Trial HSC Examination 2018
Mathematics Course

Name ______________________ Teacher ________________

Section I – Multiple Choice Answer Sheet

Allow about 15 minutes for this section

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

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 ○

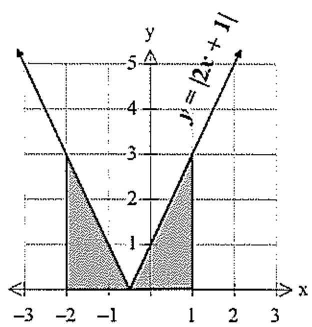
If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

correct

A ~~●~~ B ~~●~~ C ○ D ○

1.	A ○	B ●	C ○	D ○
2.	A ●	B ○	C ○	D ○
3.	A ○	B ○	C ○	D ●
4.	A ○	B ●	C ○	D ○
5.	A ●	B ○	C ○	D
6.	A ●	B ○	C ○	D ○
7.	A ○	B ○	C ○	D ●
8.	A ○	B ○	C ●	D ○
9.	A ○	B ○	C ●	D ○
10.	A ○	B ●	C ○	D ○

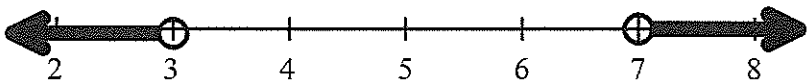
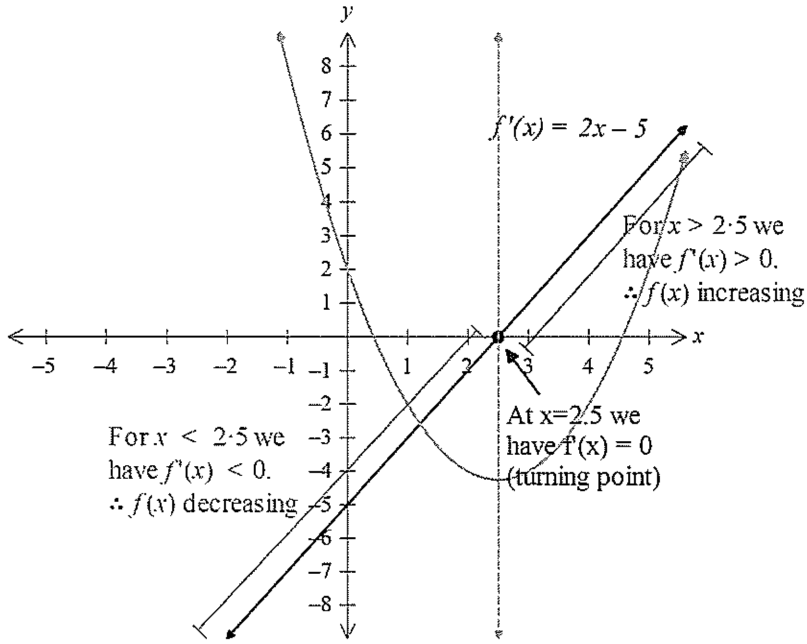
Multiple Choice Worked Solutions

No	Working	Answer
1	$3x + 2y - 10 = 0$ $2y = -3x + 10$ $y = -\frac{3}{2}x + 5$ $\therefore\ m = -\frac{3}{2}$	**B**
2	$\int \frac{x}{x^2+1}\,dx$ $\frac{d}{dx}(x^2+1) = 2x$ $\int \frac{x}{x^2+1}\,dx = \frac{1}{2}\int \frac{2x}{x^2+1}\,dx$ $= \frac{1}{2}\ln(x^2+1) + C$	**A**
3	sin and tan are both negative in the fourth quadrant.	**D**
4	$27x^3 - 8 = (3x-2)(9x^2 + 6x + 4)$	**B**
5	~~P(AFL wins) = 1-P(AFL loses)~~ $= \frac{2}{5}$ ~~P(both win)=~~ $\frac{2}{5} \times \frac{3}{8}$ $= \frac{3}{20}$ $= 15\%$	A ~~D~~
6	The graph shows a concave up parabola ($a > 0$) with 2 distinct, integer roots. For distinct integer roots, need $\Delta \neq 0$ and Δ square.	**A**
7	We have two triangles with base length 1.5 units and height 3 units. $A = \frac{1}{2}$bh gives us area = 4.5 square units  	**D**
8	At point P, the slope of the curve is positive, therefore the velocity is positive. Concavity is negative, so acceleration is negative.	**C**

