



Final Examination 2021

## NSW Year 11 Mathematics Advanced

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### General Instructions

- Reading time – 10 minutes
- Working time – 2 hours
- Write using black pen
- Calculators approved by NESA may be used
- A reference sheet is provided at the back of this paper
- For questions in Section II, show relevant mathematical reasoning and/or calculations

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### Total Marks: 80

#### Section I – 10 marks (pages 2–5)

- Attempt Questions 1–10
- Allow about 15 minutes for this section

#### Section II – 70 marks (pages 7–30)

- Attempt Questions 11–32
- Allow about 1 hour and 45 minutes for this section

**SECTION I****10 marks****Attempt Questions 1–10****Allow about 15 minutes for this section**

Use the multiple-choice answer sheet for Questions 1–10.

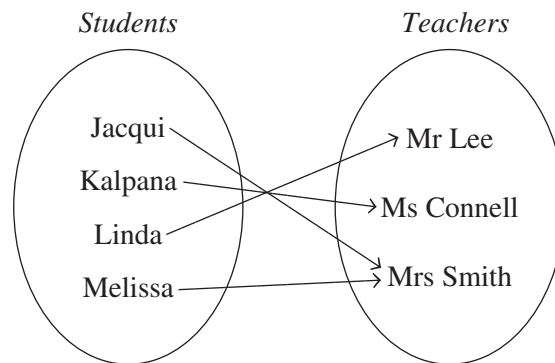
**1** What are the solutions of  $2x^2 + 3x - 4 = 0$ ?

A.  $x = \frac{-3 \pm \sqrt{41}}{4}$

B.  $x = \frac{-3 \pm \sqrt{23}}{4}$

C.  $x = \frac{3 \pm \sqrt{41}}{4}$

D.  $x = \frac{3 \pm \sqrt{23}}{4}$

**2** The diagram shows the relation of Year 11 students and their Mathematics teachers.

Which of the following most accurately describes the relation shown?

- A. one-to-one
- B. one-to-many
- C. many-to-one
- D. many-to-many

**3** What is the domain and range of the function  $f(x) = \sqrt{2-x}$ ?

- A. domain =  $(-\infty, 2)$ ; range =  $(0, \infty)$
- B. domain =  $(-\infty, 2)$ ; range =  $[0, \infty)$
- C. domain =  $(-\infty, 2]$ ; range =  $(0, \infty)$
- D. domain =  $(-\infty, 2]$ ; range =  $[0, \infty)$

4 What is the derivative of  $(5x^2 + 2)^4$ ?

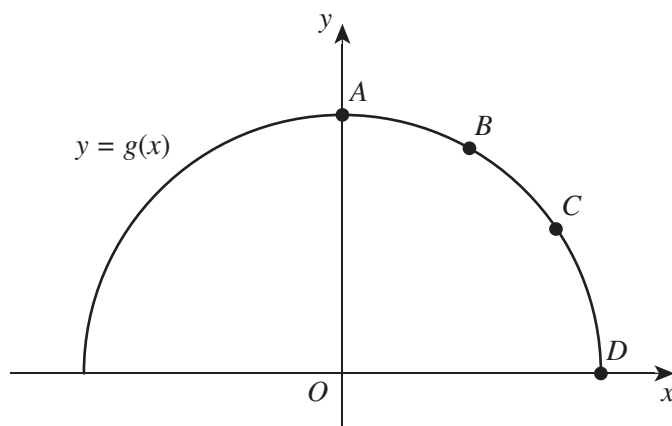
A.  $40x^2(5x^2 + 2)^3$

B.  $40x(5x^2 + 2)^3$

C.  $20x^2(5x^2 + 2)^3$

D.  $20x(5x^2 + 2)^3$

5 The graph of  $y = g(x)$  is shown.



At which point is the graph of  $y = g(x)$  NOT differentiable?

A. point A

B. point B

C. point C

D. point D

6 Points  $P(3, 4)$ ,  $Q(1, 2)$  and  $R(a, b)$  are collinear.

Which of the following statements is true?

