



Combined Science Physics Paper 1 Higher Tier: Extended Open Response

6c (2023)

*(c) Newton's second law can be stated as

$$\text{force} = \text{mass} \times \text{acceleration}$$

A student is provided with a trolley and a runway on a bench, as shown in Figure 12, and access to other equipment.

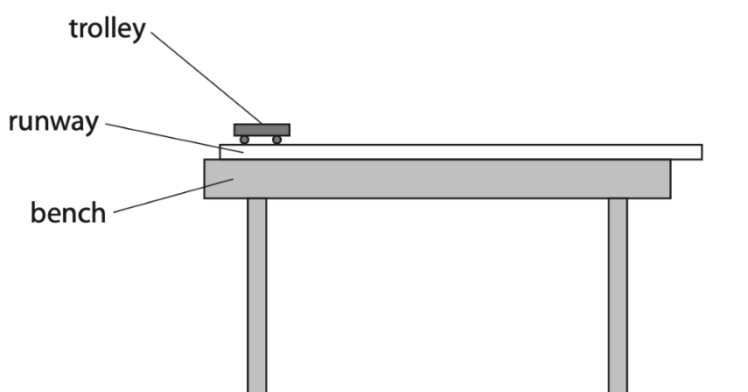


Figure 12

Describe a procedure the student could use to investigate how the acceleration of the trolley depends on the force applied to the trolley.

You may add to the diagram in Figure 12 to help your answer.

(6)

The student could undertake an experiment in which an increasing number of weights are added to the trolley, some on the trolley itself, some at the end of a string. The weights at the end of the string, hanging off the table will use their GPE to apply force to the trolley, pulling it through the light gates. The light gates, which, will be placed in the same location in each subsequent experiment can measure the speed, and thus, acceleration, helping the student investigate how force, mass and acceleration are linked.



Question number	Indicative content	Mark
6c	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;">AO1</p> <p>isolated statements</p> <ul style="list-style-type: none"> • weights on hanger • weights added to trolley • light gate(s) / ticker(tape) timer / ultrasonic transducer • datalogger • (interrupter) card on trolley • sloping runway • weigh trolley • use newtonmeter • use $a = (v-u)/t$ • measure distance and time • use stopclock and ruler • use (average) speed = distance / time • use $a = (v^2-u^2)/ 2s$ • plot graph of F against a <p>detail of procedure</p> <ul style="list-style-type: none"> • suspend weights from weight hanger to produce force • changing weights on hanger • keeping mass constant by moving weights between hanger and trolley • light gates/ticker(tape) timer/ultrasonic transducer used to measure acceleration/velocity/time • runway on slope so no (effect of) friction /so trolley rolls at constant speed (with no weights/force) • increase angle of slope to increase force • interrupter card for time through gate • final speed = 2 x average speed 	(6) AO1



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3–4	Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5–6	Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> isolated facts mention at least 2 isolated statements evidence may be seen in the diagram	<u>Possible candidate responses</u> add weights and use light gates
Level 2	3–4	<u>Additional guidance</u> limited procedure 1 detail of procedure and mention 1 other isolated statement evidence may be seen in the diagram	<u>Possible candidate responses</u> use light gates to measure acceleration/velocity/time and add weights
Level 3	5–6	<u>Additional guidance</u> detailed procedure 2 details of procedure and mention 1 other isolated statement evidence may be seen in the diagram	<u>Possible candidate responses</u> use light gates to measure acceleration/velocity/time and suspend weights from weight hanger to produce force and sloping runway