

Name	Date started	Target end date
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GCE AS/A LEVEL – BASIC PHYSICS QUESTION PACK

1321-01 (Legacy PH1)

PHYSICS – PH1

PH1.1 Basic Physics – vectors, equilibrium & moments

Every basic-physics question from the legacy WJEC PH1 papers (Jan 2009 – June 2016)

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~1 hour 30 minutes

Derived from the legacy PH1 paper's pace of ~1 min/mark (80 marks in 1¼ hours).

*You are advised to **not** attempt to complete all of this in one sitting.*

For Examiner's use only

Q	Source	Max	Mark	Q	Source	Max	Mark
1	Jun 13 Q6	9		5	Jun 14 Q7	10	
2	Jun 10 Q2	9		6	Jun 15 Q6	9	
3	Jun 11 Q3	9		7	Jun 13 Q7	10	
4	Jan 14 Q6	8		8	Jun 16 Q3	12	
				9	Jan 13 Q5	11	
				Total		87	

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every basic-physics question (vectors, equilibrium, moments and centre of gravity) from the legacy WJEC PH1 papers between January 2009 and June 2016.

Questions are grouped by sub-topic, then ordered roughly by difficulty.

INSTRUCTIONS

Use black ink or black ball-point pen. Answer all questions in the spaces provided.

A calculator is required. The Data Booklet is allowed.

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PH1.1 Basic Physics – what the legacy spec asks

WJEC GCE AS/A Level Physics (from 2008) · PH1 Assessment Unit *Motion, Energy & Charge*. The basic-physics strand – vectors, equilibrium and moments – maps directly onto the 2015 Topic 1.

Scalars & vectors **A**

- Distinguish between scalar and vector quantities; give examples of each.
- Add two vectors using a scale drawing or vector triangle.
- Resolve a vector into perpendicular components: $F_x = F \cos \theta$, $F_y = F \sin \theta$.

Forces in equilibrium **A**

- State the two conditions for a body to be in equilibrium: zero resultant force *and* zero net moment about any point.
- Apply to coplanar forces – resolve, then balance components.
- Identify tension, weight, normal contact and reaction forces in a free-body diagram.

Moments of force **B**

- Moment of a force about a point = force \times perpendicular distance from line of action.
- State and apply the principle of moments: \sum clockwise moments = \sum anticlockwise moments.
- SI unit: newton metre (N·m).

Centre of gravity **B**

- Definition: the single point through which the entire weight of a body appears to act.
- For a uniform body, the centre of gravity is at its geometric centre.
- Topple condition: a body topples when the vertical line from its centre of gravity falls outside its base.

Density & mass **B**

- $\rho = m/V$ – mass per unit volume. SI unit: kg m^{-3} .
- Use $m = \rho V$ to find the mass of a regular solid from its dimensions and material density.

Working scientifically

- Draw labelled free-body diagrams before resolving forces.
- Choose the pivot point carefully – eliminate unknown forces by picking a point on their line of action.
- Always check units (N, N·m, kg m^{-3}) and that opposing moments balance.

Section index for this question pack

A	Vectors, forces & equilibrium	Resolving forces into components, then applying the two equilibrium conditions to hanging bars, mobiles and projector beams.	35 marks · pp 5–10
B	Moments & centre of gravity	Defining and applying moments to gantry cranes, struts and pivoted planks; locating centres of gravity and predicting toppling.	52 marks · pp 12–21

Basic physics in one page

Quick-reference notes – revisit before each section.

Scalars vs vectors

Scalar: magnitude only – mass, time, energy, density, speed, temperature.

Vector: magnitude *and* direction – force, velocity, acceleration, displacement, momentum.

Direction-aware operations (addition, subtraction) must use vector rules.

Resolving a vector

For a force F at angle θ to the horizontal:

$$F_x = F \cos \theta, \quad F_y = F \sin \theta$$

- Components are independent – treat x and y separately.
- Magnitude back: $F = \sqrt{F_x^2 + F_y^2}$.

