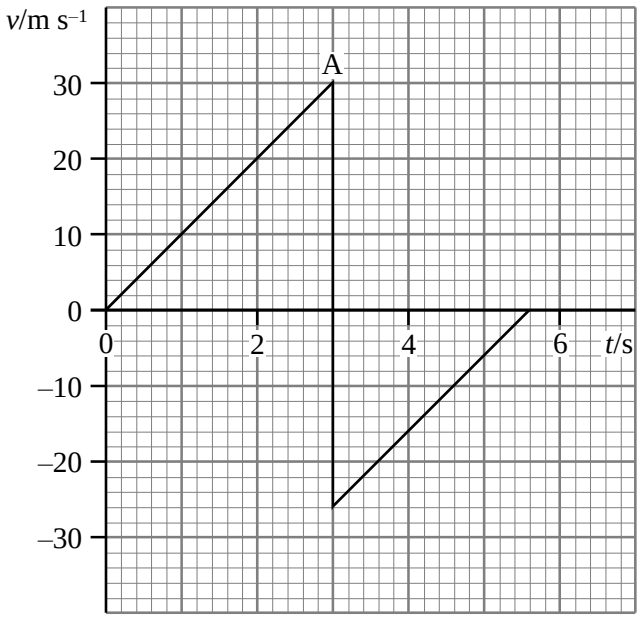
1. A ball is dropped from a high window onto a concrete floor. The velocity–time graph for part of its motion is shown.



Calculate the gradient from the origin to A.

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Gradient = ...

Comment on the significance of your answer.

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(3)

What happened to the ball at point A?

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(1)

Calculate the height of the window above the ground.

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.....

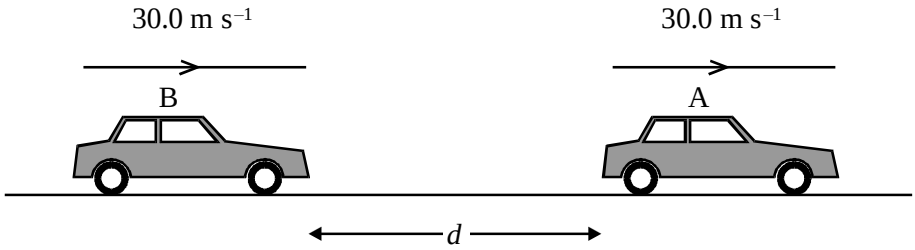
.....

Height = ...

(3)

