**M1.** (a) (i) (connect) 30 (cells)

**1**

in series

**1**

(ii) current always flows in the same direction**or**current only flows one way

**1**

(iii) 36 000

*allow **1** mark for correctly converting 2 hours to 7200 seconds*

*answers 10 or 600 score **1** mark*

**2**

coulombs / C

*do **not** accept c*

**1**

(b) (i) 2160

*allow **1** mark for correct substitution, ie ½ × 120 × $6^2$*

*answers of 1620 or 540 score **1** mark*

***2***

*(ii) reduce it*

***1***

*any **one** from:*

- *draws a larger current (from battery)*
- *motor draws greater power (from battery)*
  *accept energy per second for power*
  *accept more energy needed to move the bicycle*
- *greater resistance force (to motion) / air resistance / drag / friction*

*accept less streamlined*
*more mass to carry is insufficient*

***1***

***[10]***

***M2.*** *(a)* *(i)* *a single force that has the same effect as all the forces combined*

*accept all the forces added / the sum of the forces / overall force*

***1***

*(ii)* *constant speed (in a straight line)*

*do **not** accept stationary*

***or** constant velocity*

***1***

*(b)* *3*

*allow **1** mark for correct substitution into transformed equation*
*accept answer 0.003 gains **1** mark*
*answer = 0.75 gains **1** mark*

***2***

*$m/s^2$*

***1***

*(c)* *as speed increases air resistance increases*

*accept drag / friction for air resistance*

***1***

*reducing the resultant force*

***1***

***[7]***

***M3.*** *(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]***

***M4.*** *(a)* *47250*

*answers of 1350/ 33750/ 48600 gain **1** mark*
*allow **1** mark for correct substitution using both 18 and 3*

***2***

*(b)* *(i)* *47250 or their (a)*

*accept statement 'same as the KE (lost)'*
*ignore any units*

***1***

*(ii)* *transformed into heat/ thermal energy*

*sound on its own is insufficient*
*accept transferred/ lost/ for transformed*
*do **not** accept any other form of energy included as a list*

***1***

***[4]***

***M5.*** *(a)* *98*

*allow **1** mark for correct substitution*
*ie ½ × 0.16 × 35 × 35 provided no subsequent step shown*
*an answer of 98 000 scores 0*

***2***

*(b)* *(i)* *9.6*

*allow **1** mark for (change in velocity =) 60*
*ignore negative sign*

***2***

*(ii)* *9600*

*ignore negative sign*
***or** their (b)(i) ÷ 0.001 correctly calculated, unless (b) (i) equals 0*

***1***

*(c)* *increases the time*

***1***

*to reduce/change <u>momentum</u> (to zero)*

*only scores if 1st mark scored*
*decreases rate of change of momentum scores both marks provided there are no contradictions*
*accept decreased acceleration/deceleration*
*equations on their own are insufficient*

***1***

***[7]***

***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]***