Adding vectors

Two methods:

- **Triangle rule** – head-to-tail, resultant closes the triangle.
- **Component method** – resolve each into x/y , sum, then recombine.

For perpendicular forces A and B : $R = \sqrt{A^2 + B^2}$.

Equilibrium – two conditions

A body is in equilibrium when *both*:

1. $\sum F = 0$ – net force is zero (resolve each direction).
2. $\sum M = 0$ – net moment about *any* point is zero.

Either condition alone is not enough.

Moment of a force

$$M = F d_{\perp}$$

- F = force, d_{\perp} = perpendicular distance from the pivot to the line of action of F .
- Unit: N·m (not joules – same dimensions, different physical meaning).
- Clockwise vs anticlockwise: opposite signs.

Principle of moments

For a body in equilibrium:

$$\sum M_{\text{clockwise}} = \sum M_{\text{anticlockwise}}$$

Choose the pivot at an unknown force's line of action – that force contributes zero moment and drops out of the equation.

Centre of gravity

Single point through which the entire weight $W = mg$ appears to act.

- For a uniform body: at the geometric centre.
- For a uniform plank: weight acts at midpoint.
- Used as the pivot for the body's weight when taking moments.

Toppling vs sliding

A body on a slope topples when the vertical through its centre of gravity falls outside its base.

Critical angle from geometry of base and height of COG:

$$\tan \theta_{\text{topple}} = \frac{\text{base width}/2}{\text{COG height}}$$

Slides instead if friction is insufficient first.

Density

$$\rho = \frac{m}{V}$$

- Unit: kg m^{-3} .
- Use $m = \rho V$ to convert dimensions to mass (and then to weight $W = mg$).
- Watch units – convert cm to m before computing volume.

Free-body diagrams

Draw the body in isolation. Show every external force as an arrow from its point of application:

- Weight mg acting downward from the centre of gravity.
- Tensions along strings/cables, away from the body.
- Normal contact force perpendicular to the surface.

Pivot & hinge forces

A hinge exerts a force on the beam that can point in any direction.

Find by resolving the equilibrium condition $\sum F = 0$ *after* using moments to find other unknowns.

Magnitude: $F_{\text{hinge}} = \sqrt{F_x^2 + F_y^2}$.

Strategy – 4 steps

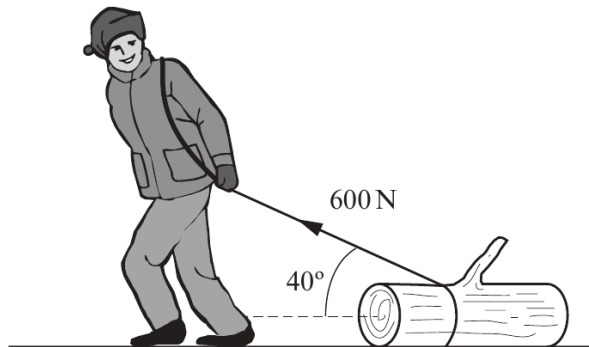
1. Draw a free-body diagram.
2. Resolve any inclined forces into perpendicular components.
3. Take moments about a clever pivot to find one unknown.
4. Use $\sum F_x = 0$, $\sum F_y = 0$ to find the rest.

SECTION A

Vectors, forces & equilibrium

Questions 1 - 4 · 35 marks

6. A man pulls a tree trunk with a force of 600 N inclined at 40° to the horizontal.



Examiner
only

(a) (i) Calculate the horizontal component of the 600 N force pulling the tree trunk forwards. [2]

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(ii) Calculate the vertical component of the 600 N force. [1]

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(b) Using your answer to (a)(ii) and taking the mass of the tree trunk to be 90 kg, determine the vertical force between the tree trunk and the ground. [2]

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- (c) The **horizontal frictional force** acting on the tree trunk is $0.8 \times$ the vertical force between the tree trunk and the ground. Calculate the acceleration of the tree trunk. [3]

