

Forces in Action

Q1.(2018)

B ✓

Q2.(2018)

B ✓

Q3.(2018)

D ✓

Q4.a(2018)

FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 0.05 (J) award 3 marks	3		
(work done) = force x distance ✓		1.2	ALLOW correct symbol equation e.g. $(w) = fxd$
$0.05 \times 1(.0)$ ✓		2.1	IGNORE triangle style equations
$= 0.05 (J)$ ✓		2.1	

Q4.b(2018)

FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 0.01 W award 4 marks	4		ALLOW ECF from 11ai e.g. 1 W if answer to 11ai is 5 (J) ✓✓✓✓ 4 W if answer to 11ai is 20 (J) ✓✓✓✓
(power) = work done ÷ time ✓		1.2	ALLOW correct symbol equation e.g. $(p) = w/t$
$0.05 \div 5$ ✓		2.1	IGNORE triangle style equations
$= 0.01$ ✓		2.1	ALLOW 0.01 with no units or incorrect units ✓✓✓
W / watts ✓		1.1	Unit mark is independent ALLOW J/s

Q4.c(2018)

3 (V)

Q4.d(2018)

FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 0.5 (A) award 3 marks (current) = potential difference ÷ resistance ✓ $3 \div 6.0$ ✓ $= 0.5 \text{ (A)}$ ✓	3	1.2 2.1 2.1	ALLOW ECF from 11bi ALLOW correct symbol equation e.g. $(I) = V/R$ IGNORE triangle style equations
Q4.e(2018) Any one from remove one of the cells ✓ add mass (to the toy car) ✓ add a resistor (to the electrical circuit to reduce current) ✓	1	3.3a	IGNORE references about how to increase the speed rather than the time taken IGNORE just reduce p.d. / reduce power ALLOW add weight (to the toy car) IGNORE just reduce current ALLOW specific changes to the motor e.g. use a lower current motor / use less powerful motor IGNORE just reduce voltage to motor / increase the resistance of the motor
Q5.(2018) arrow vertically upwards labelled air resistance/drag ✓ arrow vertically downwards labelled weight ✓ arrows are the same length ✓	3	3 x 2.1	IGNORE additional arrows unless they contradict ALLOW vertically upwards arrow by sight e.g. slightly off vertical and not drawn with a ruler BUT DO NOT ALLOW a curved arrow ALLOW wind resistance or friction for air resistance IGNORE label of just resistance / lift / upthrust ALLOW vertically downwards arrow by sight e.g. slightly off vertical and not drawn with a ruler BUT DO NOT ALLOW a curved arrow IGNORE label of gravity / gravitational force ALLOW same length by sight or by labels
Q6.(2019) <div style="font-size: 2em; color: blue; text-align: center;">A</div>			
Q7.(2019) <div style="font-size: 2em; color: blue; text-align: center;">A</div>			
Q8.(2019) <div style="font-size: 2em; color: blue; text-align: center;">B</div>			
Q9.a(2019)			

multiply mass by acceleration due to gravity / (F =) mg ✓	2	1.1	ALLOW (F =) ma
BUT (W =) 0.4 × 10 or 4 (N) ✓✓		1.2	

Q9.b(2019)

(s = d/t gives) speed at X and Y obtained ✓	2	3.3a	Must be idea of obtaining two velocities or speeds e.g. the final velocity and the initial velocity / minus initial velocity squared from final velocity squared / measure the change in velocity
BUT acceleration = change in velocity or speed ÷ time / (a =) [v – u] ÷ t ✓✓		1.1	

Q9.c(2019)

Any one from: place surface at an angle /use incline ✓ use an air track/oil ✓ increase the width of X and Y ✓ accurately weigh masses before use ✓ make sure masses are uniform ✓	1	3.3b	ALLOW use smoother surfaces /do it on a frictionless surface / airline (track) IGNORE use more light gates / repeat / find a mean
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Q9.d(2019)

