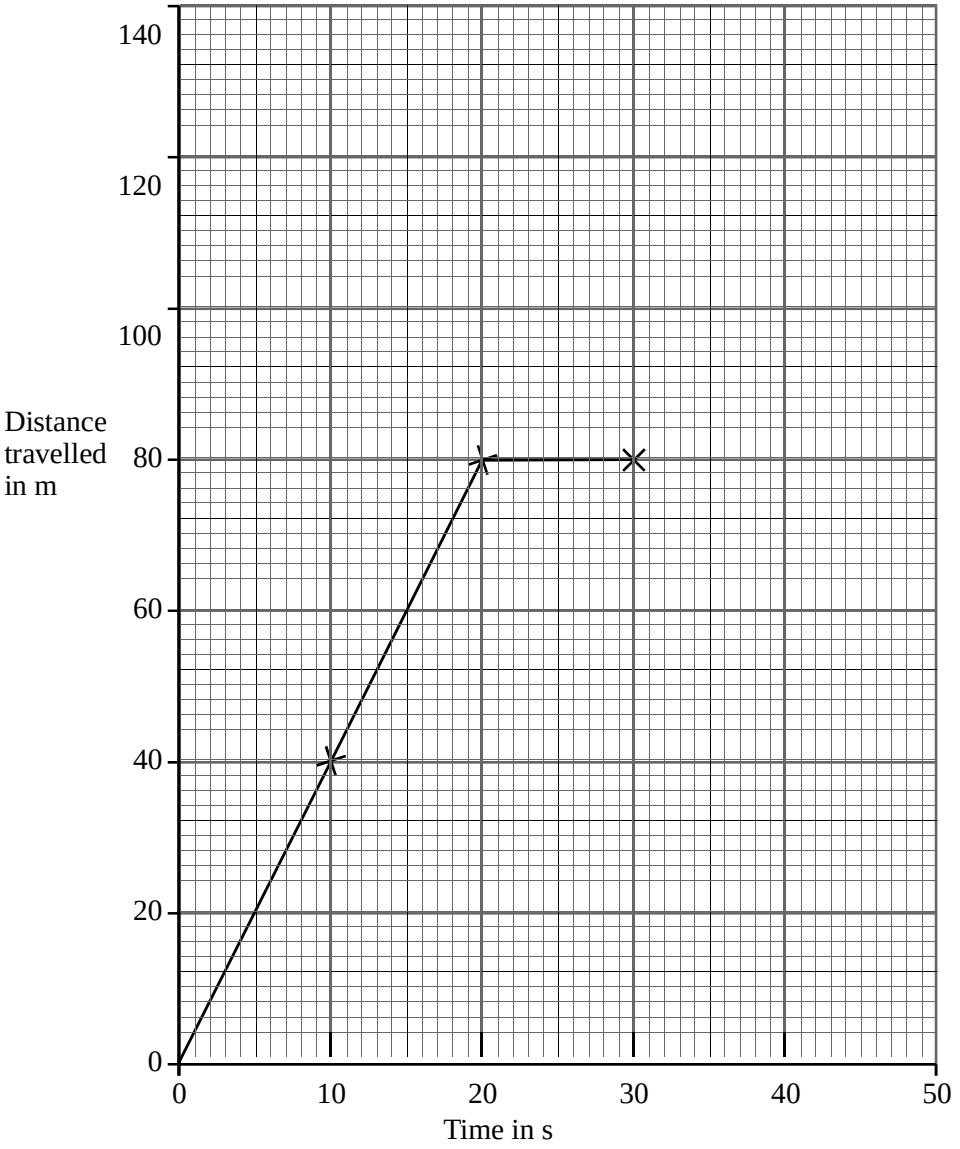
Write the correct answer (**A, B** or **C**) in the box. ☐

(1)

(b) The table shows how the distance travelled by a cyclist changes with time.

Distance travelled (m)	0	40	80	80	110	140
Time (s)	0	10	20	30	40	50

Some of these points have been plotted on the graph.



(i) Complete the graph.

(2)

(ii) Between which TWO times shown on the graph was the cyclist not moving?

Between.....s and .....s

(1)

(iii) Between which TWO times shown on the graph did the cyclist have the greatest speed?

Between.....s and .....s

Explain your answer.

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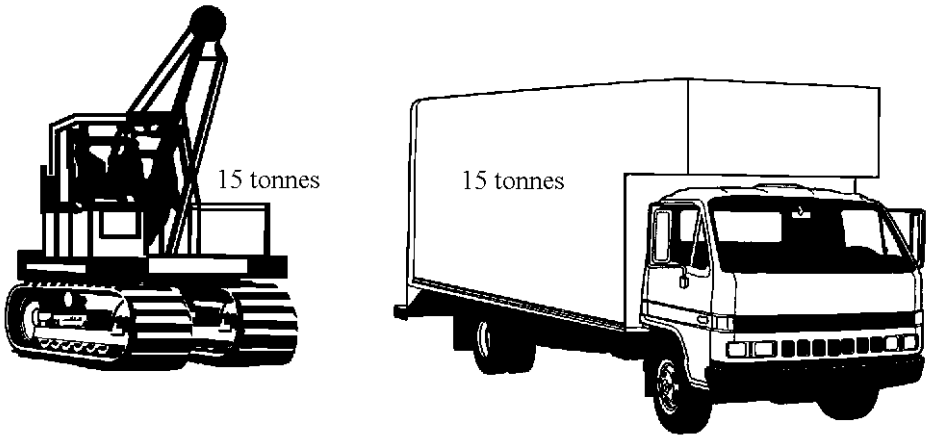
(2)