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- (d) The weight of the tree trunk is a measure of the Earth's gravitational pull on the tree trunk. Identify the Newton third law 'equal and opposite' force to the weight of the tree trunk. [1]

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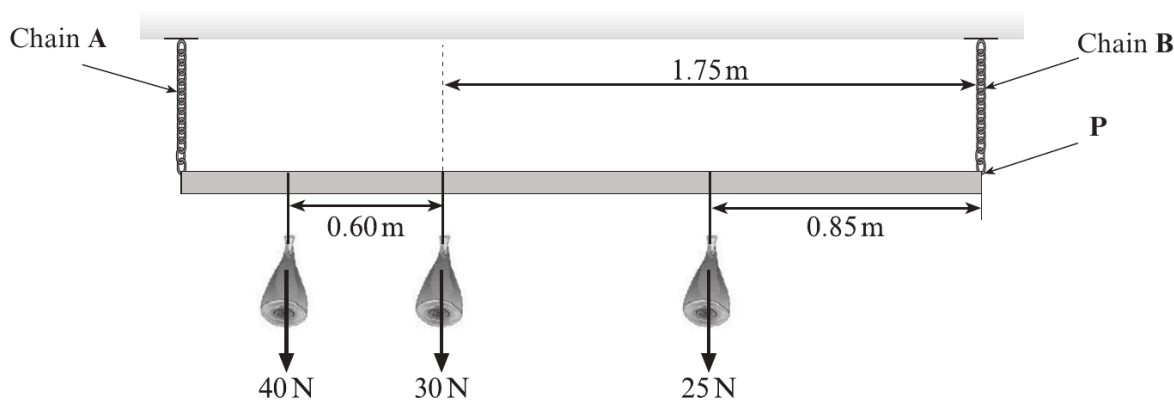
2. (a) State the conditions necessary for a body to remain in equilibrium. [2]

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- (b) The owner of a high-street butcher shop hangs joints of meat from a uniform metal bar as shown. The bar is 3.0 m long, weighs 20 N and is connected to the shop's ceiling by two light chains, A and B.



- (i) On the diagram, show the weight of the bar as an arrow acting through the centre of gravity and label it 20 N. [1]
- (ii) Taking moments about point P, calculate the tension in chain A. [4]

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- (iii) Hence calculate the tension in chain B. [2]

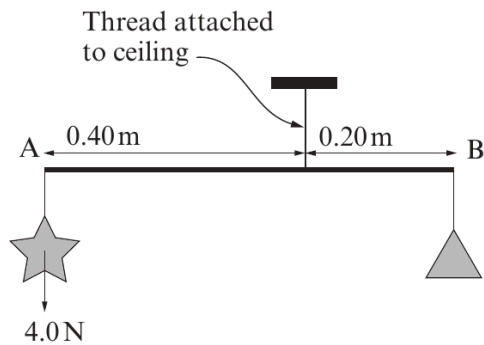
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3. (a) What name is given to the turning effect of a force? [1]

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(b) (i) A simple toy mobile, consisting of a star and a triangle is shown hanging freely. Assume the rod AB is weightless. Calculate the weight of the triangle. [2]



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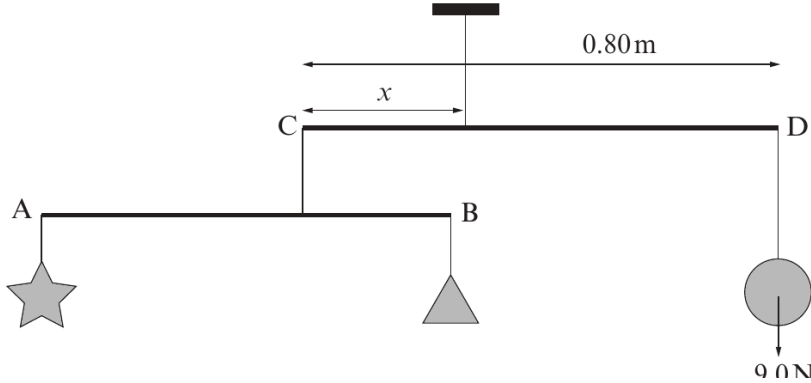
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(ii) Hence calculate the tension in the thread attached to the ceiling. [1]

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(c) The mobile is now attached to another weightless rod CD of length 0.80 m, making a more complex mobile as shown. A sphere of weight 9.0 N is attached to D and the mobile is hung freely from the ceiling.