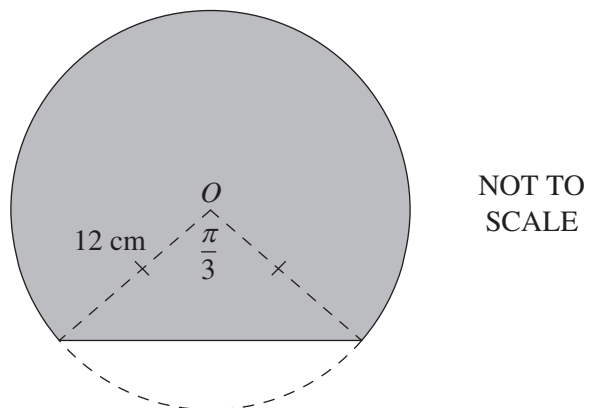
A.  $a - b = 1$

B.  $a - b = -1$

C.  $a - b = 3$

D.  $a - b = -3$

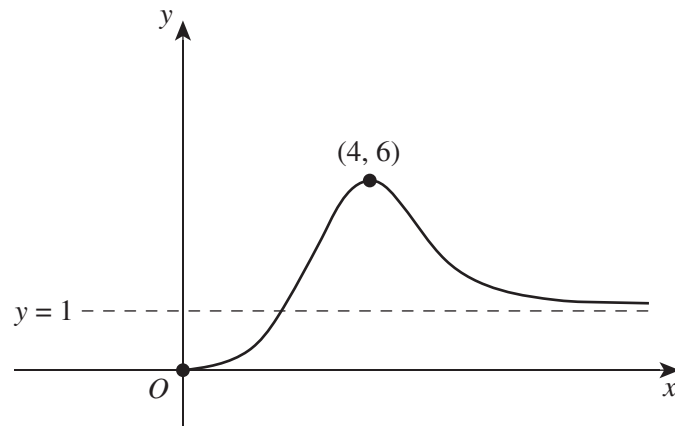
- 7 A standard deck of playing cards is shuffled and two cards are drawn at random. What is the probability that the two cards are different colours?
- A.  $\frac{1}{2}$   
 B.  $\frac{26}{51}$   
 C.  $\frac{27}{51}$   
 D.  $\frac{29}{52}$
- 8 Which of the following is equal to  $50^{\circ}24'$  in radians, correct to three significant figures?
- A. 0.87  
 B. 0.879  
 C. 0.88  
 D. 0.880
- 9 Consider the diagram shown.



What is the area of the shaded segment?

- A.  $120\pi + 36\sqrt{3} \text{ cm}^2$   
 B.  $120\pi - 36\sqrt{3} \text{ cm}^2$   
 C.  $48\pi + 36\sqrt{3} \text{ cm}^2$   
 D.  $48\pi - 36\sqrt{3} \text{ cm}^2$

- 10 The graph shows  $y = f(x)$ , which is an incomplete odd function.



Which of the following statements about  $y = f(x)$  is correct?

- A.  $f(x)$  has only one horizontal asymptote at  $y = 1$ .
- B.  $f(-4) = 6$
- C.  $f'(-3) > 0$
- D.  $f(x)$  is decreasing for  $x > 4$  and  $-4 < x < 0$ .

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# NSW Year 11 Mathematics Advanced

## Section II Answer Booklet 1

### Section II

70 marks

Attempt Questions 11–32

Allow about 1 hour and 45 minutes for this section

**Booklet 1 – Attempt Questions 11–23 (37 marks)**

**Booklet 2 – Attempt Questions 24–32 (33 marks)**

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**Instructions**

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
  - Your responses should include relevant mathematical reasoning and/or calculations.
  - Extra writing space is provided on pages 17–18 of Booklet 1. If you use this space, clearly indicate which question you are answering.
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**Please turn over**

**Question 11** (2 marks)

Find the value of  $x$  if  $6\sqrt{2} + \sqrt{128} - 3\sqrt{32} = \sqrt{x}$ .

**2**

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**Question 12** (2 marks)

What is the equation of a straight line parallel to  $3x - 2y + 4 = 0$  and passing through  $(4, -5)$ ?

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**Question 13** (3 marks)

- (a) Solve  $|3x + 4| = 7$ . **2**

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- (b) A student argues that the solution to  $|3x + 4| = 7$  is the same as the solution to  $|3x + 4| = -7$ . **1**  
 Explain why this is NOT true.