(Total 7 marks)

2. The diagram shows a mobile crane and a removal van. Each vehicle has a mass of 15 tonnes (15 000 kg).



The van and the crane both start to move. The table shows their speed during the first ten seconds of movement.

	Speed after 5 s	**Speed after 10 s**
Van	10 m/s	15 m/s
Crane	3 m/s	5 m/s

(a) Which vehicle has the greater acceleration? Explain how you can tell.

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(2)

(b) The driving force used by the mobile crane to make it move is 20 000 N. Explain why the driving force used by the removal van must be greater than 20 000 N.

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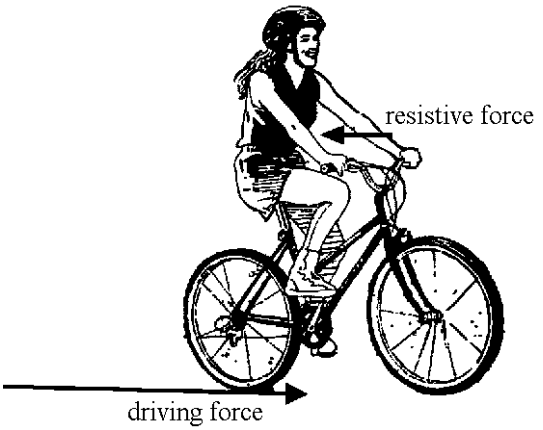
(2)
(Total 4 marks)

3. The diagram shows the horizontal forces acting on a cyclist while she is accelerating.



(a) Explain how the unbalanced force acting on the cyclist changes as she accelerates and then cycles at a constant speed.

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(3)

(b) Some racing cycles have lightweight frames. Why is it an advantage for the cycle to have a lightweight frame?

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(2)

(c) (i) A cyclist and her cycle have a total mass of 85 kg.
Calculate the combined kinetic energy of the cyclist and cycle when travelling at a speed of 12 m/s.

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(3)

(ii) The kinetic energy of the cyclist and cycle increases at an average rate of 180 joules per second.
Calculate the time it takes to gain this energy.

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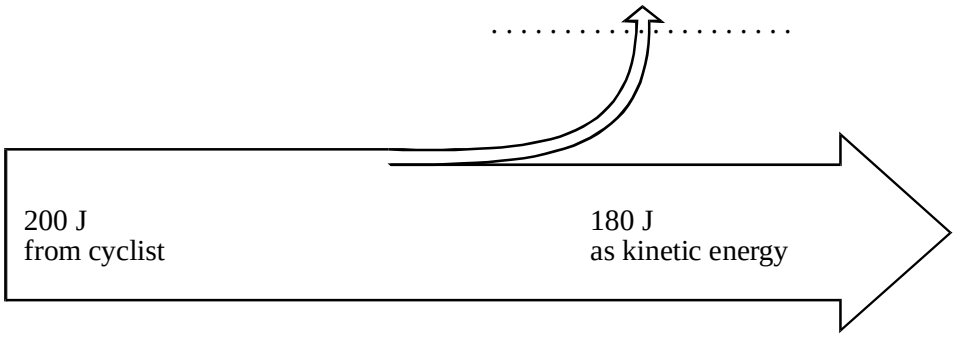
(2)

(d) The diagram shows the energy flow through the cycle during the first second that the cyclist is accelerating.



(i) Complete the diagram by labelling the top arrow.

(1)

(ii) Calculate the efficiency of the cycle.

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(3)

(iii) When the cyclist is travelling at constant speed, the kinetic energy is constant although the cyclist is still producing 200 J/s.
Where does the energy go?

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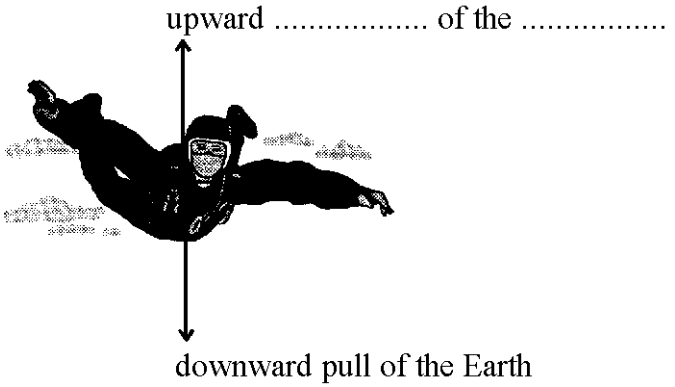
(1)

