Mechanics II Independent Revision Resource

**Specification points**

**3.2.1 Dynamics**

**(a)** net force = mass acceleration; *F* = *ma* Learners will also be expected to recall this equation.

**(b)** the newton as the unit of force

**(c)** weight of an object; *W* = *mg* Learners will also be expected to recall this equation.

**(d)** the terms tension, normal contact force, upthrust and friction

**(e)** free-body diagrams

**(f)** one- and two-dimensional motion under constant force.

**3.2.2 Motion with non-uniform acceleration**

**(a)** drag as the frictional force experienced by an object travelling through a fluid

**(b)** factors affecting drag for an object travelling through air

**(c)** motion of objects falling in a uniform gravitational field in the presence of drag

**(d) (i)** terminal velocity

**(ii)** techniques and procedures used to determine terminal velocity in fluids.

**PAG1** e.g. ball-bearing in a viscous liquid or cones in air.

**3.2.3 Equilibrium**

**(a)** moment of force

**(b)** couple; torque of a couple

**(c)** the principle of moments

**(d)** centre of mass; centre of gravity; experimental determination of centre of gravity

**(e)** equilibrium of an object under the action of forces and torques

**(f)** condition for equilibrium of three coplanar forces; triangle of forces.

**3.2.4 Density and pressure**

**(a)** density

**(b)** pressure for solids, liquids and gases

**(c)** *p* = *htg;* upthrust on an object in a fluid; Archimedes’ principle.

**3.3.1 Work and conservation of energy**

**(a)** work done by a force; the unit joule

**(b)** *W* = *Fx* cos*θ* for work done by a force

**(c)** the principle of conservation of energy

**(d)** energy in different forms; transfer and conservation

**(e)** transfer of energy is equal to work done.

**3.3.2 Kinetic and potential energies**

**(a)** kinetic energy of an object; Learners will also be expected to recall this equation

and derive it from first principles.

**(b)** gravitational potential energy of an object in a uniform gravitational field; *E*p = *mgh*

Learners will also be expected to recall this equation and derive it from first principles.

**(c)** the exchange between gravitational potential energy and kinetic energy.

**3.3.3 Power**

**Learning outcomes Additional guidance**

**(a)** power; the unit watt

**(b)** *P* = *Fv* Learners will also be expected to derive this equation from first principles.

**(c)** efficiency of a mechanical system;

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| **Website** | **Comments** |
| <https://www.s-cool.co.uk/a-level/physics/forces/revise-it/friction-and-terminal-velocity> | Basic information about friction and terminal velocity |
| <https://www.s-cool.co.uk/a-level/physics/forces/revise-it/pressure> | Pressure – basics including hydraulic systems for info and interest. |
| <https://www.s-cool.co.uk/a-level/physics/moments-couples-and-equilibrium> | Really good explanation of moments, couples and equilibrium force situations including lots of diagrams (This will help you if you struggle drawing a diagram from the question) |
| <https://www.s-cool.co.uk/a-level/physics/work-energy-and-efficiency> | Good definition of work and explanation through diagrams to show how to calculate the work done etc. in different situations. |
| <https://revisionworld.com/a2-level-level-revision/physics/force-motion/drag-terminal-velocity/terminal-velocity> | Very simple description of terminal velocity |
| <https://revisionworld.com/a2-level-level-revision/physics-level-revision/force-motion/energy-work> | Select the appropriate sections from this area (it includes electrical power). |
| <http://www.a-levelphysicstutor.com/m-kinetics-workenergy.php>  <http://www.a-levelphysicstutor.com/m-kinetics-power-efficiency.php>  <http://www.a-levelphysicstutor.com/m-statics-equilibrium.php> | Advanced – with full derivations for those who want to go into more detail. |
| <https://www.youtube.com/watch?v=HbNiwDFkgZM> | **YOUTUBE –** Newton’s 2nd law, terminal velocity and inclined plane situations. |
| <https://www.youtube.com/watch?v=2eNOIXC4UMs&list=PLGvD8d3gDHUVgyxA8evex35dWdWpl47k3&index=5> | **YOUTUBE** – balanced forces |
| <https://www.youtube.com/watch?v=QYC7Uv2Rspw&list=PLGvD8d3gDHUVgyxA8evex35dWdWpl47k3&index=4> | **YOUTUBE –** Tension versus weight – making sure you understand the difference ☺ |
| <https://www.youtube.com/watch?v=jSycRyhYZ6U> | **YOUTUBE** work done, energy and gpe. |
| <https://www.youtube.com/watch?v=NueuPY2Yqq4&list=PLGvD8d3gDHUVgyxA8evex35dWdWpl47k3&index=10> | **YOUTUBE** – moments and torque |
| <https://www.youtube.com/watch?v=lIRrZhju61g&list=PLGvD8d3gDHUVgyxA8evex35dWdWpl47k3&index=13> | **YOUTUBE –** Density |
| <https://www.youtube.com/watch?v=tqHzGfjtSVo&list=PLGvD8d3gDHUVgyxA8evex35dWdWpl47k3&index=14> | **YOUTUBE –** Upthrust  (You do not need to know the section on Stoke’s law – but if you’re going on to do engineering or more Physics it will be useful in the future ☺ |

