

Force, mass and acceleration: required practical

AQA GCSE Combined Science Trilogy 8464 and Separate Physics 8463 | Paper 2 | Both tiers

Suggested: 35–40 minutes + 15–20 minutes review | 26 parts | 44 marks

Specification points covered

8463 4.5.6.2.2 / 8464 6.5.4.2.2: $F = ma$; required practical 7 / 19
8463 4.5.6.1.5 / 8464 6.5.4.1.5: acceleration as change in velocity per second
Supporting skills: 8463 4.5.6.1.2 / 8464 6.5.4.1.2: speed = distance / time
Supporting skills: 8463 4.5.1.3 / 8464 6.5.1.3: weight = mass $\times$ g

A parcel-conveyor manufacturer uses a trolley test track to investigate how driving force and moving mass affect acceleration. You will check the measurements, interpret data and plan two fair tests.

Use a calculator, ruler and equations sheet. Show working and units. Use $g = 10 \text{ N/kg}$. These are simplified practice data. This worksheet does not replace doing the experiment.

1 Checking the conveyor model

“Resultant force” means the overall force after opposing forces are taken into account.

1(a) Explain what a forward acceleration of 0.50 m s^{-2} means for a load moving forwards. **[1 mark]**

1(b) Write the equation linking resultant force, mass and acceleration. **[1 mark]**

1(c) A test load of mass 0.80 kg experiences a resultant force of 0.40 N . Calculate its acceleration. **[1 mark]**

1(d) A 0.80 kg test load is driven by 0.90 N while a 0.10 N force opposes its motion. Calculate its acceleration. **[2 marks]**

1(e) A loaded test unit has mass 1.60 kg and accelerates at 0.50 m s^{-2} . Calculate the resultant force needed. **[1 mark]**



2 What is moving?

Figure 1 is a schematic of the test track. The card interrupts each light beam. The trolley moves towards the pulley while the hanger falls. For this worksheet, M is the total moving mass: trolley, card, all loads and hanger. With negligible friction, use $a = \text{driving force} / M$, where driving force is the total hanging weight. Neglect the mass of the string and resistance of the pulley. This is a model of the whole trolley–hanger system, not the trolley alone.

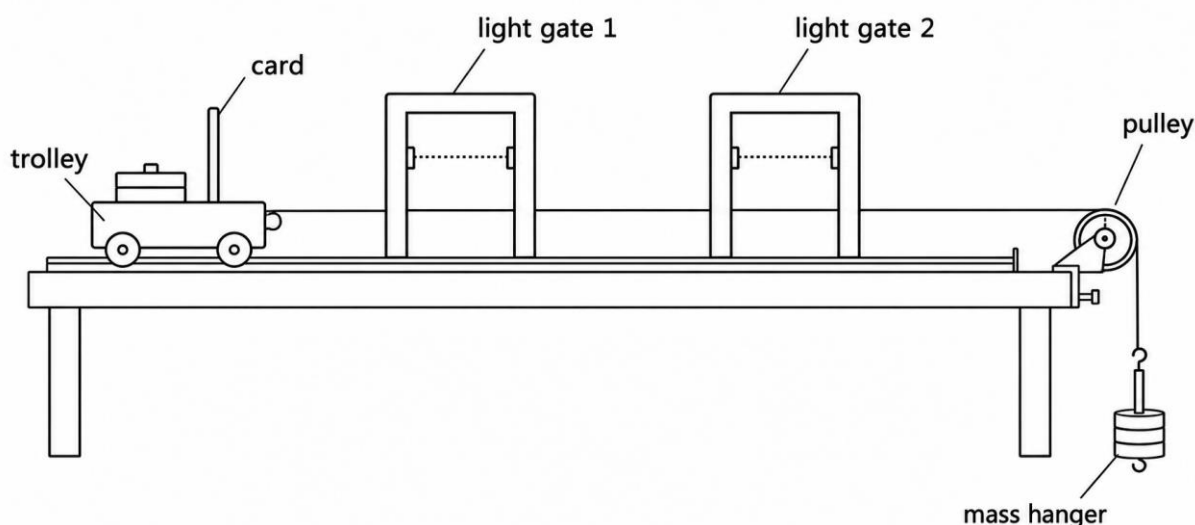


Figure 1

2(a) The light-gate software is used to find acceleration. State the two velocity readings and the time interval it must obtain. **[2 marks]**

2(b) The trolley including its card has mass 0.50 kg. The empty hanger has mass 0.020 kg. Removable weights totalling 0.28 kg are shared between them. Calculate the total moving mass M . **[1 mark]**

2(c) Initially the total hanging mass is 40 g, including the hanger. A 20 g weight is transferred from the trolley to the hanger. Calculate the new driving force using $W = mg$, and state the total moving mass M . **[2 marks]**

2(d) Instead, a trainee adds a new weight from the bench to the hanger. Explain why this is not a fair test of changing force at constant moving mass. **[2 marks]**

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3 Measuring acceleration, not assuming it

Use speed = card length / beam-blocking time. The software reports a velocity at each gate and the time between those velocity measurements. Treat these velocities as instantaneous readings. Motion is in one direction. Use acceleration = change in velocity / time taken.

