

## MATHEMATICS METHODS Year 12

### Section One: Calculator-free

Your name \_\_\_\_\_

Teacher's name \_\_\_\_\_

#### Time and marks available for this section

Reading time before commencing work: 2 minutes  
Working time for this section: 15 minutes  
Marks available: 15 marks

#### Materials required/recommended for this section

##### *To be provided by the supervisor*

This Question/Answer Booklet  
Formula Sheet

##### *To be provided by the candidate*

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener,  
correction fluid/tape, eraser, ruler, highlighters

Special items: nil

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7. It is recommended that **you do not use pencil**, except in diagrams.

See next page

## Question 1

(3 marks)

Consider the following discrete probability distribution for the random variable  $X$ .

$x$	1	2	3	4	5
$P(X = x)$	$p$	$2p$	$3p$	$4p$	$5p$

(a) Find the value of  $p$ .

(1 mark)

(b) Hence, find  $E(X)$ .

(2 marks)

## Question 2

(6 marks)

- (a) If  $\frac{dy}{dx} = e^{3x}$ , then find an expression for,  $y$ , if  $y = 1$  when  $x = 0$ . (2 marks)

- (b) Determine  $\frac{d}{dx}(5x^2e^{x^3})$ . There is no need to simplify your answer.

(2 marks)

## Question 2 continued

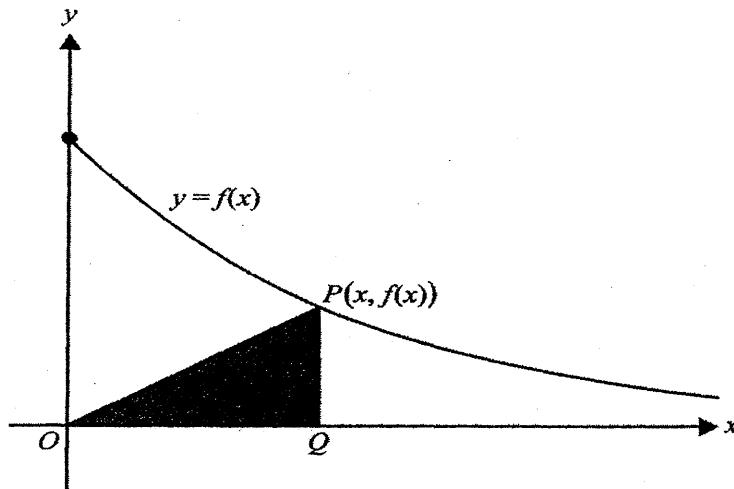
(c) Determine  $\int_0^{\frac{\pi}{6}} 2\cos(3x)dx$

(2 marks)

**Question 3**

**(6 marks)**

Let  $f(x) = 2e^{-\frac{x}{5}}$ . A right-angled triangle OQP has point O at the origin, point Q on the  $x$ -axis and point P on the graph of  $f$ , as shown. The coordinates of P are  $(x, f(x))$ .



(a) Find an expression for the area,  $A$ , of the triangle OQP in terms of  $x$ . (2 marks)

(b) Find the maximum area of triangle OQP and the value of  $x$  for which the maximum occurs. (4 marks)

**End of questions**

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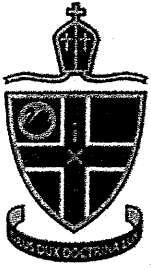
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Question number: \_\_\_\_\_







## MATHEMATICS METHODS Year 12

Section Two:

Calculator-assumed

Your name \_\_\_\_\_

Teacher's name \_\_\_\_\_

### Time and marks available for this section

Reading time before commencing work: 3 minutes  
Working time for this section: 30 minutes  
Marks available: 30 marks

### Materials required/recommended for this section

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This Question/Answer Booklet  
Formula Sheet (retained from Section One)

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Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