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| **To Do**   * Create detailed revision notes from your text book and answer the end of section and practice questions. * Review the spec points above and ensure you have included everything * Use revision guides or the above websites/clips to help explain specific details * Make sure you know, understand and can describe the practical to determine terminal velocity   Attempt past paper questions either repeating questions from your Study Booklet or **choose** from those below - MS in separate file at [Q:\Physics\A-Level\Module 3 - Forces and Motion\Revision resources\2 Mechanics B resources\Mechanics II Revision Resources MS.docx](file:///Q:\Physics\A-Level\Module%203%20-%20Forces%20and%20Motion\Revision%20resources\2%20Mechanics%20B%20resources\Mechanics%20II%20Revision%20Resources%20MS.docx) |

Past Paper questions Revision: Mechanics End of Topic Test December

**1.** A public house sign is fixed to a vertical wall as shown in the diagram.



A uniform metal bar 0.75 m long is fixed to the wall by a hinged joint that allows free movement in the vertical plane only. The wire is fixed to the wall directly above the hinge and to the free end of the horizontal metal bar. The wire makes an angle of 40° with the wall.  
A single support holds the sign and is mounted at the mid point of the metal bar so that the weight of the sign acts through that point.

(a) (i) Draw on the diagram three arrows showing the forces acting on the metal bar, given that the system is in equilibrium. Label the arrows A, B and C.

(ii) State the origin of the forces.

A .......................................................................................................................

B .......................................................................................................................

C .......................................................................................................................

(5)

(b) The combined mass of the metal bar and sign is 12 kg and the mass of the wire is negligible. By taking moments about the hinged end of the bar, or otherwise, calculate the tension in the wire.

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(4)

(Total 9 marks)

**2.** The cross-section of an overhead power cable is shown below. The cable consists of a hard steel core surrounded by fifteen straight, thick copper wires.



100m lengths of cable are suspended between adjacent pylons as part of an electricity distribution system.

Calculate the mass of a 100m length of the cable.

density of copper **=**8.93 × 103 kg m–3  
density of steel **=**7.80 × 103 kg m–3

mass of hard steel core .........................................................................................................

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mass of copper wires .............................................................................................................

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mass of cable .........................................................................................................................

(Total 4 marks)

**3.** A mass of 1500kg is attached to a cable and raised vertically by a crane. The graph shows how its velocity varies with time.



(a) Determine

(i) the initial uniform acceleration of the mass, ...................................................

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(ii) the distance travelled by the mass while it is accelerating upwards.

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(3)

(b) (i) Calculate the tension in the cable in the intervals

AB, ...................................................................................................................

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CD. ...................................................................................................................

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(ii) Stateinwhichintervalofthemotionthetensioninthecableisleast.

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(4)

(c) Calculate the power supplied by the crane during the interval CD.

