1. The manufacturer of a family car gave the following information.

Mass of car 950 kg.

The car will accelerate from 0 to 33 m/s in 11 seconds.

(a) Calculate the acceleration of the car during the 11 seconds

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.....

Answer .....

(2)

(b) Calculate the force needed to produce this acceleration.

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(3)

(c) The manufacturer of the car claims a top speed of 110 miles per hour. Explain why there must be a top speed for any car.

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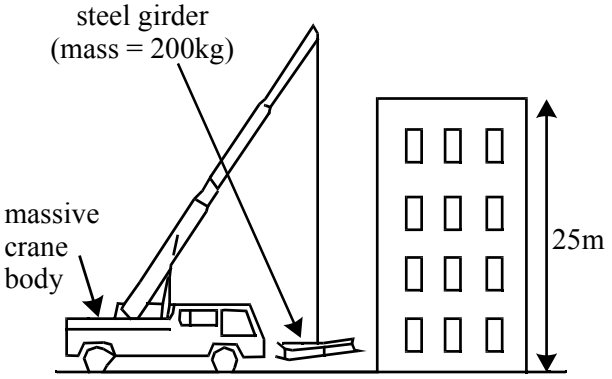
(3)
(Total 8 marks)

2. A crane is used to lift a steel girder to the top of a high building.



When it is lifted by the crane:

- the girder accelerates from rest to a speed of 0.6 m/s in the first 3 seconds;
- it then rises at a steady speed.

(a) Calculate the **acceleration** of the girder.

(Show your working.)

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(3)

(b) (i) What is the **weight** of the steel girder?

Answer ..... N

(1)

(ii) Calculate the **power** of the crane motor as it lifts the girder at a steady speed of 0.6 m/s.

(*Show your working. You can ignore the weight of the cable and hook which is small compared to the weight of the girder.*)

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Answer ..... W

(2)

(c) A new motor is fitted to the crane. This motor accelerates the girder at 0.3 m/s^2.

Calculate the **force** which the crane applies to the girder to produce this acceleration.

(Show your working.)

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Answer ..... N

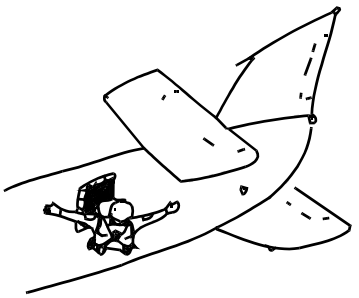
(3)

(Total 9 marks)

3. A sky-diver steps out of an aeroplane.

After 10 seconds she is falling at a steady speed of 50m/s.

She then opens her parachute.



After another 5 seconds she is once again falling at a steady speed.

This speed is now only 10m/s.

(a) Calculate the sky-diver's average acceleration during the time from when she opens her parachute until she reaches her slower steady speed. (Show your working.)

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(3)

(b) Explain, as fully as you can:

(i) why the sky-diver eventually reaches a steady speed (with or without her parachute).

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.....

(3)

(ii) why the sky-diver's steady speed is lower when her parachute is open.

.....

(1)

(c) The sky-diver and her equipment have a total mass of 75kg. Calculate the gravitational force acting on this mass. (Show your working.)

.....

.....

Answer ..... N

(1)

(Total 8 marks)

4. (a) The amount of damage caused when a car collides with a wall depends on the amount of energy transferred.

If the speed of a car **doubles**, the amount of energy transferred in a collision increases **four** times.

Explain, as fully as you can, why this is so.

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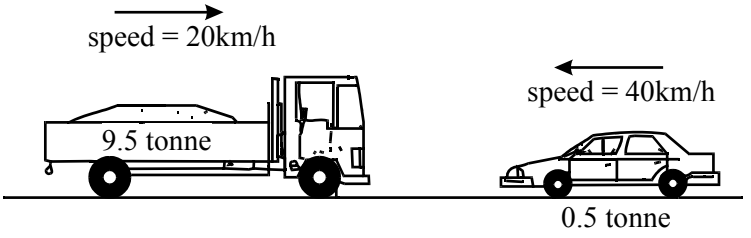
(3)

(b) The diagram shows a car and a lorry about to collide.



When they collide, the two vehicles become tightly locked together.

(i) Calculate the speed of the vehicles immediately after the collision.

(Show your working. There is no need to change to standard units.)

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Answer ..... km/h

(6)

(ii) The collision between the car and the lorry is inelastic.

Explain, in terms of energy, what this means.

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(1)

(Total 10 marks)

5. A cyclist accelerates from a set of traffic lights.

The driving force of the back tyre on the ground is 250 N.

(a) How much work is done by this force when the cyclist travels 5 metres?
(Show your working.)

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Answer ..... joules (J)

(2)

(b) What happens to the energy transferred by this force?