<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p>Level 3 (5–6 marks) Describes and explains in detail what the results show and evaluates the validity of the results. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) Describes and explains what the results show and comments on the validity of the results. OR Describes and explains in detail what the results show. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p>Level 1 (1–2 marks) Basic description or explanation of what the results show. OR Comments on the validity of the results. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks No response or no response worthy of credit.</p>	6	3×2.2 3×3.2b	<p>AO2.2 Applies knowledge and understanding of force and acceleration</p> <ul style="list-style-type: none"> as force increases, acceleration increases / there is a positive correlation line of best fit shows force is directly proportional to acceleration doubling the force, doubles the acceleration / AW linear relationship through 0 <p>AO3.2b Analyses information and ideas to draw conclusions about the graph</p> <ul style="list-style-type: none"> results suggests not proportional/not linear line of best fit is poorly drawn / does not go through majority of points actual line of best fit is not through 0 poor validity as points not close to line of best fit / points are scattered not enough results / no evidence of repeated results <p>IGNORE general statement e.g. the results are inconsistent / some results are wrong / there is an anomaly</p>
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Q9.e(2019)

FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.98 (per kg) award 2 marks (Gradient =) $5 / 5.1$ ✓ $= 0.98$ (per kg) ✓	2	2×2.1	ALLOW correct use of any correct triangle on graph, provided it covers a force greater than 1 (N) and an acceleration greater than 1 (m/s ²) ALLOW answer in range of 0.96 to 1 (per kg)
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Q9.f.(2019)

Identifies intercept as - 0.8 ✓ $y = 0.98x - 0.8$ ✓	2	2×2.1	ALLOW ECF from part (i), i.e. $y = \text{gradient} \times \text{their intercept}$ if clear or - 0.8 e.g. If answer to part (i) is 1 then $y = x - 0.8$ or $y = 1x - 0.8$ ✓✓ ALLOW $a = 0.98f - 0.8$ ✓✓
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Q11.(2020)

C

Q12.(2020)

A

Q13.(2020)

A

Q14.(2020)

Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.

Level 3 (5–6 marks)

Describes the properties of **A** and **B** using knowledge of elastic and plastic deformation.

AND

Describes the properties of **A** and **B** using knowledge of linear and non-linear relationships between force and extension.

AND

Describes how the graphs show different stiffness of **A** and **B**.

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3–4 marks)

Describes the properties of **A** and **B** using knowledge of elastic and plastic deformation.

AND

Describes the properties of **A** and **B** using knowledge of linear and non-linear relationships between force and extension.

OR

Describes the properties of **A** and **B** using knowledge of elastic and plastic deformation.

AND

Describes how the graphs show different stiffness of **A** and **B**.

6

4 × 1.2
2 × 3.2b

AO3.2b Analyses information and ideas to draw conclusions about properties of each spring

- Gradient of graph for A > gradient of graph for B
- Spring constant for A > spring constant for B
- As $k = F / x$
- A is stiffer but elastic
- B is more flexible but plastic

AO1.2 Demonstrates knowledge of linear and non-linear relationships between force and extension.

- Linear relationship (between F and x) for A / gradient is a straight line
- F proportional to x for A
- Non-linear relationship for B
- A obeys Hooke's law
- B obeys Hooke's law for small forces only or to start with / gradient is constant and then changes

AO1.2 Demonstrates knowledge of elastic and plastic deformation

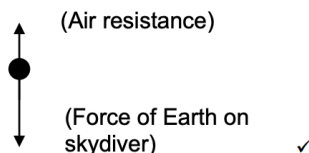
- A shows elastic behaviour / not permanently deformed
- A recovers original shape when force removed
- B shows plastic behaviour
- B shows permanent deformation (when force is removed)

Q15.(2020)

1st row:

Unbalanced forces (on skydiver) / resultant force / AW ✓

2nd row:



3rd row:

Skydiver reaches terminal/constant velocity or constant speed ✓

3

3 × 1.1

Arrow for air resistance **must** be smaller than arrow for weight.

