

Name: \_\_\_\_\_

Material: A-Math Mock Paper 2021



**OVERMUGGED MOCK PAPER 2021  
SECONDARY 4 EXPRESS  
SECONDARY 5 NORMAL ACADEMIC**

**ADDITIONAL MATHEMATICS**

**4049/02**

**Specimen Paper**

**Date: 1 September 2021**

**Duration: 2 hours 15 minutes**

**Candidates answer on separate writing paper**

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**READ THESE INSTRUCTIONS FIRST**

Write your name on all work you hand in.

Write in dark blue or black pen.

You may use a pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer all questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

You are expected to use a scientific calculator to evaluate explicit numerical expressions.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures.

Give answers in degrees to one decimal place.

For  $\pi$ , use either your calculator value of **3.142**, unless the question requires the answer in terms of  $\pi$ .

At the end of the exam, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question

The total number of marks for this paper is **90**.

Setter: Ong Kai Wen

**This question paper consists of 20 printed pages including the cover page**

## MATHEMATICAL FORMULAE

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### 1. ALGEBRA

#### *Quadratic Equation*

For the equation  $ax^2 + bx + c = 0$

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

#### *Binomial expansion*

$$(a + b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \dots + \binom{n}{r}a^{n-r}b^r + \dots + b^n,$$

where  $n$  is a positive integer and  $\binom{n}{r} = \frac{n!}{r!(n-r)!} = \frac{n(n-1)\dots(n-r+1)}{r!}$

### 2. TRIGONOMETRY

#### *Identities*

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

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

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

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\sin 2A = 2 \sin A \cos A$$

$$\cos 2A = \cos^2 A - \sin^2 A = 2 \cos^2 A - 1 = 1 - 2 \sin^2 A$$

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

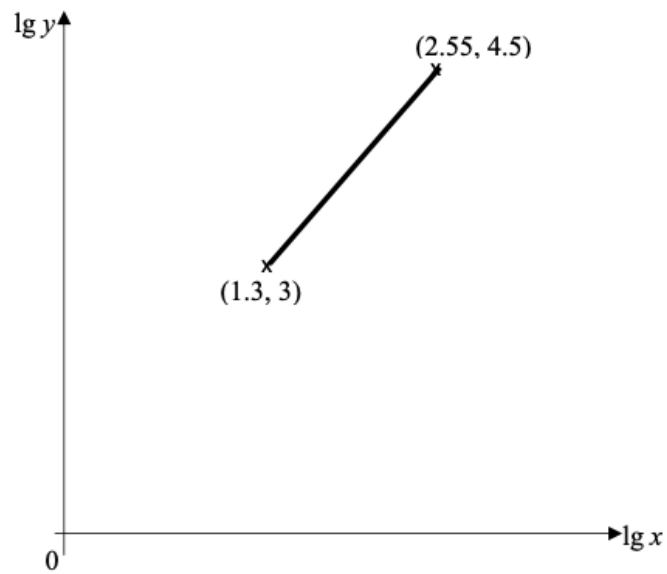
#### *Formulae for $\triangle ABC$*

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

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$\Delta = \frac{1}{2}bc \sin A$$

1.



The variables  $x$  and  $y$  are such that when  $\lg y$  is plotted against  $\lg x$ , the straight line graph shown below is obtained

(a) Find the value of  $A$  and of  $b$  when

$$y = Ax^b$$

[5]

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(b) Find the value of  $\lg y$  when  $x = 100$

[2]

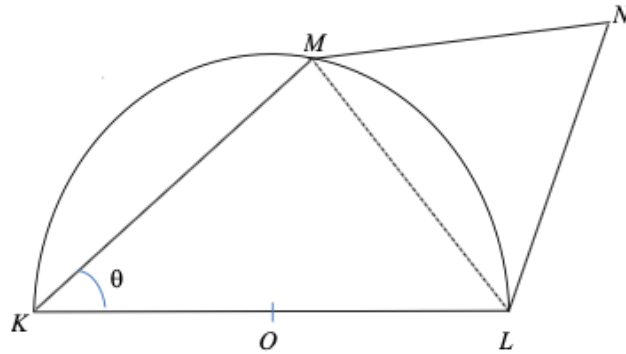
(c) Find the value of  $x$  when  $y = 8000$

[2]

[S4 HYSS P2/2020 PRELIM Qn 4]

[Total: 9 marks]

2.