Examiner only

- (i) The distance x can be adjusted to allow the rod CD to hang horizontally. Calculate x . [3]

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- (ii) The original star and triangle mobile is now replaced with a single ‘crescent moon’ of weight 12.0 N as shown. Explain whether x will now have to increase, decrease or stay the same to keep CD horizontal. [2]

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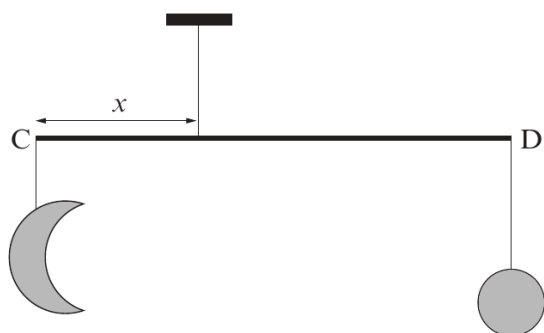
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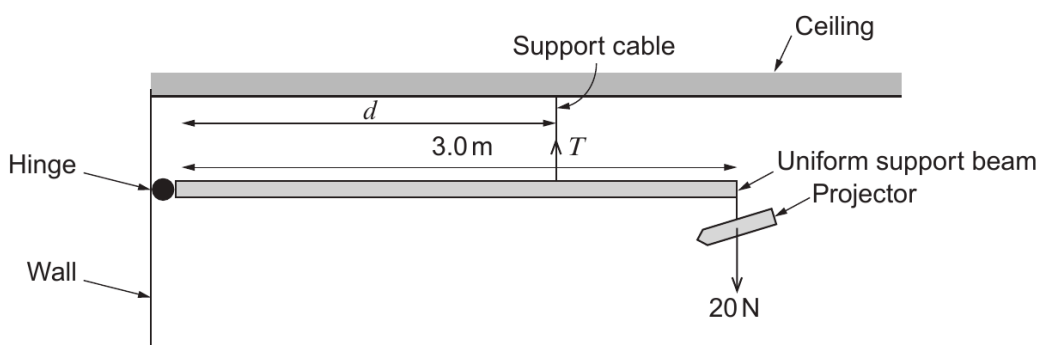
6. (a) State the **two** conditions necessary for a body to remain in equilibrium. [2]

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- (b) A school technician installs a projector of weight 20 N and uniform support beam of weight 10 N in a classroom as shown.



- (i) **Label** with an arrow on the diagram, the weight of the beam. [1]
- (ii) The manufacturer states that, for safety purposes, the tension, T , in the support cable must not exceed 40 N. Calculate the minimum distance, d , that the technician can place the cable so that the tension in it does not exceed the safe limit. [3]

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- (iii) Determine the size and direction of the force that the hinge exerts on the beam when the tension in the support cable is at its maximum safe limit. [2]

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SECTION B

Moments & centre of gravity

Questions 5 - 9 · 52 marks

Examiner only

7. (a) A student gives the following **incorrect** and **incomplete** definition of the moment of a force about a point.

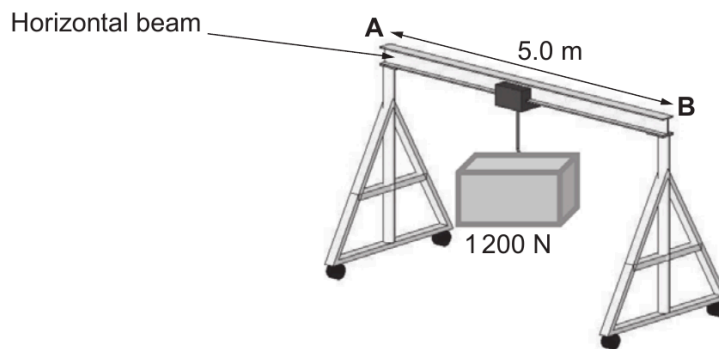
$$\text{Moment of a force about a point} = \text{mass} \times \text{distance}$$

Correct the definition.