IGNORE labels

ALLOW 'no acceleration'

DO NOT ALLOW reached the ground / constant acceleration

OR

Describes the properties of **A** and **B** using knowledge of linear and non-linear relationships between force and extension.

AND

Describes how the graphs show different stiffness of **A** and **B**.

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1–2 marks)

Describes the properties of **A** and **B** using knowledge of elastic and plastic deformation.

OR

Describes the properties of **A** and **B** using knowledge of linear and non-linear relationships between force and extension.

OR

Describes how the graphs show different stiffness of **A** and **B**.

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks

No response or no response worthy of credit.

Q16.(2021)

A ✓

Q17.(2021)

Rate or how fast work is done, or energy is transferred /
AW ✓

Q18.a(2021)

FIRST CHECK THE ANSWER ON ANSWER LINE
If answer = 908 (N) award 3 marks

$$200 \text{ lbs} = 200 \times 0.454 \text{ kg} = 90.8 \text{ (kg)} \checkmark$$

$$W = 90.8 \times 10 \checkmark$$

$$W = 908 \text{ (N)} \checkmark$$

Q18.b(2021)

FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 248 (W) award 4 marks $W = 620 \times 1.6 \checkmark$ $W = 992 \text{ (J)} \checkmark$ $P = 992 / 4 \checkmark$ $P = 248 \text{ (W)} \checkmark$	4	4×2.1	ALLOW ecf for incorrect work done for MPs 3 and 4
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Q19.a(2021)

	2	2×2.2	ALLOW for one mark if no other marks awarded, arrows of same size in opposite directions vertically and forces labelled in some incomplete way e.g., force of floor, force of ball
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Q19.b(2021)

First AND Forces on ball are balanced / resultant force = 0 $\checkmark$	1	1.1	BOTH needed.
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Q19.c(2021)

Third $\checkmark$ Forces act in pairs $\checkmark$ Force of foot on ball = force of ball on foot / one force acts on foot / AW $\checkmark$	3	1.1 2×2.1	ALLOW equal and opposite reaction
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Q19.d(2021)

FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 500 (m / s²) award 2 marks $\text{acceleration} = 25 / 0.05 \checkmark$ $\text{acceleration} = 500 \text{ (m / s}^2\text{)} \checkmark$

Q19.e(2021)

FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 480 (m / s²) award 3 marks $\text{Rearrangement: acceleration} = \text{force} \div \text{mass} \checkmark$ $\text{acceleration} = 216 / 0.45 \checkmark$ $\text{acceleration} = 480 \text{ (m / s}^2\text{)} \checkmark$

Q20.(2022)

A ✓

Q21.(2022)

B ✓

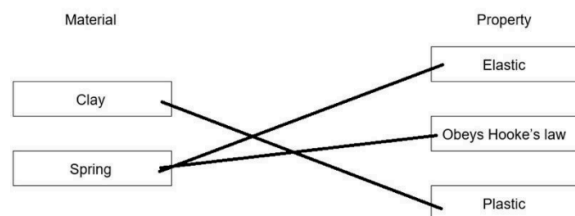
Q22.(2022)

D ✓

Q23.(2022)

B ✓

Q24.(2022)



1 mark for each line ✓✓✓

3	3 × 1.1	Four lines, three correct = 2 marks Four lines, two correct = 1 mark
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Q25.(2022)

Any four from:

If there was a single force there would be a resultant force / a resultant force would cause an acceleration ✓

Clay held in place by normal reaction from table ✓

(Up) normal reaction from table / contact or surface force / AW ✓

(Down) weight (of clay) / (pull of) gravity / pull of Earth / AW ✓

(Down) push of hand / force of child / AW ✓

4

4 × 2.1

ALLOW there is no resultant force / (small) resultant force is (only) used to deform the clay / no overall force

ALLOW mention of Newton's third law to explain why there is more than one force acting on clay / idea of equal and opposite forces

IGNORE friction / resistance / upthrust / pressure

ALLOW gravitational (force) / force of gravity / force due to gravity

ALLOW all marks from a labelled diagram / this unlabelled diagram = 1 mark, but each correct label on the diagram scores an additional mark



Q26.(2023)

B

Q27.(2023)

C

Q28.(2023)

Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.

