

Year 11 Test Review Motion 2

Questions and Answers

Q1

A plane of mass 750 kg is at rest on a runway. The engine applies a force of 4.50 kN.

- (a) Calculate the magnitude of the acceleration of the plane assuming there are no other forces acting on the plane at this point.

$$F = ma$$

$$4500 = 750 \times a$$

$$a = 6 \text{ m/s}^2$$

- (b) The required speed for take-off is 54 m/s.

Calculate the time it takes to reach this speed assuming the acceleration is constant.

$$a = \frac{v - u}{t}$$

$$6 = \frac{54 - 0}{t}$$

$$t = 54 \div 6$$

$$t = 9 \text{ s}$$

Q2

In a garage, a mechanic lifts an engine from a car using a pulley system.

- (a) The mechanic pulls 4.5 m of chain with a constant force of 250 N.

Calculate the work done by the mechanic.

$$E_w = Fd$$

$$E_w = 250 \times 4.5$$

$$E_w = 1125 \text{ J}$$

- (b) The engine has a mass of 144 kg and is raised 0.75 m.

Calculate the gravitational potential energy gained by the engine.

$$E_p = mgh$$

$$E_p = 144 \times 10 \times 0.75$$

$$E_p = 1080 \text{ J}$$

Q2 continued

(c) Calculate the percentage efficiency of the pulley system.

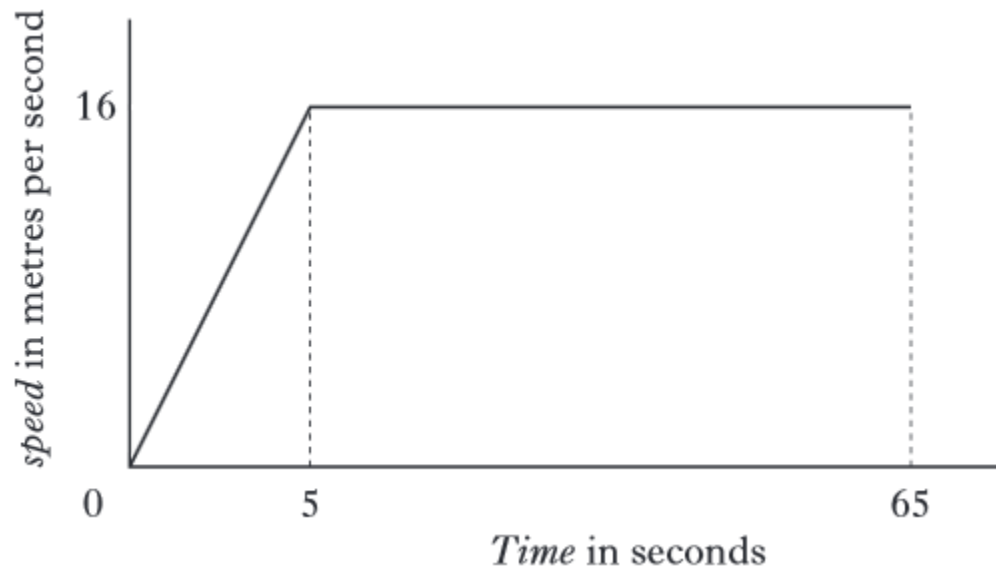
$$\text{percentage efficiency} = \frac{\text{useful } E_o}{E_i} \times 100$$

$$\text{percentage efficiency} = \frac{1080}{1125} \times 100$$

$$\text{percentage efficiency} = 96\%$$

Q3

The graph below shows the speed of a cyclist during a 1000 metre sprint race.



(a) State the maximum speed of the cyclist during the race.

16 metres per second

Q3 continued

(b) Calculate the average speed of the cyclist during the race.

average speed = distance travelled/time taken

average speed = 1000/65

average speed = 15.38 metres per second

Q4

An unmanned spacecraft is on a mission to Mars.

The engines of the spacecraft are turned off once it has travelled far into space.

(a) The spacecraft now travels at a constant speed.

Explain why this happens.

the forces are balanced OR no friction/air resistance/drag OR no forces acting against it

Q4 continued

The table below gives some information on the planets.

<i>Planet</i>	<i>Gravitational pull in newtons per kilogram</i>
Earth	10
Mars	4
Jupiter	26
Saturn	11

(b) The spacecraft has a mass of 900 kg.