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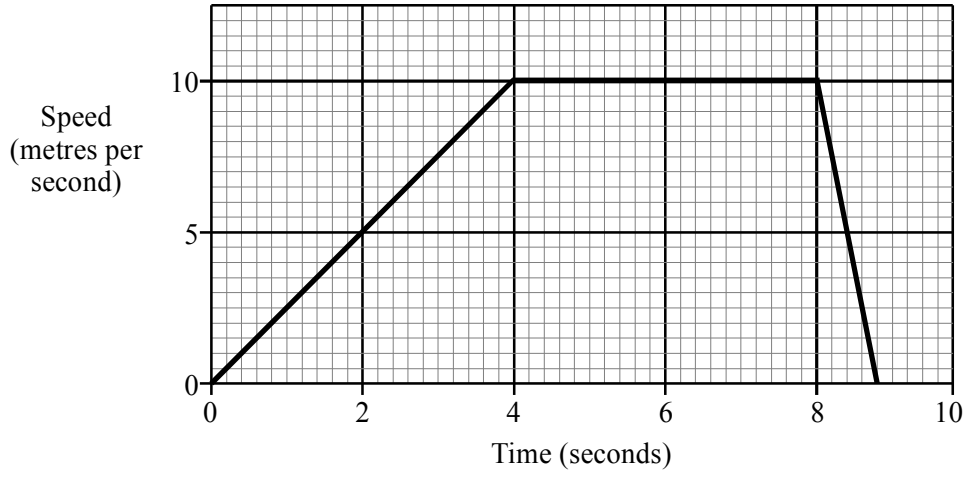
(2)

(Total 4 marks)

6. The graph shows the speed of a runner during an indoor 60 metres race.



(a) Calculate the acceleration of the runner during the first four seconds.
(Show your working.)

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(3)

(b) How far does the runner travel during the first four seconds?
(Show your working.)

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(3)

(c) At the finish, a thick wall of rubber foam slows the runner down at a rate of 25 m/s^2.
The runner has a mass of 75kg.
Calculate the average force of the rubber foam on the runner.
(Show your working.)

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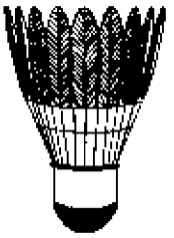
Answer ..... newtons (N)

(2)
(Total 8 marks)

7. The diagram shows a shuttlecock that is used for playing badminton.



The shuttlecock weighs very little.
When you drop it from a height of a few metres, it accelerates at first but soon reaches a steady speed.

Explain, as fully as you can:

(a) why the shuttlecock accelerates at first,

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(2)

(b) why the shuttlecock reaches a steady speed.

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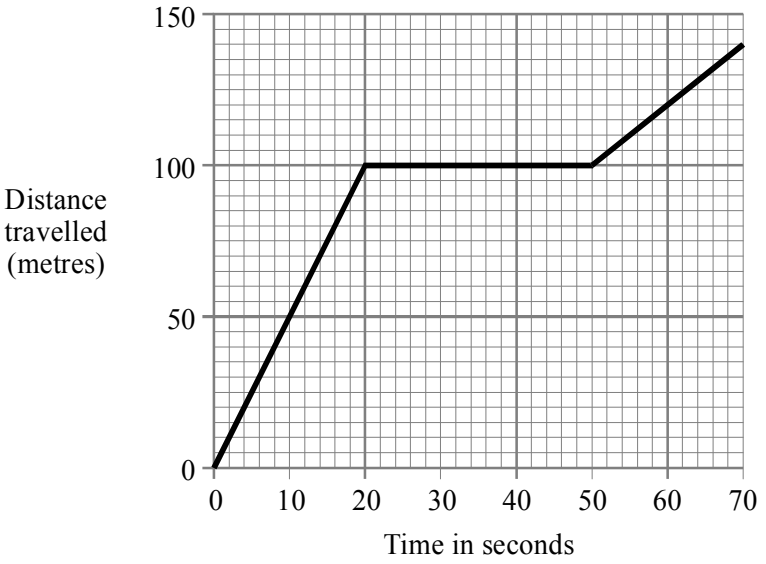
(3)
(Total 5 marks)

8. A child goes out to visit a friend.
The graph shows the child's journey.



(a) Calculate the child's average speed for the whole journey.
[Show your working and give the units in your answer.]

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(3)

(b) How many times faster is the child travelling in part A of the graph than in part C? [You should show how you obtained your answer.]