Level 3 (5–6 marks)

Detailed conclusions from graph **AND** detailed description of motion using free body force diagram (FBFD)

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3–4 marks)

Detailed conclusions from graph **AND** basic description of motion using FBFD

OR

Basic conclusions from graph **AND** detailed description of motion using FBFD

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1–2 marks)

Basic conclusions from graph **OR** basic description of motion using FBFD

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks

No response or no response worthy of credit.

6

3 x 1.1
3 x 3.1a

AO3.1a – Analyses information and idea to interpret the distance-time graph

- Initially, velocity is zero
- Gradient increases / graph is non linear
- So velocity increases
- Acceleration increases
- Gradient increases at a decreasing rate
- Acceleration decreases
- Eventually, gradient is constant / a straight line
- No acceleration
- As the skydiver reaches terminal velocity

AO1.1 – Demonstrates knowledge and understanding of forces to explain the distance-time graph

- Weight remains constant
- Unbalanced force on skydiver (at start)
- Weight greater than drag (at start)
- So drag increases
- So resultant force decreases
- Drag = weight (at end)

IGNORE reference to the parachute / after the parachute has opened

Q29.a(2023)

First check the answer on answer line
If answer = 0.12 (J) award 2 marks

(Gravitational potential energy =) $0.015 \times 10 \times 0.8$ ✓

(Gravitational potential energy =) 0.12 (J) ✓

Q29.b(2023)

Energy transferred to a thermal store ✓

2

2 x 3.2a

ALLOW (idea that) heat is dissipated to the surroundings / heat to 'lost' to the surroundings
ALLOW (idea that) energy is transferred to sound

Work done against friction / work done against air resistance ✓

ALLOW (idea that) there is friction (between marble and track) / air resistance (as the marble moves)

Q29.c(2023)

First check the answer on answer line
If answer = 2 (m / s) award 3 marks

$$(\text{Speed}^2) = \frac{2 \times \text{kinetic energy}}{\text{mass}}$$

OR

$$(\text{Speed}^2) = \frac{\text{kinetic energy}}{\frac{1}{2} \text{ mass}} \quad \checkmark$$

$$(\text{Speed}^2) = (2 \times 0.03) \div 0.015 \quad \checkmark$$

$$(\text{Speed} =) 2 \text{ (m / s)} \quad \checkmark$$

3

1.2

ALLOW correct rearrangement of equation to make either speed² or speed the subject

2.1

2.1

ALLOW 4 (m / s) on the answer line for 2 marks

Q29.d(2023)

First check the answer on answer line
If answer = 0.04 (m / s) award 3 marks

Statement of conservation of momentum **OR**
 $5 \times 0.1 = (20 \times v) - (5 \times 0.06) \quad \checkmark$

$$20 \times v = 0.8$$

OR

$$(v =) \frac{0.8}{20} \quad \checkmark$$

$$(v =) 0.04 \text{ (m / s)} \quad \checkmark$$

3

1.2

2 × 2.1

If no other marks awarded **ALLOW** 1 mark for any of the following numbers seen anywhere in the answer:
(5 × 0.1 =) 0.5 or (5 × 0.06 =) 0.3 or 0.8

Q30.(2024)

C

Q31.(2024)

B

Q32.(2024)

A

Q33.(2024)

A

Q34.(2024)

A

Q35.a(2024)

First check the answer on the answer line If answer = 30 000 (J) award 3 marks	3		
(W =) Fs selected ✓		1.2	ALLOW (W=) F x d / (work=) force x distance ALLOW 600 x 0.20 for 1 mark
(W =) 600 × 0.20 × 250 ✓		2.1	ALLOW 120 for 2 marks
(W =) 30 000 (J) ✓		2.1	