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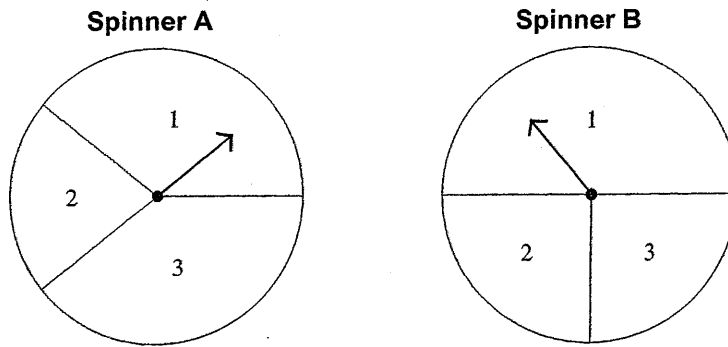
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**Question 4**

**(5 marks)**

Two different spinners are constructed by dividing a circular card into 3 sectors scoring 1, 2 and 3. Each spinner has a rotating pointer pivoted at the centre, as shown below.

(Diagrams are not drawn to scale)



**Spinner A** has angles  $135^\circ$ ,  $90^\circ$  and  $135^\circ$  for the sectors scoring 1, 2 and 3 respectively.

**Spinner B** has angles  $180^\circ$ ,  $90^\circ$  and  $90^\circ$  for the sectors scoring 1, 2 and 3 respectively.

After being set in motion, the pointers come to rest independently in random positions.

The random variable  $X$  is the **larger** of the two scores if they are different, and their common value if they are the same.

(a) Find  $P(X = 2)$ .

**(3 marks)**

(b) Complete the probability distribution for  $X$ .

**(2 marks)**

$x$	1	2	3
$P(X = x)$			

**Question 5**

**(6 marks)**

The table shows the probability distribution of a discrete random variable  $X$ .

$x$	1	2	3	4
$P(X = x)$	$\frac{p}{2}$	$2p$	$p + 0.1$	$p$

Calculate:

(a) the value of  $p$ . (1 mark)

(b)  $E(X^2)$  (1 mark)



(c)  $E(2X + 1)$  (2 marks)

(d)  $Var(2X + 1)$  (2 marks)



## Question 6

(7 marks)

Scientists are studying a complex biological process. They have measured the **rate of change** of concentration of two enzymes,  $A$  and  $B$ , over a period of time and have found that these rates are approximately modelled by the two functions

Enzyme  $A$ :  $R_A'(t) = 4e^{-0.5t}, t \geq 0$

Enzyme  $B$ :  $R_B'(t) = \frac{8}{t^2+2}, t \geq 0$

Where  $R_A'(t)$  is the rate of change of concentration of enzyme  $A$  and  $R_B'(t)$  is the rate of change of concentration of enzyme  $B$  after  $t$  minutes. Both rates of change of concentrations are measured in grams per litre per minute.

(a) Find the initial rate of change of concentration of each of the enzymes. (2 marks)

(b) State the derivative of  $R_A'(t)$  (1 mark)

(c) Determine if the functions  $R_A'(t)$  and  $R_B'(t)$  are increasing, decreasing or neither for  $t > 0$ . (2 marks)

(d) State the time(s), to 4 decimal places, where  $R_A'(t) = R_B'(t)$  for  $0 < t < 10$ . (2 marks)

See next page

**Question 7**

**(5 marks)**

A new casino gambling game is being developed. It costs \$5 to play a game. When two dice are rolled, if the uppermost numbers total 10 or more, or 4 or less, you are paid \$10. (Your \$5 cost to play and a further \$5) If the total score of 7 occurs, you receive your \$5 back. All other outcomes result in the loss of your \$5.

If  $X$  represents the amount won,

(a) complete the probability distribution for  $X$ .

**(3 marks)**

$x$			
$P(X = x)$			

(b) calculate the expected amount you will win or lose if you play 6 games.

**(2 marks)**

**Question 8****(3 marks)**

At the corner cafe, 70% of customers order a cappuccino and 30% order a latte. Of the customers who order a cappuccino, 60% order scrolls, and 25% of customers who order a latte order the scrolls.

Determine the probability that, if a scroll is ordered, the customer also ordered a cappuccino. Write your answer as a simplified fraction.