[2]

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- (b) A simple gantry crane is used to transport heavy loads. It consists of a horizontal beam (**AB**) of length 5.0 m fixed at each end to a vertical pillar as shown. It is possible to move the load along the horizontal beam.



When the gantry crane supports a load of 1200 N **at its centre**, a force of 700 N is exerted on each pillar. Calculate the weight of the horizontal beam. [2]

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Examiner
only

(c) The same load is now **moved 1.0 m towards B**.

(i) Draw arrows on the diagram below to show the forces now acting on the beam. [2]



(ii) By taking moments about a suitable point, calculate the force on the beam at **B**. [3]

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(iii) Hence calculate the force on the beam at **A**. [1]

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END OF PAPER

6. (a) Explain, with the aid of a diagram, what is meant by the moment of a force about a point. [2]

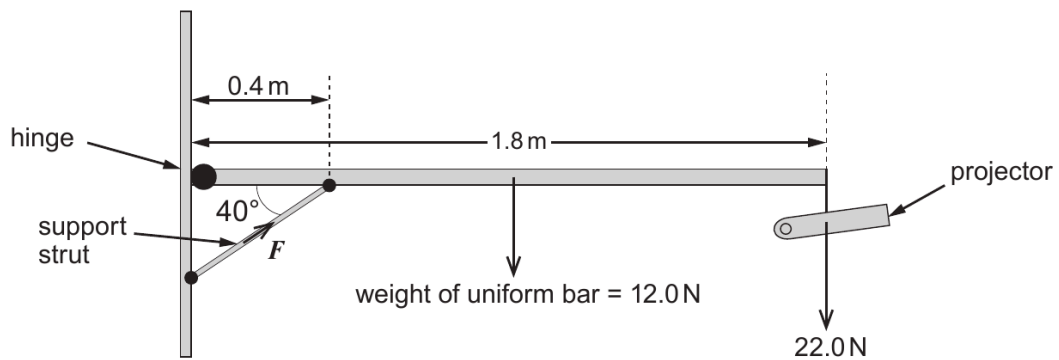
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- (b) A classroom projector is set up as shown.



- (i) By taking moments about the hinge, show that the force, F , exerted by the support strut on the uniform bar is approximately 200 N. [3]

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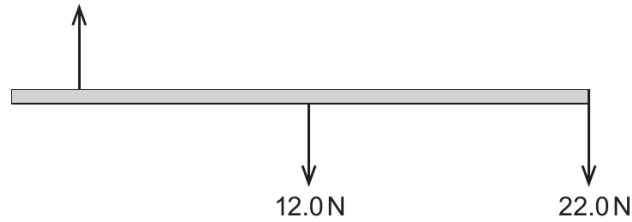
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Examiner
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- (ii) The free body diagram below shows **some of the vertical forces** acting on the uniform bar.

vertical component of
force exerted by the strut
on the bar



- (I) Calculate the value of the **vertical component** of the force exerted by the strut on the bar. [1]

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- (II) Indicate, with an arrow **on the diagram**, the direction of the vertical force on the bar due to the hinge. [1]

- (III) Calculate the size of the vertical force on the bar due to the hinge. [1]