Q35.b(2024)

First check the answer on the answer line If answer = 0.15 (kW) award 3 marks	3		
(P =) 36 000 ÷ 240 ✓		2.1	
(P =) 150 (W) ✓		2.1	
(P =) 0.15 (kW) ✓		1.2	ALLOW 1.5 x 10 ⁻¹ (kW) ALLOW incorrect answer given in W correctly converted to kW e.g. 30 converted to 0.03 ALLOW 1.5 x 10 ⁿ as the final answer for 2 marks

Q35.c(2024)

Any three from:	3	3 × 3.3a	ALLOW stairs for steps throughout
Measure height (of step) using a metre rule / tape measure / ruler ✓			IGNORE measure height/distance using a trundle wheel
Count number of steps ✓			ALLOW (use a set) amount of steps / see how many steps
Measure weight using a (weighing) scales / balance ✓			ALLOW measure weight using a newton meter / measure mass using scales/balance and multiply by g/10
Measure time using a stopwatch ✓			ALLOW measure time using a timer / stop clock
			If no other marks scored: ALLOW two different pieces of equipment to measure two different quantities for 1 mark e.g. use a metre rule and a stopwatch

Q35.d(2024)

	Yes	No
Precise	✓	
Repeatable	✓	

✓

Q35.e(2024)

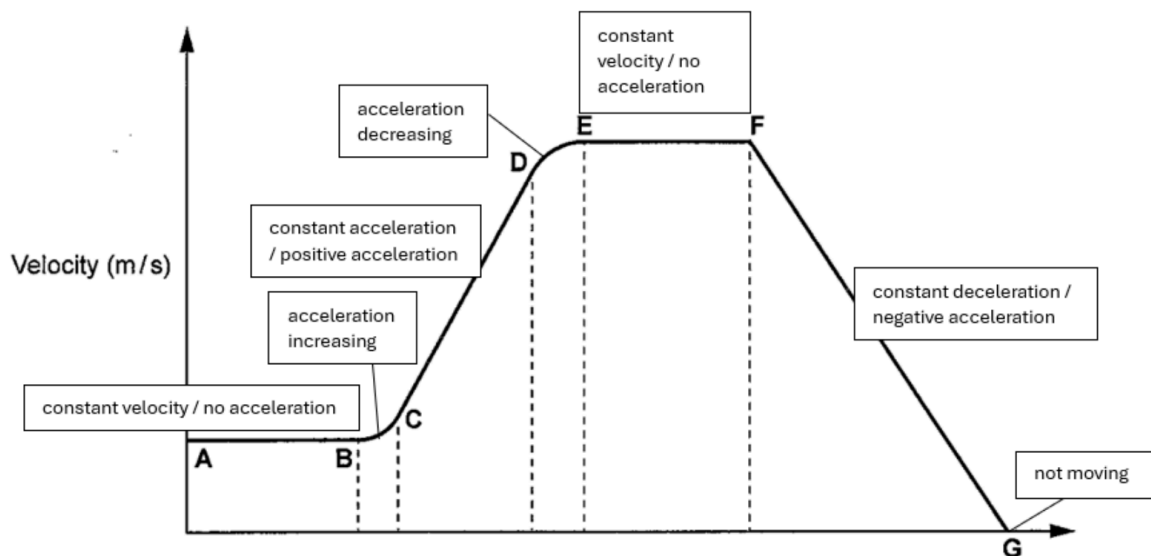
Precise because results are close together / small range ✓	2	2 × 3.2a	ALLOW results are similar / every test comes out roughly the same / low range / range of 3
Repeatable because (same person) repeats the experiment/the method/the investigation/using same equipment giving similar results ✓			ALLOW correct descriptions of precise and repeatable without linking to terms precise or repeatable for 1 mark e.g. the results have a small range because the same person repeats the investigation

