Mechanics I Independent Revision Resource

**Specification points**

**2.1.1 Physical quantities**

**(a)** physical quantities have a numerical value and a unit

**(b)** making estimates of physical quantities listed in this specification.

**2.1.2 S.I. units**

**(a)** Système Internationale (S.I.) base quantities and their units – mass (kg), length (m), time (s), current (A), temperature (K), amount of substance (mol)

**(b)** derived units of S.I. base units Examples: momentum kg m s–1 and density kg m–3

**(c)** units listed in this specification

**(d)** checking the homogeneity of physical equations using S.I. base units

**(e)** prefixes and their symbols to indicate decimal submultiples or multiples of units – pico (p), nano (n), micro (μ), milli (m), centi (c), deci (d), kilo (k), mega (M), giga (G), tera (T)

**(f)** the conventions used for labelling graph axes and table columns.

**2.2.1 Measurements and uncertainties**

**(a)** systematic errors (including zero errors) and random errors in measurements

**(b)** precision and accuracy As discussed in *The Language of Measurement* (ASE 2010).

**(c)** absolute and percentage uncertainties when data are combined by addition, subtraction, multiplication, division and raising to powers As set out in the ASE publication *Signs*, *Symbols and Systematics* (*The ASE Companion to 16–19 Science,* 2000). A rigorous statistical treatment is not expected.

**(d)** graphical treatment of errors and uncertainties; line of best fit; worst line; absolute and percentage uncertainties; percentage difference.

**2.3.1 Scalars and vectors**

**(a)** scalar and vector quantities Learners will also be expected to give examples of each.

**(b)** vector addition and subtraction

**(c)** vector triangle to determine the resultant of any two coplanar vectors To be done by calculation or by scale drawing

**(d)** resolving a vector into two perpendicular components; *F*x = *F* cos *i* ; *F*y = *F* sin *i*.

**3.1 Motion**

**3.1.1 Kinematics**

**(a)** displacement, instantaneous speed, average speed, velocity and acceleration

**(b)** graphical representations of displacement, speed, velocity and acceleration. Using data-loggers to analyse motion.

**(c)** Displacement–time graphs; velocity is gradient

**(d)** Velocity–time graphs; acceleration is gradient; displacement is area under graph. Learners will also be expected to estimate the area under non-linear graphs.

**3.1.2 Linear motion**

**(a) (i)** the equations of motion for constant acceleration in a straight line, including motion of bodies falling in a uniform gravitational field without air resistance

**(ii)** techniques and procedures used to investigate the motion and collisions of objects

**PAG1** Apparatus may include trolleys, air-track gliders, ticker timers, light gates, data-loggers and video techniques.

**(b) (i)** acceleration *g* of free fall

**(ii)** techniques and procedures used to determine the acceleration of free fall using trapdoor and electromagnet arrangement or light gates and timer **PAG1** Determining *g* in the laboratory.

**3.1.3 Projectile motion**

**(a)** independence of the vertical and horizontal motion of a projectile

**(b)** two-dimensional motion of a direction and constant acceleration in a perpendicular direction.

**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.

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| **Website** | **Comments** |
| <https://www.s-cool.co.uk/a-level/physics/forces/revise-it/the-basics> | Basic information about forces (a good reminder) |
| <https://www.s-cool.co.uk/a-level/physics/vectors-and-scalars-and-linear-motion> | Your text book written in another form with animation of vector addition etc |
| <https://www.s-cool.co.uk/a-level/physics/equations-motion> | The basiscs for the equations of motion and projectile motion. (Also includes link to energy ) |
| <https://revisionworld.com/a2-level-level-revision/physics-level-revision/force-motion/forces-vectors> | Great summary with throrough descriptions. Goes slightly further than we have covered yet… so don’t panic. |
| <https://revisionworld.com/a2-level-level-revision/physics-level-revision/force-motion/motion-one-or-two-dimensions> | Explanation and questions for equations of motion and projectile motion. Good questions at the end. |
| <http://www.a-levelphysicstutor.com/m-linmotion-unaccln.php><http://www.a-levelphysicstutor.com/m-2Dmotion-projectiles.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=fMkctIXg8P0&list=PLGvD8d3gDHUVgyxA8evex35dWdWpl47k3> | **YOUTUBE –** Watch someone else explain vectors – I liked it ☺ |
| <https://www.youtube.com/watch?v=NJRsGRNCqkQ&list=PLGvD8d3gDHUVgyxA8evex35dWdWpl47k3&index=3> | **YOUTUBE** – watch someone else explain suvat equations |
| <https://www.youtube.com/watch?v=p30tWWEElxU&list=PLGvD8d3gDHUVgyxA8evex35dWdWpl47k3&index=2> | **YOUTUBE** – projectile motion |

|  |
| --- |
| **To Do*** Create detailed revision notes from your text book
* 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 and can describe the different methods for calculating g in the class including analysis of uncertainty.

