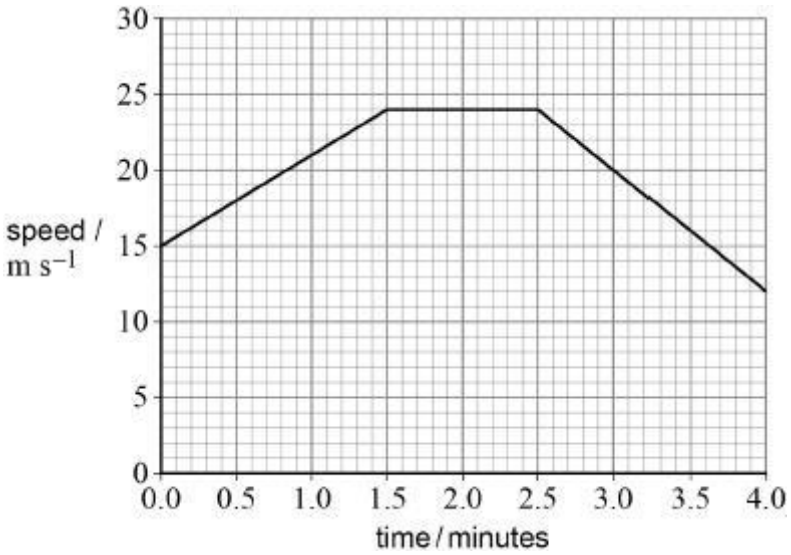
Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

A pair of cameras is used on a motorway to help determine the average speed of vehicles travelling between the two cameras.

Figure 1 shows the speed–time graph for a car moving between the two cameras.

Figure 1



(a) The speed limit for the motorway between the two cameras is 22 m s^{-1}.

Determine whether the average speed of the car exceeded this speed limit.

_____

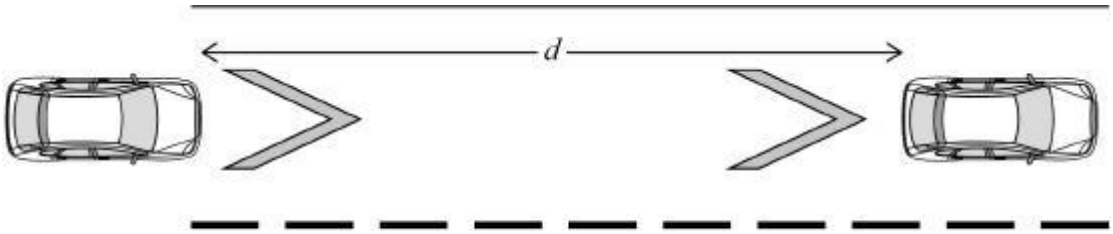
_____

(3)

(b) Markings called chevrons are used on motorways.

The chevron separation is designed to give a driver time to respond to any change in speed of the car in front. The driver is advised to keep a minimum distance d behind the car in front, as shown in **Figure 2**.

Figure 2



not to scale

Government research suggests that the typical time for a driver to respond is between 1.6 s and 2.0 s.

Suggest a value for d where the speed limit is 31 m s^{-1}.

d = _____ m

(2)

(c) The chevron separation is based on the response time, not on the time taken for a car to stop.

The brakes of a car are applied when its speed is 31 m s^{-1} and the car comes to rest. The total mass of the car is 1200 kg.

The average braking force acting on the car is 6.8 kN.

Calculate the time taken for the braking force to stop the car **and** the distance travelled by the car in this time.

time = _____ s

distance = _____ m

(4)

(d) Suggest why the chevron separation on motorways does not take into account the distance travelled as a car comes to rest after the brakes are applied.

_____

_____

_____

_____

(1)

(e) At bends on motorways the road is sloped so that a car is less likely to slide out of its lane when travelling at a high speed.

Figure 3 shows a car of mass 1200 kg travelling around a curve of radius 200 m. The motorway is sloped at an angle of 5.0°.

Figure 4 shows the weight W and reaction force N acting on the car. The advisory speed for the bend is chosen so that the friction force down the slope is zero.

Figure 3

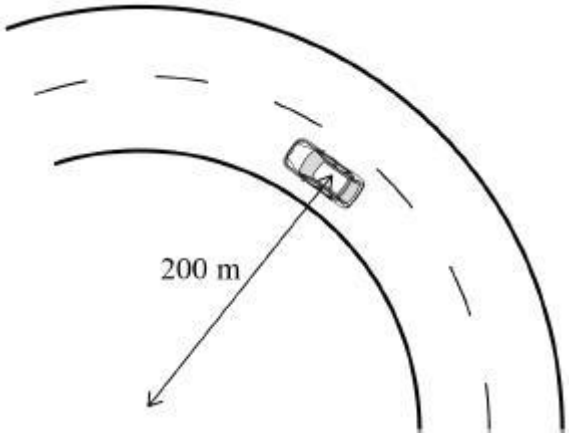
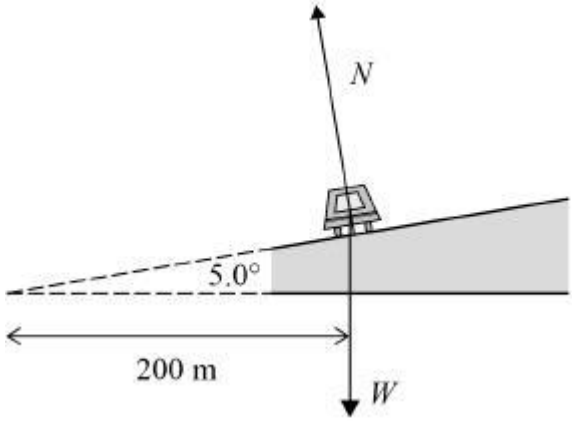