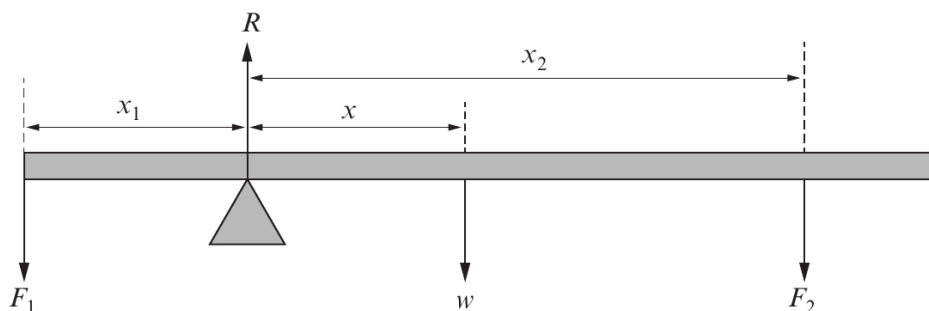
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Examiner only

7. (a) One condition for a body to remain in equilibrium is that there should be *no net moment* acting on it about any point. State the other condition necessary for a body to remain in equilibrium. [1]

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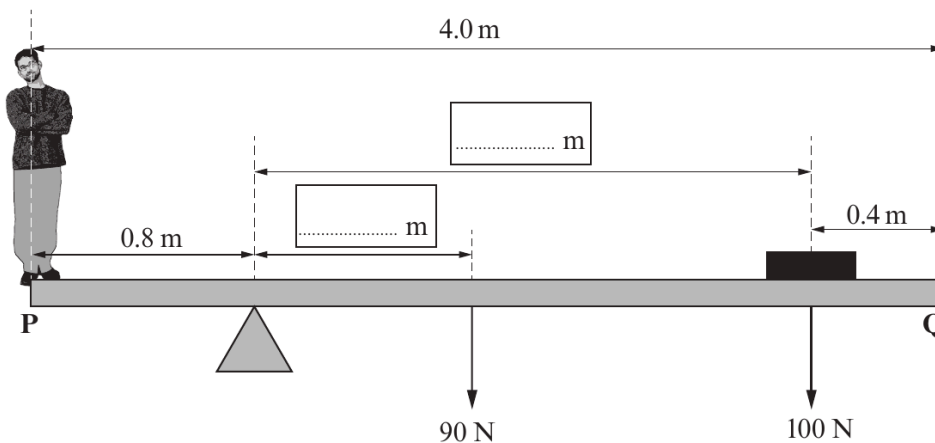
- (b) The diagram shows a uniform plank of weight w pivoted so that it remains in equilibrium when forces F_1 and F_2 are applied to it at distances x_1 and x_2 as shown. R represents the contact force at the pivot.



Applying the principle of moments about the pivot, complete the equation: [1]

$$F_1 x_1 = \dots\dots\dots$$

- (c) An experiment is carried out to find the weight of a Physics student. A uniform plank of wood **PQ**, 4.0 m long and weighing 90 N is pivoted about a point 0.8 m from **P**. A 100 N weight is placed 0.4 m from **Q** in order to balance the plank horizontally.



- (i) Use the information given to fill in the two blank boxes with relevant distances. [1]

(ii) Hence calculate the weight of the student. [2]

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(iii) Determine the value of the force exerted by the pivot on the plank. [1]

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(iv) By taking moments about **Q**, and using your answers to (c)(ii) and (c)(iii), confirm that the plank is in equilibrium. [2]

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(v) The student now steps off the plank and is replaced by another, heavier student who stands at point **P**. Which way must the **pivot** be moved in order to balance the plank horizontally? Explain your answer. [2]

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END OF PAPER

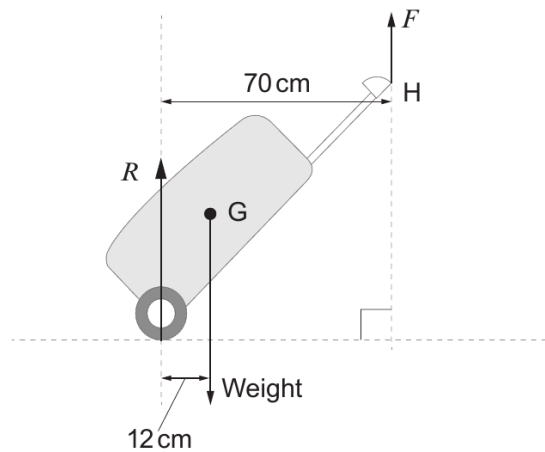
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3. A passenger at an airport pulls a travel case as shown.