(Total 15 marks)

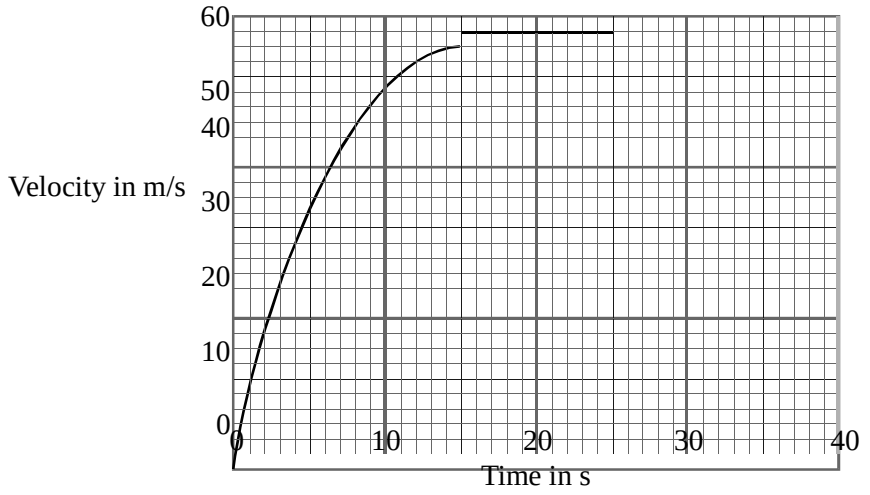
4. A skydiver jumps out of an aircraft.
The diagram shows the two forces acting on the skydiver.



(a) Complete the label on the upward arrow.

(2)

(b) The graph shows how her velocity changes before she opens her parachute.



What is the skydiver's terminal velocity?

..... m/s

(1)

(c) What is the relationship between the two forces on the skydiver,

(i) before she reaches terminal velocity;

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(1)

(ii) when she is travelling at terminal velocity?

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(1)

(d) The skydiver opens her parachute 25 s after leaving the aircraft.
She reaches a new terminal velocity ten seconds later.

(i) Add a line to the graph to show how her velocity changes after she opens her parachute.

(2)

(ii) Explain why her velocity changes in this way.

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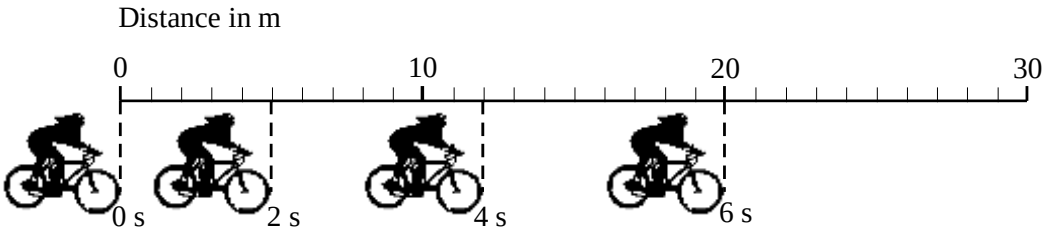
(3)
(Total 10 marks)

5. A cyclist sets off from a standing start.
Photographs are taken of the cyclist at 2 s intervals.
The diagram shows the results.



(a) What happens to the cyclist's speed during the 6 s shown?
Explain how you can tell.

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(2)

(b) How far does the cyclist travel in the first 4 s?

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(1)

(c) After 6 s the cyclist slows down.
Mark the scale with an **X** to show a possible position of the cyclist's front wheel when the next photograph is taken.

(1)
(Total 4 marks)

6. (a) (i) A book slides across a flat horizontal table and comes to rest.
What causes it to stop?

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(1)

(ii) What has happened to its kinetic energy?

.....

(1)

(b) The diagram shows some of the forces acting between a shoe and the ground while walking.

Name the force **F**.

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(1)

(Total 3 marks)

7. When an athlete attempts to jump over a horizontal hurdle he pushes down on the ground.

(a) Describe the force that causes the athlete to move upwards.

