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) straight 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

(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

(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

even though there are fewer of these bikes than bikes over 500 cc
(c) (i) increases the time taken to stop
accept increases collision time

decreases rate of change in momentum
accept reduces acceleration / deceleration

\[ F = \frac{\Delta m v}{\Delta t} \]
accept reduces momentum is insufficient

reduces the force (on the rider)

(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
M3. (a) 98

allow 1 mark for correct substitution
ie \( \frac{1}{2} \times 0.16 \times 35 \times 35 \) provided no subsequent step shown

an answer of 98 000 scores 0

(b) (i) 9.6

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

(ii) 9600
ignore negative sign
or their (b)(i) \( \div 0.001 \) correctly calculated, unless (b) (i) equals 0

(c) increases the time

to reduce/change momentum (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

[7]
M4. (a) direction

(b) 54 000

allow 1 mark for calculating and identifying momentum as 10 800

or

allow 1 mark for correct substitution into second equation

\[
\frac{1200 \times 9}{0.2}
\]

ie

(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 force (on the head)

1
M5. (a) (moving in) different / opposite directions
accept one has positive momentum the other negative
momentum
accept they have different velocities

(b) (i) momentum before = momentum after or (total) momentum stays the same
accept no momentum is lost
accept no momentum is gained

(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))

(c) any two from:
• work is done
• (against) friction
  any reference to increasing friction negates this marking point
• (transforming) (kinetic) energy into heat

[7]
M6. (a)  
(i)  *momentum before = momentum after*
    accept no momentum is lost
    accept no momentum is gained

    *or*(total) momentum stays the same

(ii)  *an external force acts (on the colliding objects)*
    accept colliding objects are not isolated

(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/s ie 1200 × 8

    kg m/s
    *or*
    Ns
    this may be given in words rather than symbols
    do not accept nS

(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
M7. (a) Zero / 0
Accept none
Nothing is insufficient

velocity / speed = 0
accept it is not moving
paintball has not been fired is insufficient

(b) 0.27
allow 1 mark for correct substitution, ie \( p = 0.003(0) \times 90 \)
provided no subsequent step

(c) equal to
M8.  (a)  momentum before (jumping) = momentum after (jumping)  
accept momentum (of the skateboard and skateboarder) is conserved  

before (jumping) momentum of skateboard and skateboarder is zero 
accept before (jumping) momentum of skateboard is zero 
accept before (jumping) total momentum is zero  

after (jumping) skateboarder has momentum (forwards) so skateboard must have (equal) momentum (backwards) 
answers only in terms of equal and opposite forces are insufficient  

(b)  7  
accept $-7$ for 3 marks  
allow 2 marks for momentum of skateboarder equals 12.6  
or  
$0 = 42 \times 0.3 + (1.8 \times -v)$  
or  
allow 1 mark for stating use of conservation of momentum  

[6]