(i) What is the weight of the spacecraft on Earth?

$$\mathbf{\text{weight} = \text{mass} \times 10}$$

$$\mathbf{\text{weight} = 900 \times 10}$$

$$\mathbf{\text{weight} = 9000 \text{ newtons.}}$$

Q4 continued

- (ii) Complete the following sentence by **circling** the correct word or phrase.

The mass of the spacecraft on Mars is

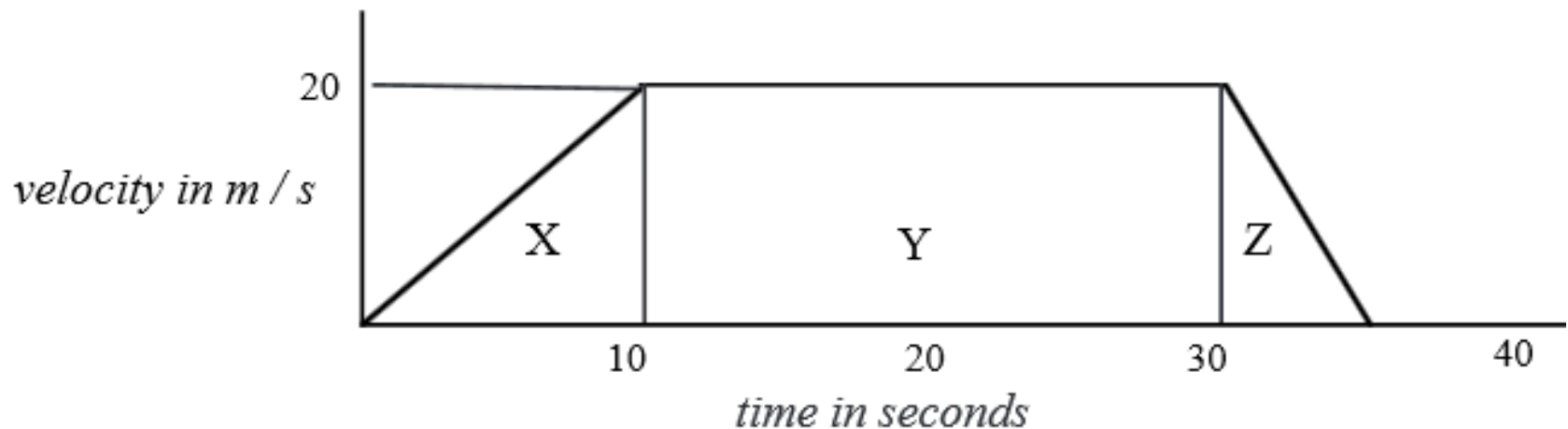
{	the same as its mass on Earth.
	zero.
	different from its mass on Earth.

the same as its mass on Earth

Q5

The graph describes the motion of a car during 35 seconds.

- a) What was the initial acceleration of the car?*
- b) What was the deceleration?*
- c) How far did the car travel in the 35 seconds?*



Q5 continued

a) *initial acceleration lasts from 0 - 10 s:* $u = 0, v = 20 \text{ m/s}, t = 10 \text{ s}$

$$a = \frac{v - u}{t} = \frac{20 - 0}{10} = 2 \text{ m/s}^2$$

b) *deceleration was from 30 - 35 s:* $u = 20 \text{ m/s}, v = 0, t = 5 \text{ s}$

$$a = \frac{v - u}{t} = \frac{0 - 20}{5} = -4 \text{ m/s}^2$$

c) *distance travelled = area under graph:*

divide into sections of rectangles and triangles: X + Y + Z: use scale for sizes

$$\text{area X} = \frac{1}{2} \text{ base} \times \text{height} = \frac{1}{2} \times 10 \times 20 = 100 \text{ m}$$

$$\text{area Y} = \text{length} \times \text{breadth} = 20 \times 20 = 400 \text{ m}$$

$$\text{area Z} = \frac{1}{2} \text{ base} \times \text{height} = \frac{1}{2} \times 5 \times 20 = 50 \text{ m}$$

$$\text{Total area} = 550 \text{ m so: distance travelled} = 550 \text{ m}$$

Q6

- a) *What is the weight of a 50 kg girl on Earth?*
b) *What would she weigh on the moon where the gravitational field strength is 1.6 N/kg?*