9	$5, \frac{5}{7}, \frac{5}{49}$ $a = 5$ $r = \frac{1}{7}$ $S_\infty = \frac{a}{1-r}$ $= \frac{5}{1-\frac{1}{7}}$ $= 5\ \frac{5}{6}$	**C**
10	$l = r\theta$ $8 = r\theta$ $r = \frac{8}{\theta}$ $Area = \frac{1}{2}r^2\theta$ $= \frac{1}{2} \times \left(\frac{8}{\theta}\right)^2 \times \theta$ $= \frac{1}{2} \times \frac{64}{\theta^2} \times \theta$ $= \frac{32}{\theta}$ square units	**B**

Question 11	**2018**

	Question 11 Solutions	Marks	Allocation of marks
(a)	For $\frac{3x+2}{2x^3-5x^2}$ let $u = 3x+2$ and $v = 2x^3-5x^2$ then $u' = 3$ and $v' = 6x^2-10x$ $y' = \frac{vu'-uv'}{v^2}$ $= \frac{3(2x^3-5x^2)-(3x+2)(6x^2-10x)}{(2x^3-5x^2)^2}$	1	Correct use of quotient rule
	$= \frac{6x^3-15x^2-18x^3+30x^2-12x^2+20x}{(2x^3-5x^2)^2}$ $= \frac{-12x^3+3x^2+20x}{(2x^3-5x^2)^2}$	1	Correct expansion & simplification
(b)	(i) $\frac{3}{\sqrt{2}-7} \times \frac{\sqrt{2}+7}{\sqrt{2}+7} = \frac{3\sqrt{2}+21}{2-49}$	1	Multiplication by correct fraction with conjugate.
	$= \frac{3\sqrt{2}+21}{-47}$	1	Correct answer.
	(ii) $a = -\frac{21}{47}$ and $b = -\frac{3}{47}$	1	Correct separation of values from answer reached in (i).
(c)	$a = 10, b = -13, c = -3, a \times c = -30$ Use -15 and 2	2	2 marks for correct answer.
	$10x^2-13x-3 = \frac{(10x-15)(10x+2)}{10}$ $= \frac{5(2x-3)\,2(5x+1)}{10}$ $= (2x-3)(5x+1)$		1 mark if incorrect answer due to a minor error
(d)	$\left[\frac{d}{dx}(-\cos 2x) = 2\sin 2x\right]$ $\int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \sin 2x\,dx = -\frac{1}{2}[\cos 2x]_{\frac{\pi}{4}}^{\frac{\pi}{2}}$	1	
	$= -\frac{1}{2}\left[\cos\pi - \cos\frac{\pi}{2}\right]$ $= -\frac{1}{2}[-1-0]$ $= \frac{1}{2}$	1	
(e)	(i) $\lvert x-5\rvert > 2$ $x-5 > 2$ or $-x+5 > 2$ $x > 7$ $-x > -3$	1	Correct inequalities set up using concept of absolute value.
	$x > 7$ $x < 3$	1	Correct conclusion.

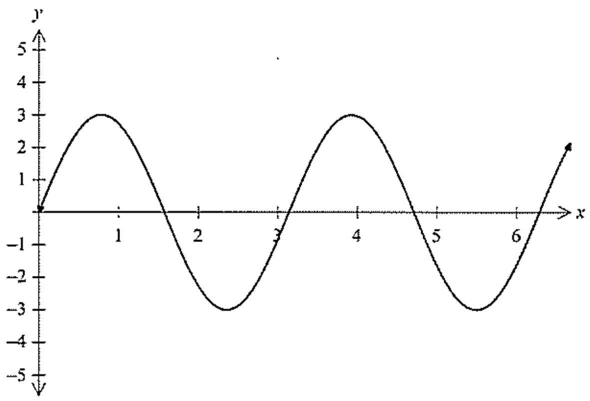
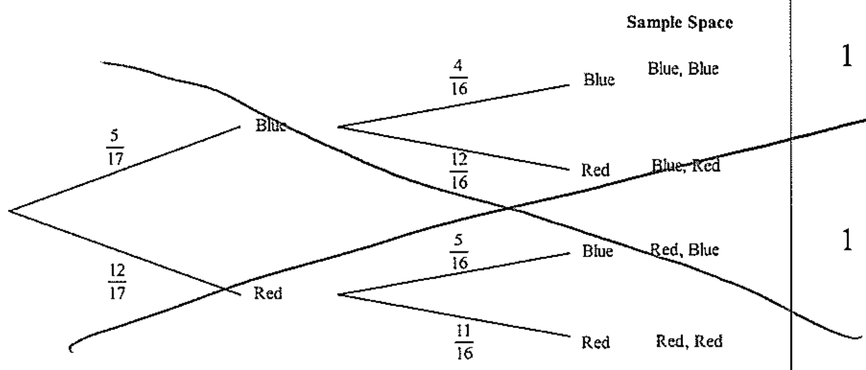
<table>
<tr><td></td><td>Question 11 Solutions</td><td>Marks</td><td>Allocation of marks</td></tr>
<tr><td></td><td>(ii)