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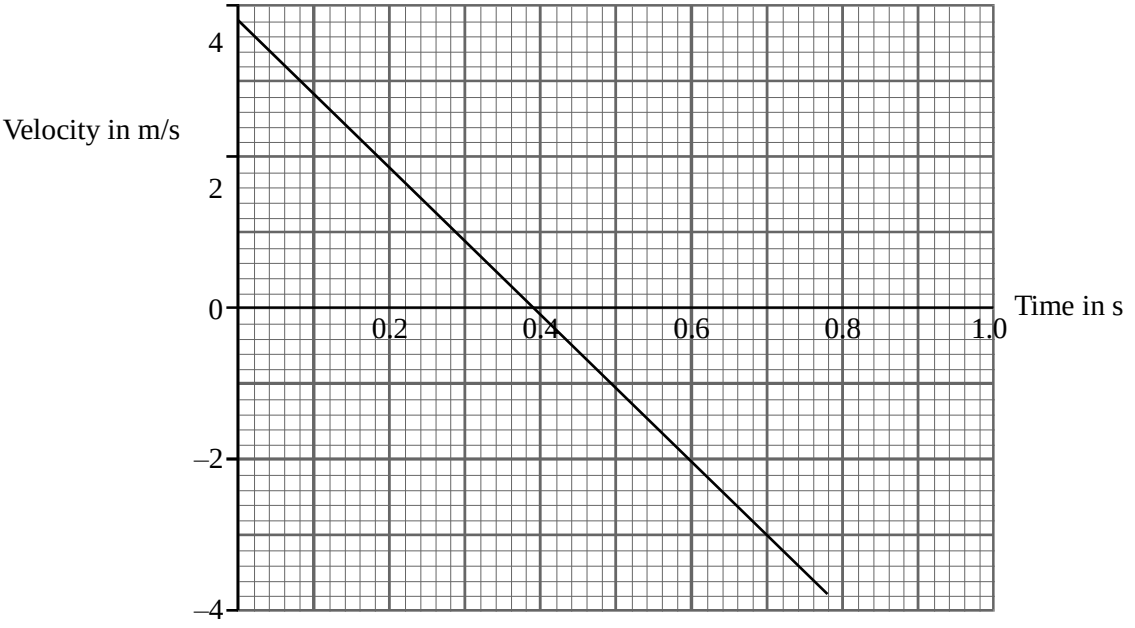
(2)

(b) The graph shows how the upwards velocity of the athlete changes after leaving the ground.



(i) After what time does the athlete reach his maximum height?

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(1)

(ii) What height does the athlete reach?

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(3)

(iii) Calculate the acceleration of the athlete.

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(3)

(iv) What is the direction of the acceleration?
Explain how you can tell from the graph.

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(2)

(v) The mass of the athlete is 65 kg.
Calculate the force required to cause this acceleration.

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(3)

(vi) Describe the force that causes the athlete's acceleration.

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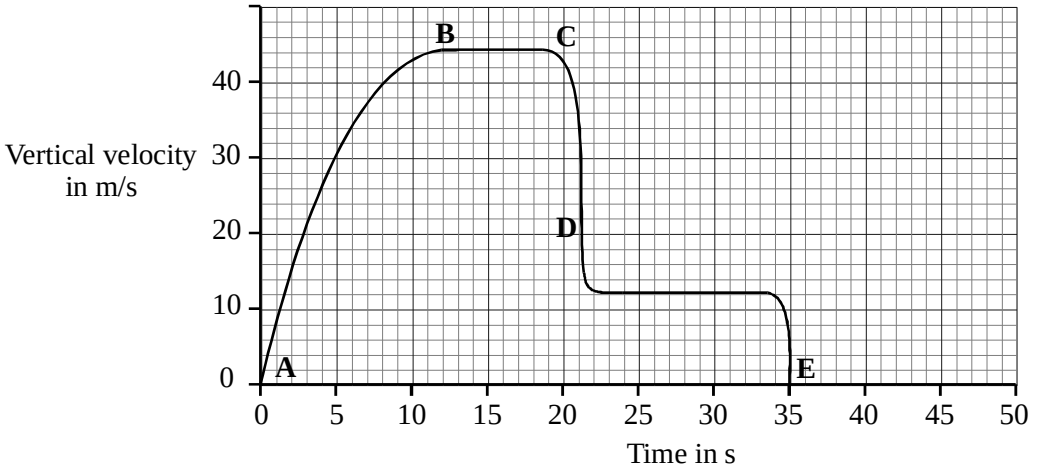
(1)

(Total 15 marks)

8. A sky-diver of mass 70 kg jumps from a plane. The graph shows how the vertical velocity of the sky-diver varies with time. Parts of the graph have been labelled **A**, **B**, **C**, **D** and **E**.



(a) At **A**, the sky-diver has an acceleration equal to the acceleration due to gravity of 10 m/s^2. Calculate the resultant force acting on the sky-diver at this instant.

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(3)

(b) How can you tell from the graph that in the time period from **B** to **C** the resultant force acting on the sky-diver is zero?

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(2)

(c) Describe and explain the motion of the sky-diver from **C** until he lands at **E**.

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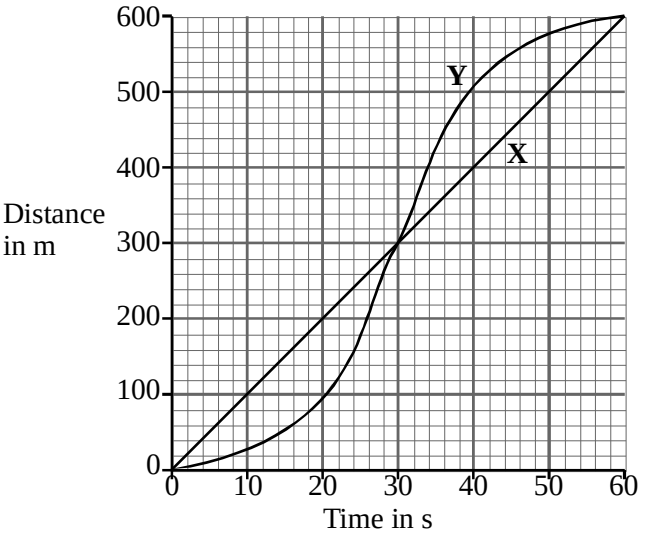
(4)

(d) A sky-diver, of the same mass, falls from the same height but uses a parachute with a larger surface area. On the grid, sketch a graph to show his motion.