a) $W = mg = 50 \times 10 = 500 \text{ N}$

b) $W = mg = 50 \times 1.6 = 80 \text{ N}$

Q7

*A car of mass 1000 kg has an unbalanced force of 1600 N acting on it.
What will be its acceleration?*

$$m = 1000 \text{ kg}$$

$$F = 1600 \text{ N}$$

$$a = \frac{F}{m} = \frac{1600}{1000} = 1.6 \text{ m/s}^2$$

Q8

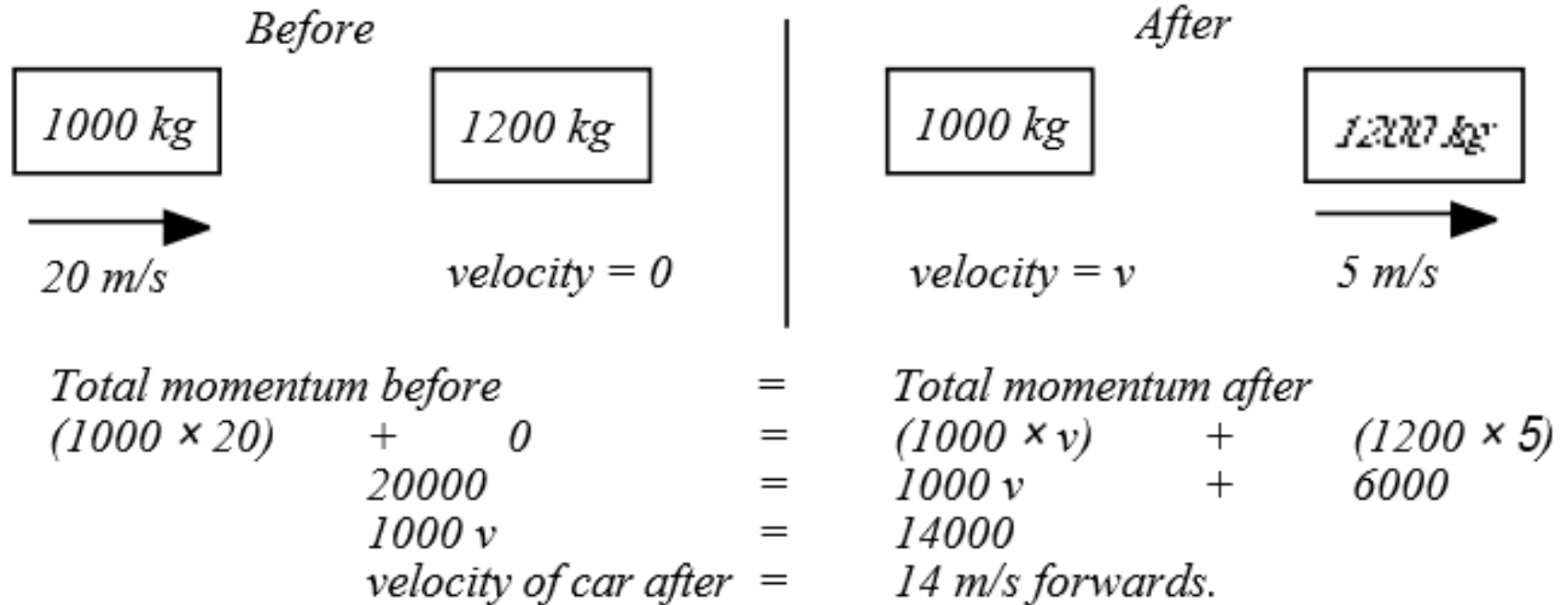
A car of mass 1000 kg experiences friction equal to 500 N. If the engine force is 1300 N, what will be the car's acceleration?

$$\textit{Resultant force} = 1300 - 500 = 800 \textit{ N}$$

$$a = \frac{F}{m} = \frac{800}{1000} = 0.8 \textit{ m/s}^2$$

Q9

A car of mass 1000 kg travelling at 20 m/s collides with a stationary van of mass 1200 kg. If the van moves off at 5 m/s, what will be the velocity of the car after the collision?



Q10

*A dog pulls a 4 kg sledge for a distance of 15 m using a force of 30 N.
How much work does the dog do?*

$$F = 30 \text{ N}$$

$$d = 15 \text{ m}$$

$$E_w = F \times d$$

$$= 30 \times 15$$

$$= 450 \text{ J}$$

Work done is 450 J.

