M1. (a) **D – E**

reason only scores if D – E chosen

1

shallowest slope / gradient

accept smallest distance in biggest time
accept longest time to travel the same distance
accept the line is not as steep accept it is a less steep line
*do **not** accept the line is not steep*

1

(b)   80 000

*allow **1** mark for correct substitution, ie 16 000 × 5 provided no subsequent step shown*

2

(c)   (i)   <u>straight</u> line starting at origin

accept within one small square of the origin

1

passing through t = 220 and d = 500

1

(i)   186

accept any value between 180 and 188
accept where their line intersects given graph line correctly read ±4 s

1

[7]

M2. (a)   4.2

> *2 marks for correct substitution **and** transformation, ie 1155/275*
>
> *allow **1** mark for correct resultant force with a subsequent incorrect method, ie 1155*
>
> *allow **1** mark for an incorrect resultant force with a subsequent correct method,*
>
> *eg answers of 7.27 or 10.34 gain **1** mark*

3

(b)   (i)   YES

> *marks are for the explanation*

any **two** from:

- data (from police files) can be trusted

- data answers the question asked
  > *allow a conclusion can be made from the data*

- large sample used

NO

any **two** from:

- the sample is not representative

- the sample size is too small

- accident files do not indicate age / experience of riders
  > *an answer YES and NO can score **1** mark from each set of mark points*

2

(ii)   more accidents with motorbikes up to 125 cc

> *accept for **2** marks an answer in terms of number of under 125 cc to accidents ratio compared correctly with number of over 500 cc to accidents ratio*

1

even though there are fewer of these bikes than bikes over 500 cc

1

(c) (i) increases the time taken to stop
               accept increases collision time

1

          decreases rate of change in momentum
               accept reduces acceleration / deceleration

          accept $F = \dfrac{\Delta mv}{\Delta t}$

          reduces momentum is insufficient

1

          reduces the <u>force</u> (on the rider)

1

     (ii) YES

          any sensible reason, eg:
               the mark is for the reason

          • cannot put a price on life / injury
               accept may save lives

          • fewer (serious) injuries
               accept reduces risk of injury

          • reduces cost of health care / compensation

          NO

          any sensible suggestion, eg:

          • money better spent on …
               needs to be specific

          • total number of riders involved is small

1

[11]

M3. (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]

M4. (a) direction

1

(b) 54 000

*allow **1** mark for calculating and identifying momentum as 10 800*

or

*allow **1** mark for correct substitution into second equation*

ie $\dfrac{1200 \times 9}{0.2}$

2

(c) increases the time taken (for head) to stop

accept increases impact time

*do **not** accept reference to slowing down time unless qualified*

1

decreases rate of change in momentum

accept reduces acceleration / deceleration

*accept increases the time taken to reduce momentum to zero is worth **2** marks*

reduces momentum is insufficient

1

reduces the <u>force</u> (on the head)

1

[6]

M5. (a)   (moving in) different / opposite directions

     accept one has positive momentum the other negative
     momentum

     accept they have different velocities

                         1

  (b)   (i)   momentum before = momentum after **or** (total) momentum stays the same

     accept no momentum is lost

     accept no momentum is gained

                         1

    (ii)   2.2

     *allow **1** mark for calculation of teenagers' momentum as 22*
     (kgm/s) and

     *allow **1** mark for correct statement, eg momentum before =*
     momentum after

     or

     *allow **2** marks for a numerical expression of above, eg*

     55 × 0.4 = m × 10

     ***or** 0 = (55 × 0.4) + (m × (-10))*

                         3

  (c)   *any **two** from:*

     •   *work is done*

     •   *(against) friction*

      any reference to increasing friction negates this marking
      point

     •   *(transforming) (kinetic) energy into heat*

                         2

                          [7]

M6. (a) (i) momentum before = momentum after

accept no momentum is lost
accept no momentum is gained

or *(total) momentum stays the same*

1

(ii) an external force acts (on the colliding objects)

accept colliding objects are not isolated

1

(b) (i) 9600

allow 1 mark for correct calculation of momentum before or after ie 12000 or 2400
or
correct substitution using change in velocity = 8 m/sie 1200 × 8

2

kg m/s
or
Ns

this may be given in words rather than symbols
*do **not** accept nS*

1

(ii) 3 or their (b)(i)   3200 correctly calculated

allow 1 mark for stating momentum before = momentum after

or

clear attempt to use conservation of momentum

2

[7]

Page 8

M7. (a) *Zero / 0*

> *Accept none*
> *Nothing is insufficent*

1

velocity / speed = 0

> *accept it is not moving*
> *paintball has not been fired is insufficient*

1

(b) *0.27*

> *allow **1** mark for correct substitution, ie p = 0.003(0) × 90*
> *provided no subsequent step*

2

(c) *equal to*

1

[5]

Page 9

M8.   **(a)**   *momentum before (jumping) = momentum after (jumping)*

         accept momentum (of the skateboard and skateboarder) is conserved

1

     before (jumping) momentum of skateboard and skateboarder is zero

         accept before (jumping) momentum of skateboard is zero

         accept before (jumping) total momentum is zero

1

     after (jumping) skateboarder has momentum (forwards) so skateboard must have (equal) momentum (backwards)

         answers only in terms of equal and opposite forces are insufficient

1

     (b)   7

         *accept –7 for **3** marks*

         *allow **2** marks for momentum of skateboarder equals 12.6*

         or

         0 = 42 × 0.3 + (1.8 × –v)

         or

         *allow **1** mark for stating use of conservation of momentum*

3

[6]