

Name of the Student: \_\_\_\_\_

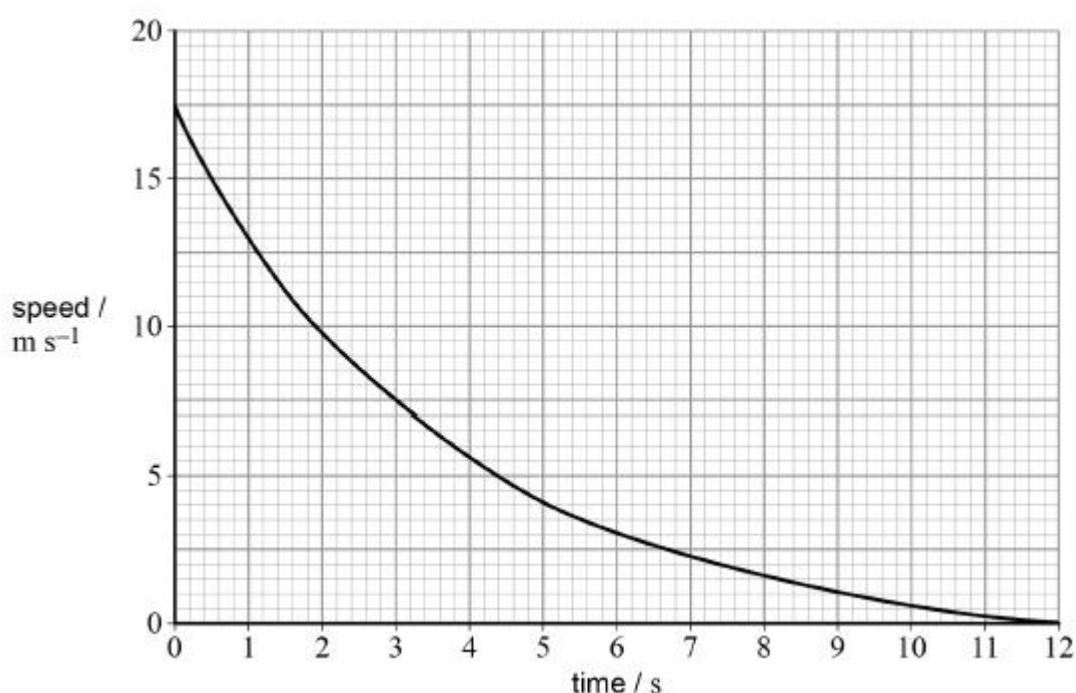
Max. Marks : 20 Marks

Time : 20 Minutes

**Q1.**

Horizontal escape lanes made of loose gravel have been constructed at the side of some roads on steep hills so that vehicles can stop safely when their brakes fail.

The graph shows an engineer's prediction of how the speed of an unpowered vehicle of mass  $1.8 \times 10^4$  kg will vary with time as the vehicle comes to rest in an escape lane.



- (a) Determine the force decelerating the vehicle 2.0 s after entering the escape lane.

force decelerating the vehicle = \_\_\_\_\_ N

**(3)**

- (b) Deduce whether a lane of length 85 m is long enough to stop the vehicle, assuming that the engineer's graph is correct.

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(3)

(c) Discuss the energy transfers that take place when a vehicle is decelerated in an escape lane.

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(2)

(d) An alternative to an escape lane containing gravel is an escape lane that consists of a ramp. An escape ramp is a straight road with a concrete surface that has a constant upward gradient.

One escape ramp makes an angle of  $25^\circ$  to the horizontal and is 85 m long.

Deduce whether this escape ramp is sufficient to stop the vehicle.

Assume that any frictional forces and air resistance that decelerate the vehicle are negligible.

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(3)

(e) Discuss whether an escape lane containing gravel or an escape ramp would provide the safer experience for the driver of the vehicle as it comes to rest.

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(1)

**Q2.**

The diagram shows two railway trucks **A** and **B** travelling towards each other on the same railway line which is straight and horizontal.



The trucks are involved in an inelastic collision. They join when they collide and then move together.

The trucks move a distance of 15 m before coming to rest.

Truck **A** has a total mass of 16 000 kg and truck **B** has a total mass of 12 000 kg

Just before the collision, truck **A** was moving at a speed of  $2.8 \text{ m s}^{-1}$  and truck **B** was moving at a speed of  $3.1 \text{ m s}^{-1}$

- (a) State the quantity that is **not** conserved in an inelastic collision.

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(1)

- (b) Show that the speed of the joined trucks immediately after the collision is about  $0.3 \text{ m s}^{-1}$

(3)

- (c) Calculate the impulse that acts on each truck during the collision.  
Give an appropriate unit for your answer.

impulse = \_\_\_\_\_ unit \_\_\_\_\_

(2)

- (d) Explain, without doing a calculation, how the motion of the trucks immediately after the collision would be different for a collision that is perfectly elastic.

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(2)  
(Total 8 marks)