Examiner only

(a) When the passenger is stationary, a free body diagram for the travel case is shown below. It is held at rest by the passenger's hand at H and its centre of gravity is at G. The mass of the case is 8.5 kg.



(i) Define the *moment of a force*. [1]

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(ii) Calculate the size of the upward pull, F , of the hand on the case. [3]

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(iii) Calculate the value of R , the force of the ground on the case. [1]

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Examiner only

- (iv) Explain how repacking the case so as to move the centre of gravity further away from the wheel would affect the size of force F . [2]

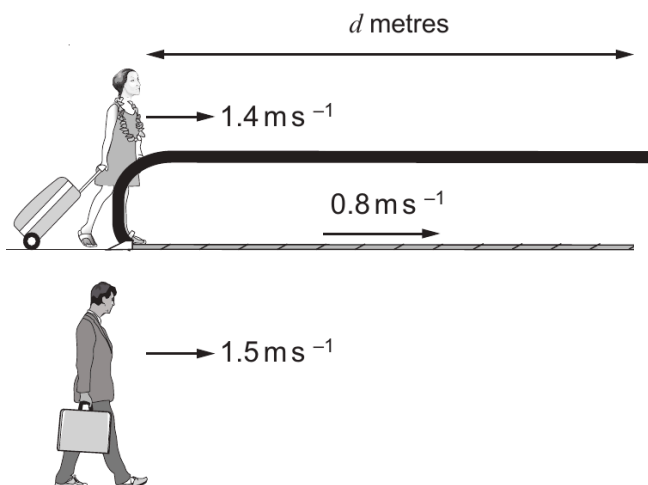
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- (b) The passenger now walks at 1.4 ms^{-1} onto a walkway of length d metres which is itself moving at 0.8 ms^{-1} . At the instant she steps on the walkway, another passenger initially alongside it decides not to take the walkway, but instead walks alongside it at a speed of 1.5 ms^{-1} . The passenger on the walkway takes a time, t , to reach the end. The passenger walking alongside takes an **additional 14 seconds** before reaching the end of the walkway.



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- (i) Write down an expression for the distance, d , travelled by the passenger on the walkway. [1]

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- (ii) Write down an expression for the distance, d , travelled by the passenger walking alongside the walkway. [1]

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- (iii) Hence, determine the length, d , of the walkway. [3]

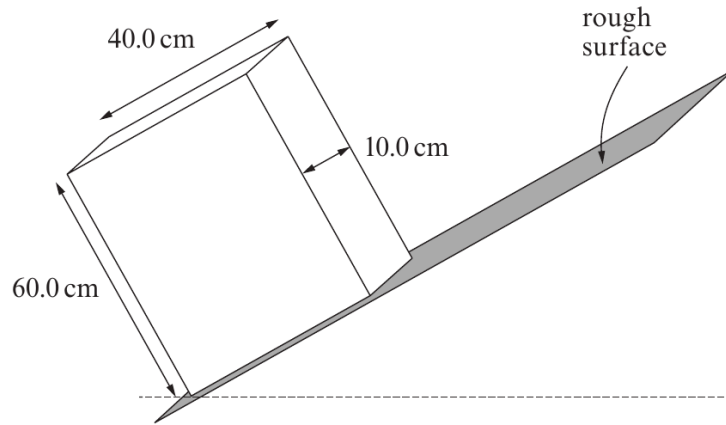
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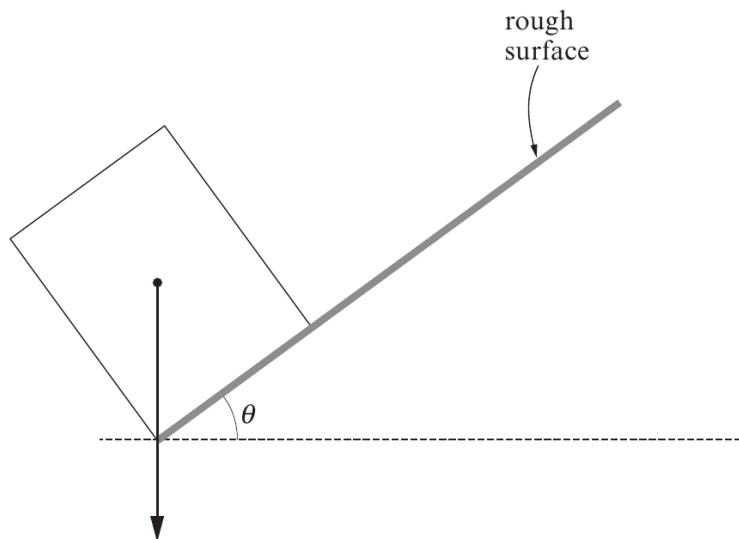
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5. (a) A solid block of uniform density with sides 60.0 cm, 40.0 cm and 10.0 cm rests on a sloping rough surface.