Table 1

Measurement	Value
Card length	50 mm
First gate: beam blocked	0.100 s
Second gate: beam blocked	0.050 s
Between velocity measurements	0.50 s

3(a) The card is 50 mm long. It blocks the first gate for 0.100 s. Calculate the velocity reported at the first gate, in m/s. **[2 marks]**

3(b) The same card blocks the second gate for 0.050 s. Calculate the velocity reported at the second gate. **[1 mark]**

3(c) The software gives 0.50 s between the two velocity measurements. Calculate the acceleration. **[1 mark]**

3(d) Three repeats give accelerations of 0.98, 1.00 and 1.02 m s⁻². Calculate the mean acceleration. **[1 mark]**

3(e) Explain why using a mean of repeated measurements is better than using one reading. **[1 mark]**

3(f) The hanger lands on a tray before the card reaches the second gate. Explain why this run cannot test the intended constant driving force, and suggest a suitable change to the set-up. **[2 marks]**

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4 Investigation A: changing the driving force

The total moving mass is kept at 0.80 kg by transferring weights from the trolley to the hanger. Table 2 gives idealised mean accelerations with negligible friction. Each mean is based on repeated light-gate measurements, not calculated from $F = ma$.

Table 2

Driving force / N	Mean acceleration / m s^{-2}
0.20	0.25
0.40	0.50
0.60	0.75
0.80	1.00
1.00	1.25

4(a) Plot all five results from Table 2 on Figure 2. Draw a straight line of best fit. **[3 marks]**

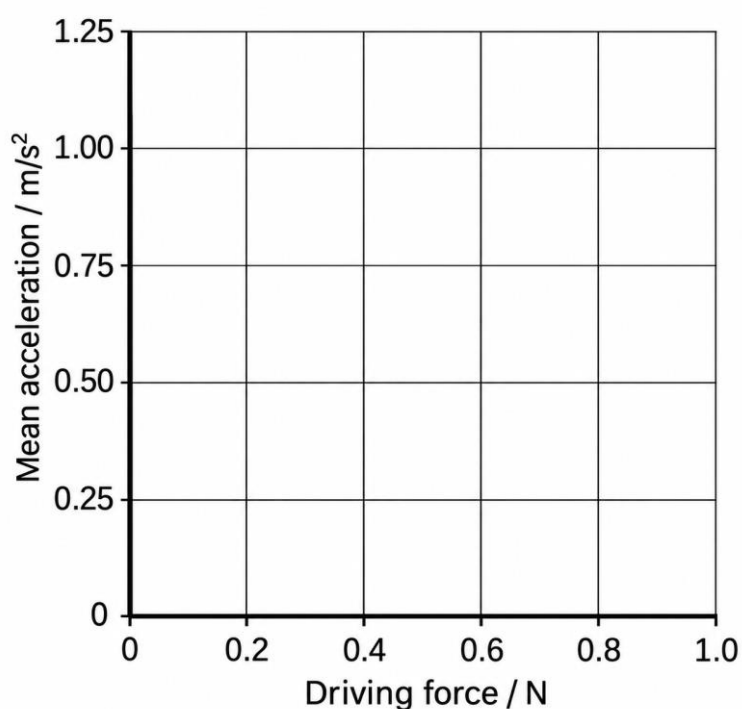


Figure 2

4(b) Describe the relationship between driving force and mean acceleration. Give graph evidence that supports your description. **[2 marks]**

4(c) Use your graph to estimate the acceleration when the driving force is 0.50 N. **[1 mark]**

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5 Investigation B: changing the moving mass

The hanging mass is now kept fixed, giving a driving force of 0.80 N. Loads are added to the trolley from the bench. Table 3 gives idealised light-gate results with negligible friction. M still includes the hanger and its weights.

Table 3

Total moving mass M / kg	Mean acceleration / m s ⁻²
0.80	1.00
1.00	0.80
1.25	0.64
1.60	0.50
2.00	0.40

5(a) Use two pairs of values from Table 3 to show what happens to acceleration when total moving mass doubles at constant force. **[2 marks]**

5(b) Use the negligible-friction model to predict the acceleration if M were 2.50 kg with the same 0.80 N driving force. **[1 mark]**

5(c) Describe how to increase the total moving mass while keeping the driving force constant in Investigation B. **[2 marks]**

5(d) In a separate test, the driving force is 0.80 N and M is 0.80 kg. A constant friction force of 0.16 N opposes the motion. Calculate the acceleration using the whole-system model. **[2 marks]**

5(e) For the test in 5(d), a trainee estimates M by dividing the 0.80 N driving force by the measured acceleration. Calculate this estimate and explain why it is too large. **[2 marks]**

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