EDEXCEL A-LEVEL MATHEMATICS (9MA0) · PAPER 3 MECHANICS · A-LEVEL MECHANICS A* REVISION · SHEET 1 OF 6

Hints online, answers free with an account:
mathswariz.uk/worksheets/a-level-mechanics-a-star-revision-1/

A-Level Mechanics A* revision 1

94 marks

Date

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

X Exam questions

Edexcel 9MA0 Paper 3 Mechanics style, later parts of long questions. Take g = 9.8 m s^{-2} and give answers to 2 or 3 significant figures. Show all your working: an answer with no method may score no marks. The hints are at the end of the sheet. Use one at a time.

X1 A particle P moves along a straight line. At time t seconds the acceleration of P is $(6t - 30)\ \mathrm{m\ s^{-2}}$, in the direction of x increasing. When $t = 0$, P is at the point O and is moving with velocity $48\ \mathrm{m\ s^{-1}}$ in the direction of x increasing. [10 marks]

Find the total distance travelled by P in the interval $0 \leqslant t \leqslant 9$, and the greatest distance of P from O in this interval.

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

X2 A motorcycle is waiting at a set of traffic lights at the point L on a straight horizontal road. At time $t = 0$ a car passes L moving at $18\ \mathrm{m\ s^{-1}}$, and at that instant the driver of the car brakes. The car then decelerates uniformly at $1.5\ \mathrm{m\ s^{-2}}$ until it stops, and it stays at rest. [10 marks]

When $t = 2$ the motorcycle sets off from rest at L and moves in the same direction as the car with constant acceleration $1.2\ \mathrm{m\ s^{-2}}$.

The car and the motorcycle are modelled as particles. Find the time at which the motorcycle draws level with the car, and the distance of this point from L. Give the time to 3 significant figures.

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

Answer .....

X3 In this question $\mathbf{i}$ and $\mathbf{j}$ are horizontal unit vectors due east and due north. A particle P of mass 2.5 kg moves on a smooth horizontal surface under the action of two forces, $\mathbf{F}_1 = (3\mathbf{i} - 2\mathbf{j})$ N and $\mathbf{F}_2 = (k\mathbf{i} + 7\mathbf{j})$ N, where k is a constant. The resultant of the two forces is parallel to the vector $(2\mathbf{i} + \mathbf{j})$.

(a) Find the value of k. [3 marks]

Answer .....

(b) At time $t = 0$ the velocity of P is $(-6\mathbf{i} + 5\mathbf{j})\ \text{m s}^{-1}$. Find the speed of P at the instant when it is moving due north. [3 marks]

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(c) Find the bearing on which P is moving when $t = 1$. Give your answer to the nearest degree. [3 marks]

Answer .....

(d) Explain why P is never moving due west for $t \geqslant 0$. [2 marks]

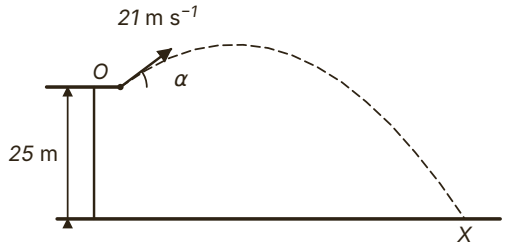
Answer .....

Total for X3: 11 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

X4 A stone is thrown from a point O on a bridge. The point O is $25\ \text{m}$ above the surface of a river. The stone is thrown with speed $21\ \text{m s}^{-1}$ at an angle α above the horizontal, where $\tan\alpha = \frac{3}{4}$, and it enters the water at the point X. The stone is modelled as a particle moving freely under gravity, and the surface of the river is modelled as horizontal. [11 marks]

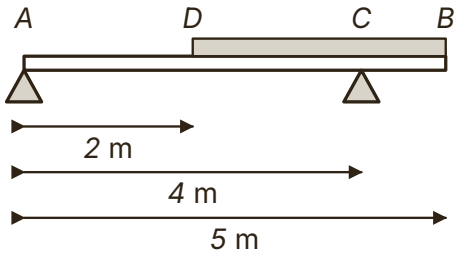
Find the horizontal distance between O and X, and find the speed and the direction of motion of the stone as it enters the water. Give your answers to 3 significant figures.



© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

Answer .....

X5 A uniform plank AB has length 5 m and mass 30 kg. It rests horizontally on two supports, one at A and one at C, where $AC = 4$ m. Sand of total mass 20 kg is spread evenly along the part DB of the plank, where $AD = 2$ m, as shown in the figure.