Q11

A cyclist uses a force of 60 N and travels 2 km in 8 minutes.

What is her average power?

$$F = 60 \text{ N}$$

$$d = 2 \text{ km} = 2000 \text{ m}$$

$$t = 8 \text{ min} = 480 \text{ s}$$

$$\begin{aligned} \text{Work done } E_w &= 60 \times 2000 \\ &= 120000 \text{ J} \end{aligned}$$

$$\begin{aligned} P &= \frac{E_w}{t} \\ &= \frac{120000}{480} = 250 \text{ W} \end{aligned}$$

Q12

A chairlift raises a skier of mass 50 kg to a height of 250 m. How much potential energy does the skier gain?

$$m = 50 \text{ kg}$$

$$g = 10 \text{ N/kg}$$

$$h = 250 \text{ m}$$

$$E_p = mgh$$

$$= 50 \times 10 \times 250$$

$$= 125000 \text{ J}$$

Q13

How much kinetic energy does a car of mass 1000 kg have when it is travelling at 20 m/s

$$\begin{aligned} m &= 1000 \text{ kg} & E_k &= \frac{1}{2} mv^2 & &= \frac{1}{2} \times 1000 \times 20^2 = 200000 \text{ J} \\ v &= 20 \text{ m/s} \end{aligned}$$

Q14

What is the efficiency of an electric hoist which uses a 400 W motor if it takes 10 s to lift a 60 kg load to a height of 4 m?

$$P = 400 \text{ W}$$

$$t = 10 \text{ s}$$

$$m = 60 \text{ kg}$$

$$h = 4 \text{ m}$$

$$\text{Useful energy out} = \text{potential energy}$$

$$= mgh$$

$$= 60 \times 10 \times 4$$

$$= 2400 \text{ J}$$

$$\text{Total energy in} = Pt$$

$$= 400 \times 10$$

$$= 4000 \text{ J}$$

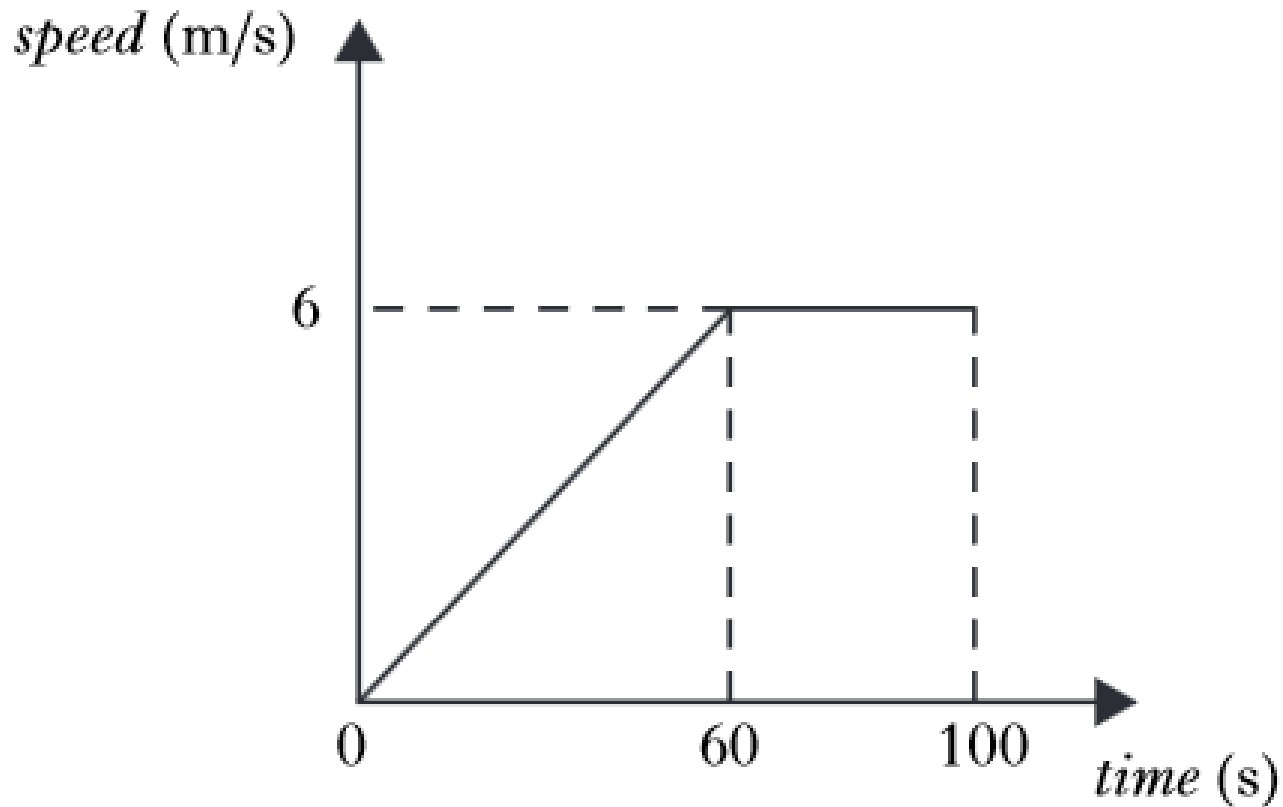
$$\% \text{ Efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times \frac{100}{1}$$

