

# 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 2000.

### HISTORICAL CONTRIBUTION

- C1 Rates of Change has contributed 4.6% 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 (3.4%), 2-Motion and Time (9%), and 3-Related Rates of Change (1.2%).
- This analysis looks at Related Rates of Change.

### HSC ANALYSIS - What to expect and common pitfalls

- Related Rates of Change (1.4%) has been examined in 2 out of 4 new syllabus exams, below in 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 revise" 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 trig in this context was examined in 2012 and poorly answered. Not tested again since and worthy of a revision focus.
- 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  $0.2 \text{ m s}^{-1}$ .

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,  $v$ , in metres per second at  $t$  seconds, is given by the function

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

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  $5 \text{ cm s}^{-1}$ .

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  $t$ .

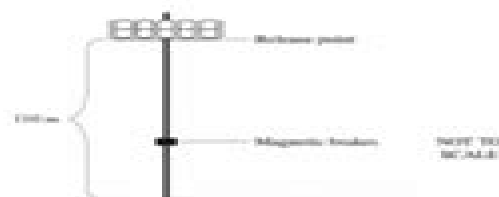
The particle is stationary when  $t = 11$  and when  $t = 15$ .

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  $s$  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

**Ivan Georgiev, Hristo Kostadinov, Elena  
Lilkova**

## Smaths 4732 Revision:

Mathematics of Investment Revised , Catalog of Federal Tax Forms, Form Letters, and Notices United States.  
Internal Revenue Service,1988      **Business Mathematics And Statistics Class 12 Revised 18th Edition for the Session of 2025-26** Dr. S. K. Singh, ,Dr. Awadesh Kumar Singh,Sudha Singh,2025-04-20 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 Theor9 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 Log and Antilog Tables Latest Model Paper Board Examination Paper      Business Mathematics And Statistics Class 12 Revised 17th Edition for the Session of 2024-25 Dr. S. K. Singh, ,Dr. Awadesh Kumar Singh ,Sudha Singh,2024-03-15 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 Theor9 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 Log and Antilog Tables Latest Model Paper Board Examination Paper      Basic Engineering Mathematics John Bird,2014-03-26 John Bird s approach to mathematics based on numerous worked examples and interactive problems is ideal for vocational students who require an entry level textbook Theory is kept to a minimum with the emphasis firmly placed on problem solving skills making this a thoroughly practical introduction to the basic mathematics engineering that students need to master The extensive and thorough topic coverage makes this an ideal introductory textbook for vocational engineering courses including the BTEC National Specifications Now in its sixth edition Basic Engineering Mathematics has helped thousands of students to succeed in their exams The new edition includes a section at the start of each chapter to explain why the content is important and how it relates to real life It is also supported by a fully updated companion website with resources for both students and lecturers The text contains over 750 worked problems and it has full solutions to all 1600 further questions contained in the 161 practice exercises All 420 illustrations used in the text can be downloaded for use in the classroom      *Bird's Comprehensive Engineering Mathematics* John Bird,2018-06-19 Studying engineering whether it is mechanical electrical or civil relies heavily on an understanding of mathematics This textbook clearly demonstrates the relevance of mathematical principles and shows how to apply them in real life engineering problems It deliberately starts at an elementary level so that students who are starting from a low knowledge base will be able to quickly get up to the level required Students who have not studied mathematics for some time will find this an excellent refresher Each chapter starts with the basics before gently increasing in complexity A full outline of essential definitions formulae laws and procedures is presented before real world practical situations and problem solving

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**Caribbean Maths Connect: Book 1** Benita Byer-Bowen, 2006-01-17 This publication written and developed by experienced Caribbean teachers and advisors has been designed to meet the requirements of maths syllabuses from across the region It includes worked examples objectives and explanation boxes overviews of chapters real life case studies assessments and reviews and progressive exercises that support the development of critical thinking skills and independent learning among Caribbean

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mathematical answer should be implemented Also addressed is the question of what to consider when more than one answer is obtained for a problem

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**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

**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

*Structured Object-Oriented Formal Language and Method* Shaoying Liu,Zhenhua Duan,Cong Tian,Fumiko Nagoya,2017-04-20 This book constitutes revised selected papers from the 6th International Workshop on Structures Object Oriented Formal Language and Method SOFL MSVL 2016 held in Tokyo Japan in November 2016 The 13 papers presented in this volume were carefully reviewed and selected from 26 submissions They are organized in topical sections named modeling and specification animation and prototyping verification and validation and model checking

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