(a) Explain why, when taking moments, the sand can be modelled as a single particle of mass 20 kg placed 3.5 m from A. [2 marks]

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(b) Find the magnitude of the reaction at each support. Give your answers to 3 significant figures. [4 marks]

Answer .....

(c) A worker of mass 75 kg walks along the plank from A towards B. The worker is modelled as a particle. Find the distance of the worker from A when the plank is about to tip. [4 marks]

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

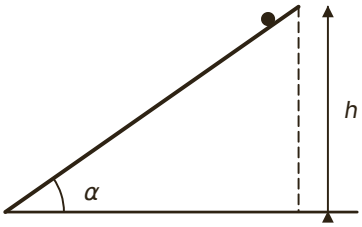
(d) Extra sand is spread evenly along AD so that the worker can stand at B without the plank tipping. Find the least mass of extra sand needed. [2 marks]

Answer .....

Total for X5: 12 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

X6 A playground slide is modelled as a straight rough slope inclined at an angle α to the horizontal. The top of the slope is a vertical height h above the bottom. A child starts from rest at the top and slides down to the bottom. The coefficient of friction between the child and the slope is μ, where $\mu < \tan\alpha$. The child is modelled as a particle.



(a) Show that the speed of the child at the bottom of the slope is $\sqrt{2gh\,(1-\mu\cot\alpha)}$. [6 marks]

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(b) For one slide $h = 2.4$ m, $\alpha = 35^\circ$ and $\mu = 0.3$. Find the speed of the child at the bottom of this slide. Give your answer to 2 significant figures. [2 marks]

Answer .....

(c) Using the model, explain why [2 marks]
(i) a heavier child reaches the bottom with the same speed,
(ii) a steeper slide of the same height gives a greater speed at the bottom.

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

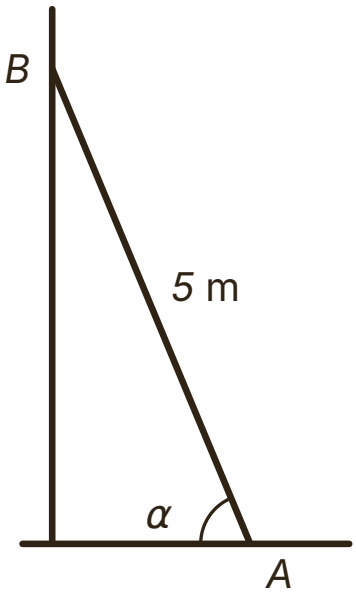
(d) A child is placed at rest on a slope of this material, with $\mu = 0.3$. Find the angle of the slope for which the child is in limiting equilibrium, giving your answer to 3 significant figures, and state what happens to a child placed at rest on a slope at a smaller angle. [3 marks]

Answer .....

Total for X6: 13 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

X7 A ladder AB is modelled as a uniform rod of length $5\ \mathrm{m}$ and mass $18\ \mathrm{kg}$. The ladder rests with its end A on rough horizontal ground and its end B against a smooth vertical wall, in a vertical plane perpendicular to the wall. The ladder makes an angle α with the ground, where $\tan\alpha = \frac{12}{5}$. The coefficient of friction between the ladder and the ground is 0.25. A painter of mass $72\ \mathrm{kg}$, modelled as a particle, climbs the ladder from A.



© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(a) When the painter is x metres from A, the ladder is in equilibrium. State, with a reason, the direction of the friction force acting on the ladder at A, and show that the magnitude of this friction force is $\frac{3g(5+8x)}{4}$ N. [5 marks]

Answer .....

(b) Find how far up the ladder the painter can climb before the ladder slips. [3 marks]

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(c) So that the painter can reach B, a load of mass M kg is fixed to the ladder at A. Find the least value of M. [4 marks]

Answer .....

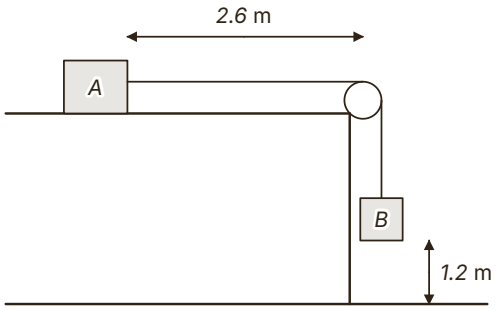
(d) State how you have used the modelling assumption that the wall is smooth. [1 mark]

Answer .....

Total for X7: 13 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

X8 A particle A of mass 3 kg rests on a rough horizontal table. It is attached to one end of a light inextensible string. The string passes over a small smooth pulley fixed at the edge of the table, and its other end is attached to a particle B of mass 2 kg, which hangs freely 1.2 m above the floor. Particle A is 2.6 m from the pulley. The coefficient of friction between A and the table is 0.25. The system is released from rest with the string taut.



