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

Page 3

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 radiusboth 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 × 25
***or** their part (b)(i) = F × 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

            $\frac{\text{their (b)(ii)}}{8000}$ 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]