Figure 4



Suggest an appropriate advisory speed for this section of the motorway.

advisory speed = _____ m s^{-1}

(4)

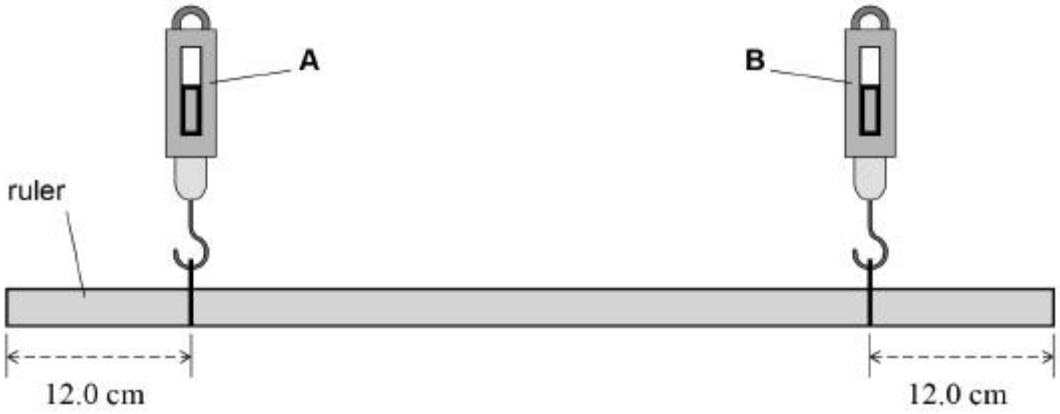
(Total 14 marks)

Q2.

A student investigates moments by suspending a 100 cm ruler from two force meters, **A** and **B**. **A** and **B** are attached to the ruler 12.0 cm from each end. Their supports are adjusted to make **A** and **B** vertical and the ruler horizontal.

Figure 1 is a simplified diagram of the experiment.

Figure 1



(a) The ruler is uniform and weighs 1.12 N.

Determine the reading on **A**.

reading = _____ N

(1)

(b) The student suggests that the forces exerted on the ruler by **A** and **B** act as a couple.

Discuss whether his suggestion is correct.

_____

_____

_____

_____

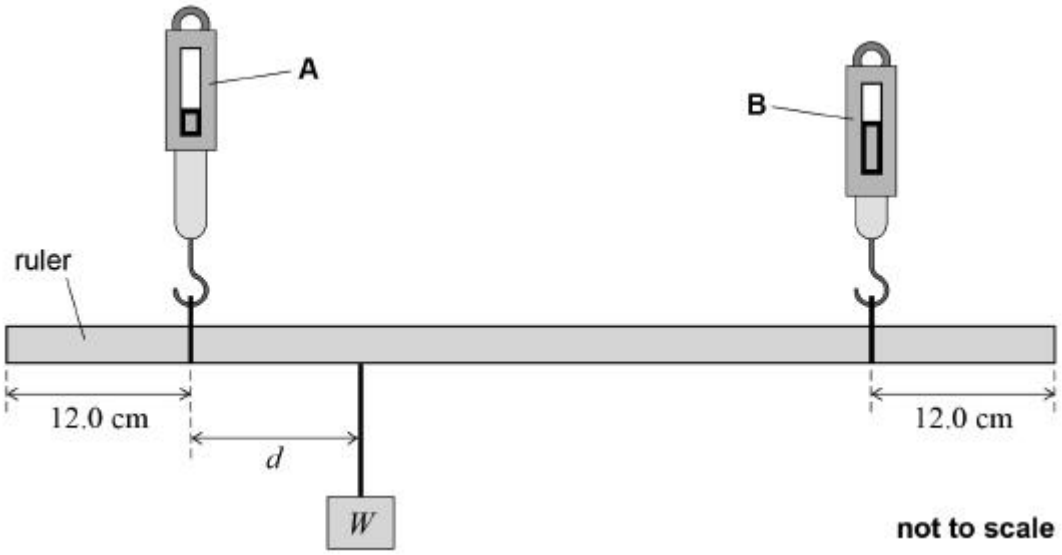
_____

_____

(2)

(c) The student hangs a mass of weight W on the ruler between **A** and **B**, as shown in **Figure 2**. He adjusts the supports so that **A** and **B** are again vertical and the ruler is horizontal. The mass hangs at a distance d from **A**.

Figure 2



The reading on **A** is 0.82 N and the reading on **B** is 0.62 N.

Determine

- W
- d.

W = _____ N

d = _____ m

(4)

(d) A second student sets up the same apparatus as shown in **Figure 2**.
She suspends the mass in the same position on the ruler as in question (c).
She moves the supports to make **A** and **B** vertical but does not make the ruler horizontal.

Discuss whether the readings on **A** and **B** taken by this student are different to those in question (c).

_____

_____

_____

_____

_____

_____

(2)

(Total 9 marks)