$$= \frac{2400}{4000} \times \frac{100}{1}$$

$$= 60\%$$

Q15

- A balloon of mass 400 kg rises vertically from the ground. The graph shows how the vertical speed of the balloon changes during the first 100 s of its upward flight.



Q15 continued

(a) Calculate the acceleration of the balloon during the first 60 s.

$$\begin{aligned} \text{(a)} \quad a &= \frac{v - u}{t} \\ &= \frac{6 - 0}{60} \\ &= 0.1 \text{ m/s}^2 \end{aligned}$$

Q15 continued

(b) Calculate the distance travelled by the balloon in 100 s.

$$\begin{aligned} \text{(b)} \quad s &= \text{area under graph} \\ &= (0.5 \times 60 \times 6) + (40 \times 6) \\ &= 420 \text{ m} \end{aligned}$$

(c) Calculate the average speed of the balloon during the first 100 s.

$$\begin{aligned} \text{(c)} \quad v &= \frac{s}{t} \\ &= \frac{420}{100} \\ &= 4.2 \text{ m/s} \end{aligned}$$

Q15 continued

(d) Calculate the weight of the balloon.

$$\begin{aligned} \text{(d)} \quad W &= mg \\ &= 400 \times 10 \\ &= 4000 \text{ N} \end{aligned}$$

(e) Calculate the total upward force acting on the balloon during the first 60 s of its flight.

$$\begin{aligned} \text{(e)} \quad F &= ma \\ &= 400 \times 0.1 \\ &= 40 \text{ (N)} \end{aligned}$$

$$\begin{aligned} \text{Upward force} &= 4000 + 40 \\ &= 4040 \text{ N} \end{aligned}$$

Q16

A ski lift with a gondola of mass 2000 kg travels to a height of 540 m from the base station to a station at the top of the mountain.

(a) Calculate the gain in gravitational potential energy of the gondola.

$$\begin{aligned} (a) \quad E_p &= mgh \\ &= 2000 \times 10 \times 540 \\ &= \underline{10800000 \text{ J}} \\ &= (1.08 \times 10^7 \text{ J}) \quad (= 10.8 \text{ MJ}) \end{aligned}$$

Q16 continued

- (b) During the journey, the kinetic energy of the gondola is 64 000 J.
Calculate the speed of the gondola.