(2)

(Total 11 marks)

9. The graph shows how the distances travelled by two cars **X** and **Y** varies with time.



(a) State the total distance travelled by each car.

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(1)

(b) At 20 seconds, how much further has car **X** travelled than car **Y**?

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(2)

(c) How do you know from the graph that car **X** travelled at a steady speed?

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(1)

(d) Which car is travelling at the greatest speed after 30 seconds?
State how you know.

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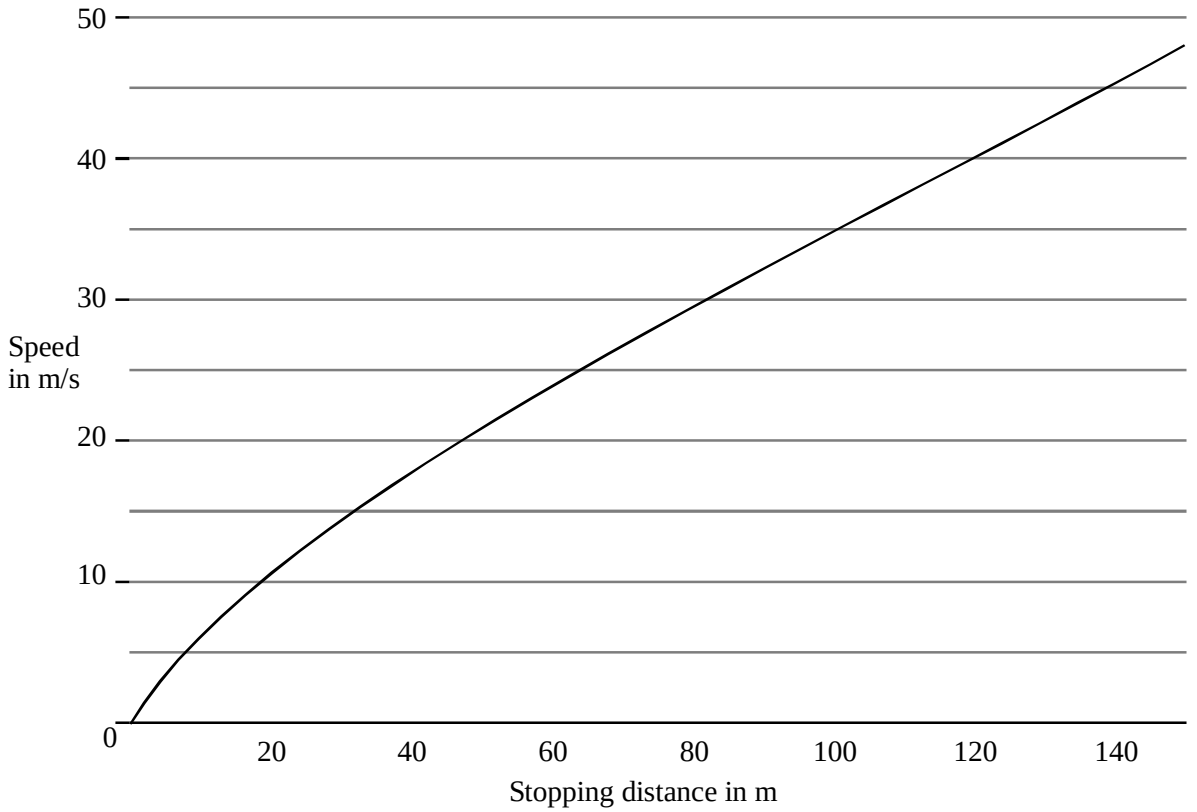
(2)

(Total 6 marks)

10. The graph shows how the stopping distance of a car on a dry level road depends on the speed.



(a) State how the stopping distance changes with the speed of the car.

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(1)

(b) Use the graph to estimate the stopping distance for a speed of 45 m/s.

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(1)

(c) When the weather conditions are poor, the stopping distances change.
Add another line to the graph to show how the stopping distance may vary with speed if the road conditions are very wet.

(2)

(d) Describe the energy changes taking place as the car is brought to a stop by the brakes.

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(2)

(e) Explain why the stopping distance of a car travelling uphill is less than when it is travelling on a level road.

