

M1. (a) more streamlined
accept decrease surface area 1

air resistance is smaller (for same speed)
accept drag for air resistance
friction is insufficient 1

so reaches a higher speed (before resultant force is 0)
ignore reference to mass 1

(b) (i) 1.7
allow 1 mark for correct method, ie $\frac{5}{3}$
or allow 1 mark for an answer with more than 2 sig figs that rounds to 1.7
or allow 1 mark for an answer of 17 2

(ii) 7.5
allow 1 mark for correct use of graph, eg $\frac{1}{2} \times 5 \times 3$ 2

(iii) air (resistance)
accept wind (resistance)
drag is insufficient
friction is insufficient 1

[8]

- M2.** (a) the distance travelled under the braking force 1
- (b) the reaction time will increase 1
- increasing the thinking distance (and so increasing stopping distance)
(increases stopping distance is insufficient) 1
- (c) No, because although when the speed increases the thinking distance increases by the same factor the braking distance does not. 1
- eg
- increasing from 10 m / s to 20 m / s increases thinking distance from 6 m to 12 m
but the braking distance increases from 6 m to 24 m 1
- (d) If the sled accelerates the value for the constant of friction will be wrong. 1
- (e) only a (the horizontal) component of the force would be pulling the sled forward 1
- the vertical component of the force (effectively) lifts the sled reducing the force of the surface on the sled 1
- (f) $-u^2 = 2 \times -7.2 \times 22$
award this mark even with 0^2 and / or the negative sign missing 1

$$u = 17.7(99)$$

1

18

1

allow 18 with no working shown for 3 marks

allow 17.7(99) then incorrectly rounded to 17 for 2 marks

[11]

M3. (a) any **two** from:

- (acceleration occurs when) the direction (of each capsule) changes
- velocity has direction
- acceleration is (rate of) change of velocity

2

(b) to(wards) the centre (of the wheel)

1

(c) the greater the radius / diameter / circumference (of the wheel) the smaller the (resultant) force (required)

accept 'the size' for radius both parts required for the mark

1

[4]

M4. (a) (i) longer reaction time
accept slower reactions
*do **not** accept slower reaction time unless qualified*

or greater thinking distance
accept greater thinking time

or greater stopping distance
accept greater stopping time
greater braking distance negates answer

1

(ii) lines / slopes have the same gradient
accept slopes are the same

or velocity decreases to zero in same time / in 2.6 seconds
accept any time between 2.4 and 2.8
accept braking distances are the same

1

(iii) 12
accept extracting both reaction times correctly for 1 mark (0.6 and 1.4)
or
time = 0.8 (s) for 1 mark
accept 0.8×15 for 2 marks
*accept calculating the distance travelled by car **A** as 28.5 m*
or
*the distance travelled by car **B** as 40.5 m for 2 marks*

3

(b) **Z**

1

different force values give a unique / different resistance
*only scores if **Z** chosen*
*do **not** accept force and resistance are (directly) proportional*
*accept answers in terms of why either **X** or **Y** would not be best eg*
***X** – same resistance value is obtained for 2 different force values*

Y – all force values give the same resistance

1

[7]

- M5.** (a) (i) 100 (m) 1
- (ii) stationary 1
- (iii) accelerating 1
- (iv) tangent drawn at $t = 45$ s 1
- attempt to determine slope* 1
- speed in the range 3.2 – 4.2 (m / s)
dependent on 1st marking point 1
- (b) (i) 500 000 (J)
ignore negative sign 1
- (ii) 20 000 (N)
ignore negative sign
allow 1 mark for correct substitution, ie
 $500\,000 = F \times 25$
or their part (b)(i) = $F \times 25$
provided no subsequent step 2

(iii) *(kinetic) energy* transferred by heating

1

to the brakes

ignore references to sound energy

if no other marks scored allow k.e. decreases for 1 mark

1

[11]

M6. (a) (i) distance vehicle travels during driver's reaction time
accept distance vehicle travels while driver reacts 1

(ii) any **two** from:

- tiredness
- (drinking) alcohol
- (taking) drugs
- speed
- age

accept as an alternative factor distractions, eg using a mobile phone 2

(b) (i) 320 000

*allow 1 mark for correct substitution, ie $\frac{1}{2} \times 1600 \times 20^2$
provided no subsequent step shown* 2

(ii) 320000 **or** their (b)(i) 1

(iii) 40

or

their (b)(ii)
8000 correctly calculated
allow 1 mark for statement work done = KE lost

or
*allow 1 mark for correct substitution, ie
8000 × distance = 320 000 or their (b)(ii)* 2

(iv) any **one** from:

- icy / wet roads
accept weather conditions
- (worn) tyres
- road surface
- mass (of car and passengers)
accept number of passengers
- (efficiency / condition of the) brakes

1

(v) (work done by) friction
(between brakes and wheel)

*do **not** accept friction between road and tyres / wheels*

1

(causes) decrease in KE and increase in thermal energy
*accept heat for thermal energy accept
KE transferred to thermal energy*

1

(c) the battery needs recharging less often
accept car for battery

1

or increases the range of the car

*accept less demand for other fuels **or** lower emissions **or**
lower fuel costs
environmentally friendly is insufficient*

as the efficiency of the car is increased
accept it is energy efficient

1

the decrease in (kinetic) energy / work done charges the battery (up)

accept because not all work done / (kinetic) energy is wasted

1
[14]