The diagram shows a triangle  $KLM$  is a semi-circle with centre  $O$  and radius  $2\text{ cm}$ .  $M$  is a point on the circumference such that  $\angle MKL = \theta^\circ$ . An equilateral triangle  $LNM$  is drawn on side  $LM$

(a) The area of the quadrilateral  $KLNM$  is  $A\text{ cm}^2$ . Show that

$$A = 4 \sin 2\theta - 2\sqrt{3} \cos 2\theta + 2\sqrt{3}$$

[5]

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- (b) Find the value of  $R$  and of  $\alpha$  when  $4 \sin 2\theta - 2\sqrt{3} \cos 2\theta$  is expressed as  $R \sin(2\theta - \alpha)$ , where  $R$  and  $\alpha$  are constant

[2]

- (c) Hence, find the maximum area of the quadrilateral  $KLNM$  and the corresponding value of  $\theta$  and the corresponding perimeter

[5]

[S4 HSS P2/2020 PRELIM Qn 11]

[Total: 12 marks]

3.

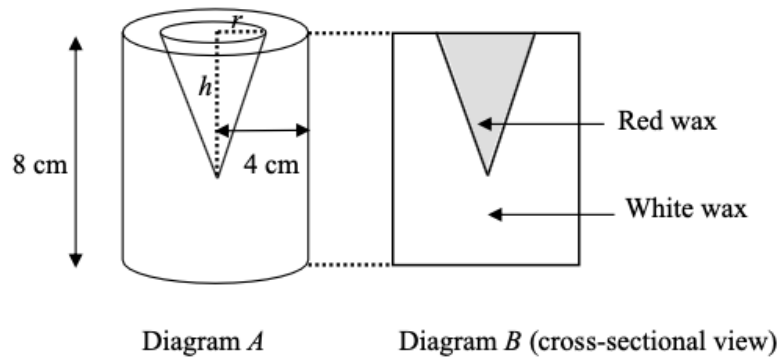


Diagram A shows a cylindrical candle stick of height **8 cm** and radius **4 cm**. The candle stick is made of white wax and red wax as shown in Diagram B. The red wax forms an inverted cone of radius  $r$  cm and height  $h$  cm

- (a) Given that the sum of the radius and height of the cone is to remain constant at **5 cm**, express  $h$  in terms of  $r$

[1]

- (b) Show that the volume,  $V$ , of the white wax is given by

$$V = 128\pi - \frac{5}{3}\pi r^2 + \frac{1}{3}\pi r^3$$

[3]

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(c) Find the value of  $r$  for which  $V$  is stationary

[4]

[S4 HIHS P2/2020 PRELIM Qn 2]

[Total: 8 marks]



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4. (a) Solve the equation

$$\log_3(x - 2) = \log_3(12 - x) - 2$$

[4]

(b) Express  $y$  in terms of  $x$  given that

$$(2 \log_5 y)(\log_x 5) = 8$$

[3]

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- (c) Explain why there are no real solutions for the following equation

$$e^{4x} + 7 = 3e^{2x}$$

[Hint: Substitution]

[3]

[S4 CCHS(M) P2/2020 PRELIM Qn 2]

[Total: 10 marks]

5. A circle,  $C_1$ , has equation

$$x^2 + y^2 - 4x + 6y = 36$$

- (a) Find the radius and the coordinates of the centre of  $C_1$

[3]

The highest point on a second circle,  $C_2$ , is  $(3, 6)$  and the equation of the tangent at the lowest point is  $y = 4$

- (b) Find the radius and the coordinates of the centre of  $C_2$

[2]

- (c) Find the equation of  $C_2$

[1]

- (d) Showing your working clearly, determine whether the circles  $C_1$  and  $C_2$  meet each other

[2]

[S4 CHIJ SNGS P2/2020 PRELIM Qn 3]

[Total: 8 marks]

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6. The following curve, where  $a$  is a constant, has two stationary points

$$y = \frac{a}{2x+1} + 9x - 5$$

- (a) Find the value of  $y$  given that one of the stationary points is

$$\left(-\frac{1}{6}, y\right)$$

[5]

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(b) Find the coordinates of the other stationary point

[3]

(c) Determine the nature of these stationary points

[3]