</td><td>1</td><td>Correct graph including open circles and correct region.</td></tr>
<tr><td>(f)</td><td>(i)

</td><td>1

1</td><td>Correct identification of turning point x-value.

Any concave up parabola with turning point somewhere on the line x=2.5.</td></tr>
<tr><td></td><td>(ii) $f'(x) = 2x - 5$
$f(x) = \int 2x - 5 \; dx$
$= x^2 - 5x + C$
When $x = 2, y = 0$
$\therefore \quad 0 = 2^2 - 5(2) + C$
$0 = 4 - 10 + C$
$0 = -6 + C$
$C = 6$
$\therefore \quad y = x^2 - 5x + 6$</td><td>1</td><td>Correct answer</td></tr>
</table>

Question 12	2018

	Question 12 Solutions	Marks	Allocation of marks
(a)	(i) The line passing through (2, 4) and (5,3) has: $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3-4}{5-2} = -\frac{1}{3}$	1	Correct gradient.
	$y - y_1 = m(x - x_1)$ $y - 4 = -\frac{1}{3}(x-2)$ $3y - 12 = -x + 2$ $x + 3y - 14 = 0$	1	Any correct method for finding equation of line.
	(ii) The diagonals in a rhombus are perpendicular to each other. For perpendicular lines: $m_1 \times m_2 = -1$ $-\frac{1}{3} \times m_2 = -1$ $\therefore\ m_2 = 3$	1	Correct gradient with mention of perpendicularity.
	(iii) Using perpendicular distance formula with $x + 3y - 14 = 0$ and (5,8) $d = \frac{\lvert ax_1 + by_1 + c\rvert}{\sqrt{a^2 + b^2}}$	1	Correct use of perpendicular distance formula or other appropriate method.
	$= \frac{\lvert 5 + 3(8) - 14\rvert}{\sqrt{1^2 + 3^2}} = \frac{15}{\sqrt{10}}$	1	Correct answer to here.
	$\frac{15}{\sqrt{10}} \times \frac{\sqrt{10}}{\sqrt{10}} = \frac{15\sqrt{10}}{10} = \frac{3\sqrt{10}}{2}$ units OR Find coordinates of M (3½, 5½) and use distance formula		

	Question 12 Solutions	Marks	Allocation of marks
	(iv) M is the midpoint of AC and is therefore the midpoint of BD (diagonals in a rhombus bisect each other).		
	$\therefore \quad BD = 2BM$ $= 3\sqrt{10}$	1	Correct length of BD.
	Using distance formula: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ $AC = \sqrt{(5-2)^2 + (3-4)^2}$ $= \sqrt{10}$	1	Correct length of AC.
	Area of rhombus $= \frac{1}{2}xy$ where x and y are the diagonals. $= \frac{1}{2} \times 3\sqrt{10} \times \sqrt{10}$ $= 15$ square units	1	Correct area.
(b)	$2 = \log_3 9$	1	Expressing 2 in log form.
	$\therefore 2 - \log_3 a = \log_3 9 - \log_3 a$ $= \log_3 \left(\frac{9}{a}\right)$	1	Using difference identity.
(c)			Graph not required.
	Period $= \frac{2\pi}{2}$ $= \pi$	1	Correct period.
	Range $= -3 \leq y \leq 3$	1	Correct range.
(d)	(i) 	1	Correct sample space
		1	Correct probabilities

	Question 12 Solutions	Marks	Allocation of marks
	(ii) p(matching pair) = $P(Blue$, Blue or Red, $Red)$ $= P(\text{Blue},\text{Blue}) + P(Red, Red)$ $= \frac{5}{17} \times \frac{4}{16} + \frac{12}{17} \times \frac{11}{16}$ $= \frac{152}{272}$ $= \frac{19}{34}$ or 0.5588235294 or 55.88235294%	1	Correct answer.

