

EXTENSION 1

Stage 6

Calculus (EXT1), C1 Rates of Change (Y11)

Related Rates of Change (EXT)

Rates of Change with respect to time (EXT)

Teacher: Christy Cheung

Exam Equivalent Time: 175.5-minutes (based on allocation of 1.5 minutes per mark)



C1 Rates of Change



Growth and Decay
Related Rates of Change

SmartMaths analysis based on
the average contribution to
Extension 1 exams since 2016

HISTORICAL CONTRIBUTION

- C1 Rates of Change has contributed 4.5% per new syllabus Ext1 exam since it was introduced in 2020.
- This topic has been split into three sub-categories for analysis purposes which are: 1-Growth and Decay (3.2%), 2-Motion and Time (2%), and 3-Related Rates of Change (1.3%).
- This analysis looks at Related Rates of Change.

HSC ANALYSIS - What to expect and common pitfalls

- Related Rates of Change (1.3%) has been examined in 2 out of 4 new syllabus exams, based on the longer answer section.
- Allocated marks in new syllabus exams are below this topic's historical average. Notwithstanding this, effective revision should include high mark "old syllabus" examples which are well represented in the database.
- 2023 Ext1 12a combined this topic with differential equations in an extremely challenging "must review" question.
- The toughest examination of this topic was between 2011-2013 where sub-50% mean marks resulted each year. Any revision should include these examples.
- The most popular underlying subject matter of recent past questions is earth rotating areas/volumes (2 times) and Pythagoras (twice) (4 times).
- Markov's comments have flagged that students can often achieve half marks by simply stating a correct chain rule and that students who draw diagrams in their solution are more successful. Good advice. Follow it.
- Pitfalls: The use of non-right angled triangles in this context was examined in 2012 and poorly answered. Not tested again since and worthy of a mention for us.
- If a constant rate of change is established, students have struggled with follow up questions in 2013 Ext1 12a and 2020 Ext1 15a. A red flagged knowledge gap worthy of attention.

4. Calculus, EXT1* C1 2013 HSC 10 MC

A particle is moving along the x -axis. The displacement of the particle at time t seconds is s metres.

At a certain time, $s = -3 \text{ m s}^{-1}$ and $\frac{ds}{dt} = 2 \text{ m s}^{-2}$.

Which statement describes the motion of the particle at that time?

- The particle is moving to the right with increasing speed.
- The particle is moving to the left with increasing speed.
- The particle is moving to the right with decreasing speed.
- The particle is moving to the left with decreasing speed.

5. Calculus, EXT1 C1 EQ-Bank 12

A tank is initially full. It is drained so that at time t seconds the volume of water, V , in litres, is given by

$$V = 50 \left(1 - \frac{t}{100} \right)^2 \quad \text{for } 0 \leq t \leq 100$$

- How much water was initially in the tank? (1 mark)
- After how many seconds was the tank completely full? (1 mark)
- At what rate was the water draining out the tank when it was one-quarter full? (2 marks)

6. Calculus, EXT1 C1 2019 HSC 12a

Distance A is inversely proportional to distance B such that $A = \frac{10}{B}$ where A and B are measured in metres. The two distances vary with respect to time. Distance B is increasing at a rate of 0.2 m s^{-1} .

What is the value of $\frac{dA}{dt}$ when $A = 12$? (2 marks)

7. Calculus, EXT1 C1 EQ-Bank 1

A particle is moving along the x -axis with a velocity, u , in metres per second at t seconds, is given by the function

$$u = \sqrt{5t + 4t^2} - t^2$$

Find the acceleration of the particle when $t = 3$. (2 marks)

Questions

1. Calculus, EXT1 C1 2017 HSC 8 MC

A stone drops into a pond, creating a circular ripple. The radius of the ripple increases from 0 cm, at a constant rate of 5 cm s^{-1} .

At what rate is the area enclosed within the ripple increasing when the radius is 15 cm?

- $25\pi \text{ cm}^2 \text{ s}^{-1}$
- $30\pi \text{ cm}^2 \text{ s}^{-1}$
- $150\pi \text{ cm}^2 \text{ s}^{-1}$
- $225\pi \text{ cm}^2 \text{ s}^{-1}$

2. Calculus, EXT1 C1 2020 HSC 10 MC

The quantities P , Q and R are connected by the related rates

$$\frac{dR}{dt} = -P^2$$

$$\frac{dP}{dt} = -P + \frac{dR}{dt}$$

$$\frac{dP}{dt} = m^2 = \frac{dQ}{dt}$$

where m , l and n are non-zero constants.

Which of the following statements is true?

- P is increasing and Q is increasing
- P is increasing and Q is decreasing
- P is decreasing and Q is increasing
- P is decreasing and Q is decreasing

3. Calculus, EXT1* C1 2019 HSC 10 MC

A particle is moving along a straight line with displacement s at time t .

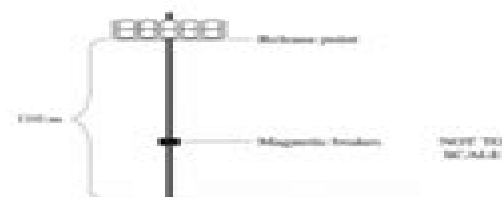
The particle is stationary when $t = 11$ and when $t = 15$.

Which of the following MUST be true in this case?

- The particle changes direction at some time between $t = 11$ and $t = 15$.
- The displacement function of the particle has a stationary point at some time between $t = 11$ and $t = 15$.
- The acceleration of the particle is 0 at some time between $t = 11$ and $t = 15$.
- The acceleration function of the particle has a stationary point at some time between $t = 11$ and $t = 15$.

