Cambridge Assessment International Education

Interactive

Interactive Example Candidate Responses
Paper 5 (May/June 2016), Question 1
Cambridge International AS & A Level Physics 9702

Version 1.0

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Select page

HIGH | MIDDLE | LOW

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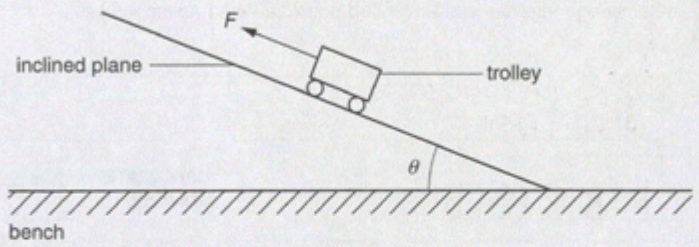

Fig. 1.1

The student is investigating the relationship between the acceleration a of the trolley and the angle θ of the inclined plane when a force F is applied to the trolley.

It is suggested that the relationship is

$$ma = F - (mg\sin\theta + k)$$

where g is the acceleration of free fall, m is the mass of the trolley and k is a constant.

Design a laboratory experiment to test the relationship between a and θ. Explain how your results could be used to determine a value for k. You should draw a diagram, on page 3, showing the arrangement of your equipment. In your account you should pay particular attention to

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[15]

$F = BIl\sin\theta$

$F =$

$\frac{k}{m} - 9$

$\frac{k}{m}$

$ma = F - mg\sin\theta + k$

$ma = \frac{F}{m} - g\sin\theta + \frac{k}{m}$

$a = -g\sin\theta + \left(\frac{k}{m} - 9\right)$

$ma = F - mg\sin\theta - k$

$a = \frac{F}{m} - g\sin\theta - \frac{k}{m}$

$a = -g\sin\theta + \left(\frac{F-k}{m}\right)$

$\frac{F-k}{m} = c$

$mc = F - k$

$F - mc = k$

Your Mark

1 ☐

Q1 Mark scheme

Planning (15 marks)

Defining the problem (2 marks)

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P Keep F constant. [1]

Methods of data collection (4 marks)

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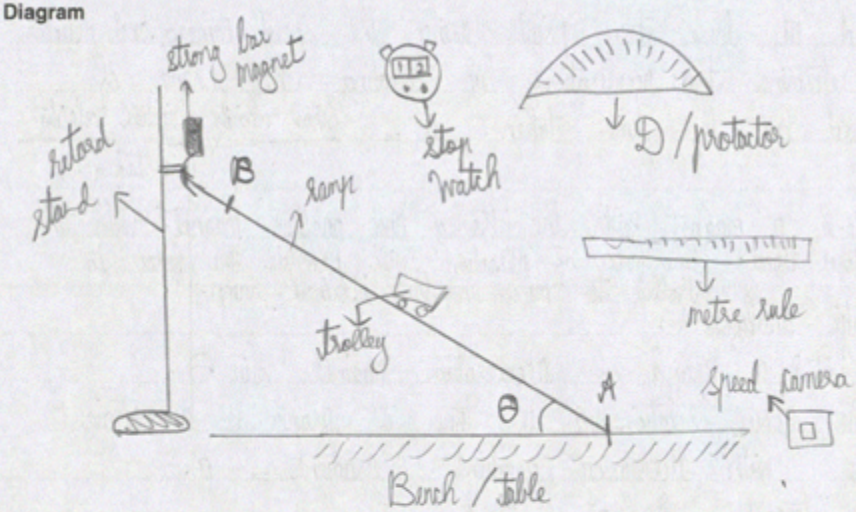
EXAMINER COMMENTS | MARK SCHEME

Select page

HIGH | MIDDLE | LOW

Diagram



Defining problem –:
- θ is the independant variable
- a is the dependant variable
- m should be kept constant by using the same trolley.