(d) (ii)

$$y = x\cos x$$

$$y' = x(-\sin x) + \cos x(1)$$

$$= -x\sin x + \cos x$$

At $\left(\frac{\pi}{2}, 0\right)$

$$y' = -\frac{\pi}{2}$$

Eq^n to tangent

$$y - 0 = -\frac{\pi}{2}\left(x - \frac{\pi}{2}\right)$$

$$y = -\frac{\pi}{2}x + \frac{\pi^2}{4}$$

(i) crosses x-axis $\Rightarrow y = 0$

$$x\cos x = 0$$

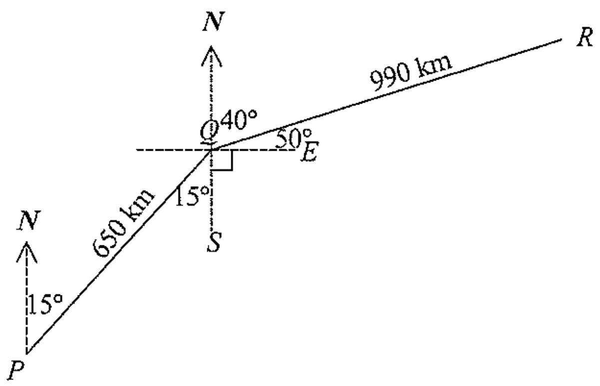
$$x = 0 \text{ or } \cos x = 0$$

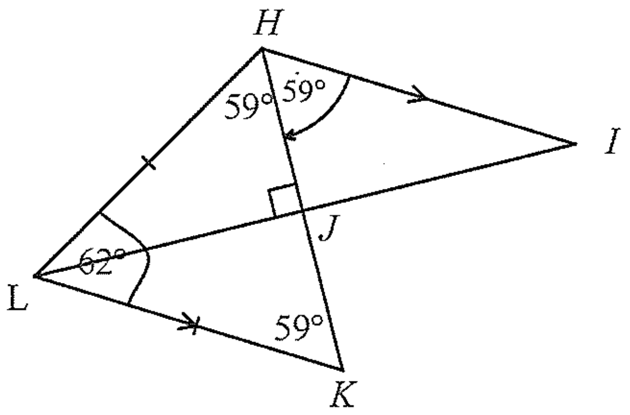
$$x = \frac{\pi}{2}$$

$\Rightarrow$ First point to the right $x = \frac{\pi}{2}$

$\therefore y = 0 \quad \therefore \left(\frac{\pi}{2}, 0\right)$

Question 13	**2018**

	Question 13 Solutions	Marks	Allocation of marks
(a)	(i) $y = -x^2 + 3x + 4$ ① $y = -x + 7$ ② $-x^2 + 3x + 4 = -x + 7$ (*sub* ① into (2)) $-x^2 + 4x - 3 = 0$ $x^2 - 4x + 3 = 0$ $(x-3)(x-1) = 0$ $\therefore$ $x = 1$ (which we already knew) and $x = 3$ $\therefore$ point A has x-coordinate 3.	1 1	Correct use of simultaneous equations. Correct x-coordinate.
	(ii) $A = \int_1^3 (-x^2 + 3x + 4) - (-x + 7) \ dx$ $= \int_1^3 (-x^2 + 4x - 3) \ dx$ $= \left[-\frac{x^3}{3} + 2x^2 - 3x \right]_1^3$ $= \left[\left(-\frac{27}{3} + 2(3^2) - 3(3) \right) - \left(-\frac{1}{3} + 2(1^2) - 3(1) \right) \right]$ $= \left[0 + \frac{4}{3} \right]$ $= \frac{4}{3}$ square units.	1 1 1	Setting up correct integral. Correct integration. Correct answer.
(b)	(i)  $\angle PQS = \angle NPQ = 15°$ (alternate angles on parallel lines) $\angle RQE + \angle RQN_2 = 90°$ (complementary "angles") $\therefore \angle RQE = 50°$ $\angle PQR = \angle PQS + \angle SQE + \angle RQE$ $= 15 + 90 + 50$ $= 155°$	1 1	Correct $\angle PQS$ Correct $\angle RQE$

