The Distance-Time Relationship

Mark Scheme 1

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Physics
Exam Board	AQA
Topic	6.5 Forces
Sub-Topic	The Distance-Time Relationship
Difficulty Level	Silver Level
Booklet	Mark Scheme 1

Time Allowed: **60 minutes**

Score: **/57**

Percentage: **/100**

Grade Boundaries:

M1.(a) the time it took from seeing the green light to pressing a key

1

(b) he could have been distracted

1

(c) boys have a shorter reaction time than girls

or

reaction time improves with practice

1

(d) collect more data / larger sample size

must link to response in 06.3

or

take more repeat readings per person

1

(e) reaction time will have less effect (as distance increases)

1

because it is a smaller proportion of the total race time

1

(f) **Level 3 (5–6 marks):**
A coherent description of the race, which uses data from the graph, including discussion
of the meanings of the changing gradient of both of the lines.

Level 2 (3–4 marks):
Multiple pieces of data taken from the graphs used to evidence a comparison between
the runners. Likely to include discussion of the meaning of the (changing) gradient of one of the lines. Answer not coherently structured.

Level 1 (1–2 marks):
Some data taken from the graph, but may be limited to one aspect or simple readings.
Lack of coherence in answer.

0 marks:
No relevant content.

Indicative content
- A starts at constant speed *for 440 m / 60 s*
- A then slows down *from 60 s*
- the gradient for B is lower at the start so B starts at a slower speed
- the gradient for B increases so B accelerates
- B overtook A *at 700 m / 114 s*
- B has a greater top speed because the maximum gradient is greater
- B won the race *in 126 s* / beat A *by 34 s*

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M2.(a) 3.3×10^2 m / s

1

(b) **Level 2 (3–4 marks):**
A detailed and coherent explanation of the shape of the graph and what it says about the motion of the car between each point is given. Values from the graph are clearly referred
in a logical and consistent way.

Level 1 (1–2 marks):
An attempt at an explanation of the motion of the car is given, which may be incomplete
or not in a logical sequence. Values from the graph may not be referred to or referred to incorrectly.

0 marks:
No relevant content.

Indicative content
- between **A** and **B** car is moving from origin
- the gradient of the line shows it's moving at a constant speed
- speed between these points is 250 / 20 = 12.5 m / s
- between **B** and **C** car is stationary / not moving
- because between these points the graph is flat
- showing that the car's speed is 0 m / s
- between **C** and **D** car is moving further from origin
- at a constant speed
- speed is 250 / 20 = 12.5 m / s
- movement between these points is the same as at **A–B**

- because the gradient is the same
- between **D** and **E** moves towards origin
- at a constant speed
- speed is 500 / 30 = 16.7 m / s
- gradient between **D** and **E** shows that car moves faster **or** at a greater speed than between any other points

4

(c) kinetic energy = 0.5 × mass × (speed)^2

allow $E_k = ½\ mv^2$

1

(d) ½ × 1 650 × 30^2

1

= 742.5 (kJ)

answer must be in kJ for mark

1

*allow 742.5 with no working shown for **2** marks*

(e) **Level 3 (5–6 marks):**
A detailed and coherent explanation is given of why the man may not be able to stop in time, clearly and logically linking factors that could affect the braking in the situation given

Level 2 (3–4 marks):
An explanation is given, with an attempt at linking factors affecting braking distance to
the situation given. Links made between factors and explanation may not be complete
and the logic may be unclear.

Level 1 (1–2 marks):
Simple relevant statements made about factors affecting braking, but no attempt to link
to explanations of how they are relevant in the situation given

0 marks:
No relevant content.

Indicative content

- overall stopping distance related to thinking distance and braking distance
- factors affecting thinking distance:
  - driver could be distracted
  - driver could be tired
  - driver could be on medication that affects thinking (eg make drowsy)
  - driver could have drunk alcohol

- mean that reaction time will be longer so will not brake as quickly
- factors that affect braking distance:
  - condition of car (eg worn brakes means can't stop as quickly, wear on tyres reduces friction with road)
  - speed car is travelling (faster means more kinetic energy)
  - condition of the road (eg the road is wet so friction between tyres and road reduced)

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M3.(a) acceleration = change in velocity / time taken

allow a = Δv / t

1

(b) $= \frac{(5 - 3)}{6}$

1

–0.33 (m / s^2)

1

*allow 0.33 m / s^2 with no working shown for **2** marks*

(c) force = mass × acceleration

allow F = m a

1

(d) 70 × 0.33

allow ecf from 4.3

1

23.1 (N)

*allow 23.1 with no working shown for **2** marks*

1

(e) before throwing the bag the momentum of the skater and bag is zero

1

when it is thrown the bag has momentum forwards

1

because momentum before = momentum after

1

the skater has equal backwards momentum so will move backwards

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

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M5. (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]

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

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