M1. (a) increases

1

increases

1

(b) 23 (m)

*accept 43 circled for **1** mark*
*accept 9 + 14 for **1** mark*

2

(c) (i) all points correctly plotted

all to ± ½ small square
*one error = **1** mark*
*two or more errors = **0** marks*

2

line of best fit

1

(ii) correct value from their graph (± ½ small square)

1

(d) (i) 70

*½ × 35 × 4 gains **2** marks*
*attempt to estimate area under the graph for **1** mark*

3

(ii) line from (0.6,35)

1

sloping downwards with a less steep line than the first line

1

cutting time axis at time > 4.6 s

accept cutting x-axis at 6

1

(e) (i) 42 000

*1200 × 35 gains **1** mark*

2

kgm / s

Ns

1

(ii) 10 500 (N)

*42 000 / 4 gains **1** mark*

alternatively:

a = 35 / 4 = 8.75 m / s²

F = 1200 × 8.75

2

[19]

M2. (a) (i) as one goes up so does the other

or (directly) proportional

accept change by the same ratio

1

(ii) steeper straight line through the origin

judge by eye

1

(iii) Yes with reason

eg data would have been checked / repeated

accept produced by a reliable/ official/ government source

*do **not** accept it needs to be reliable*

or No with reason

eg does not apply to all conditions / cars / drivers

or are only average values

or Maybe with a suitable reason

eg cannot tell due to insufficient information

1

(b) (i) stopping distance = thinking distance + braking distance

1

(ii) any **two** from:

factors must be to do with increasing braking distance

- smooth road / loose surface
- rain / snow / ice

accept wet road/ petrol spills

*do **not** accept condition of road unless suitably qualified*

- badly maintained brakes

accept worn brakes

accept bad/ worn/ rusty brakes

*do **not** accept old brakes*

- worn tyres
  accept bald tyres
  accept lack of grip on tyres
  *do **not** accept old tyres*

- downhill slope/gradient

- heavily loaded car

2

[6]

M3. (a) **A** constant speed / velocity

accept steady pace
*do **not** accept terminal velocity*
*do **not** accept stationary*

1

B acceleration

accept speeding up

1

C deceleration

accept slowing down
accept accelerating backwards
accept accelerating in reverse
*do **not** accept decelerating backwards*

1

(b) (i) the distance the car travels under the braking force

accept braking distance

1

(ii) speed/velocity/momentum

1

(c) (i) 5000 (N) to the left

***both** required*
accept 5000(N) with the direction indicated by an arrow drawn pointing to the left
accept 5000(N) in the opposite direction to the force of the car (on the barrier)
accept 5000(N) towards the car

1

(ii) to measure/detect forces exerted (on dummy / driver during the collision)

1

(iii) 4

*allow **1** mark for showing a triangle drawn on the straight part of the graph*

***or** correct use of two pairs of coordinates*

2

m/s^2

*do **not** accept mps^2*

1

[10]

M4. *(a)* *(i)* *gravitational potential (energy)*

1

(ii) *kinetic (energy)*

1

(b) *(i)* *slope or gradient*

1

(ii) *area (under graph)*

*do **not** accept region*

1

(iii) *starts at same y−intercept*

1

steeper slope than original and cuts time axis before original

the entire line must be below the given line

allow curve

1

(c) *(i)* *31*

and

31

*correct answers to 2 significant figures gains **3** marks even if no working shown*

*both values to more than 2 significant figures gains **2** marks:*
30.952…...
30.769….

65 / 2.1 and / or
*80 / 2.6 gains **1** mark*

*if incorrect answers given but if both are to 2 significant figures allow **1** mark*

3

(ii) *student 1 incorrect because 80 ≠ 65*

1

student 2 correct because average velocities similar
ecf from ***(c)(i)***

1

student 3 incorrect because times are different

1

[12]

M5. *(a) gravitational / gravity / weight*

*do **not** accept gravitational potential*

1

(b) accelerating

accept speed / velocity increases

1

the distance between the drops increases

1

but the time between the drops is the same

accept the time between drops is (always) 5 seconds
accept the drops fall at the same rate

1

*(c) (i) any **one** from:*

- *speed / velocity*
- *(condition of) brakes / road surface / tyres*
- *weather (conditions)*

accept specific examples, eg wet / icy roads
accept mass / weight of car friction is insufficient
reference to any factor affecting thinking distance negates this answer

1

(ii) 75 000

*allow **1** mark for correct substitution, ie 3000 × 25 provided no subsequent step shown*

***or** allow **1** mark for an answer 75**or** allow **2** marks for 75 k(+ incorrect unit), eg 75 kN*

2

joules / J

*do **not** accept j*

*an answer 75 kJ gains **3** marks*

for full marks the unit and numerical answer must be consistent

1

[8]