	Question 13 Solutions	Marks	Allocation of marks
	(ii) $PR^2 = 650^2 + 990^2 - 2 \times 650 \times 990 \cos 155$ $= 2569018.122$	1	Correct use of cosine rule.
	$PR = \sqrt{2569018.122}$ $= 1602.815686$ ≈ 1603 km	1	Correct answer.
(c)	(i) 		
	$HI \parallel LK$ (given) $\angle IHJ = \angle JKL = 59°$ (alternate angles on parallel lines) $\angle LHJ = \angle JKL = 59°$ (equal base angles in isosceles Δ)	1	Correct reasoning.
	$\angle HLK = 180 - (\angle LHJ + \angle JKL)$ (angle sum of triangle HLK) $\therefore \quad \angle HLK = 62°$	1	Correct answer.
	(ii) In ΔHLJ and ΔHIJ : $\angle LHJ = \angle IHJ = 59°$ (*see* part (*i*)) HJ is a common side $\angle HJL + \angle HJI = 180°$ (angles on a straight line) $\therefore \angle HJI = \angle HJL = 90°$ $\therefore \Delta JLJ \equiv \Delta HIJ$ (AAS) $\therefore LH = IH$ (corresponding sides in congruent triangles)	2	1 mark if working towards correct proof, but incomplete. 2 marks for complete proof with reasoning.
(d)	(see table and working below)	1	Correct use of trapezoidal rule.
		1	Correct answer.

x	0	0.5	1	1.5	2
xe^x	0	$0.5e^{0.5}$	e	$1.5e^{1.5}$	$2e^2$

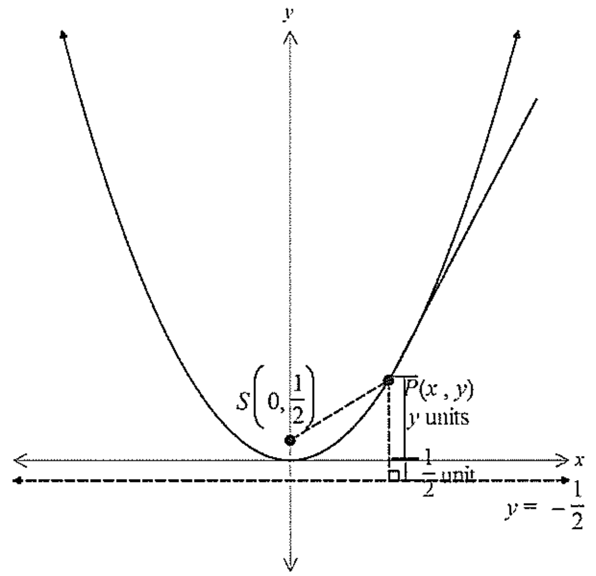
$$\int_0^2 xe^x \, dx \approx \frac{0.5}{2}[0 + 2 \times 0.5e^{0.5} + 2 \times e + 2 \times 1.5e^{1.5} + 2e^2]$$