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\1 Mechanics A resources\ASA Motion .doc](file:///Q%3A%5CPhysics%5CA-Level%5CModule%203%20-%20Forces%20and%20Motion%5CRevision%20resources%5C1%20Mechanics%20A%20resources%5CASA%20Motion%20.doc) |

**A Level Physics Mechanics 1 Questions**

1. The graphs below show corresponding distance-time, velocity-time and acceleration-time

 variations for particles (a), (b) and (c). Complete the graphs (i) to (vi).

t

t

a

t

a

t

a

t

v

t

v

t

v

t

s

t

s

s

(iii)

(v)

(vi)

(i)

(vi)

(ii)

 (a) (b) (c)

2. A child throws a ball vertically upwards, then catches it again.

 (a) Taking the initial velocity to be 10.0 ms-1, g to be *9.8ms-2* and ignoring effects of air resistance, calculate:

 (i) the total time of flight of the ball

[3]

 (ii) the maximum height it reaches

[2]

 (b) Sketch the following graphs for its complete flight, taking the upwards direction as positive:

 (i) velocity - time graph

 [3]

 (ii) acceleration – time graph

[2]

Total 10 marks

3. A dart player throws a dart horizontally. By the time it reaches the dartboard, 3.0m away, it has

fallen a height of 0.20m.

Taking g as *9.8ms-2*, find:

3.0m

0.20m



 (a) The time of flight

[2]

 (b) The initial velocity

[2]

 (c) The magnitude and direction of the velocity as it is just about to hit the dartboard.

 [6]

Total 10 marks

4. A tennis ball is dropped from a height h and bounces so that the speed immediately after each bounce is half the speed just before the bounce.

On the axis given below, sketch the following graphs from the time of release until the ball hits the ground for the third time. In each case, take the upward direction as positive.

 (a) The velocity – time graph

v

t

[3]

 (b) The displacement – time graph

s

t

[3]

Total 6 marks

5. A vehicle is travelling at 24 ms-1 and then decelerates uniformly. It travels 48m during braking

 before coming to rest.

(a) Calculate

 (i) its average speed during deceleration.

[2]

1. the time it takes to come to rest while braking.

[2]

 (iii) its deceleration

[2]

(b) If the vehicle now travels at twice it previous speed, then comes to rest with the same

 deceleration as before, find

 (i) the new time to come to rest while braking

[2]

 (ii) the distance it travels while braking.

[2]

Total 10 marks

6. A motorist is travelling at 10 ms-1 in a car whose maximum deceleration rate is 5.0 ms-2. His effective reaction time between seeing a hazard and starting to brake is 0.5s.

(a) Calculate the “thinking distance” for the driver at this speed, i.e. the distance travelled during his reaction time.

 [2]

(b) Calculate:

 (i) the minimum braking distance, i.e. the distance travelled during maximum deceleration.

[2]

 (ii) the total minimum stopping distance at 10 ms-1.

[1]

(c) Sketch a velocity – time graph for the driver doing an emergency stop from 10 ms-1, showing the reacting and braking stages. Mark on values of v and t.

[4]

. (d) The car approaches traffic lights at 12 ms-1 and the lights turn red when it is 20m from the

 line. Show whether it is possible for the car to stop before reaching the line and calculate

 how far from the line it will stop.

[4]

Total 13 marks

7. An aircraft on a famine relief mission flies horizontally at 50 ms-1 at a height of 500m above level ground, and drops a sack of flour. Assuming negligible air resistance and taking g as
*9.8ms-2*, calculate;

(a) the time taken for the sack to fall to the ground.

 [2]

(b) the vertical component of its velocity as it hits the ground.

[2]

(c) its resultant velocity as it hits the ground

[4]

(d) the horizontal distance it travels before landing

[2]

Total 10 marks

1. The graph below shows the displacement of an object with time along a straight line.

0

-50

50

50

40

30

20

10

60

70

80

s/ m

t/ s

A

B

C

D

E

H

G

F

1. Describe the motion shown in sections:

(i) OA

(ii) AB

(iii) BC

(iv) CD

(v) DE

(vi) EF

(vii) FG

(viii) GH

[8]

(b) Sketch the corresponding velocity – time graph for this motion. The curved sections BC and CD of the s-t graph are parabolic.

0

50

40

30

20

10

60

70

80

v/ ms-1

t/ s

[7]

9. A car and lorry travel in the same direction at constant speed of 30ms-1 and 20ms-1 . The front of

 the car is 95m behind the back of the lorry.

95m

30ms-1

20ms-1

5m

 (a) (i) How long does it take for the car to draw level with the lorry?

[2]

 (ii) How far does the car travel along the road during this time?

[2]

 (iii) How far ahead of the lorry is the car after a further 10 seconds?

[2]

 (b) From this position, the car now brakes to a halt with a uniform deceleration of 1ms-2.