Examiner only



The following diagram shows the block viewed from the side **at the point of toppling**. An arrow is shown passing through the centre of gravity of the block.



- (i) Explain what is meant by 'centre of gravity'. [1]

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- (ii) Calculate the angle θ . Assume that no sliding occurs. [2]

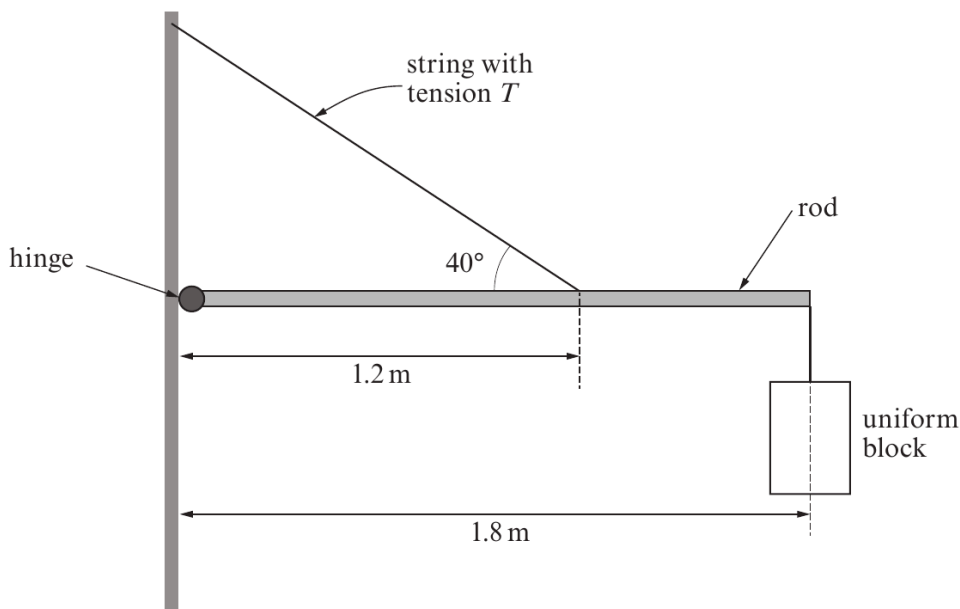
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- (b) The block (in part (a)) is now attached to a rod of **negligible weight** which is supported by a string and a frictionless hinge as shown in the diagram below.



- (i) The density of the material of the block is 400 kg m^{-3} . Show that the mass of the block is 9.6 kg. [2]

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- (ii) By taking moments about the hinge, calculate the tension in the string. [4]

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- (iii) Hence calculate the horizontal component of the force that the rod exerts on the hinge. [2]

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END OF QUESTION PACK

9 questions · 87 marks · ~1 h 30 min

Mark schemes available from WJEC and Physics & Maths Tutor.