**Question 9****(2 marks)**

A discrete random variable  $X$  has the probability function  $P(X = x) = k(1 - k)^x$  where  $x > 0$ . Write an expression for  $P(X > 1)$  in terms of  $k$ , leaving your answer in simplified form.

## Question 10

(2 marks)

If  $y = e^{\cos(x)}$  and  $\frac{dx}{dt} = \frac{-1}{\cos(x)}$ , then find the value of  $\frac{dy}{dt}$  when  $x = \frac{\pi}{3}$ .

End of questions



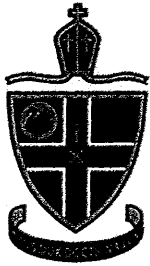
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## MATHEMATICS METHODS Year 12

### Section One: Calculator-free

Your name \_\_\_\_\_ • SOLUTIONS •

Teacher's name \_\_\_\_\_

#### Time and marks available for this section

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Question 1

(3 marks)

Consider the following discrete probability distribution for the random variable  $X$ .

$x$	1	2	3	4	5
$P(X = x)$	$p$	$2p$	$3p$	$4p$	$5p$

(a) Find the value of  $p$ .

(1 mark)

$$15p = 1$$

$$\therefore p = \frac{1}{15} \quad \checkmark$$

(b) Hence, find  $E(X)$ .

(2 marks)

$$E(x) = 1 \times p + 2 \times 2p + 3 \times 3p + 4 \times 4p + 5 \times 5p \quad \checkmark \left( \sum x \cdot p(x) \right)$$

$$= 1p + 4p + 9p + 16p + 25p$$

$$= 55p$$

$$= \frac{55}{15} \quad \checkmark \quad (\text{ANSW})$$

[OR 2 mks for just answ.]

Question 2

(6 marks)

- (a) If  $\frac{dy}{dx} = e^{3x}$ , then find an expression for,  $y$ , if  $y = 1$  when  $x = 0$ . (2 marks)

$$\int e^{3x} dx = \frac{e^{3x}}{3} + c \quad (\text{Anti-diff}) \quad \checkmark$$

$$1 = \frac{e^0}{3} + c$$

$$\therefore c = \frac{2}{3}$$

$$y = \frac{1}{3} e^{3x} + \frac{2}{3} \quad \checkmark \quad (\text{Answ})$$

- (b) Determine  $\frac{d}{dx} (5x^2 e^{x^3})$ . There is no need to simplify your answer. (2 marks)

$$y' = u'v + uv'$$

$$\frac{dy}{dx} = \frac{10x \cdot e^{x^3} + 5x^2 \cdot (3x^2) e^{x^3}}{\quad} \quad \checkmark (u'v)$$

$$\quad \quad \quad \checkmark (uv')$$

$$\text{OR } 5x e^{x^3} (2 + 3x^3)$$

(not required)

## Question 2 continued

(c) Determine  $\int_0^{\frac{\pi}{6}} 2\cos(3x)dx$

(2 marks)

$$= \left[ \frac{2\sin(3x)}{3} \right]_0^{\frac{\pi}{6}} \quad \checkmark \text{ (Anti-diff)}$$

$$= \frac{2\sin\frac{\pi}{2}}{3} - 0$$

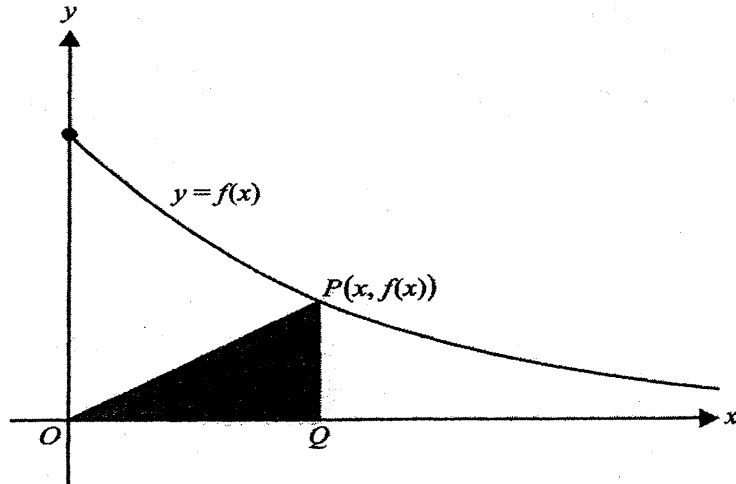
$$= \underline{\underline{\frac{2}{3}}} \quad \checkmark \text{ (Answ)}$$

2

Question 3

(6 marks)

Let  $f(x) = 2e^{-\frac{x}{5}}$ . A right-angled triangle OQP has point O at the origin, point Q on the  $x$ -axis and point P on the graph of  $f$ , as shown. The coordinates of P are  $(x, f(x))$ .