$$= 0.25\left[e^{0.5} + 2e + 3e^{1.5} + 2e^2\right]$$

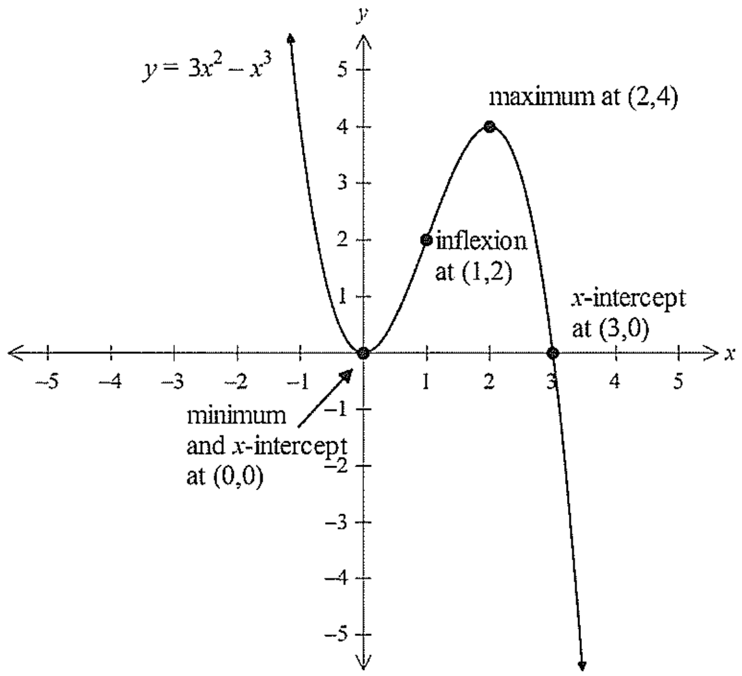
$$= 0.25[35.30846434]$$

$$\approx 8.83 \text{ (2 dec places)}$$

Question 14	**2018**

	Question 14 Solutions	Marks	Allocation of marks
(a)	(i) 		
	The distance from P to the directrix is $y+\frac{1}{2}$.	1	Correct distance from P to directrix.
	$\text{PS} = y+\frac{1}{2}$ $\text{PS}^2 = \left(y+\frac{1}{2}\right)^2$ $(x-0)^2+\left(y-\frac{1}{2}\right)^2 = \left(y+\frac{1}{2}\right)^2$ $x^2+y^2-y+\frac{1}{4} = y^2+y+\frac{1}{4}$ $x^2-y=y$ $x^2=2y$	1	Correct manipulation of equation to get to $x^2-y=y$
	(ii) $x^2=2y$ $y=\frac{x^2}{2}$ $y'=x$ At $x=2$, $y'=2$	1	Calculating gradient.
	$y-y_1=m(x-x_1)$ $y-2=2(x-2)$ $y-2=2x-4$ $2x-y-2=0$	1	Using valid method to find equation.

	Question 14 Solutions	Marks	Allocation of marks
(b)	(i) $y = 3x^2 - x^3$ $y' = 6x - 3x^2$ Let $y' = 0$ $6x - 3x^2 = 0$ $3x(2 - x) = 0$ $x = 0$ or $x = 2$ When $x = 0, y = 0$ When $x = 2, y = 3 \times 2^2 - 2^3$ $= 4$ Therefore stationary points at (0, 0) and (2, 4) $y'' = 6 - 6x$ At (0,0), $y'' = 6$ $> 0 \therefore$ minimum turning point At (2,4), $y'' = 6 - 6 \times 2$ $= -6$ $< 0 \therefore$ maximum turning point	1 1 1	Correct use of y' to identify x-coordinates of stationary points. Correct y-coordinates. Valid method and correct identification of nature of stationary points.
	(ii) Possible inflexion at $y'' = 0$ $y'' = 6 - 6x$ Let $6 - 6x = 0$ $6 = 6x$ $x = 1$ Test concavity either side. At $x = \frac{1}{2}, y'' = 6 - 3$ $> 0 \therefore$ concave up At $x = \frac{3}{2}, y'' = 6 - 9$ $< 0 \therefore$ concave down. Since concavity changes, the point (1,2) is an inflexion point.	1 1	Using y'' to find possible inflexion. Testing of appropriate points either side of x=1. Note: testing needs to be done in the range 0<x<2 since there are turning points at x=0 and x=2.
	(iii) A horizontal inflexion has y'=0 and y''=0. There is a change in concavity at a stationary point. The inflexion at (1,2) does not have y'= 0 (it is not a stationary point.)	1	Mention of y'= 0 or stationary point.

	Question 14 Solutions	Marks	Allocation of marks
	(iv) $y = 3x^2 - x^3$ x-intercept at $y = 0$ $0 = 3x^2 - x^3$ $0 = x^2(3 - x)$ $x = 0$ (which we already knew) and $x = 3$	1	Correct x-intercepts.
		1	Correct shape of curve – decreasing, increasing, decreasing left-right.
(c)	V=volume of cylinder – volume of solid formed below the curve $y = \sqrt{x+1}$ $= \pi r^2 h - \pi \int_{-1}^{8} y^2 \, dx$	1	Setting up correct difference of volumes.
	$= \pi \times 3^2 \times 9 - \pi \int_{-1}^{8} x + 1 \, dx$	1	Correct integral set up.
	$= 81\pi - \pi \left[\frac{x^2}{2} + x \right]_{-1}^{8}$ $= 81\pi - \pi \left[\left(\frac{64}{2} + 8 \right) - \left(\frac{1}{2} - 1 \right) \right]$ $= 81\pi - \pi \left[\frac{81}{2} \right]$ $= \frac{81}{2} \pi$ cubic units	1	Correct answer.