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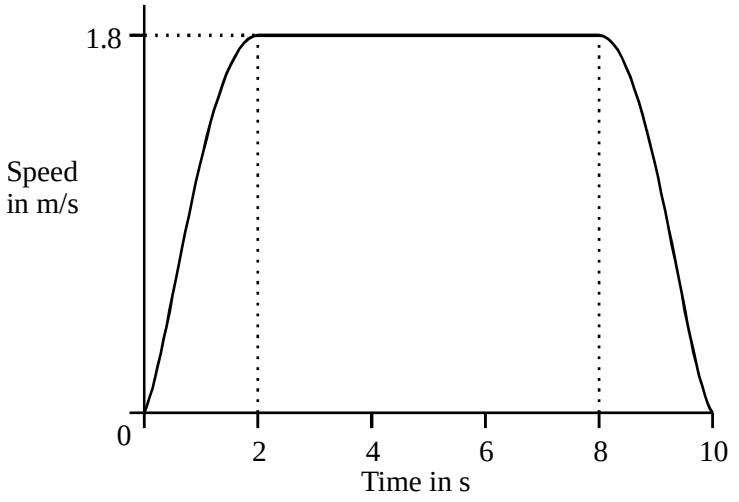
(1)
(Total 7 marks)

11. The graph shows how the speed of a lift changes with time as it **descends** from the third to the ground floor of a building.



Use the graph to answer the following questions.

(a) Between which times is the lift increasing in speed?

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(1)

(b) What is the direction of the resultant force on the lift between 8 and 10 seconds? Explain your answer.

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(2)

(c) Estimate the height of the third floor above the ground floor.
Show clearly how you arrived at your answer.

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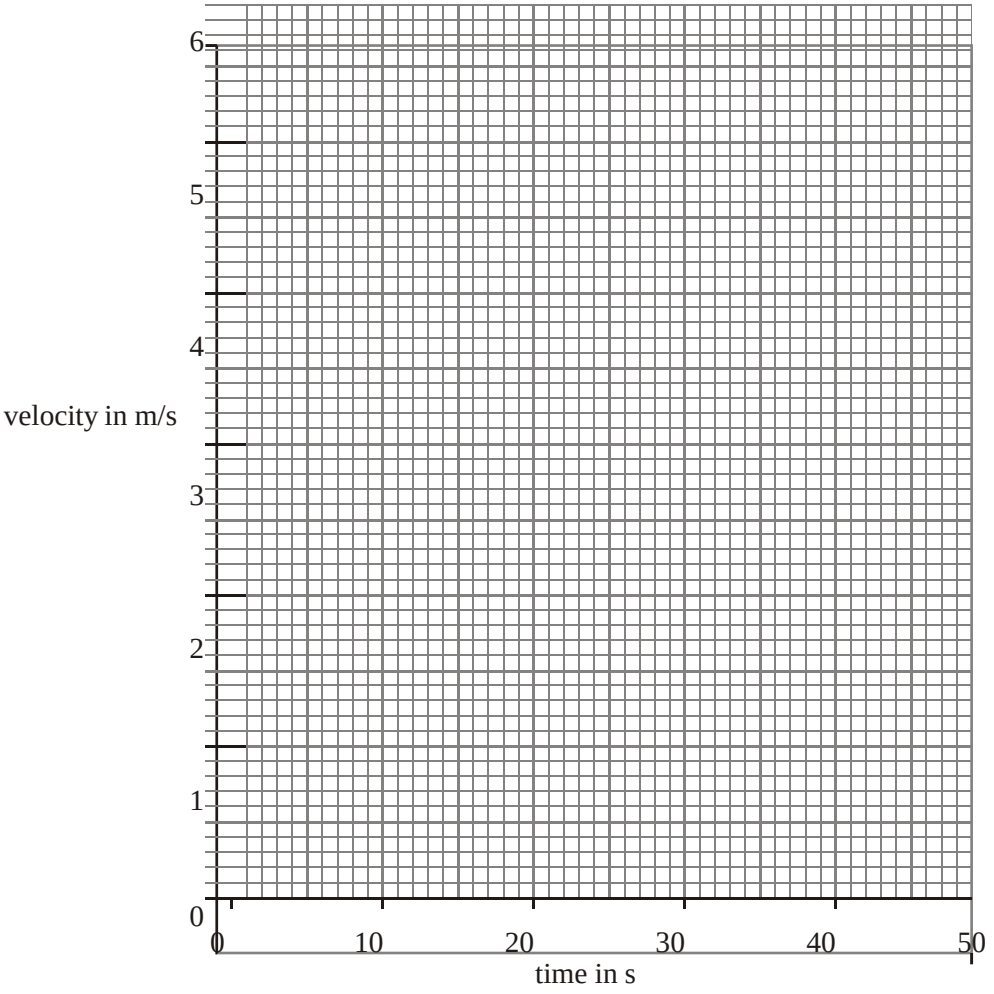
(3)
(Total 6 marks)

12. A train accelerates from rest along a straight track.

The table shows how the train's velocity changes with time.

time (s)	0	10	20	25	30	40
velocity (m/s)	0	2	4	4.5	5	5

(a) Use the grid to draw a graph of velocity against time.



(2)

(b) What is the train's velocity at 15 s?

