Advanced Physics Homework

15052

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Introduction

This collection of Question & Answer sheets is designed for use by 16 - 19 year old students. They were written to match the EDEXCEL AS / A2 specification but are suitable for use with AQA / OCR or any other syllabus with/ without adaptation. The answers given are brief and mainly numerical because the purpose of the sheets is to test the *method* of finding the solution in most problems. The only sheet in which it is *intended* that the answers be withheld is "Motion Graphs". The sheets have been trial tested successfully as Homework and (when adapted) as Progress Tests. Students are expected to have access to the formula sheet that would be provided in an examination or to have memorised formulae as required.

The easiest way to use the sheets is to photocopy directly from this book. Most topics consist of 2 pages (including answers) and can be conveniently copied "back-to-back". The sheets can be reduced to A5 (i.e. to fit 2 pages side-by-side on an A4 sheet) on a good quality photocopier. If in doubt please try a sample copy to check that all sub/super-scripts are legible.

The electronic versions of the sheets are supplied as Microsoft Word 7 documents and may be edited as required to suit the nature of the course/ order of topic coverage / creation of tests etc.

Suggested Adaptations:

- **Editing questions:** questions may be re-phrased, data changed, parts added or removed as required. If used as "Revision Sheets" it may be desirable to extend the answers to include the *method* – especially for pupils working unsupervised for any length of time (i.e. on "study leave" or over a summer break etc.).
- **Removal of answers:** although answers provide a useful incentive for pupils to check their working before submitting homework, it may be useful to remove them for certain pupils or when using the sheet as a quick Progress/ Revision Test.
- **End of Topic/ Module Test:** i.e. to create a "Mechanics" test just open a new document and copy & paste selected questions from the relevant sheets. The answers will follow as End Notes. The questions & answers will be automatically re-numbered. Insert a Page Break after the last question to ensure that the answers are printed as a separate sheet.
- **Create a new version of an old sheet:** just change some of the data in the original questions and re-calculate (and edit) the answers. This can be useful when creating tests from sheets already used for homework.
- **Create a new sheet:** questions from various sheets may be combined (as suggested with "Tests") to make sheets that better match a syllabus or the preferred order of teaching topics within a syllabus.

Advanced Physics Homework

Contents:

Equations of Motion

For each of the following questions:

- show the "given" information (including conversion of all quantities to standard SI Units)
- write the equation and all major steps in the algebra that lead to the final form of the equation
- Substitute the numerical quantities -- with their units -- into the expression
- express the final answer to a sensible number of significant figures (i.e. usually only 2 or 3)

Data:

➢ Acceleration due to gravity (g) = $9.81ms^{-2}$ near the surface of the **earth**.

Example Question:

A car travelling at $15ms^{-1}$ accelerates uniformly at a rate of $2.3ms^{-2}$ for 17s. Calculate its final velocity and its displacement (distance moved) during the acceleration.

Example Answer:

Given: u = $15ms^{-1}$, a = $2.3ms^{-2}$, t = 17s and **v = u + at** → Then: v = $15ms^{-1}$ + ($2.3ms^{-2}$)(17s)
∴ $\underline{v = 54.1ms^{-1}}$ (or write v = $54ms^{-1}$ as only 2 significant figures are used in the question at most)
Also: $\mathbf{x = ut + 1/2at^2}$ So: x = ($15ms^{-1}$)(17s)+ 0.5($2.3ms^{-2}$)$(17s)^2$
∴ $\underline{x = 578m}$ (or write x = 580m for 2 significant figures)

1. An apple falls from a tree to the ground. Assume that it falls from rest through a height of 3.2m. Calculate the time it takes to fall and its velocity just before striking the ground. Acceleration due to gravity (g) = $9.81ms^{-2}$ near the surface of the earth.

2. A bullet is fired vertically upwards with an initial velocity of $150ms^{-1}$. Calculate the time it takes to reach its maximum height and the value of the maximum height. (ignore air resistance).

