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]