$$(b) E_k = \frac{1}{2}mv^2$$

$$64000 = 0.5 \times 2000 \times v^2$$

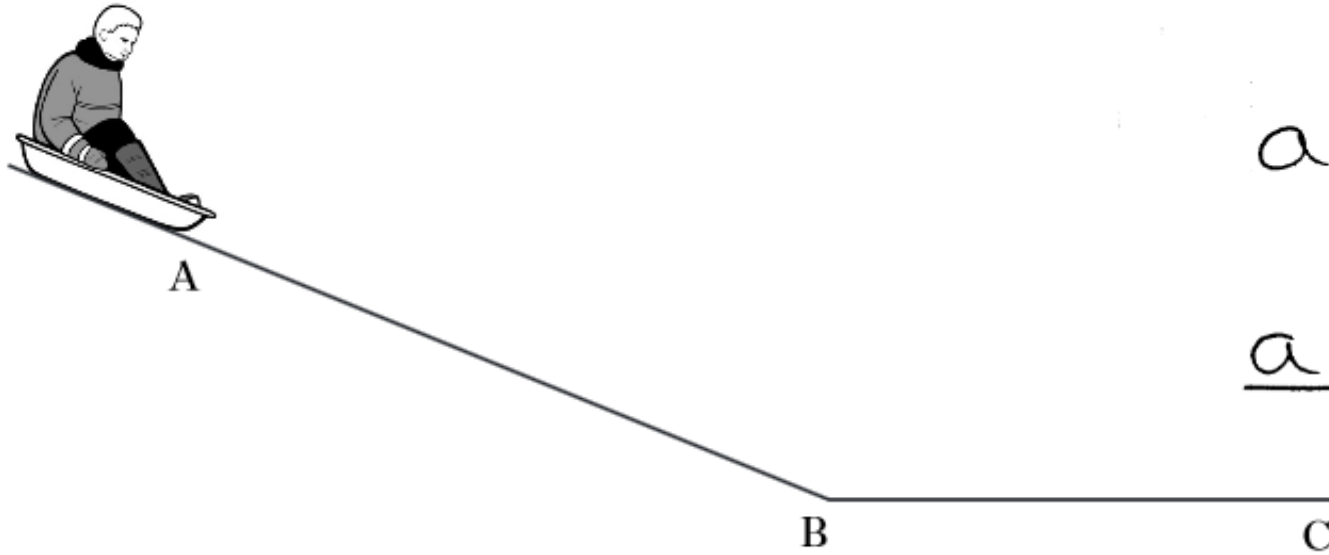
$$v^2 = \frac{64000}{1000}$$

$$v^2 = 64$$

$$\underline{v = 8 \text{ m/s}}$$

Q17

A child sledges down a hill.



$$(a) \quad a = \frac{(v-u)}{t}$$

$$a = \frac{3-0}{5}$$

$$\underline{a = 0.6 \text{ m/s}^2}$$

The sledge and child are released from rest at point A. They reach a speed of 3 m/s at point B.

(a) The sledge and child take 5 s to reach point B.

Calculate the acceleration.

Q17 continued

- (b) The sledge and child have a combined mass of 40 kg.
Calculate the unbalanced force acting on them.

(b)

$$F = ma$$

$$F = 40 \times 0.6$$

$$\underline{F = 24\text{N}}$$

Q18

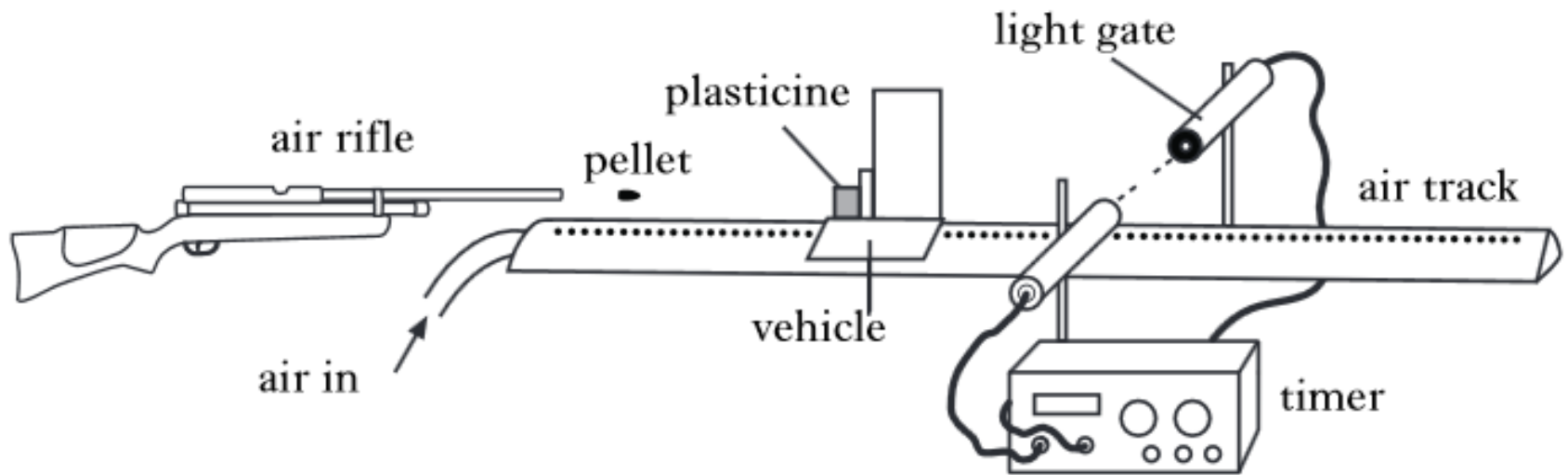
- (c) After the sledge and child pass point B, they slow down, coming to a halt at point C.