Q36.(2024)

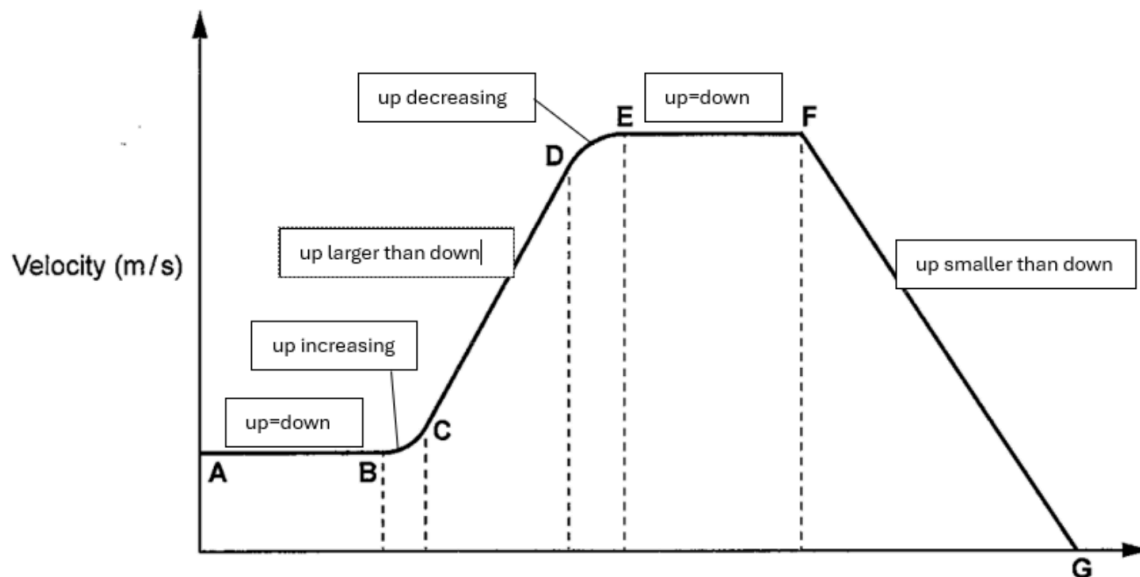
<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p>Level 3 (5–6 marks) Detailed description of motion including change in acceleration AND Detailed description of forces and resultant force on the block</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) Basic description of motion in terms of velocity AND Detailed description of forces acting on block</p> <p>OR</p> <p>Detailed description of motion including change in acceleration AND Basic description of forces acting on block</p> <p><i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p>	6	<p>2 × 2.2 2 × 3.2a 2 × 3.2b</p>	<p>Please refer to the appendix for more guidance on interpreting the graph</p> <p>AO2.2 Applies knowledge and understanding of velocity-time graphs</p> <ul style="list-style-type: none"> • Gradient gives acceleration • No acceleration/constant velocity AB EF • Acceleration increasing BC • (Constant) acceleration CD • Acceleration decreasing DE • (Constant) deceleration FG • Not moving/stationary/zero velocity G <p>AO3 Analyses information and ideas to interpret the graph and draw conclusions about forces</p> <ul style="list-style-type: none"> • Downward force is constant • Upward force = downward force AB EF • Upward force increasing BC • Upward force larger than downward force CD • Upward force decreasing DE • Upward force smaller than downward force FG <ul style="list-style-type: none"> • Resultant force zero AB EF • Resultant force increasing BC • Resultant force upwards constant CD • Resultant force decreasing DE • Resultant force downwards constant FG
<p>Level 1 (1–2 marks) Basic description of motion in terms of velocity OR Basic description of forces acting on block</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks No response or no response worthy of credit.</p>			<p>ALLOW 'weight' for 'downward force' and 'tension' for 'upward force' and 'speed' for 'velocity'</p>

Appendix: Question 12 Level of Response

AO2.2 Motion



AO3 Forces
down is constant



A03 Resultant force

