M1. (a) It will have a constant speed.

1

(b) distance travelled = speed × time

1

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

1

a = 1.5

*allow 1.5 with no working shown for **2** marks*

1

(d) resultant force = mass × acceleration

1

(e) F = (1120+80) × 1.5

1

F = 1800 (N)

*allow 1800 with no working shown for **2** marks*

1

*accept their 10.3 × 1200 correctly calculated for **2** marks*

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

1

$s = 18^2 - 9^2 / 2 \times 1.5$

1

s = 81 (m)

1

*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

4

[14]

M2. (a) gravity

accept weight
*do **not** accept mass*
accept gravitational pull

1

(b) (i) Initially force L greater than force M

accept there is a resultant force downwards

1

(as speed increases) force M increases

accept the resultant force decreases

1

when M = L, (speed is constant)

accept resultant force is 0
accept gravity/weighty for L
accept drag/ upthrust/resistance/friction for M
*do **not** accept air resistance for M but penalise only once*

1

(ii) terminal <u>velocity</u>

1

(iii) 0.15

accept an answer between 0.14 – 0.16
an answer of 0.1 gains no credit
*allow **1** mark for showing correct use of the graph*

2

[7]

M3. (a) (i) 4.5

*allow **1** mark for correct substitution i.e. 9 ÷ 2*

2

(ii) m/s^2

accept answer given in (a)(i) if not contradicted here

1

(iii) speed

1

(iv) straight line from the origin passing through (2s, 9m/s)

*allow **1** mark for straight line from the origin passing through to t = 2 seconds*

*allow **1** mark for an attempt to draw a straight line from the origin passing through (2,9)*

*allow **1** mark for a minimum of 3 points plotted with no line provided if joined up would give correct answer. Points must include(0,0) and (2,9)*

2

(b) (i) **B**

*if **A** or **C** given scores **0** marks in total*

1

smallest (impact) force

1

on all/ every/ any surfaces

these marks are awarded for comparative answers

1

(ii) (conditions) can be repeated

or

difficult to measure forces with human athletes

accept answers in terms of variations in human athletes e.g.

athletes may have different weights area / size of feet may be different difficult to measure forces athletes run at different speeds

accept any answer that states or implies that with humans the conditions needed to repeat tests may not be constant

e.g.
athletes unable to maintain constant speed during tests (or during repeat tests)

*do **not** accept the robots are more accurate*

removes human error is insufficient

fair test is insufficient

1

[10]

M4. (a) 750

*allow **1** mark for correct substitution, ie 75 × 10 provided no subsequent step shown*

2

newton(s) / N

*do **not** accept n*

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the Marking Guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief attempt to explain why the velocity / speed of the parachutist changes.
or
the effect of opening the parachute on velocity/speed is given.

Level 2 (3-4 marks)
The change in velocity / speed is clearly explained in terms of force(s)
or
a reasoned argument for the open parachute producing a lower speed.

Level 3 (5-6 marks)
There is a clear and detailed explanation as to why the parachutist reaches terminal velocity **and** a reasoned argument for the open parachute producing a lower speed

examples of the physics points made in the response to explain first terminal velocity

- on leaving the plane the only force acting is weight (downwards)
  accept gravity for weight throughout
- as parachutist falls air resistance acts (upwards)
  accept drag / friction for air resistance
- weight greater than air resistance
  orresultant force downwards
- (resultant force downwards) so parachutist accelerates
- as velocity / speed increases so does air resistance
- terminal velocity reached when air resistance = weight

accept terminal velocity reached when forces are balanced

to explain second lower terminal velocity

- opening parachute increases surface area
- opening parachute increases air resistance
- air resistance is greater than weight
- resultant force acts upwards / opposite direction to motion
- parachutist decelerates / slows down
- the lower velocity means a reduced air resistance

air resistance and weight become equal but at a lower (terminal) velocity

6

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

- mass of the (modelling) clay
  accept size/shape of clay size/amount/volume/shape of clay
  accept plasticine for (modelling)clay
- material parachute made from
  accept same (plastic) bag
- number / length of strings

1

(ii) **C**

*reason only scores if **C** is chosen*

1

smallest (area) so falls fastest (so taking least time)

accept quickest/quicker for fastest

*if **A** is chosen with the reason given as 'the largest area so falls slowest' this gains **1** mark*

1

[12]

M5. (a) 96

*allow **1** mark for correct substitution*
ie 80 × 1.2

2

newton or N

allow Newton
*do **not** allow n*

1

(b) (i) direction

1

(ii) velocity and time are continuous (variables)

answers must refer to both variables
accept the variables are continuous / not categoric
accept the data / 'it' is continuous
accept the data / 'it' is not categoric

1

(iii) **C**

1

velocity is not changing

*the **2** marks for reason may be scored even if **A** or **B** are chosen*
accept speed for velocity
accept speed is constant (9 m/s)
*accept **not** decelerating*
*accept **not** accelerating*
accept reached terminal velocity

1

forces must be balanced

accept forces are equal
accept arrows are the same length / size

or

resultant force is zero

*do **not** accept the arrows are equal*

1

[8]

M6. (a) 2.75

*allow **1** mark for correct substitution, ie* $\frac{11}{4}$

or $\frac{23-12}{4}$

provided no subsequent step shown

2

m/s^2

1

(b) driving force increases

1

frictional force increases

accept air resistance / drag for frictional force

1

driving force > frictional force

1

[6]