Method of ~~data~~ data collection –:
- Set up the apparatus as shown in diagram by clamping one end of the ramp with retord stand.
- Measure the angle between the bench and ramp by using a protactor.
- Measure the length of the ramp through which the trolley moves.
- Between 2 fixed points on ramp, ~~measure~~ record the time taken by the trolley and note the change in

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1

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EXAMINER COMMENTS | MARK SCHEME

Speed at these two points using the speed camera and detector.
• Determine the acceleration by dividing the change of speed by the time taken. $a = \frac{\text{final velocity} - \text{initial velocity}}{\text{time taken}}$.
• Attach a magnet with the trolley and another magnet with the retord stand. The force of attraction will provide the force to trolley to move up the inclined ramp.

Data analysis –:
• Plot a graph of acceleration against Sin Θ.
• The given relationship is true if graph is a straight line with decreasing gradient. gradient = -g.
y-intercept = $\frac{F-k}{m}$

∴ k = (~~y intercept + g~~) m F - m(y-intercept)

Safety precaution –:
• Do not touch the trolley while it is moving on the ramp as it may injure the hands. Wear thick rubber gloves.
• Use a sand tray. The trolley will fall into it rather than falling on the bench.

Additional detail –:
• Use a large protector to minimize error in measuring Θ.
• ~~Change the angle Θ~~ Make large changes to the angle Θ to have noticeable change in acceleration.
• Release the trolley from the same point everytime and use the same length of ramp for determining speed changes with time. The distance should be large for greater changes in speed.
• Use the same ramp everytime with minimum friction to have smooth movement of trolley.
• The force applied should be same and there should be no external forces like wind from fan.

[Total: 15]

Select page

HIGH | MIDDLE | LOW

Your Mark

1

Q1 Mark scheme

Additional detail (6 marks)

Relevant points might include: [6]

1 Keep mass of trolley constant/use same trolley.

2 Correct trigonometry relationship to determine sin θ or θ using marked lengths.

3 Use ruler to measure appropriate distance to determine a, e.g. length of slope, length of card for light gate method, position of motion sensor.

4 Equation to determine a <u>from measurements taken appropriately</u> with a as the subject.

5 Measurement of *F* for a valid method e.g. take reading from newton-meter or from stretched elastic/spring from extension (allow falling weight e.g. $F = mg$).

6 Use a constant extension to produce a <u>constant</u> force when using stretched spring/elastic.

7 Method to ensure the inclined plane is the same height each side of the plane or spirit level across plane or ensure force *F* (or string) is parallel to the plane.

8 Safety precaution linked to falling mass/trolley or spring/elastic breaking (not string).

9 Rearrangement of relationship into y = mx + c
e.g. $ma = -mg \sin\theta + (F - k)$ **or**
$a = g \sin\theta + \frac{F - K}{m}$ or correct y-intercept (subject must be y-axis).

10 Repeat experiment for each angle θ to find average for a.

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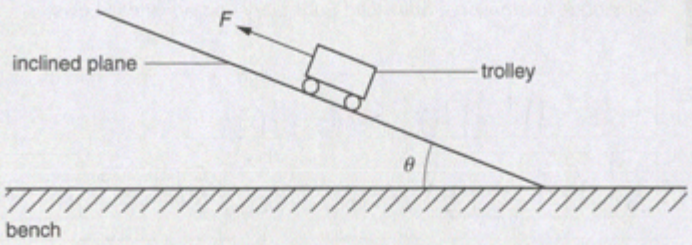

Fig. 1.1

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$a = \frac{F}{m} - g\sin\theta + \frac{k}{m}$