Explain this motion in terms of forces.

(c) friction acts against the motion of the sledge.

Q19

The following apparatus is used to determine the speed of a pellet as it leaves an air rifle. The air rifle fires a pellet into the plasticine, causing the vehicle to move.



Q19 continued

The speed of the vehicle is calculated as 0.35 m/s after impact.

The mass of the pellet is 5.0×10^{-4} kg. The mass of the vehicle and plasticine before impact is 0.30 kg.

- (i) Show that the momentum of the pellet **before** impact with the plasticine is 0.105 kg m/s.
- (ii) Hence, calculate the velocity of the pellet **before** impact with the plasticine.

$$(i) \text{ total momentum before} = \text{total momentum after}$$

this is combined mass of pellet & the plasticine. \rightarrow

$$\begin{aligned} &= M V \\ &= (0.3 + 5 \times 10^{-4}) \times 0.35 \\ &= 0.3005 \times 0.35 \\ &= \underline{0.105 \text{ kg m s}^{-1}} \end{aligned}$$

Q19 continued

(ii) momentum before = 0.105 kgms^{-1}

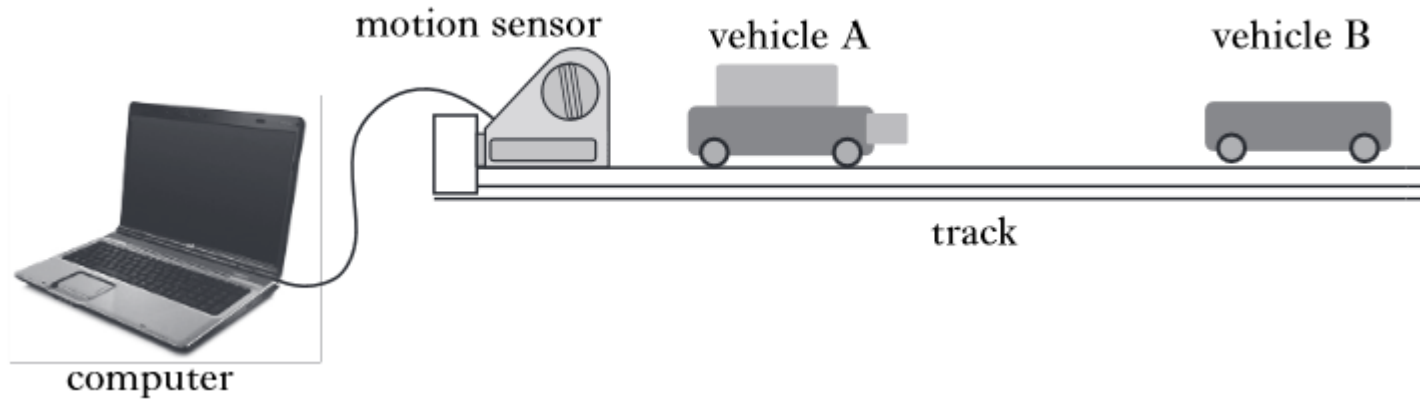
$$M v = 0.105$$

$$v = \frac{0.105}{M} = \frac{0.105}{5 \times 10^{-4}}$$

$$\underline{v = 210 \text{ m/s}}$$

Q20

The apparatus shown is set up to investigate collisions between two vehicles on a track.