3. A ball is made to roll up a slope which is 30° to the horizontal. It rolls for 1.2s until it is caught whilst moving down the slope at a speed of 2.4ms^{-1} . {The acceleration down the slope will be 1/2 g at this angle}. Calculate the initial velocity of the ball and its displacement from its starting position on the ramp.

4. A cyclist is moving at 7.5ms^{-1} along a straight road when a lorry pulls out from a warehouse driveway 17m ahead. Ignore the reaction time of the cyclist and assume that she applies the brakes as soon as she sees the obstruction. The brakes give the bicycle a deceleration of 2.3ms^{-2} . Calculate her stopping distance and the time it takes her to stop. Did she avoid the lorry? On a wet road the brakes only give a deceleration of 1.4ms^{-2} -- what would be a maximum safe speed in these conditions should the same thing happen again?

5. An ant crawling at 2cms^{-1} smells some sugar dead ahead and accelerates towards it. If the sugar was 8.3mm away when first detected and the ant took only 315ms to reach it then calculate the acceleration of the ant and its final velocity at the sugar (before it stops!).

6. A super-tanker is sailing at 30km per hour towards its destination port. At a certain distance away the captain orders the engines to be reversed to slow it to 2km per hour by the time it reaches the pilot vessel near the port. It takes 37 minutes to complete this manoeuvre. Calculate the acceleration of the tanker (in ms^{-2}) and the distance from point of the initial order to the pilot.

Solutions to Equations of Motion problems

1 t = 0.81s v = 7.92ms^{-1}

2 t = 15.3s x = 1150 m

3 u = 3.49ms^{-1} x = 0.65m

4 x = 12.2m t = 3.26s YES (avoided lorry) wet road: u = 6.90ms^{-1}

5 a = 0.0403ms^{-2} v = 0.0327ms^{-1}

6 a = -0.00350ms^{-2} x = 9870m

Motion Graphs

For each of the following questions:

- make a sketch copy of each graph
- indicate on *your copy* any information you used to find the solution to each problem – the actual measurements should be made on the printed version.
- show all stages of your calculations (i.e. for gradient calculations show both X values used for the ΔX calculation and both Y values for the ΔY calculation etc.)
- express the final answer to a sensible number of significant figures with units.

1 A radio controlled car is given a short test drive:

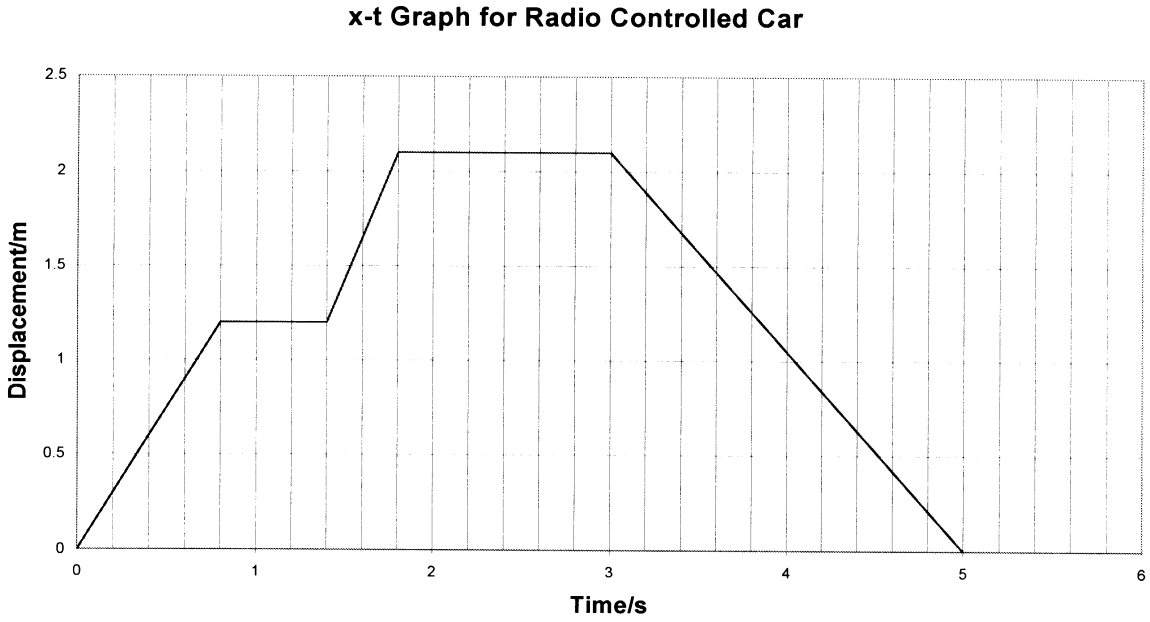
a) Over which time period is the car stationary?