(a) Write down an equation of motion for A and an equation of motion for B. Hence show that the acceleration of B is $\frac{g}{4}$. [6 marks]

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(b) Find the tension in the string while B is falling. [2 marks]

Answer .....

(c) Find the speed of B as it hits the floor. Give your answer to 3 significant figures. [2 marks]

Answer .....

(d) B does not rebound. Determine whether A reaches the pulley. [4 marks]

Answer .....

Total for X8: 14 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

F How did it go?

Colour one circle on each line.

	Not yet	Nearly	Yes
I can draw a full force diagram and resolve, take moments or write F = ma for the right body, with every distance perpendicular.	○	○	○
I can find my own route through a mechanics question that has no parts, and give answers to 2 or 3 significant figures.	○	○	○
I can use calculus and vectors for motion that is not constant acceleration, with the constant of integration from the start.	○	○	○
I can explain a result and criticise a model: friction direction, limiting equilibrium, one limitation of the model.	○	○	○

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

Hints

Use one hint at a time. Cover the ones below it with a sheet of paper.

X1

Hint 1 Integrate the acceleration and use the velocity at $t = 0$ to find the constant.

Hint 2 Find the times in the interval at which $v = 0$. The particle changes direction at each of them.

Hint 3 Find the position at $t = 2$, 8 and 9. Add the distance of each stage as a positive number; the greatest distance from O is the largest of these positions in size.

X2

Hint 1 Work out when and where the car stops before you set any distances equal.

Hint 2 The motorcycle has been moving for $(t - 2)$ seconds at time t. Check whether it reaches the car before the car stops.

Hint 3 At $t = 12$ the motorcycle is only 60 m from L. So it meets a car that is at rest 108 m from L: solve $0.6(t - 2)^2 = 108$.

X3

Hint 1 Add the two forces first. "Parallel to $2\mathbf{i} + \mathbf{j}$" means the $\mathbf{i}$ component is twice the $\mathbf{j}$ component.

Hint 2 Use $\mathbf{a} = \dfrac{\mathbf{F}}{m}$ and $\mathbf{v} = \mathbf{u} + \mathbf{a}t$. Moving due north means the $\mathbf{i}$ component of the velocity is zero and the $\mathbf{j}$ component is positive.

Hint 3 A bearing is measured clockwise from north. For (d), find when the $\mathbf{j}$ component of the velocity would be zero.

X4

Hint 1 Resolve the initial velocity into horizontal and vertical components before using either.

Hint 2 Take upwards as positive. The water is below O, so the vertical displacement when the stone enters it is -25 m; solve the quadratic for t and keep the positive root unrounded.

Hint 3 The horizontal velocity does not change. Find the vertical velocity at X, then combine the two components for the speed and use $\tan$ for the angle below the horizontal.

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

X5

Hint 1 The plank is uniform, so its weight acts at its midpoint. The sand is spread evenly, so its weight acts at the midpoint of DB.

Hint 2 For (c), the plank turns about C, the support nearer the worker. Just before it tips, the support at A pushes with zero force.

Hint 3 Take moments about C: the plank (1.5 m) and the sand (0.5 m) are on one side, the worker on the other. For (d) the new sand is 3 m from C.

X6

Hint 1 Resolve perpendicular to the slope for R, then write $F = ma$ down the slope. The child is moving, so friction is μR.

Hint 2 The child travels $\dfrac{h}{\sin\alpha}$ along the slope, starting from rest. Use $v^2 = u^2 + 2as$ and divide through by $\sin\alpha$.

Hint 3 For (d), "limiting equilibrium" means the weight component down the slope equals μR exactly. The m and g cancel.

X7

Hint 1 Draw every force: the ladder's weight at its midpoint, the painter's weight, the reaction at B perpendicular to the wall, and the normal reaction and friction at A.

Hint 2 Take moments about A, so that the two unknown forces at A do not appear. Use perpendicular distances, with $\sin\alpha = \frac{12}{13}$ and $\cos\alpha = \frac{5}{13}$.

Hint 3 The ladder is about to slip when $F = 0.25R$. A load fixed at A adds to R but has no moment about A.

X8

Hint 1 Draw the forces on A and on B separately. On the table $R = 3g$ and the friction is μR, acting away from the pulley.

Hint 2 Write $F = ma$ for each particle with the same T and the same a, then add the two equations to remove T.

Hint 3 When B hits the floor the string goes slack: A then has only friction acting on it, so it has a new deceleration. Find how much further it slides and add the 1.2 m it has already moved.

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.