- (a) Find an expression for the area,  $A$ , of the triangle OQP in terms of  $x$ . (2 marks)

$$A = \frac{1}{2} b \times h$$

$$A = \frac{1}{2} x \times 2e^{-\frac{x}{5}}$$

$$A = x \cdot e^{-\frac{x}{5}}$$

$$\left( \frac{1}{2}x \text{ by } 2e^{-\frac{x}{5}} \right)$$

- (b) Find the maximum area of triangle OQP and the value of  $x$  for which the maximum occurs. (4 marks)

$$\frac{dA}{dx} = e^{-\frac{x}{5}} + x \left( -\frac{1}{5} e^{-\frac{x}{5}} \right)$$

$$= e^{-\frac{x}{5}} \left( 1 - \frac{x}{5} \right)$$

$$\frac{dA}{dx} = 0$$

$$\Rightarrow x = 5$$

$$\text{When } x=5 \Rightarrow A = 5e^{-1}$$

OR

$$A = \frac{5}{e} \text{ units}^2$$

End of questions

✓ (correct value)

6



**Additional working space**

Question number: \_\_\_\_\_

**Additional working space**

Question number: \_\_\_\_\_



## MATHEMATICS METHODS Year 12

Section Two:

Calculator-assumed

Your name \_\_\_\_\_ *• SOLUTIONS •*

Teacher's name \_\_\_\_\_

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Working time for this section: 30 minutes  
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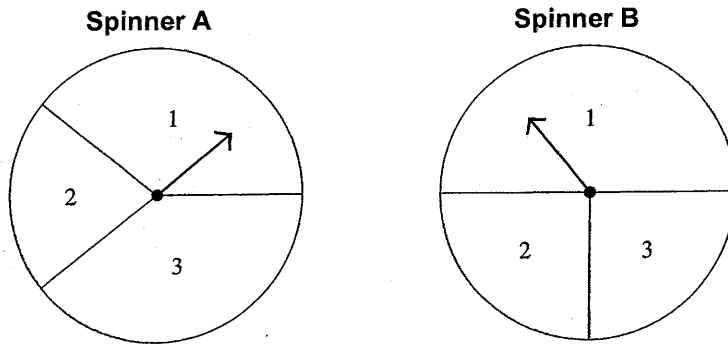
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(5 marks)

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 After being set in motion, the pointers come to rest independently in random positions.  
 The random variable  $X$  is the **larger** of the two scores if they are different, and their common value if they are the same.

(a) Find  $P(X = 2)$ .

	Spinner A	Spinner B
$P(1)$	$\frac{3}{8}$	$\frac{1}{2}$
$P(2)$	$\frac{1}{4}$	$\frac{1}{4}$
$P(3)$	$\frac{3}{8}$	$\frac{1}{4}$

(3 marks)

$$P(X=2) = P(1,2) + P(2,1) + P(2,2)$$

✓ (All combinations)

$$= \left(\frac{3}{8} \times \frac{1}{4}\right) + \left(\frac{1}{4} \times \frac{1}{2}\right) + \left(\frac{1}{4} \times \frac{1}{4}\right)$$

✓ (working)

$$= \frac{9}{32} \quad (0.28125)$$

✓ (ANSW)

(b) Complete the probability distribution for  $X$ .

(2 marks)

$x$	1	2	3
$P(X = x)$	$\frac{3}{8} \times \frac{1}{2} = \frac{6}{32}$	$\frac{9}{32}$	$\frac{17}{32}$

OR  $\frac{3}{16}$  ✓  
0.1875

See next page

0.28125

✓  
0.53125

5

Question 5

(6 marks)

The table shows the probability distribution of a discrete random variable  $X$ .