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(2)

(Total 9 marks)

**5.** The Thrust SSC car raised the world land speed record in 1997. The mass of the car was  
1.0 × 104 kg. A 12s run by the car may be considered in two stages of constant acceleration.  
Stage one was from 0 to 4.0 s and stage two 4.0 s to 12 s.

(i) In stage one the car accelerates from rest to 44 m s–1 in 4.0 s. Calculate the acceleration produced and the force required to accelerate the car.

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(ii) In stage two the car continued to accelerate so that it reached 280 m s–1 in a further  
8.0 s. Calculate the acceleration of the car during stage two.

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(iii) Calculate the distance travelled by the car from rest to reach a speed of 280 m s–1.

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(Total 6 marks)

**6.** (a) State the principle of moments.

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(2)

(b) (i) A uniform plank of length 1.5m and mass 9.0kg is placed horizontally on two narrow vertical supports as shown. A block, X, of mass 3.0 kg is placed at the end of the plank immediately above the centre of the right-hand support.



Calculate the magnitude of the downward force on

the right-hand support,......................................................................................

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the left-hand support..........................................................................................

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(ii) The block X is now moved so that its centre of mass is immediately above a point  
1.0 m from the right hand edge of the plank.



Calculate the magnitude of the downward force on

the right-hand support,.....................................................................................

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the left-hand support.......................................................................................

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(6)

(Total 8 marks)

**10.** The diagram shows a uniform bar, AB, which is 1.6 m long and freely pivoted to a wall at B.  
The bar is maintained horizontal and in equilibrium by an angled string which passes over a pulley and which carries a mass of 2.0 kg at its free end.



(a) The pulley is positioned as shown in the diagram, with the string at 30° to the vertical.

(i) Calculate the tension, *T*, in the string.

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(ii) Show that the mass of the bar is approximately 3.5 kg.

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(4)

(b) A mass, M, is attached to the bar at a point 0.40 m from A. The pulley is moved horizontally to change the angle made by the string to the vertical, and to maintain the rod  
horizontal and in equilibrium.  
Determine the largest value of the mass, M, for which this equilibrium can be maintained.

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(4)

(Total 8 marks)

**13.** The graph shows how the vertical speed of a parachutist changes with time during the first  
20 s of his jump. To avoid air turbulence caused by the aircraft, he waits a short time after jumping before pulling the cord to release his parachute.



(a) Regions A, B and C of the graph show the speed before the parachute has opened. With reference to the forces acting on the parachutist, explain why the graph has this shape in the region marked

(i) A, ......................................................................................................................

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(ii) B, .......................................................................................................................

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(iii) C. ......................................................................................................................

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(6)

(b) Calculate the maximum deceleration of the parachutist in the region of the graph marked D, which shows how the speed changes just after the parachute has opened. Show your method clearly,

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(2)

(c) Use the graph to find the total vertical distance fallen by the parachutist in the first 10 s of the jump. Show your method clearly.

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(4)

(d) During his descent, the parachutist drifts sideways in the wind and hits the ground with a vertical speed of 5.0 m s–1 and a horizontal speed of 3.0 m s–1. Find

(i) the resultant speed with which he hits the ground,

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(ii) the angle his resultant velocity makes with the vertical.

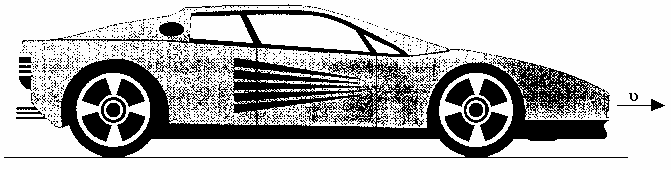
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(2)

(Total 14 marks)

**15.** The diagram shows a car travelling at a constant velocity along a horizontal road.



(a) (i) Draw and label arrows on the diagram representing the forces acting on the car.

(ii) Referring to Newton’s Laws of motion, explain why the car is travelling at constant velocity.

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(5)

(b) The car has an effective power output of 18 kW and is travelling at a constant velocity of 10 m s–1. Show that the total resistive force acting is 1800 N.