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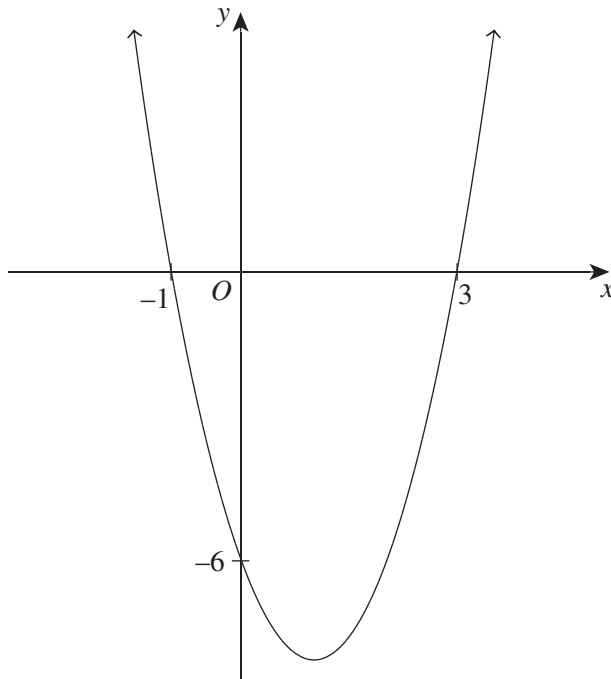
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**Question 14** (2 marks)

Consider the graph shown.

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Find the equation of the graph.

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**Question 15** (5 marks)

- (a) Solve  $2 \cos \theta = -\sqrt{2}$  for  $[0, 2\pi]$ . 2

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- (b) Solve  $\sin^2 2x = \frac{1}{4}$  for  $-180^\circ \leq x \leq 180^\circ$ . 3

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**Question 16** (2 marks)

- Differentiate  $\frac{5x}{5x + 3}$  with respect to  $x$ . 2

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**Question 17** (2 marks)

Differentiate  $f(x) = x^2 - 3x$  using  $f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$ .

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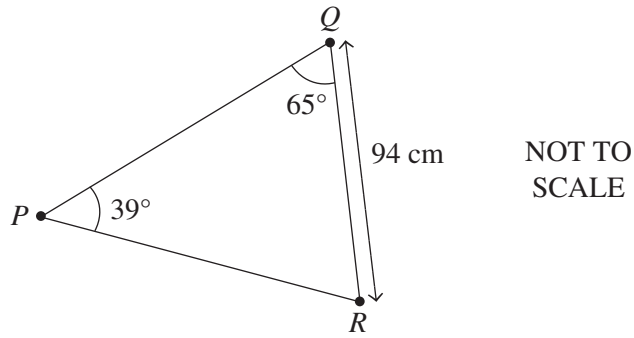
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**Question 18** (2 marks)

Consider the diagram.

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Find the length of the longest side, correct to the nearest centimetre.

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**Question 19** (3 marks)

What is the gradient of the normal at  $x = -1$  when  $y = 3e^x - ex^3$ ?

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**Question 20** (3 marks)

Prove that  $\frac{\tan A}{1 + \sec A} - \frac{\tan A}{1 - \sec A} = 2 \operatorname{cosec} A$ .

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**Question 21** (3 marks)

Find the exact values of  $m$  if the line  $y = mx - 4$  is a tangent to the curve  $y = \frac{x^2}{2}$ .

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**Question 22** (2 marks)

The graph of  $f(x) = \log_2 x$  is transformed to produce  $g(x) = 1 - \log_2(x - 2)$ .

**2**

Describe, in words, the transformation steps used to obtain the graph of  $y = g(x)$ .

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**Question 23** (6 marks)

A supermarket buys 45% of its fruit from farm *A*, 35% of its fruit from farm *B* and the rest from farm *C*. The probability that a randomly chosen fruit supplied by farms *A*, *B* or *C* is rotten is 0.01, 0.03 and 0.04 respectively.