[S4 CHIJ CHIJS P2/2020 PRELIM Qn 12]

[Total: 11 marks]

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7. (a) Prove that

$$\frac{\operatorname{cosec}^2 \theta - 2}{\operatorname{cosec}^2 \theta} = \cos 2\theta$$

[3]

(b) Hence, solve the equation, for  $0 < \theta < 5$

$$\frac{\operatorname{cosec}^2 \theta - 2}{\operatorname{cosec}^2 \theta} + \frac{3}{\operatorname{cosec} 2\theta} = 0$$

[4]

[S4 BPGHS P2/2020 PRELIM Qn 6]

[Total: 7 marks]

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8. A particle  $P$  leaves a fixed point  $O$  and moves in a straight line so that,  $t$  seconds after leaving  $O$ , its velocity,  $V$  m/s is given by the following, where  $k$  is a constant

$$v = -3t^2 + kt + 15$$

- (a) Given that its deceleration is  $8 \text{ m/s}^2$  when  $t = 2$ , find the value of  $k$

[2]

- (b) Find the value of  $t$  for which the particle is at instantaneous rest

[2]

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(c) Find the maximum velocity of the particle

[2]

(d) Find the time taken for the particle to return to point  $O$

[3]

[S4 BGSS P2/2020 PRELIM Qn 11]

[Total: 9 marks]



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9. (a) Without using a calculator, show that

$$\tan 15^\circ = 2 - \sqrt{3}$$

[4]

(b) Hence, find the values of the integers  $a$  and  $b$  such that

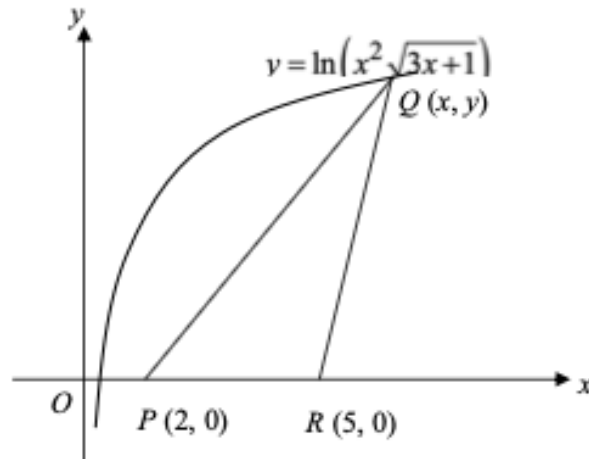
$$\sec^2 15^\circ = a - b\sqrt{3}$$

[3]

[S4 ACS(B) P2/2020 PRELIM Qn 9(a)]

[Total: 7 marks]

10.



The diagram shows the curve and three points  $P(2, 0)$ ,  $Q(x, y)$  and  $R(5, 0)$ . The point  $Q(x, y)$  lies on the curve

$$y = \ln(x^2 \sqrt{3x+1})$$

(a) Show that the area,  $A$  units<sup>2</sup>, of the triangle  $PQR$  is given by

$$A = 3 \ln x + \frac{3}{4} \ln(3x+1)$$

[2]

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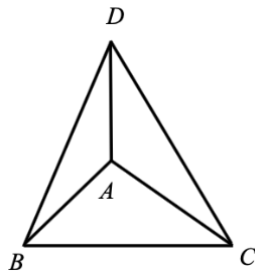
- (b) Given that  $x$  is increasing at a rate of **0.2 units/s**, find the rate at which the area,  $A$ , is changing at the instant when  $x = 15$  units

[3]

[S4 AHS P1/2020 PRELIM Qn 9]

[Total: 5 marks]

11.



A solid triangular pyramid,  $ABCD$ , with base  $ABC$  and vertex  $D$  such that  $D$  is vertically above  $A$ , has a base area of  $(8 + 2\sqrt{5}) \text{ cm}^2$  and height  $(12 - \sqrt{5}) \text{ cm}$ . The top part of the pyramid is removed by a cut parallel to its base and passing through the midpoint of  $AD$ . Find the volume of the remaining solid, leaving your answer in the following form, where  $a$  and  $b$  are integers

$$\frac{7(a + b\sqrt{5})}{12} \text{ cm}^3$$

[4]

[S4 ANDSS P1/2020 PRELIM Qn 10(b)]

[Total: 4 marks]

End of Paper 😊