**BTEC Assignment Brief**

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| **Qualification** | Pearson BTEC Level 3 National Extended Diploma in Engineering |
| **Unit number and title** | **Unit 7: Calculus to solve engineering problems** |
| **Learning aim(s)** (For NQF only) | **A:** Examine how differential calculus can be used to solve engineering problems |
| **Assignment title** | Solving engineering problems that involve differentiation |
| **Assessor** |  |
| **Issue date** |  |
| **Hand in deadline**  |  |
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| **Vocational Scenario or Context** | You are working as an apprentice engineer at a company involved in the research, design production and maintenance of bespoke engineering solutions for larger customers.Part of your apprenticeship is to spend time working in all departments, however a certain level of understanding needs to be shown before the managing director allows apprentices into the design team and so she has developed a series of questions on differentiation to determine if you are suitable. |
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| **Task 1** | Produce a report that contains written descriptions, analysis and mathematics that shows how calculus can be used to solve engineering problems as set out below. 1 The equation for a distance, s(m), travelled in time t(s) by an object starting with an initial velocity u(ms-1) and uniform acceleration a(ms-2) is:The tasks are to:1. Plot a graph of distance (s) vs time (t) for the first 10s of motion if and .
2. Determine the gradient of the graph at and .
3. Differentiate the equation to find the functions for
4. Velocity
5. Acceleration
6. Use your result from part c to calculate the velocity at and .
7. Compare your results for part b and part d.

2 The displacement of a mass is given by the function .The tasks are to:1. Draw a graph of the displacement y(m) against time t(s) for the time to .
2. Identify the position of any turning points and whether they are maxima, minima or points of inflexion.
3. Calculate the turning points of the function using differential calculus and show which are maxima, minima or points of inflexion by using the second derivative.

Compare your results from parts b and c. 3 The equation for the instantaneous voltage across a discharging capacitor is given by, where is the initial voltage and is the time constant of the circuit.The tasks are to:1. Draw a graph of voltage against time for and , between and .
2. Calculate the gradient at and .
3. Differentiate and calculate the value of at and .
4. Compare your answers for part b and part c.
5. Calculate the second derivative of the instantaneous voltage .

4 The same capacitor circuit is now charged up to 12V and the instantaneous voltage is **.**The tasks are to:1. Differentiate with respect to to give an equation for .
2. Calculate the value of at and .
3. Find the second derivative .

5 The gain of an amplifier is found to be **,**:The tasks are to find equations for:6 The displacement, (m), of a body in damped oscillation is **.** The task is to:1. Use the Product Rule to find an equation for the velocity of the object if .

7 The velocity of a moving vehicle is given by the equation The task is to:1. Use the Chain Rule to determine an equation for the acceleration when .

8 A communication signal is given by the function The task is to:1. Derive and equation for using the Quotient Rule.

9 A company is required to fence off the area around a robot arm to comply with health and safety law. They have 750m of fencing available The task is to:1. Find the maximum area they can fence off?

10 You plan to make a simple, open topped box from a piece of sheet metal by cutting a square – of equal size – from each corner and folding up the sides as shown in the diagram:

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If and calculate:1. The value of x which will give the maximum volume
2. The maximum volume of the box
3. Comment of the value obtained in part b.
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| **Checklist of evidence required**  | Your informal report should contain:* analysis
* worked solutions to the problems

Each worked solution should be laid out clearly and contain brief explanations of the stages of the calculation to indicate your understanding of how calculus can be used to solve an engineering problem. You explanation should be detailed in response to questions 9 and 10 to show how the variables are optimised in each case. Graphs should be well presented and clearly labelled and comparisons between methods should be accurate and well presented. |
| **Criteria covered by this task:** |
| Unit/Criteria reference | To achieve the criteria you must show that you are able to: |
| 7/A.D1 | Evaluate, using technically correct language and a logical structure, the correct graphical and analytical differential calculus solutions for each type of given routine and non-routine function, explaining how the variables could be optimised in at least two functions. |
| 7/A.M1 | Find accurately the graphical and analytical differential calculus solutions and, whereappropriate, turning points for each type of given routine and non-routine function and compare the results. |
| 7/A.P1 | Find the first and second derivatives for each type of given routine function. |
| 7/A.P2 | Find, graphically and analytically, at least two gradients for each type of given routine function. |
| 7/A.P3 | Find the turning points for given routine polynomial and trigonometric functions. |
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| **Sources of information to support you with this Assignment** | <http://www.mathsisfun.com/index.htm><http://www.mathcentre.ac.uk/students/topics> |
| **Other assessment materials attached to this Assignment Brief** |  |