(a) Draw a probability tree diagram representing this information. **2**

(b) Find the probability that a randomly chosen fruit is rotten. **2**

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(c) Given that a randomly chosen fruit is NOT rotten, what is the probability that it was supplied by farm *B*? **2**

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# NSW Year 11 Mathematics Advanced

## Section II Answer Booklet 2

### Booklet 2 – Attempt Questions 24–32 (33 marks)

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**Instructions**

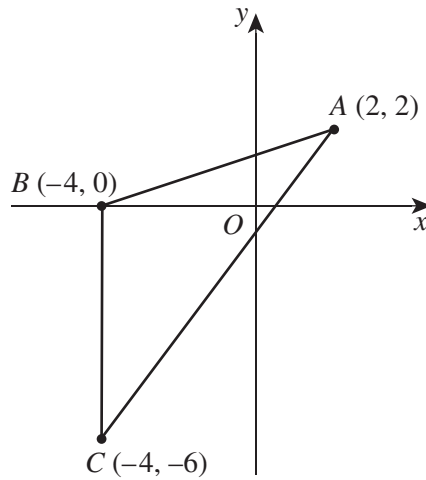
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
  - Your responses should include relevant mathematical reasoning and/or calculations.
  - Extra writing space is provided on pages 28–30 of Booklet 2. If you use this space, clearly indicate which question you are answering.
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**Please turn over**

**Question 24** (2 marks)

The diagram shows triangle  $ABC$  with vertices  $A(2, 2)$ ,  $B(-4, 0)$  and  $C(-4, -6)$ .

**2**



Calculate the size of the obtuse angle in the triangle, correct to the nearest degree.

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**Question 25** (5 marks)

Given that  $\log_7 3 = a$  and  $\log_7 8 = b$ , express the following in terms of  $a$  and  $b$ .

(a)  $\log_7 63$

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(b)  $\log_7 \frac{16}{27}$

**3**

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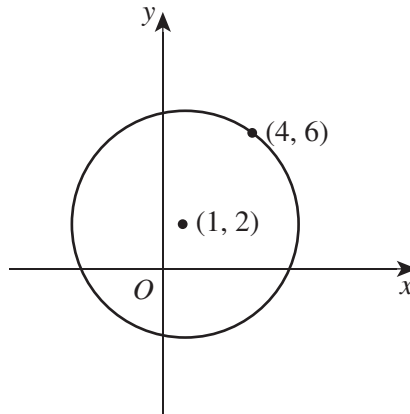
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**Question 26** (2 marks)

A circle with centre (1, 2) and passing through (4, 6) is shown.

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What is the equation of the circle? Give your answer in the form  $x^2 + ax + y^2 + by + c = 0$ .

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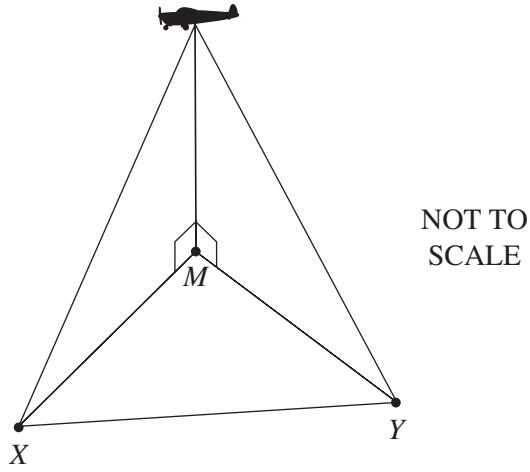
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**Question 27** (4 marks)

When an aircraft is flying directly above point  $M$ , its angle of elevation is measured from points  $X$  and  $Y$  to be  $26^\circ$  and  $25^\circ$  respectively, as shown in the diagram.

4

$X$  and  $Y$  are 6.5 km apart, and  $\angle XMY = 70^\circ$ .



Calculate the aircraft's altitude when it is flying above point  $M$ . Give your answer correct to the nearest metre.

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**Question 28** (4 marks)

A certain radioactive substance decays such that its mass,  $M$  grams, after  $t$  hours is given by  $M = 75e^{-kt}$ , where  $k$  is a constant.

A block of this substance had an original mass of 75 grams. After 10 hours, its mass had reduced to 62 grams.