b) Calculate the velocity of the car between:

i) 0.0 and 0.8 seconds,

ii) 1.4 and 1.8 seconds,

iii) 3.0 and 5.0 seconds.



2 A stamping machine moves rapidly up and down in a factory as shown in the graph on the next page:

a) At which time is the magnitude of its velocity greatest?

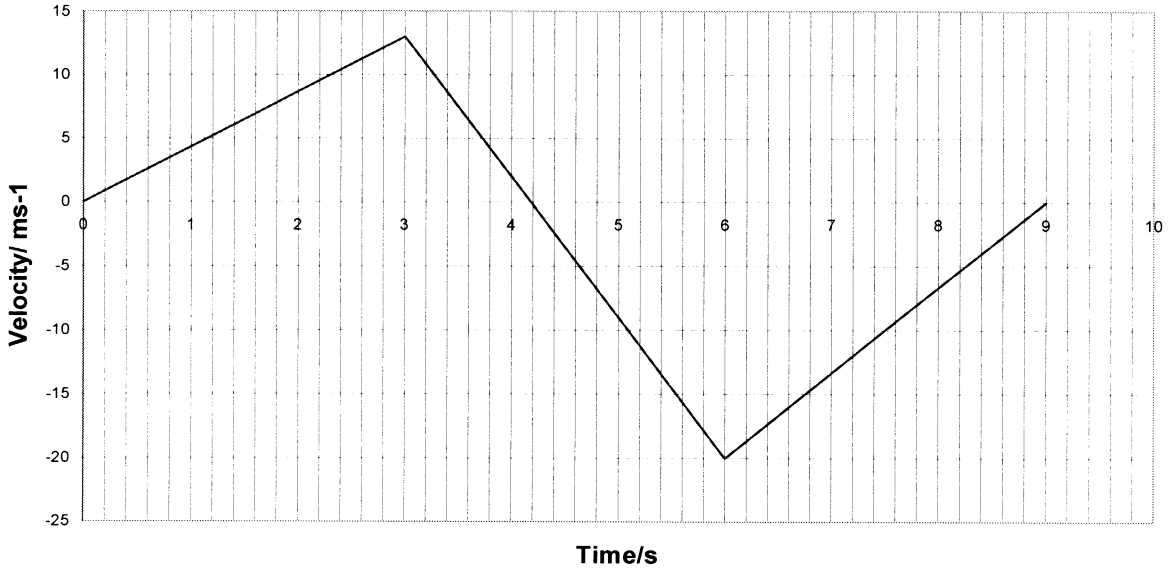
b) Calculate the acceleration of the stamp between:

i) 0.0 and 3.0 seconds,

ii) 3.0 and 6.0 seconds.

c) Calculate the displacement of the blade at 9.0 seconds (compared to its starting position at 0.0 seconds).

v-t Graph for Stamp Machine



3 A balloon is dropped in a room and is affected noticeably by air resistance as it falls:

a) Estimate the maximum ("Terminal") velocity of the balloon.

b) Calculate the acceleration of the balloon at:

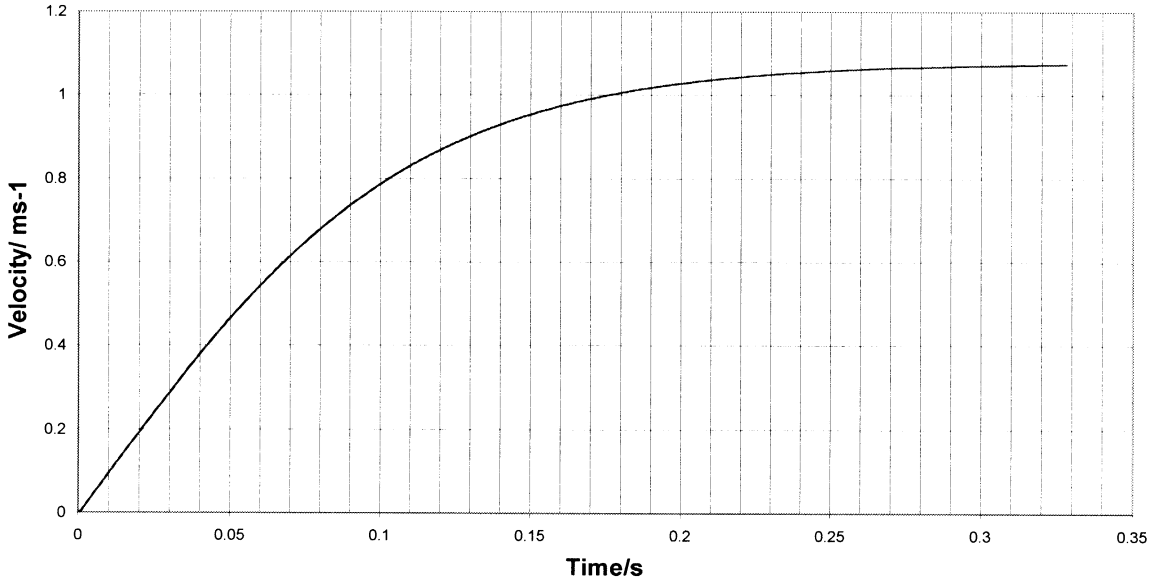
i) 0.0 seconds,

ii) 0.1 seconds,

iii) 0.2 seconds.

c) Estimate carefully the distance fallen by the balloon in the first 0.3 seconds (explain your method clearly).

v-t Graph for Falling Balloon



Solutions to Motion Graphs Questions

(not to be given out with questions)

1

a) 0.8s to 1.4s and 1.8s to 3.0s

b)

i) $1.50ms^{-1}$

ii) $2.25ms^{-1}$

iii) $-1.05ms^{-1}$

2

a) 6s

b)

i) $4.3ms^{-2}$

ii) $-11.0ms^{-2}$

c) – 20.7m

3

a) $1.1ms^{-1}$ (allow 1.05 to 1.15)

b)

i) $9.8ms^{-2}$ (allow $\pm$ $0.2ms^{-2}$)

ii) $4.9ms^{-2}$ (allow $\pm$ $0.2ms^{-2}$)

iii) $0.9ms^{-2}$ (allow $\pm$ $0.2ms^{-2}$)

c) about 0.25m [actually *0.24433m by calculation!*] (allow $\pm$ $0.03ms^{-2}$)

Forces

For each of the following questions:

- show the "given" information (including conversion of all quantities to standard SI Units)
- remember to draw force diagrams clearly
- write all major steps in the algebra that lead to the final form of the chosen equation(s)
- Substitute the numerical quantities -- with their units -- into the expression
- express the final answer to a sensible number of significant figures (i.e. usually only 2 or 3)

Data:

➢ Acceleration due to gravity (g) = $9.81 ms^{-2}$ near the surface of the **earth**.

1 A plane of mass 1500 kg is flying horizontally at 130 ms^{-1} using an engine thrust of 6000N

a) Draw a free-body force diagram of the plane with all forces labelled by name and magnitude.

b) The pilot increases engine thrust to 6100N – draw the new free-body force for the instant the increase is made.

c) What force is the Newton's 3rd Law pair with the thrust of the engines?

2 A small child of mass 25 kg slides down a park slide at a constant speed of $2ms^{-1}$. The angle of the slide is 40° to the horizontal.

a) Draw a free-body force diagram of the child.

b) Calculate the Normal Reaction of the slide on the child.

c) Calculate the magnitude of the Friction force acting on the child.