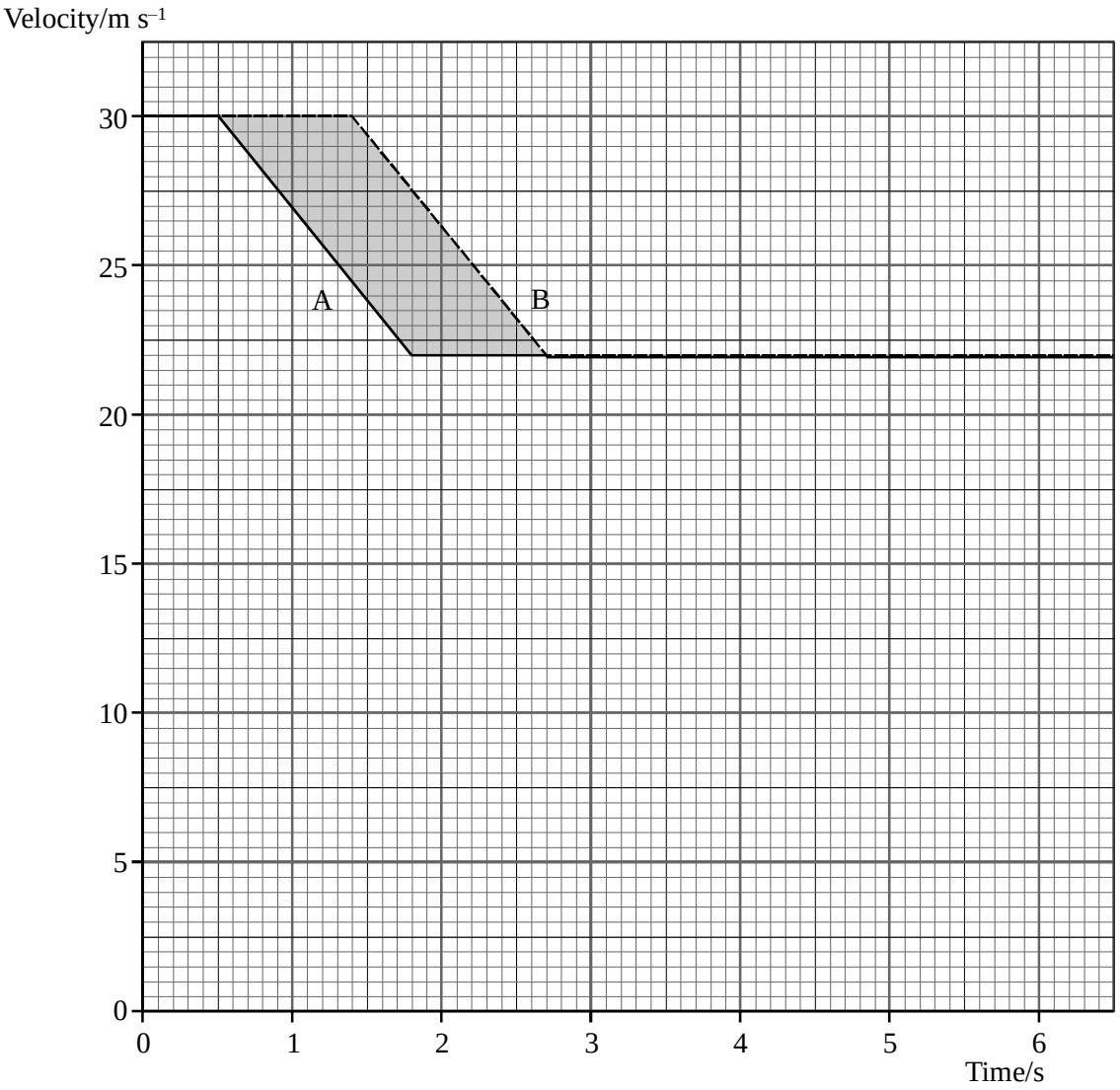
(Total 7 marks)

2. Two cars, A and B, are travelling along the outside lane of a motorway at a speed of 30.0 m s^{-1}. They are a distance *d* apart.



The driver of car A sees a slower vehicle move out in front of him, and brakes hard until his speed has fallen to 22.0 m s^{-1}. The driver of car B sees car A brake and, after a reaction time of 0.900 s, brakes with the same constant deceleration as A.

The diagram below shows velocity-time graphs for car A (solid line) and car B (broken line).



Find the deceleration of the cars whilst they are braking.

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Deceleration = ...

(3)

What does the area under a velocity-time graph represent?

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(1)

Determine the shaded area.

.....

.....

.....

Area = ...

(2)

State the minimum value of the initial separation *d* if the cars are not to collide.
Explain how you arrived at your answer.

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.....

(2)

Suppose that, instead of only slowing down to 22.0 m s^{-1}, the cars had to stop. Add lines to the grid above to show the velocity–time graphs in this case. (Assume that the cars come to rest with the same constant deceleration as before.)

(1)

Explain why a collision is now more likely.

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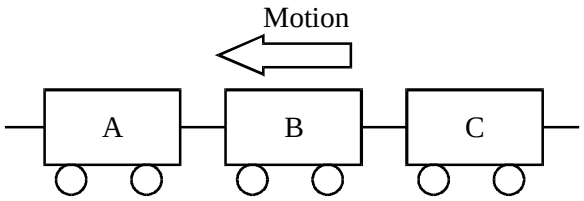
(2)

(Total 11 marks)

3. The diagram shows three trucks which are part of a train. The mass of each truck is 84 000 kg.



The train accelerates uniformly in the direction shown from rest to 16 m s^{-1} in a time of 4.0 minutes. Calculate the resultant force on each truck.