- (a) Find the exact value of  $k$ . 2

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- (b) How much has the substance's mass reduced after 5 hours? Give your answer correct to one decimal place. 2

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**Question 29** (5 marks)

Consider the functions  $f(x) = \sqrt{2x + 4}$  and  $g(x) = x^2 - 1$ .

- (a) Find the composite function  $y = g(f(x))$ . Give your answer in its simplest form. **2**

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- (b) What is the domain of  $y = g(f(x))$ ? **1**

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- (c) Sketch the graph of  $y = g(f(x))$ , showing the intercepts and any domain restrictions. **2**

**Question 30** (3 marks)

A sector with radius 8 cm has an area of  $80 \text{ cm}^2$ .

**3**

Calculate the perimeter of the sector.

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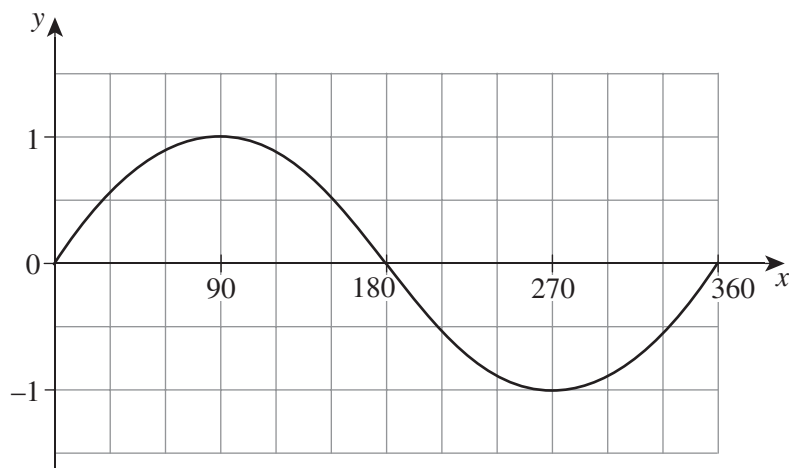
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**Question 31** (3 marks)

The number plane shows the graph of  $y = \sin x^\circ$  for  $[0, 360]$ .



(a) On the number plane, draw the graph of  $y = \cos x^\circ$  for  $[0, 360]$ .

**2**

(b) Hence, solve  $\sin x^\circ = \cos x^\circ$  for  $[0, 360]$ .

**1**

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**Question 32 (5 marks)**

A discrete random variable  $X$  has the probability distribution shown.

**5**

$X$	$a$	$2a$	$3a$	$4a$
$P(X = x)$	$k$	$k^2$	$2k^2$	$k$

The expected value of this discrete probability distribution is  $\frac{23}{18}$ .

Calculate the variance of the distribution.

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**MATHEMATICS ADVANCED**  
**MATHEMATICS EXTENSION 1**  
**MATHEMATICS EXTENSION 2**  
**REFERENCE SHEET**

**Measurement****Length**

$$l = \frac{\theta}{360} \times 2\pi r$$

**Area**

$$A = \frac{\theta}{360} \times \pi r^2$$

$$A = \frac{h}{2}(a + b)$$

**Surface area**

$$A = 2\pi r^2 + 2\pi rh$$

$$A = 4\pi r^2$$

**Volume**

$$V = \frac{1}{3}Ah$$

$$V = \frac{4}{3}\pi r^3$$

**Functions**

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

For  $ax^3 + bx^2 + cx + d = 0$ :

$$\alpha + \beta + \gamma = -\frac{b}{a}$$

$$\alpha\beta + \alpha\gamma + \beta\gamma = \frac{c}{a}$$

$$\text{and } \alpha\beta\gamma = -\frac{d}{a}$$

**Relations**

$$(x - h)^2 + (y - k)^2 = r^2$$

**Financial Mathematics**

$$A = P(1 + r)^n$$

**Sequences and series**

$$T_n = a + (n - 1)d$$

$$S_n = \frac{n}{2}[2a + (n - 1)d] = \frac{n}{2}(a + l)$$

$$T_n = ar^{n-1}$$

$$S_n = \frac{a(1 - r^n)}{1 - r} = \frac{a(r^n - 1)}{r - 1}, r \neq 1$$

$$S = \frac{a}{1 - r}, |r| < 1$$

**Logarithmic and Exponential Functions**

$$\log_a a^x = x = a^{\log_a x}$$

$$\log_a x = \frac{\log_b x}{\log_b a}$$

$$a^x = e^{x \ln a}$$

**Trigonometric Functions**

$$\sin A = \frac{\text{opp}}{\text{hyp}}, \quad \cos A = \frac{\text{adj}}{\text{hyp}}, \quad \tan A = \frac{\text{opp}}{\text{adj}}$$