 Calculate the:

 (i) distance that the car travels while braking

[2]

9. (b) (ii) distance the lorry travels while the car is braking

[3]

 (iii) distance between the car and the lorry when the car comes to rest

[2]

Total 13 marks

10. A ball drops off a balcony on to level ground 4.9m below.

 (a) Neglecting air resistance and taking g = *9.8ms-2*, calculate the:

 (i) speed at which it hits the ground.

[2]

 (ii) time of flight.

[2]

 (b) If the ball rebounds at half its landing speed, calculate the:

 (i) height it reaches on this bounce.

[2]

 (ii) time between the first and second bounce.

[3]

10. (c) On the axes below, sketch the velocity – time graph for the ball's complete motion, taking

 upwards as positive, and including values where appropriate.

t/ s

v/ ms-1

 [4]

11. A rocket accelerates from rest for 20s with a constant upward acceleration of 10ms-2. At the

 end of 20s the fuel is used up and it completes its flight under gravity alone. Assuming that air resistance can be neglected and taking *g = 9 8ms-2*, calculate the:

 (a) speed reached after 20s.

[2]

 (b) height after 20s.

[2]

 (c) maximum height reached.

[3]

11.(d) speed just before the rocket hits the ground.

[2]

 (e) total time taken for the flight.

[4]

Total 13 marks

12.A rifle bullet, of mass 10g, is fired and takes 2.0ms to travel down the rifle barrel of length

 0.50m with constant acceleration.

0.50m

 (a) Calculate the:

 (i) muzzle velocity ( bullet velocity on leaving the barrel)

[2]

 (ii) acceleration in the barrel

[3]

 (b) After travelling a short distance through air, the resistance of which can be neglected, the bullet hits a target and penetrates to a depth of 2.5 cm. Calculate the average force acting on of the bullet while it is coming to rest.

[3]

Total 8 marks

13. Raindrops fall from a broken gutter at 1.0s intervals to the ground, 19.6m below.

19.6m

 (a) Neglecting air resistance and taking g as *9.8ms-1*, calculate the:

 (i) time for each drop to reach the ground

[2]

 (ii) velocity of the drops as they reach the ground.

[2]

 (iii) distance between successive drops as one hits the ground.

[3]

 (iv) speed of drop at the height calculated in (iii)

[2]

13.(b) After rain, water flows from the end of the gutter with a horizontal velocity of 0.50ms-1.

 How far does the water hit the ground from the point where the drops usually fall.

[2]

Total 11 marks

14. A train takes 5.0 minutes to travel 6.0 km. It accelerates uniformly for  of its journey time and

 decelerates uniformly for the remainder, starting and finishing at rest.

 (a) (i) Sketch a speed – time graph for the journey.

[3]

(ii) What does the area under this graph represent?

[1]

(iii) Use the graph to calculate the distance that the train travels while accelerating.

[2]

 (b) Calculate the:

 (i) maximum velocity of the train.

[2]

 (ii) acceleration for the first  of the journey time

[2]

14.(b) (iii) speed of the train when it is halfway (in distance) between the start and finish of its journey.

[2]

Total 12 marks

15.A window cleaner drops his can of fizzy drink while cleaning the windows of a skyscraper.

 The can completes the last 20% of the distance fallen in the last 1.0s of its journey.

 (a) Write an equation relating h, g, and the time to complete the fall, T.

 [2]

 (b) Write an equation relating h, g and t, the time to fall the first 80% of the distance.

[1]

 (c) Calculate the entire height h fallen.

[5]

Total 8 marks

16. The table shows the time for a ball to fall through different distances from rest.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Distance/ m | 0.5 | 1.0 | 1.5 | 3.0 | 5.0 | 8.0 | 10.0 |
| Time/ s | 0.32 | 0.44 | 0.55 | 0.77 | 1.0 | 1.29 | 1.38 |



(a) Plot a graph of distance fallen against time.

[3]

 (b) What does the shape of the graph indicate about the ball’s motion?

 [2]

 (c) (i) Find the gradient of the graph when t = 0.6s

[2]

(ii) What physical quantity does this gradient represent?

[1]

16.(c) (iii) Use this result to calculate a value for the acceleration due to gravity.

[2]

Total 10 marks

17. An object is moving with constant acceleration. The following measurements of its velocity

 are recorded:

|  |  |  |
| --- | --- | --- |
| Time/ s | 10 | 20 |
| Velocity/ ms-1 | 70 | 40 |

(a) Calculate the:

 (i) acceleration.

 [2]

 (ii) velocity at t = 0.

[2]

 (iii) total distance moved from t = 0 until the object stops.

[2]

 (iv) time at which it stops.

 [2]

17.(b) Sketch a distance – time graph for this motion, using the t = 0 point, the stop point and two

 intermediate points.



[5]

Total 13 marks