M1. (a) 2.75

\[
\frac{11}{4} \quad \text{or} \quad \frac{23 - 12}{4}
\]

allow 1 mark for correct substitution, ie provided no subsequent step shown

\[
m/s^2
\]

(b) driving force increases

frictional force increases

accept air resistance / drag for frictional force

[6] driving force > frictional force

1
M2. (a) 3
\[ g \text{ains } 1 \text{ mark} \]
\[ \text{m/s}^2 \quad \text{gains } 1 \text{ mark} \]
else working \( g \text{ains } 1 \text{ mark} \)

(b) 2850 ecf
\( g \text{ains } 1 \text{ mark} \)
\( N \quad \text{gains } 1 \text{ mark} \)
else working \( g \text{ains } 1 \text{ mark} \)

(c) friction/air resistance increases with speed; till frictional = max forward force; then force/acceleration is zero
\[ \text{for } 1 \text{ mark each} \]
alternative limitation for safety
\( g \text{ains } 1 \text{ mark only} \)
M3. (a) air(resistance) has greatest effect on paper

(b) paper or both fall faster

(both) fall together

*accept same speed or rate*
M4. (a) (i) accelerating
   accept getting faster
   accept speed / velocity increasing

   (ii) acceleration increases
        accept velocity / speed increases more rapidly
        do not accept velocity / speed increases

(b) (i) acceleration = \frac{\text{change in velocity}}{\text{time (taken)}}

   \frac{v - u}{t} \quad \text{or} \quad \frac{v_1 - v_2}{t}

   do not accept velocity for change in velocity
   do not accept change in speed

   \frac{v}{t}

   do not accept \( a = \frac{v}{t} \)

(ii) 15

   allow 1 mark for an answer of 900 or for correct use of 540 seconds

(iii) velocity includes direction
     accept velocity is a vector (quantity)
     accept converse answer

[6]
M5. (a) It will have a constant speed.

(b) distance travelled = speed × time

(c) $a = \frac{18 - 9}{6}$

\[ a = 1.5 \]

*allow 1.5 with no working shown for 2 marks*

(d) resultant force = mass × acceleration

(e) $F = (1120 + 80) \times 1.5$

\[ F = 1800 \text{ (N)} \]

*allow 1800 with no working shown for 2 marks*

*accept their $10.3 \times 1200$ correctly calculated for 2 marks*

(f) $18^2 - 9^2 = 2 \times 1.5 \times s$

\[ s = \frac{18^2 - 9^2}{2 \times 1.5} \]

\[ s = 81 \text{ (m)} \]
allow 81 (m) with no working shown for 3 marks
accept answer using their 10.3 (if not 1.5) correctly calculated for 3 marks

(g) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that include references to the numerical factor.

**Level 1 (1–2 marks):**
Simple statements are made. The response may fail to make logical links between the points raised.

**0 marks:**
No relevant content.

**Indicative content**
- doubling speed increase the kinetic energy
- kinetic energy increases by a factor of 4
- work done (by brakes) to stop the car increases
- work done increases by a factor of 4
- work done is force × distance and braking force is constant
- so if work done increases by 4 then the braking distance must increase by 4
M6. (a) (produces) a force from water on the boat

in the forward direction

*accept in the opposite direction*

this must refer to the direction of the force not simply the boat moves forwards

an answer produces an (equal and) opposite force gains 1 mark

(b) (i) 1.5

allow 1 mark for correct substitution, ie $\frac{16 - 4}{8}$ or $\frac{12}{8}$

provided no subsequent step shown

ignore sign

$m/s^2$

(ii) 102 or their (b)(i) × 68 correctly calculated

allow 1 mark for correct substitution, ie 1.5 × 68

or their (b)(i) × 68

provided no subsequent step shown

(iii) greater than

*reason only scores if greater than chosen*

need to overcome resistance forces

*accept named resistance force*

*accept resistance forces act (on the water skier)*

do *not* accept gravity
M7. (a) A constant speed / velocity
   accept steady pace
   do not accept terminal velocity
   do not accept stationary

B acceleration
   accept speeding up

C deceleration
   accept slowing down
   accept accelerating backwards
   accept accelerating in reverse
   do not accept decelerating backwards

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

(ii) speed/velocity/momentum

(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

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

m/s²
do not accept mps²

[10]