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.....

Resultant force =.....

(3)

The force exerted by truck B on truck C is 11 200 N. Draw a free-body force diagram for truck B, showing the magnitudes of all the forces. Neglect any frictional forces on the trucks.

(4)

The total mass of the train is 3.0×10^6 kg. Calculate the average power delivered to the train during the accelerating process.

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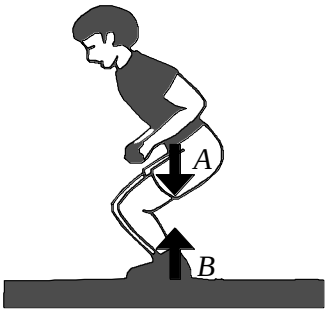
Average power =.....

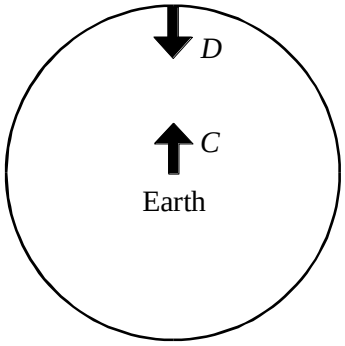
(3)

(Total 10 marks)

4. A child is crouching at rest on the ground

Below are free-body force diagrams for the child and the Earth.





Complete the following table describing the forces *A*, *B* and *C*.

Force	Description of force	Body which exerts force	Body the force acts on
A	Gravitational	Earth	Child
B			
C			

(4)

All the forces *A*, *B*, *C* and *D* are of equal magnitude.

Why are forces *A* and *B* equal in magnitude?

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Why must forces *B* and *D* be equal in magnitude?

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(2)

The child now jumps vertically upwards. With reference to the forces shown, explain what he must do to jump, and why he then moves upwards.

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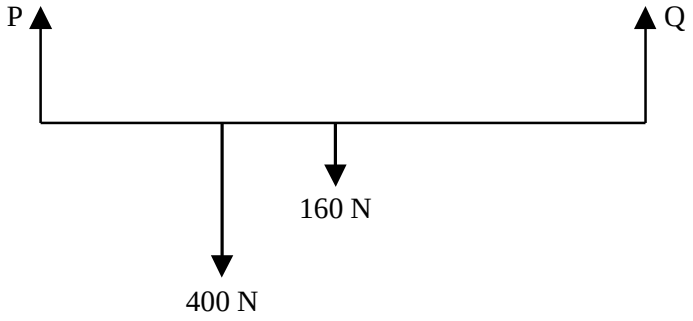
(3)

(Total 9 marks)

5. A uniform beam of length 4.0 m and weight 160 N is suspended horizontally by two identical vertical wires attached to its ends. A load of 400 N is placed on the beam 1.2 m from one end. The diagram is a free-body force diagram for the beam.



Calculate the tension in each suspended wire.

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Tension =……..……

(Total 4 marks)

6. An athlete of mass 55.0 kg runs up a flight of stairs of vertical height 3.60 m in 1.80 s.

Calculate the gain in gravitational potential energy of the athlete in doing this.

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.....

.....

Gain in g.p.e. =……..

Calculate the power that this athlete develops in doing this.

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Power =……

(4)

One way of comparing athletes of different sizes is to compare their power-to-weight ratios.
Find a unit for the power-to-weight ratio in terms of SI base units.

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(2)

Calculate the athlete's power-to-weight ratio.

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Power-to-weight ratio =……

(2)
(Total 8 marks)

7. A projectile is launched with initial velocity 25 m/s at an angle of 30° to the horizontal.

Find the horizontal and the vertical components of the initial velocity.

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(3)

A pole of height H metres is placed at a horizontal distance of 20 m from the point of launch. What is the maximum value of H to ensure that the projectile passes over the pole?

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(3)
(Total 6 marks)