Question 15	2018

	Question 15 Solutions	Marks	Allocation of marks
(a)	(i) $RTP \quad \frac{dC}{dt} = -0.18C$, where $C = Ae^{-0.18t}$ $\text{LHS} = \frac{d}{dt}(Ae^{-0.18t})$ $= -0.18Ae^{-0.18t}$ $= -0.18C \quad$ (since $C = Ae^{-0.18t}$) $= RHS$	1	Valid proof by differentiating $C = Ae^{-0.0018t}$
	(ii) A is the starting amount = 24 mL. Possible calculation: $C = Ae^{-0.18t}$ $24 = Ae^{-0.18 \times 0}$ $24 = Ae^{0}$ $A = 24$ ***mg***	1	Correct answer.
	(iii) $C = 24e^{-0.18 \times 3}$ $= 13.98595806$ ≈ 14 ***mg***	1	Correct answer from correct substitution.
	(iv) $C < 5$ $24e^{-0.18t} < 5$ $e^{-0.18t} < \frac{5}{24}$ $-0.18t < \ln\left(\frac{5}{25}\right)$ $t > \frac{\ln\left(\frac{5}{24}\right)}{-0.18}$ > 8.71538277 $= 8h$ 42 min 52.32 sec $\approx$ 8 hours 43 minutes	1 1 1	Correct manipulation of exponential equation to make t the subject Correct calculator answer. Correct time rounding from calculator answer.
(b)	(i) $\cos 2x + \cos x = \cos^2 x - \sin^2 x + \cos x$ $= \cos^2 x - (1 - \cos^2 x) + \cos x$ $= 2\cos^2 x - 1 + \cos x$ $= 2\cos^2 x + \cos x - 1$	1	Use of $\sin^2 x + \cos^2 x = 1$ identity.

	Question 15 Solutions	Marks	Allocation of marks
	(ii) $\cos 2x + \cos x = 0$ $2\cos^2 x + \cos x - 1 = 0$ let $u = \cos x$ $2u^2 + u - 1 = 0$ $\frac{(2u+2)(2u-1)}{2} = 0$ $(u+1)(2u-1) = 0$ $u = -1$ or $u = \frac{1}{2}$ $\therefore$ $\cos x = -1$ or $\cos x = \frac{1}{2}$. $x = \pi$ $x = \frac{\pi}{3}, \frac{5\pi}{3}$. Solutions $x = \frac{\pi}{3}, \pi, \frac{5\pi}{3}$	1 1 1	Use of part (i) to set up equation. Factorisation or other method to find solutions for $\cos x$. Correct values for x from solutions for $\cos x$.
(c)	(i) Amount at end of first month $= \$300(1.0025)$ Amount at end of second month $= (\$300(1.0025) + \$300(1.015))(1.0025)$ $= \$300(1.0025)^2 + \$300(1.015)(1.0025)$	1 1	Correct expression for end of first month. Correct expression for end of second month including 2nd deposit.
	(ii) Let A_n represent the amount at the end of nth month. $A_3 = (\$300(1.0025)^2 + \$300(1.015)(1.0025) + \$300(1.015)^2)(1.0025)$ $= \$300(1.0025)^3 + \$300(1.015)(1.0025)^2 + \$300(1.015)^2(1.0025)$ Following this pattern: $A_n = \$300(1.0025)^n + \$300(1.015)(1.0025)^{n-1} + \$300(1.015)^2(1.0025)^{n-2} + \dots + \$300(1.015)^{n-1}(1.0025)$ $= \$300(1.0025)^n\left(1 + \frac{1.015}{1.0025} + \left(\frac{1.015}{1.0025}\right)^2 + \dots + \left(\frac{1.015}{1.0025}\right)^{n-1}\right)$ Now $\left(1 + \frac{1.015}{1.0025} + \left(\frac{1.015}{1.0025}\right)^2 + \dots + \left(\frac{1.015}{1.0025}\right)^{n-1}\right)$ is a geometric series with $a = 1$, $r = \left(\frac{1.015}{1.0025}\right)$ $S_n = \left(\frac{a(r^n - 1)}{r-1}\right)$ $= \frac{\left(\frac{1.015}{1.0025}\right)^n - 1}{\frac{1.015}{1.0025} - 1}$ $\therefore A_n = \$300(1.0025)^n\left(\frac{\left(\frac{1.015}{1.0025}\right)^n - 1}{\frac{1.015}{1.0025} - 1}\right)$	1 1	Any correct expression for A_n. Use of sum of geometric series.

