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INTERNATIONAL A LEVEL MATHEMATICS • MECHANICS 1

Mechanics 1

Exam Questions by Topic

Pearson Edexcel International Advanced Level (WME01/01) • Calculator allowed • Take $g = 9.8 \text{ m s}^{-2}$

Multi-step exam questions at the difficulty of the real WME01 paper, with a full mark scheme

Chapters (tap a chapter to jump to it)	Qs	Marks	Page	My score
1 Mathematical Models in Mechanics Not examined on its own: modelling ideas are tested within Chapters 2 to 8	—	—	Not applicable	
2 Constant Acceleration Motion graphs, the suvat formulae, vertical motion under gravity	10	82	own PDF	
3 Vectors in Mechanics Resultants, velocity and position vectors, $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}t$	10	81	own PDF	
4 Dynamics of a Particle Moving in a Straight Line $F = ma$, connected particles, pulleys, lifts	10	82	own PDF	
5 Forces and Friction Resolving forces, friction, inclined planes	10	86	2	
6 Momentum and Impulse Conservation of momentum, impulse	10	81	own PDF	
7 Statics of a Particle Equilibrium, limiting friction	10	82	own PDF	
8 Moments Beams and rods, tilting, non-uniform rods	10	82	own PDF	

[Full mark scheme](#)

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Page 1 of 27

CHAPTER 5 • KEY SKILLS

5

Forces and Friction

Specification M1: Forces and friction • 10 questions • 86 marks • about 103 minutes

1 Resolving a force

A force P at θ to a direction has components $P \cos \theta$ along it and $P \sin \theta$ perpendicular to it.

2 Inclined planes

Weight mg : $mg \sin \alpha$ down the plane and $mg \cos \alpha$ into the plane. Resolve parallel and perpendicular to the plane.

3 Normal reaction

Resolve perpendicular to the surface: R is not always mg or $mg \cos \alpha$. A pull upwards reduces R ; a push downwards increases it.

4 Friction

$F \leq \mu R$. When sliding, $F = \mu R$ and it opposes the motion, so it reverses when the motion reverses.

5 Equations of motion

Along the plane: resultant = ma .
Perpendicular to the plane: resultant = 0. Constant speed means $a = 0$.

6 Exact trigonometry

$\tan \alpha = \frac{3}{4}$ gives $\sin \alpha = \frac{3}{5}$, $\cos \alpha = \frac{4}{5}$;
 $\tan \alpha = \frac{5}{12}$ gives $\frac{5}{13}$, $\frac{12}{13}$. Keep these exact.

7 Will it move?

Compare the force trying to move the particle with the greatest possible friction μR . On a plane alone: slides if $\tan \alpha > \mu$

8 Pulleys on planes

One equation for each particle. Force on the pulley: add the two tensions, using the angle between the two parts of the string.

9 When forces change

Removing a force changes R , so friction and the acceleration change. Show an inequality when asked whether something is reached.

Skills map every skill above is tested at least once; interleaved skills come from GCSE or other chapters

Skill	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Marks	6	6	6	6	6	12	11	11	10	12
1 Resolving a force	•	•		•		•				
2 Inclined planes		•			•	•	•		•	•
3 Normal reaction	•	•		•		•				
4 Friction	•		•	•	•	•	•	•		•
5 Equations of motion	•	•	•	•	•	•	•	•	•	•
6 Exact trigonometry					•		•			•
7 Will it move?					•	•				•
8 Pulleys on planes							•	•		
9 When forces change				•		•	•	•	•	
Interleaved: constant acceleration and motion graphs (Chapter 2)			•			•	•	•	•	•
Interleaved: connected particles and pulleys (Chapter 4)							•	•	•	
Interleaved: trigonometry and inequalities (P1)		•			•		•	•		

Exam difficulty. Questions 1 to 5 check each skill on its own. Questions 6 to 10 are multi-step questions built like the last questions on a real WME01 paper, where one part leads into the next and skills from different topics are combined.

Must learn. Draw a force diagram with friction opposing the motion. Resolve perpendicular to the surface first to find R , including every force with a perpendicular component. Use exact values of $\sin \alpha$ and $\cos \alpha$ when $\tan \alpha$ is given.



Question 1 continued

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Question 2 continued

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3. A small stone slides in a straight line across a rough horizontal sheet of ice. The stone passes a point A with speed 8 m s^{-1} and comes to rest 10 m from A . The stone is modelled as a particle.
- (a) Find the deceleration of the stone. (2)
- (b) Find the coefficient of friction between the stone and the ice. (2)
- (c) Find the time taken for the stone to come to rest after passing A . (1)
- (d) Explain why your answer to part (b) does not depend on the mass of the stone. (1)

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Question 4 continued

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5. A particle is placed at rest on a rough plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{5}{12}$. The coefficient of friction between the particle and the plane is 0.3. The particle is released.

(a) Show that the particle slides down the plane.

(3)

(b) Find the acceleration of the particle.

(2)

(c) State the least value of the coefficient of friction for which the particle would remain at rest.

(1)

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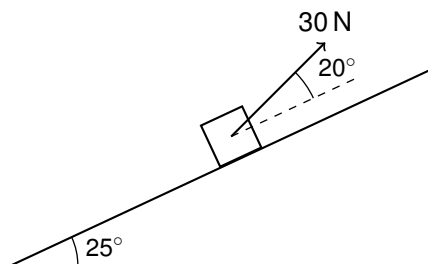


Figure 4

A parcel of mass 3 kg is pulled up a rough plane inclined at 25° to the horizontal by a force of magnitude 30 N. The force acts at 20° to the plane, as shown in Figure 4, and its line of action lies in a vertical plane containing a line of greatest slope of the plane. The coefficient of friction between the parcel and the plane is 0.4. The parcel is modelled as a particle.

(a) Find the acceleration of the parcel.

(5)

The points A and B lie on a line of greatest slope of the plane, with B above A and $AB = 5$ m. The parcel passes A with speed 2 ms^{-1} , moving up the plane.

(b) Find the speed of the parcel at B .

(2)

The 30 N force is removed at the instant the parcel passes B . The parcel comes to instantaneous rest at the point C .

(c) Find the distance BC .

(3)

(d) Determine whether the parcel remains at rest at C , giving a reason.

(2)



Question 6 continued

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Question 6 continued

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A diagram showing a mechanical system. A pulley is at the top right. A rope passes over the pulley. One end of the rope is attached to a block labeled 'A' which is on an inclined plane. The other end of the rope is attached to a block labeled 'B' which hangs vertically. The angle of the inclined plane is labeled α .

Figure 5

(a) Find the frictional force acting on A .

(2)

(b) Show that the acceleration of A is $0.2g$, and find the tension in the string.

(4)

(c) Find the magnitude of the force exerted on the pulley by the string.

(2)

B was released 1 m above the ground and does not rebound when it reaches the ground. A does not reach the pulley.

(d) Find the further distance that A moves up the plane after B reaches the ground.

(3)

Question 7 continued

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Question 7 continued

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Question 8 continued

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Question 8 continued

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Question 9 continued

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Question 9 continued

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Question 10 continued

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Question 10 continued

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(Total for Question 10 is 12 marks)**TOTAL FOR CHAPTER 5 IS 86 MARKS****Join students already acing their exams.**Book your FREE lesson at www.eclassroom.org.uk