8. Calculus, EXT1* C1 2015 HSC 14a

In a theme park ride, a chair is released from a height of 110 metres and falls vertically. Magnetic brakes are applied when the velocity of the chair reaches -20 metres per second.



The height of the chair at time t seconds is h metres. The acceleration of the chair is given by $\frac{dh}{dt} = -20$ at the release point, $t = 0$, $h = 110$ and $\frac{dh}{dt} = 0$.

i. Using calculus, show that $h = -5t^2 + 110$. (2 marks)

ii. How far has the chair fallen when the magnetic brakes are applied? (2 marks)

9. Calculus, EXT1 C1 2004 HSC 3c

A ferry wheel consists of a floating pontoon linked to a jetty by a 4 metre long walkway. Let A metres be the difference in height between the top of the pontoon and the top of the jetty and let s metres be the horizontal distance between the pontoon and the jetty.



i. Find an expression for $\frac{ds}{dt}$ in terms of A . (2 marks)

When the top of the pontoon is 1 metre lower than the top of the jetty, the tide is rising at a rate of 0.3 metres per hour.

ii. At what rate is the pontoon moving away from the jetty? (2 marks)

Smaths 4732 Revision

John Bird



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Science and Mathematics for Engineering John Bird, 2019-10-08 A practical introduction to the engineering science and mathematics required for engineering study and practice Science and Mathematics for Engineering is an introductory textbook that assumes no prior background in engineering This new edition covers the fundamental scientific knowledge that all trainee engineers must acquire in order to pass their examinations and has been brought fully in line with the compulsory science and mathematics units in the new engineering course specifications A new chapter covers present and future ways of generating electricity an important topic John Bird focuses upon engineering examples enabling students to develop a sound understanding of engineering systems in terms of the basic laws and principles This book includes over 580 worked examples 1300 further problems 425 multiple choice questions with answers and contains sections covering the mathematics that students will require within their engineering studies mechanical applications electrical applications and engineering systems This book is supported by a companion website of materials that can be found at www.routledge.com/bird This resource includes fully worked solutions of all the further problems for students to access and the full solutions and marking schemes for the revision tests found within the book for instructor use In addition all 447 illustrations will be available for downloading by lecturers **The improved practical navigator, revised by T. Kirby** Nathaniel Bowditch, 1809 **Finite**

Mathematics, Models, and Structure William J. Adams, 2009-02-16 Still another book on finite math Why Hasnt everything that should have been said been said No I would argue The shortcoming that troubles me most about the books I am familiar with is their failure to provide perspective on what math technique and the use of technology can do for us and its limitations This can only be addressed through vigorous and sustained use of the mathematical modeling perspective which is a hallmark of this books exposition A point continually stressed is that reaching a mathematical answer to a problem is not the end of the story It is in a sense the end of a chapter but the next chapter is concerned with questions about whether and how

the mathematical answer should be implemented Also addressed is the question of what to consider when more than one answer is obtained for a problem A Systems Approach to Improving K-12 STEM Education United States. Congress. House. Committee on Science and Technology (2007). Subcommittee on Research and Science Education,2010

Compilation of Navy and Other Laws from the Revised Statutes and Statutes at Large Passed by the Forty-third Congress, Ended March 4, 1875 United States,1875 **Business Mathematics And Statistics Class 12 Revised 17th Edition for the Session of 2024-25** Dr. S. K. Singh ,Samresh Chauhan,2024-04-04 Business Mathematics 1 Arithmetic Progression A P 2 Geometric Progression G P 3 Harmonic Progression H P 4 Properties of A P G P and H P 5 Permutation and Combination 6 Determinants 7 Matrices 8 Set Theory 9 Differentiation 10 Integration Statistics 1 Measures of Central Tendency Arithmetic Mean 2 Median 3 Mode 4 Geometric Mean 5 Harmonic Mean 6 Analysis of Time Series 7 Theory of Probability 8 Interpolation and Extrapolation Logarithms and Antilogarithms Tables Latest Model Paper Board Examination Paper *Advanced Computing in Industrial Mathematics* Ivan Georgiev,Hristo Kostadinov,Elena Lilkova,2023-09-26 This book gathers the peer reviewed proceedings of the 14th Annual Meeting of the Bulgarian Section of the Society for Industrial and Applied Mathematics BGSIAM 19 held in Sofia Bulgaria The general theme of BGSIAM 19 was industrial and applied mathematics with particular focus on mathematical physics numerical analysis high performance computing optimization and control mathematical biology stochastic modeling machine learning digitization and imaging and advanced computing in environmental biomedical and engineering applications

Parallel Processing and Applied Mathematics Roman Wyrzykowski,Jack Dongarra,Marcin Paprzycki,Jerzy Wasniewski,2004-04-14 It is our pleasure to provide you with the volume containing the proceedings of the 5th International Conference on Parallel Processing and Applied Mathematics which was held in Czestochowa a Polish city famous for its Jasna Gora Monastery on September 7 10 2003 The first PPAM conference was held in 1994 and was organized by the Institute of Mathematics and Computer Science of the Czestochowa University of Technology in its hometown The main idea behind the event was to provide a forum for researchers involved in applied and computational mathematics and parallel computing to exchange ideas in a relaxed atmosphere Conference organizers hoped that this arrangement would result in cross pollination and lead to successful research collaborations In addition they hoped that the initially mostly Polish conference would grow into an international event The fact that these assumptions were correct was proven by the growth of the event While the first conference consisted of 41 presentations the conference reached 150 participants in Nałeczów in 2001 In this way the PPAM conference has become one of the premiere Polish conferences and definitely the most important one in the area of parallel distributed computing and applied mathematics This year's meeting gathered almost 200 participants from 32 countries A strict refereeing process resulted in the acceptance of approximately 150 contributed presentations while the rejection rate was approximately 33%

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