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(1)

(c) (i) State the equation for acceleration in terms of velocity and time.

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(1)

(ii) Calculate the acceleration of the train in the first 15 s.

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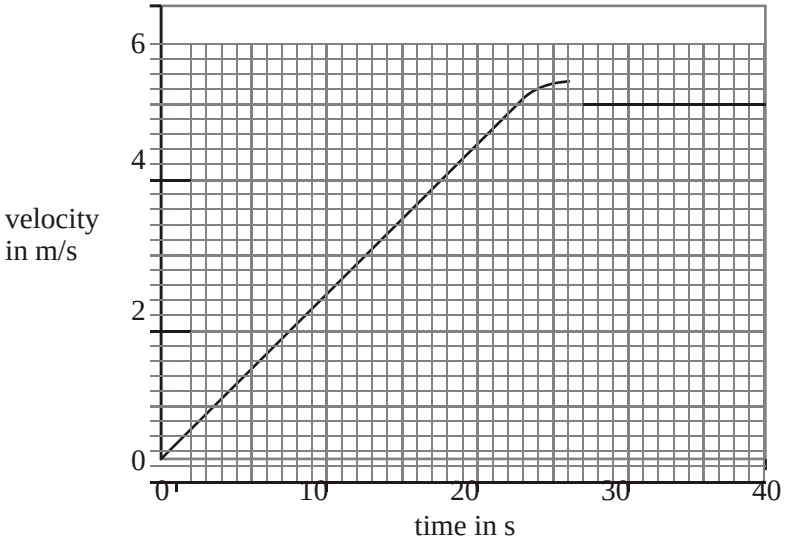
(2)

(Total 6 marks)

13. A train accelerates from rest along a straight track.

The graph shows how the train's velocity changes with time.



(a) (i) How can the distance travelled be determined from a velocity-time graph?

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(1)

(ii) Calculate the distance travelled by the train in the first 15 s.

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(2)

(b) The mass of the train is 120 000 kg.

Calculate the unbalanced force on the train at 10 s.

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(4)

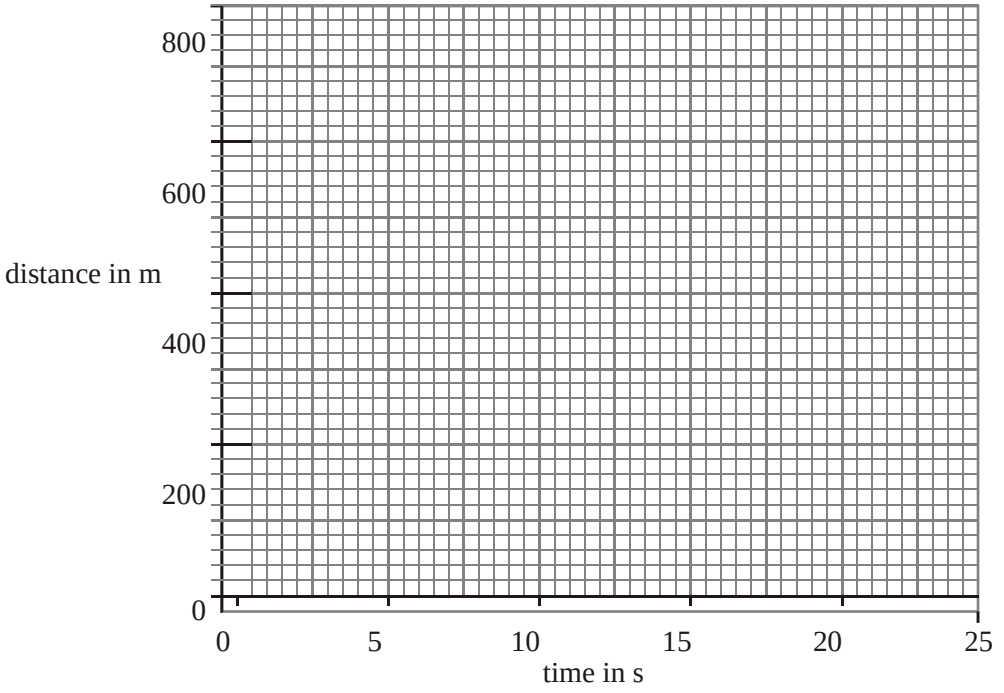
(Total 7 marks)

14. The table shows how the distance travelled by a train on a straight section of track varies with time.

distance (m)	0	150	300	450	600	750

time (s)	0	5	10	15	20	25

(a) Use the grid to plot a graph of distance against time.



(2)

(b) How can you tell from the graph that the train was travelling at a constant speed?

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(1)

(c) Use the graph to calculate the speed of the train on this section of the track.

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(3)

(d) A constant driving force acts on the train throughout this section of track.

Explain why the speed of the train does not increase.