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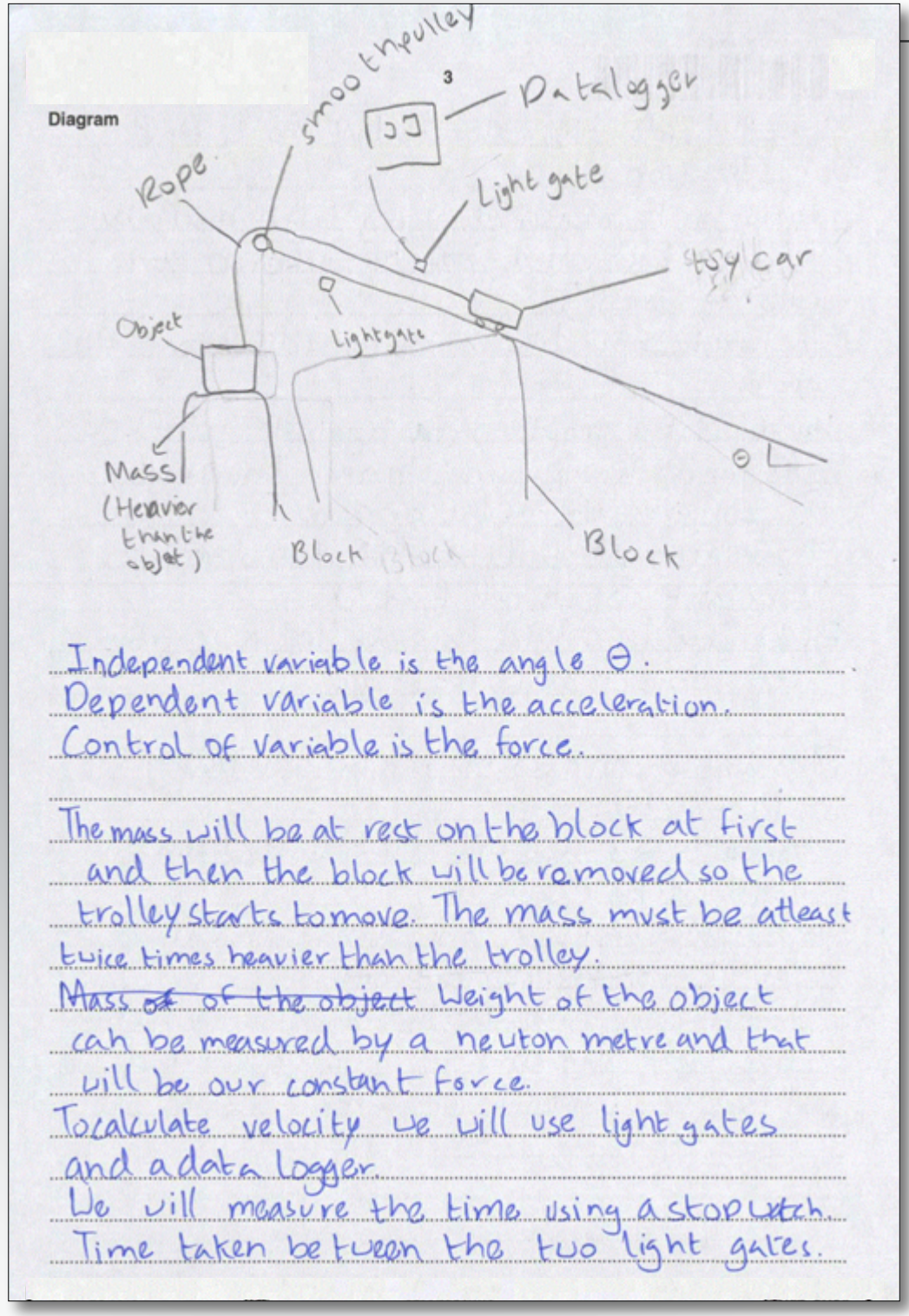

Independent variable is the angle θ.
Dependent variable is the acceleration.
Control of variable is the force.

The mass will be at rest on the block at first and then the block will be removed so the trolley starts to move. The mass must be atleast twice times heavier than the trolley.
~~Mass of the object~~ Weight of the object can be measured by a neuton metre and that will be our constant force.
To calculate velocity we will use light gates and a data logger.
We will measure the time using a stopwatch.
Time taken between the two light gates.

