M1. (a) (i) friction

1

(ii) air resistance

accept drag

friction is insufficient

1

(iii) 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 information on page 5, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1–2 marks)
There is an attempt to explain in terms of forces A and B why the velocity of the cyclist changes between any two points
or
a description of how the velocity changes between any two points.

Level 2 (3–4 marks)
There is an explanation in terms of forces A and B of how the velocity changes between X and Y and between Y and Z
or
a complete description of how the velocity changes from X to Z.
or
an explanation and description of velocity change for either X to Y or Y to Z

Level 3 (5–6 marks)
There is a clear explanation in terms of forces A and B of how the velocity changes between X and Z
and
a description of the change in velocity between X and Z.

examples of the points made in the response

extra information

X to Y

- at X force A is greater than force B
- cyclist accelerates
- and velocity increases
- as cyclist moves toward Y, force B (air resistance) increases (with increasing velocity)
- resultant force decreases
- cyclist continues to accelerate but at a smaller value
- so velocity continues to increase but at a lower rate

Y to Z

- from Y to Z force B (air resistance) increases
- acceleration decreases

- force B becomes equal to force A
- resultant force is now zero
- acceleration becomes zero
- velocity increases until…
- cyclist travels at constant / terminal velocity

accept speed for velocity throughout

6

(b) (i) 3360

*allow **1** mark for correct substitution,*

ie 140 × 24 provided no subsequent step

*accept 3400 for **2** marks if correct substitution is shown*

2

joule / J

*do **not** accept j*

*do **not** accept Nm*

1

(ii) decreases

accept an alternative word / description for decrease

do not accept slows down

1

temperature

accept thermal energy

accept heat

1

[13]

M2. (a) (i) air resistance/drag/friction (or upthrust)
weight/gravitational pull/gravity
for 1 mark each

1

(ii) air resistance/friction acts in opposite direction to motion

1

(iii) Y

1

(iv) the sky-diver accelerates/his speed increases
in downward direction/towards the Earth/falls
for 1 mark each

2

(b) force X has increased force Y has stayed the same the speed of the sky-diver will stay the same
for 1 mark each

3

(c) (i) CD

1

(ii) 500
(iii) 50
} (but apply e.c.f. from (i))

3

(iv) 10 (but apply e.c.f. from (ii) and (iii))
gets 2 marks

or 500/50 or d/t
gets 1 mark

2

[14]

M3. (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 velocity

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]

M4. (a) air(resistance) has greatest effect on paper

1

(b) paper **or** both fall faster

1

(both) fall together

*accept same speed **or** rate*

1

[3]

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) **B**

reason only scores if B is chosen

1

gradient / slope is the steepest / steeper

answers must be comparative

accept steepest line

ignore greatest speed

1

(b) (velocity includes) direction

'it' refers to velocity

1

[3]

M7. (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]