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(1)

(c) The total resistive force consists of two components. One of these is a constant frictional force of 250 N and the other is the force of air resistance, which is proportional to the square of the car’s speed.

Calculate

(i) the force of air resistance when the car is travelling at 10 m s–1,

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(ii) the force of air resistance when the car is travelling at 20 m s–1,

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(iii) the effective output power of the car required to maintain a constant speed of  
20 m s–1 in a horizontal road.

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(4)

(Total 10 marks)

**16.** (a) The torque of a couple is given by

torque = *Fs.*

(i) With the aid of a diagram explain what is meant by a couple. Label *F* and *s* on your diagram.

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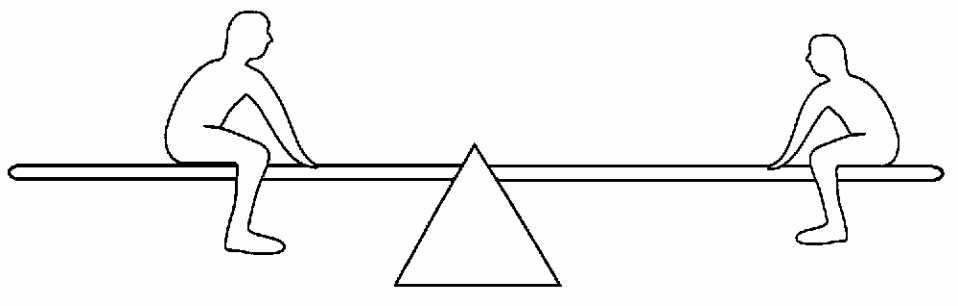
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(ii) State the unit for the torque of a couple.

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(4)

(b) The see-saw shown in the diagram consists of a uniform beam freely pivoted at the centre of the beam. Two children sit opposite each other so that the see-saw is in equilibrium.



Explain why

(i) the see-saw is in equilibrium,

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(ii) the weight of the beam does not affect equilibrium.

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(3)

(c) The diagram shows the see-saw with three children of weights 400N, 250N and 200N sitting so that the see-saw is in equilibrium.



Calculate the distance, *d*.

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(2)

(Total 9 marks)

**47.** A fairground ride ends with the car moving up a ramp at a slope of 30° to the horizontal as shown in the figure below.



(a) The car and its passengers have a total weight of 7.2 × 103 N. Show that the component of the weight parallel to the ramp is 3.6 × 103 N.

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(1)

(b) Calculate the deceleration of the car assuming the only force causing the car to decelerate is that calculated in part (a).

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(2)

(c) The car enters at the bottom of the ramp at 18 m s–1. Calculate the minimum length of the ramp for the car to stop before it reaches the end. The length of the car should be neglected.

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(2)

(d) Explain why the stopping distance is, in practice, shorter than the value calculated in part (c).

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(2)

(Total 7 marks)

**53.** The figure belowshows an apparatus used to locate the centre of gravity of a non-uniform metal rod.



The rod is supported horizontally by two wires, P and Q and is in equilibrium.

(a) State **two** conditions that must be satisfied for the rod to be in equilibrium.

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(2)

(b) Wire Q is attached to a newtonmeter so that the force the wire exerts on the rod can be measured. The reading on the newtonmeter is 2.0 N and the weight of the rod is 5.0 N.  
Calculate

(i) the force that wire P exerts on the rod,

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(ii) the distance *d*.

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(3)

(Total 5 marks)

**57.** A ball is dropped and rebounds vertically to less than the original height.

For this first bounce only, sketch graphs of

(a) the velocity of the ball plotted against time,



(4)

(b) the acceleration of the ball plotted against time.



(1)

(c) 

The ball is then thrown at an angle to the horizontal and follows the trajectory shown in the diagram.

Mark on the diagram the directions of

(i) the acceleration vector at P,

(ii) the acceleration vector at Q,

(iii) the momentum vector at P,

(iv) the momentum vector at Q.

(4)

(Total 9 marks)