$x$	1	2	3	4
$P(X = x)$	$\frac{p}{2}$	$2p$	$p + 0.1$	$p$

Calculate:

(a) the value of  $p$ .

(1 mark)

$$\frac{p}{2} + 2p + p + 0.1 + p = 1 \Rightarrow p = 0.2 \checkmark$$

(b)  $E(X^2)$

(1 mark)

$$E(X^2) = 1^2 \cdot \frac{p}{2} + 2^2 \cdot 2p + 3^2 \cdot (p + 0.1) + 4^2 \cdot p = 7.6 \checkmark$$

$\frac{38}{5}$

(c)  $E(2X + 1)$

(2 marks)

$$E(X) = 2.6 \quad \text{CPad.} \quad \checkmark (E(X))$$

$$\begin{aligned} \therefore E(2X + 1) &= 2(2.6) + 1 \\ &= \underline{6.2} \quad \checkmark (E(2X + 1)) \end{aligned}$$

(d)  $\text{Var}(2X + 1)$

(2 marks)

$$\begin{aligned} \sigma &= 0.9165151 \\ \therefore \sigma^2 &= 0.84 \end{aligned} \quad \left. \begin{array}{l} \text{CPad.} \\ \checkmark (\text{VAR}) \end{array} \right\}$$

$$\begin{aligned} \therefore \text{Var}(2X + 1) &= 2^2 (0.84) \\ &= \underline{\underline{3.36}} \quad \checkmark (\text{ANSW}) \end{aligned}$$

Question 6

(7 marks)

Scientists are studying a complex biological process. They have measured the **rate of change** of concentration of two enzymes, *A* and *B*, over a period of time and have found that these rates are approximately modelled by the two functions

Enzyme *A*:  $R_A'(t) = 4e^{-0.5t}, t \geq 0$

Enzyme *B*:  $R_B'(t) = \frac{8}{t^2+2}, t \geq 0$

Where  $R_A'(t)$  is the rate of change of concentration of enzyme *A* and  $R_B'(t)$  is the rate of change of concentration of enzyme *B* after *t* minutes. Both rates of change of concentrations are measured in grams per litre per minute.

- (a) Find the initial rate of change of concentration of each of the enzymes. (2 marks)

$$R_A'(0) = \underline{4} \text{ g/L/min} \quad \checkmark$$

$$R_B'(0) = \underline{4} \text{ g/L/min} \quad \checkmark$$

- (b) State the derivative of  $R_A'(t)$

(1 mark)

$$R_A''(t) = \underline{-2e^{-t/2}} \quad \checkmark$$

- (c) Determine if the functions  $R_A'(t)$  and  $R_B'(t)$  are increasing, decreasing or neither for  $t > 0$ . (2 marks)

$$R_A'(t) \Rightarrow \underline{\text{Decreasing}} \quad \checkmark$$

$$R_B'(t) \Rightarrow \underline{\text{Decreasing}} \quad \checkmark$$

- (d) State the time(s), to 4 decimal places, where  $R_A'(t) = R_B'(t)$  for  $0 < t < 10$ .

(2 marks)

$$t = 1.4817 \text{ min} \quad \checkmark$$

$$t = 5.6853 \text{ min} \quad \checkmark$$

(-1 if not to 4 dp)

Question 7

(5 marks)

A new casino gambling game is being developed. It costs \$5 to play a game. When two dice are rolled, if the uppermost numbers total 10 or more, or 4 or less, you are paid \$10. (Your \$5 cost to play and a further \$5) If the total score of 7 occurs, you receive your \$5 back. All other outcomes result in the loss of your \$5. If  $X$  represents the amount won,

(a) complete the probability distribution for  $X$ .