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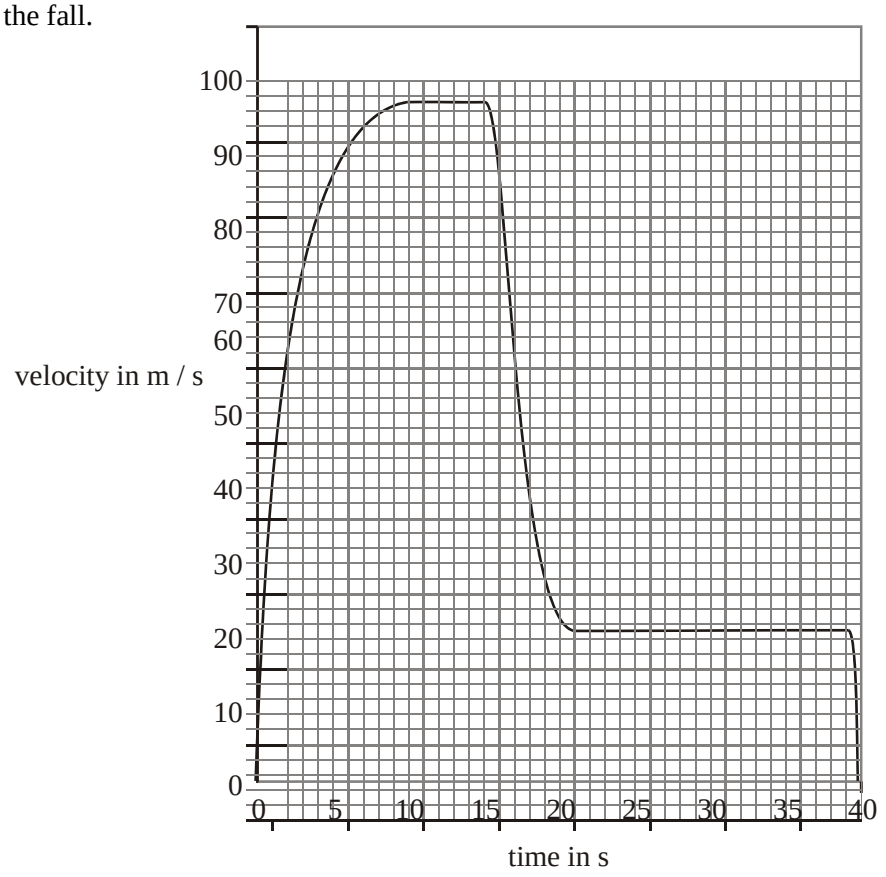
(2)

(Total 8 marks)

15. (a) The graph shows how the downward velocity of a parachutist changes with time from leaving the aircraft to landing on the ground. The parachute is not opened until some time into the fall.



Use the graph to answer the following questions.

(i) What was the maximum velocity of the parachutist?

..... m/s

(1)

(ii) For how long did the parachutist fall after leaving the aircraft?

..... s

(1)

(iii) At what time did the parachutist open the parachute?

Explain your answer.

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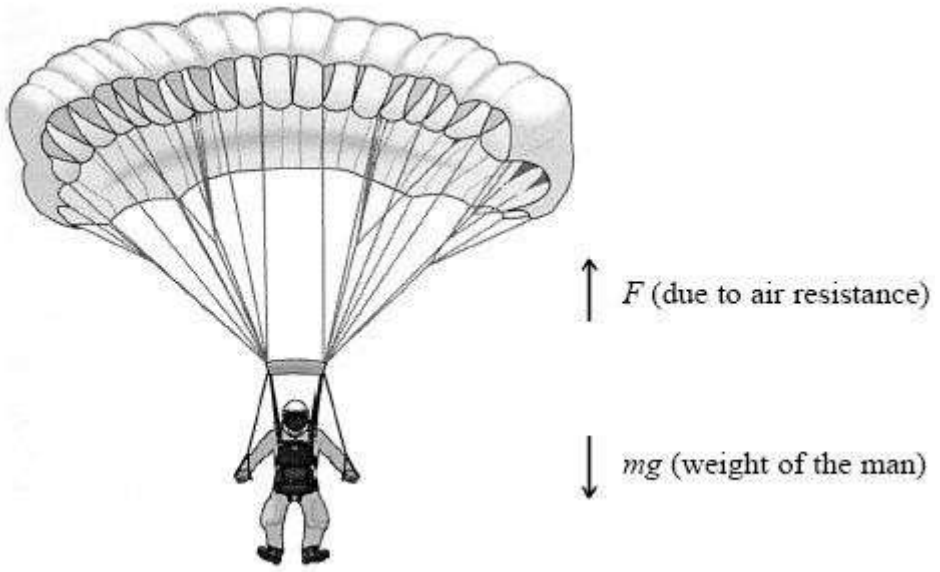
(2)

(iv) What was the terminal velocity at which the parachutist fell while the parachute was open?

..... m/s

(b) The diagram shows the forces acting on the parachutist once the parachute has been opened.



Between 16 and 21 seconds the parachutist's velocity changes.

Describe the way in which the forces acting on the parachutist change during this time.

Your answer should refer to the two forces shown in the diagram.

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(3)

(Total 8 marks)