$$A = \frac{1}{2} ab \sin C$$

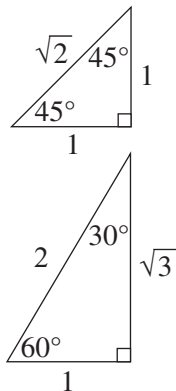
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$c^2 = a^2 + b^2 - 2ab \cos C$$

$$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$$

$$l = r\theta$$

$$A = \frac{1}{2} r^2 \theta$$


**Trigonometric identities**

$$\sec A = \frac{1}{\cos A}, \quad \cos A \neq 0$$

$$\operatorname{cosec} A = \frac{1}{\sin A}, \quad \sin A \neq 0$$

$$\cot A = \frac{\cos A}{\sin A}, \quad \sin A \neq 0$$

$$\cos^2 x + \sin^2 x = 1$$

**Compound angles**

$$\sin(A + B) = \sin A \cos B + \cos A \sin B$$

$$\cos(A + B) = \cos A \cos B - \sin A \sin B$$

$$\tan(A + B) = \frac{\tan A + \tan B}{1 - \tan A \tan B}$$

$$\text{If } t = \tan \frac{A}{2} \text{ then } \sin A = \frac{2t}{1+t^2}$$

$$\cos A = \frac{1-t^2}{1+t^2}$$

$$\tan A = \frac{2t}{1-t^2}$$

$$\cos A \cos B = \frac{1}{2} [\cos(A - B) + \cos(A + B)]$$

$$\sin A \sin B = \frac{1}{2} [\cos(A - B) - \cos(A + B)]$$

$$\sin A \cos B = \frac{1}{2} [\sin(A + B) + \sin(A - B)]$$

$$\cos A \sin B = \frac{1}{2} [\sin(A + B) - \sin(A - B)]$$

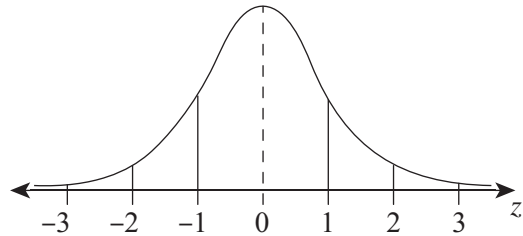
$$\sin^2 nx = \frac{1}{2} (1 - \cos 2nx)$$

$$\cos^2 nx = \frac{1}{2} (1 + \cos 2nx)$$

**Statistical Analysis**

$$z = \frac{x - \mu}{\sigma}$$

An outlier is a score less than  $Q_1 - 1.5 \times IQR$  or more than  $Q_3 + 1.5 \times IQR$

**Normal distribution**


- approximately 68% of scores have  $z$ -scores between  $-1$  and  $1$
- approximately 95% of scores have  $z$ -scores between  $-2$  and  $2$
- approximately 99.7% of scores have  $z$ -scores between  $-3$  and  $3$

$$E(X) = \mu$$

$$\operatorname{Var}(X) = E[(X - \mu)^2] = E(X^2) - \mu^2$$

**Probability**

$$P(A \cap B) = P(A)P(B)$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A|B) = \frac{P(A \cap B)}{P(B)}, \quad P(B) \neq 0$$