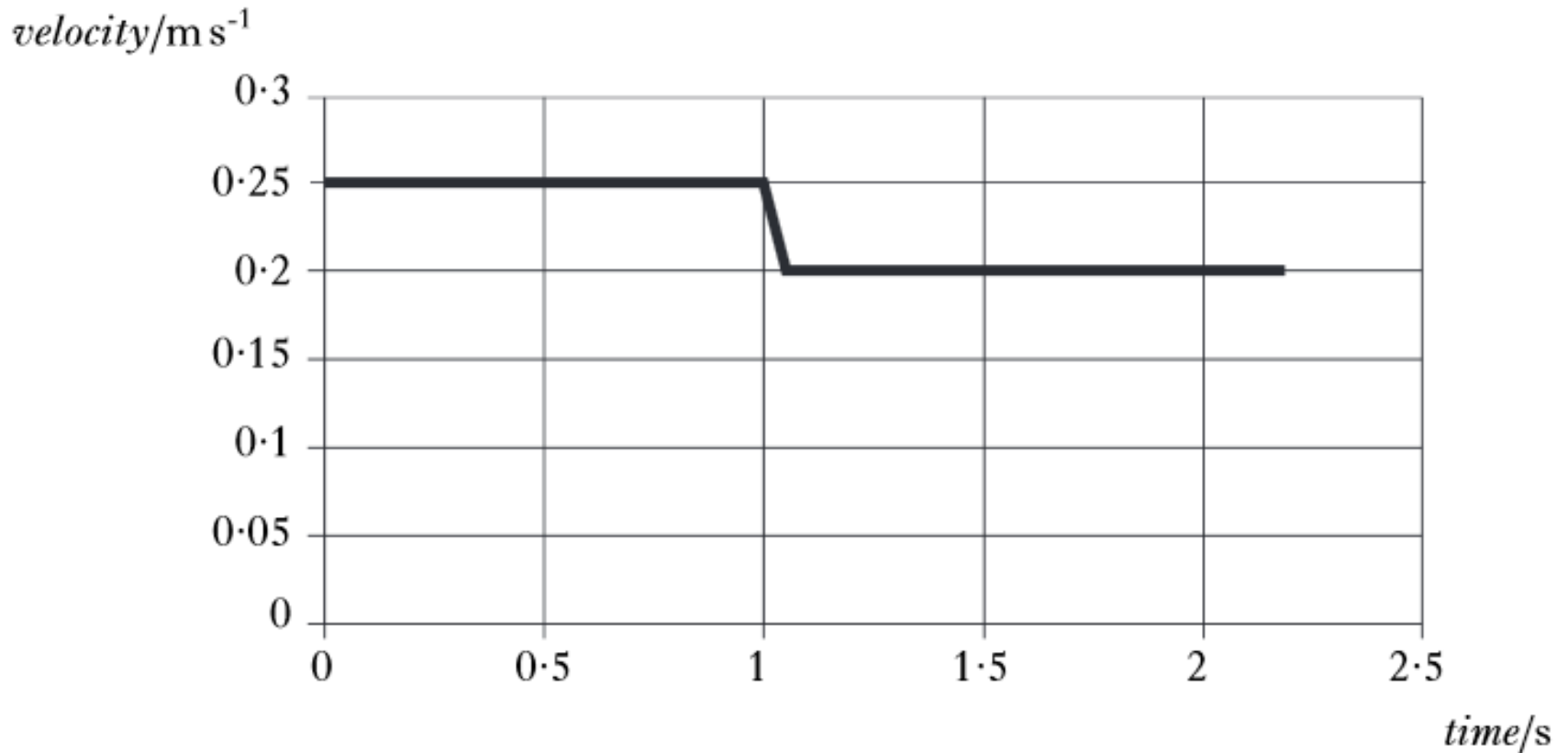


The mass of vehicle A is 0.22 kg and the mass of vehicle B is 0.16 kg .

The effects of friction are negligible.

Q20 continued

- (a) During one experiment the vehicles collide and stick together. The computer connected to the motion sensor displays the velocity-time graph for vehicle A.



Q20 continued

- (i) State the law of conservation of momentum.
- (ii) Calculate the velocity of vehicle B before the collision.

- (a) (i) The **total** momentum before (a collision) equals the **total** momentum after (the collision)

In the absence of external forces
Or in an isolated system

$$(ii) \quad m_A u_A + m_B u_B = m_A v_A + m_B v_B$$

$$(0.22 \times 0.25) + 0.16u = (0.38 \times 0.2)$$

$$0.055 + 0.16u = 0.076$$

$$u = 0.13 \text{ m s}^{-1}$$

Q20 continued

(b) The same apparatus is used to carry out a second experiment.

In this experiment, vehicle B is stationary before the collision.

Vehicle A has the same velocity before the collision as in the first experiment.

After the collision, the two vehicles stick together.

Is their combined velocity less than, equal to, or greater than that in the first collision?

Justify your answer.

- (b) Less
Total (initial) momentum is less
Mass is constant
 $v = \text{momentum} / \text{mass}$