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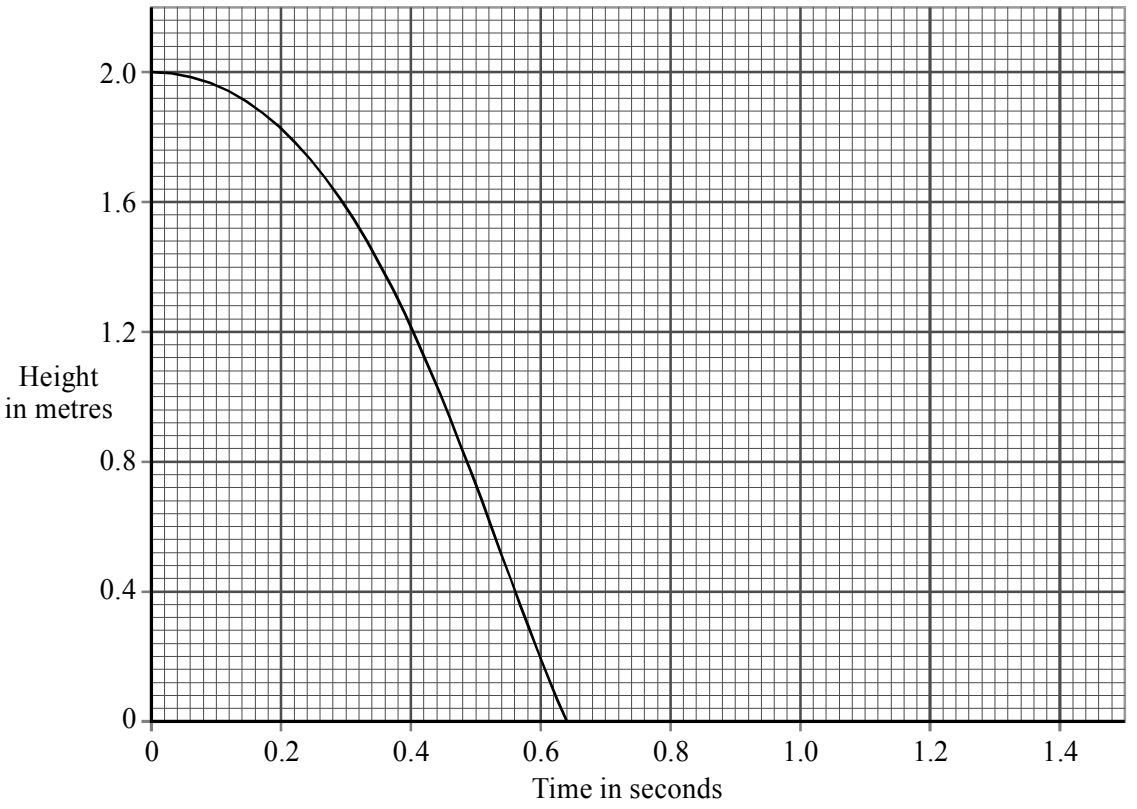
(2)
(Total 5 marks)

9. A bouncy ball is dropped vertically from a height of 2.00 m onto the floor. The graph shows the height of the ball above the floor at different times during its fall until it hits the floor after 0.64 s.



(a) What is the average speed of the ball over the first 0.64 s? Show clearly how you work out your answer.

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Average speed = ... m/s

(1)

(b) After it hits the floor the ball bounces back to a height of 1.25 m. It reaches this height 1. 16 s after it was dropped. Plot this point on the grid above and sketch a graph to show the height of the ball above the floor between 0. 64 s and 1.16 s.

(3)

(c) (i) The ball bounces on the floor 0.64 s after being dropped. How long after being dropped will it be before it bounces a second time?

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(1)

(ii) What distance will the ball travel between its first and second bounce?

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(1)

(d) The ball was held stationary before being dropped. On the graph and your sketch mark **two** other points $\mathbf{X_1}$ and $\mathbf{X_2}$, where the ball is stationary, and in each case explain why the ball is not moving.

$\mathbf{X_1}$ .....

.....

$\mathbf{X_2}$ .....

.....

(2)
(Total 8 marks)

10. Mira and Susan are rock climbing. They are using a nylon climbing rope. Mira has fastened herself to the rock face and to one end of the rope. The other end of the rope is fastened to Susan. This means that, if Susan falls, the rope will hold her. Susan weighs 540 N.

(a) (i) Use the words *distance*, *force* and *work* to write an equation which shows the relationship between them

.....

(1)

(ii) What vertical distance up the rock face does Susan climb when she does 2000 J of work against gravity? Show your working and give your answer to the nearest 0.1 m.

.....

.....

Distance = ... metres

(2)

(iii) How much gravitational energy will Susan gain when she does 2000 J of work against gravity?

.....

(1)

(b) The climbers dislodge a 3 kg stone which falls down the rock face.

What is the speed of the stone when its kinetic energy is 600 J?

$$\text{kinetic energy} = \tfrac{1}{2} \text{ mass} \times \text{speed}^2$$

Show clearly how you get to your answer and give the unit.

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Speed = ...

(3)

(c) The climbing rope is made of nylon. Nylon is very strong. Another advantage is that it stretches. This means that, if Susan falls, it transfers some of her kinetic energy to elastic (or strain) energy at the end of the fall.

Explain, in terms of *force* and *deceleration*, what would happen if Susan fell and the climbing rope did **not** transfer any of her kinetic energy to elastic energy.

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(3)

(Total 10 marks)