**Continuous random variables**

$$P(X \leq r) = \int_a^r f(x) dx$$

$$P(a < X < b) = \int_a^b f(x) dx$$

**Binomial distribution**

$$P(X = r) = {}^n C_r p^r (1 - p)^{n-r}$$

$$X \sim \operatorname{Bin}(n, p)$$

$$\Rightarrow P(X = x)$$

$$= \binom{n}{x} p^x (1 - p)^{n-x}, \quad x = 0, 1, \dots, n$$

$$E(X) = np$$

$$\operatorname{Var}(X) = np(1 - p)$$



**Differential Calculus****Function****Derivative**

$$y = f(x)^n$$

$$\frac{dy}{dx} = nf'(x)[f(x)]^{n-1}$$

$$y = uv$$

$$\frac{dy}{dx} = u \frac{dv}{dx} + v \frac{du}{dx}$$

$$y = g(u) \text{ where } u = f(x)$$

$$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$$

$$y = \frac{u}{v}$$

$$\frac{dy}{dx} = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2}$$

$$y = \sin f(x)$$

$$\frac{dy}{dx} = f'(x) \cos f(x)$$

$$y = \cos f(x)$$

$$\frac{dy}{dx} = -f'(x) \sin f(x)$$

$$y = \tan f(x)$$

$$\frac{dy}{dx} = f'(x) \sec^2 f(x)$$

$$y = e^{f(x)}$$

$$\frac{dy}{dx} = f'(x) e^{f(x)}$$

$$y = \ln f(x)$$

$$\frac{dy}{dx} = \frac{f'(x)}{f(x)}$$

$$y = a^{f(x)}$$

$$\frac{dy}{dx} = (\ln a) f'(x) a^{f(x)}$$

$$y = \log_a f(x)$$

$$\frac{dy}{dx} = \frac{f'(x)}{(\ln a) f(x)}$$

$$y = \sin^{-1} f(x)$$

$$\frac{dy}{dx} = \frac{f'(x)}{\sqrt{1-[f(x)]^2}}$$

$$y = \cos^{-1} f(x)$$

$$\frac{dy}{dx} = \frac{f'(x)}{\sqrt{1-[f(x)]^2}}$$

$$y = \tan^{-1} f(x)$$

$$\frac{dy}{dx} = \frac{f'(x)}{1+[f(x)]^2}$$

**Integral Calculus**

$$\int f'(x)[f(x)]^n dx = \frac{1}{n+1}[f(x)]^{n+1} + c$$

where  $n \neq -1$

$$\int f'(x) \sin f(x) dx = -\cos f(x) + c$$

$$\int f'(x) \cos f(x) dx = \sin f(x) + c$$

$$\int f' \sec^2 f(x) dx = \tan f(x) + c$$

$$\int f'(x) e^{f(x)} dx = e^{f(x)} + c$$

$$\int \frac{f'(x)}{f(x)} dx = \ln |f(x)| + c$$

$$\int f'(x) a^{f(x)} dx = \frac{a^{f(x)}}{\ln a} + c$$

$$\int \frac{f'(x)}{\sqrt{a^2 - [f(x)]^2}} dx = \sin^{-1} \frac{f(x)}{a} + c$$

$$\int \frac{f'(x)}{a^2 - [f(x)]^2} dx = \frac{1}{a} \tan^{-1} \frac{f(x)}{a} + c$$

$$\int u \frac{dv}{dx} dx = uv - \int v \frac{du}{dx} dx$$

$$\int_a^b f(x) dx$$
$$\approx \frac{b-a}{2n} \{f(a) + f(b) + 2[f(x_1) + \dots + f(x_{n-1})]\}$$

where  $a = x_0$  and  $b = x_n$

**Combinatorics**

$${}^n P_r = \frac{n!}{(n-r)!}$$

$$\binom{n}{r} = {}^n C_r = \frac{n!}{r!(n-r)!}$$

$$(x+a)^n = x^n + \binom{n}{1}x^{n-1}a + \dots + \binom{n}{r}x^{n-r}a^r + \dots + a^n$$

**Vectors**

$$|\underline{u}| = |x\underline{i} + y\underline{j}| = \sqrt{x^2 + y^2}$$

$$\underline{u} \cdot \underline{v} = |\underline{u}||\underline{v}|\cos\theta = x_1x_2 + y_1y_2,$$

$$\text{where } \underline{u} = x_1\underline{i} + y_1\underline{j}$$

$$\text{and } \underline{v} = x_2\underline{i} + y_2\underline{j}$$

$$\underline{r} = \underline{a} + \lambda\underline{b}$$

**Complex Numbers**

$$\begin{aligned} z = a + ib &= r(\cos\theta + i\sin\theta) \\ &= re^{i\theta} \end{aligned}$$

$$\begin{aligned} [r(\cos\theta + i\sin\theta)]^n &= r^n(\cos n\theta + i\sin n\theta) \\ &= r^n e^{in\theta} \end{aligned}$$