Select page

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EXAMINER COMMENTS | MARK SCHEME

We will divide the velocity by time to find acceleration.
Angle can be measured using trignometry by finding base and height using metre rule. $Tan^{-1}(\frac{a}{b})$
The lengths should be varied for a different angle.
We will plot a graph of a against gsinθ.
A straight line passing through the origin will confirm the relationship.
The y intercept will be $\frac{F+k}{m}$, F and m are constant so we can find K.
For safety we should keep our feet away from the object as we let it go.

The angle can also be taken out using a protractor.
A smooth surface with little friction should be used.
We should take a large range of values for θ. ~~for better outcome~~
Acceleration can be worked out also by making free body diagrams for the object and the car. (Tension is the same).

[Total: 15]

Select page

HIGH | MIDDLE | LOW

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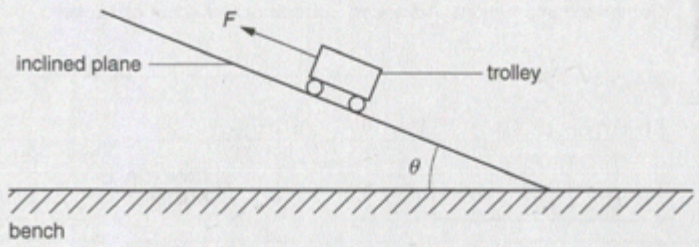

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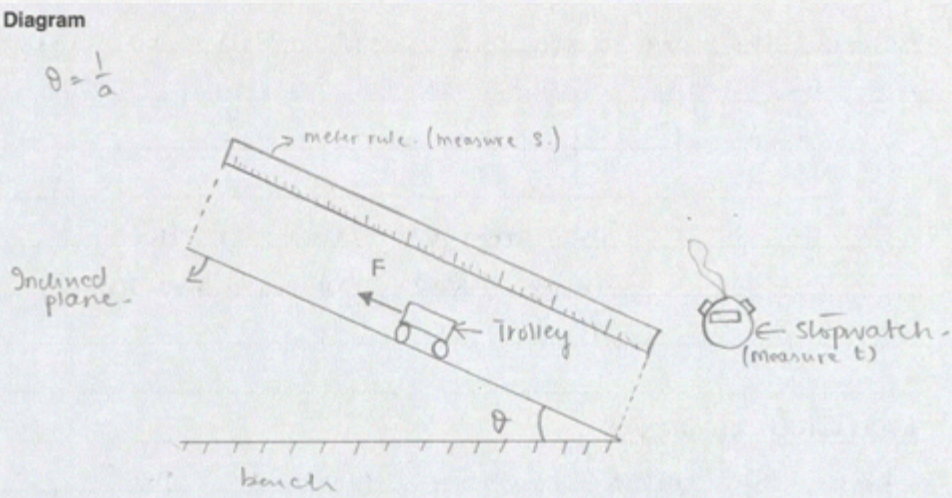

In this expriment; Angle θ is the independent variable while acceleration a, is the dependent variable. Keeping length of the plane constant. measure angle θ using a protector, calculate change in ~~speed~~ velocity ~~over time~~ of the trolley moving up a inclined plane; $v = s/t$, where s is the length of plane and 't' can be measured using a stopwatch. The change in velocity over a period of time will be acceleration; $a = v - u/t$.
Take few sets of readings for the variations in acceleration of the trolley on increasing or decreasing the angle θ between bench and a plane.

Select page

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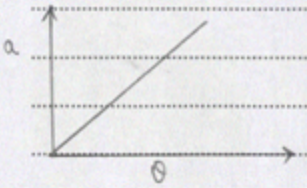
Record the values of θ, sinθ and acceleration in the table and sketch a graph of a and θ



The straight line of the graph ~~and~~ ~~stating~~ ~~the~~ proves this relationship.

Additional details:-

keep the mass and g constant. The force applied should be ~~kept~~ same ~~for~~ throughout the experiment.

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EXAMINER COMMENTS

MARK SCHEME

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