(3 marks)

$x$	\$5	\$0	\$-5
$P(X = x)$	$\frac{12}{36}$	$\frac{6}{36}$	$\frac{18}{36}$

$$\begin{aligned}
 &P(10, 11, 12) + P(4, 3, 2) && \left(\frac{2}{6}\right) && \left(\frac{1}{6}\right) && \left(\frac{3}{6}\right) \\
 &= \frac{6}{36} + \frac{6}{36} && \checkmark && \checkmark && \checkmark
 \end{aligned}$$

(b) calculate the expected amount you will win or lose if you play 6 games.

(2 marks)

$$\begin{aligned}
 E(X) &= 5\left(\frac{2}{6}\right) + 0\left(\frac{1}{6}\right) - 5\left(\frac{3}{6}\right) \\
 &= -\frac{5}{6} \quad \checkmark (E(X))
 \end{aligned}$$

ie losing \$  $\frac{5}{6}$  per game

$\therefore$  \$5 loss for 6 games  $\checkmark$  (Answ)

5

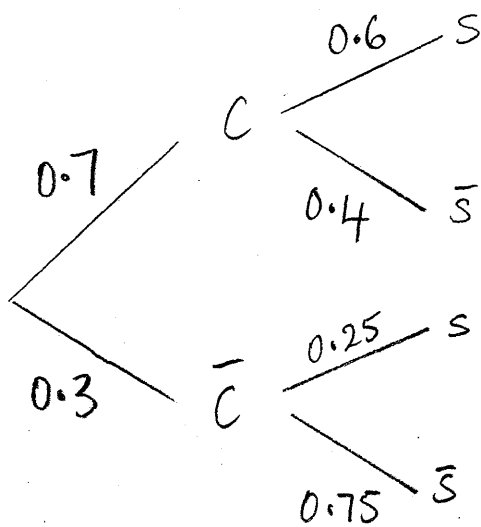


Question 8

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At the corner cafe, 70% of customers order a cappuccino and 30% order a latte. Of the customers who order a cappuccino, 60% order scrolls, and 25% of customers who order a latte order the scrolls.

Determine the probability that, if a scroll is ordered, the customer also ordered a cappuccino. Write your answer as a simplified fraction.



$$P(c/s) = \frac{P(cns)}{P(s)}$$

$$\checkmark \text{ (num)} = \frac{0.7 \times 0.6}{0.7 \times 0.6 + 0.3 \times 0.25}$$

$$\checkmark \text{ (denom)}$$

$$= \frac{0.42}{0.495}$$

$$= \frac{28}{33} \quad \checkmark \text{ (simplified fraction)}$$

$0.\overline{84}$

Question 9

(2 marks)

A discrete random variable  $X$  has the probability function  $P(X = x) = k(1 - k)^x$  where  $x > 0$ . Write an expression for  $P(X > 1)$  in terms of  $k$ , leaving your answer in simplified form.

$$P(X > 1) = 1 - [P(X = 1)] \quad \text{Given } x > 0$$

$$= 1 - (k(1-k)^1) \quad \checkmark \text{ (complement in } k\text{'s)}$$

$$= 1 - (k - k^2)$$

$$= k^2 - k + 1 \quad \checkmark \text{ (simplified)}$$

OR

$$= k(k-1) + 1 \quad \text{either}$$

See next page

Question 10

(2 marks)

If  $y = e^{\cos(x)}$  and  $\frac{dx}{dt} = \frac{-1}{\cos(x)}$ , then find the value of  $\frac{dy}{dt}$  when  $x = \frac{\pi}{3}$ .

$$\frac{dy}{dt} = \frac{dy}{dx} \times \frac{dx}{dt} \quad \text{but} \quad \frac{dy}{dx} = -\sin(x) e^{\cos(x)}$$

$$\frac{dy}{dt} = -\sin(x) e^{\cos(x)} \times \left(\frac{-1}{\cos(x)}\right)$$

$$\frac{dy}{dt} = \frac{\sin(x)}{\cos(x)} e^{\cos(x)} \quad \text{OR} \quad \tan(x) e^{\cos(x)} \quad \checkmark \quad \left(\text{either } \frac{dy}{dt}\right)$$

$$\left. \frac{dy}{dt} \right|_{x=\frac{\pi}{3}} = \sqrt{3}e \quad \checkmark \quad (\text{ANSW})$$

2.855

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