**Mechanics**

$$\frac{d^2x}{dt^2} = \frac{dv}{dt} = v \frac{dv}{dx} = \frac{d}{dx} \left( \frac{1}{2}v^2 \right)$$

$$x = a \cos(nt + \alpha) + c$$

$$x = a \sin(nt + \alpha) + c$$

$$\ddot{x} = -n^2(x - c)$$

# Neap Final Examination 2021

## NSW Year 11 Mathematics Advanced

### DIRECTIONS:

Write your name in the space provided.

Write your student number in the boxes provided below. Then, in the columns of digits below each box, fill in the oval which has the same number as you have written in the box. Fill in **one** oval only in each column.

Read each question and its suggested answers. Select the alternative A, B, C, or D that best answers the question. Fill in the response oval completely, using blue or black pen. Mark only **one** oval per question.

A  B  C  D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A  B  C  D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and draw an arrow as follows.

A  B  C  D   
*correct*  
 ↓

STUDENT NAME: \_\_\_\_\_

STUDENT NUMBER:

<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="radio"/> 1	<input type="radio"/> 1	<input type="radio"/> 1	<input type="radio"/> 1	<input type="radio"/> 1	<input type="radio"/> 1	<input type="radio"/> 1	<input type="radio"/> 1	<input type="radio"/> 1
<input type="radio"/> 2	<input type="radio"/> 2	<input type="radio"/> 2	<input type="radio"/> 2	<input type="radio"/> 2	<input type="radio"/> 2	<input type="radio"/> 2	<input type="radio"/> 2	<input type="radio"/> 2
<input type="radio"/> 3	<input type="radio"/> 3	<input type="radio"/> 3	<input type="radio"/> 3	<input type="radio"/> 3	<input type="radio"/> 3	<input type="radio"/> 3	<input type="radio"/> 3	<input type="radio"/> 3
<input type="radio"/> 4	<input type="radio"/> 4	<input type="radio"/> 4	<input type="radio"/> 4	<input type="radio"/> 4	<input type="radio"/> 4	<input type="radio"/> 4	<input type="radio"/> 4	<input type="radio"/> 4
<input type="radio"/> 5	<input type="radio"/> 5	<input type="radio"/> 5	<input type="radio"/> 5	<input type="radio"/> 5	<input type="radio"/> 5	<input type="radio"/> 5	<input type="radio"/> 5	<input type="radio"/> 5
<input type="radio"/> 6	<input type="radio"/> 6	<input type="radio"/> 6	<input type="radio"/> 6	<input type="radio"/> 6	<input type="radio"/> 6	<input type="radio"/> 6	<input type="radio"/> 6	<input type="radio"/> 6
<input type="radio"/> 7	<input type="radio"/> 7	<input type="radio"/> 7	<input type="radio"/> 7	<input type="radio"/> 7	<input type="radio"/> 7	<input type="radio"/> 7	<input type="radio"/> 7	<input type="radio"/> 7
<input type="radio"/> 8	<input type="radio"/> 8	<input type="radio"/> 8	<input type="radio"/> 8	<input type="radio"/> 8	<input type="radio"/> 8	<input type="radio"/> 8	<input type="radio"/> 8	<input type="radio"/> 8
<input type="radio"/> 9	<input type="radio"/> 9	<input type="radio"/> 9	<input type="radio"/> 9	<input type="radio"/> 9	<input type="radio"/> 9	<input type="radio"/> 9	<input type="radio"/> 9	<input type="radio"/> 9
<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0

### SECTION I MULTIPLE-CHOICE ANSWER SHEET

- A  B  C  D
- A  B  C  D
- A  B  C  D
- A  B  C  D
- A  B  C  D
- A  B  C  D
- A  B  C  D
- A  B  C  D
- A  B  C  D
- A  B  C  D

**STUDENTS SHOULD NOW CONTINUE  
WITH SECTION II**