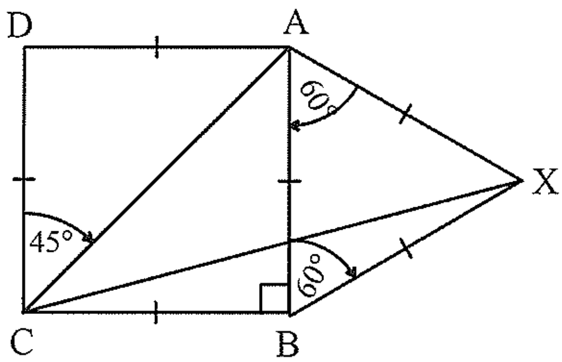
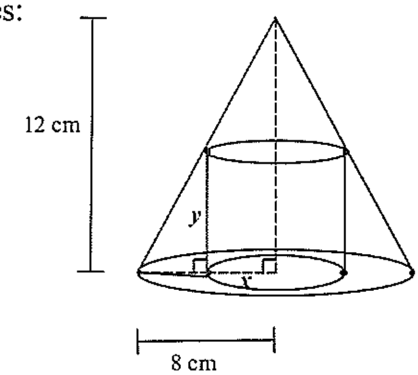
	Question 15 Solutions	Marks	Allocation of marks
	(iii) $A_{60} = \$300(1.0025)^{60} \times \dfrac{\left(\dfrac{1.015}{1.0025}\right)^{60} - 1}{\dfrac{1.015}{1.0025} - 1}$ $= \$30\,835.36804$ $\approx \$30\,835$	1	Correct use of calculator from correct substitution.

Question 16	**2018**

	Question 16 Solutions	Marks	Allocation of marks
(a)	(i) A is the vertical intercept, so its vertical coordinate is the velocity when $t = 0$. at $t = 0$ $v = 2 - \frac{3}{1+0}$ $= 2 - 3$ $= -1 \text{ ms}^{-1}$ $\therefore A = (0, -1)$	1	Finding v when $t = 0$.
	(ii) B is the point at which velocity is zero (particle is stationary) at $v = 0$ $0 = 2 - \frac{3}{1+2t}$ $2 = \frac{3}{1+2t}$ $2 + 4t = 3$ $4t = 1$ $t = \frac{1}{4}$ seconds $\therefore \quad B = \left(\frac{1}{4}, 0\right)$	1	Finding the value of t when $v = 0$.

	Question 16 Solutions	Marks	Allocation of marks
	(iii) $a = \frac{dv}{dt} = \frac{d}{dt}\left(2 - \frac{3}{1+2t}\right)$ let $u = -3 \quad v = 1 + 2t$ $u' = 0 \quad v' = 2$ $\frac{vu' - uv'}{v^2} = \frac{0 - (-3)(2)}{(1+2t)^2}$ $= \frac{6}{(1+2t)^2}$ $\therefore \frac{d}{dt}\left(2 - \frac{3}{(1+2t)^2}\right) = \frac{6}{(1+2t)^2}$	1	Correct derivative of v to get expression for a.
	Particle is stationary at $t = \frac{1}{4}$ When $t = \frac{1}{4}$ $a = \frac{6}{\left(1 + 2\left(\frac{1}{4}\right)\right)^2}$ $= \frac{6}{\left(\frac{3}{2}\right)^2}$ $= \frac{6}{\frac{9}{4}}$ $= 6 \times \frac{4}{9}$ $= \frac{8}{3}\text{ ms}^{-2}$	1	Correct answer.
	(iv) $v = 2 - \frac{3}{1+2t}$ As $t \to \infty \quad \frac{3}{1+2t} \to 0$ $\therefore v \to 2 - 0$ $= 2\text{ ms}^{-1}$ $\therefore C$ has coordinates (0,2)	1	Using limit to show vertical coordinate of C is 2.

	Question 16 Solutions	Marks	Allocation of marks
	(v) The velocity is negative between $t = 0$ and $t = \frac{1}{4}$. It then becomes positive. So the particle changes direction.		
	Distance $= -\int_0^{\frac{1}{4}} \left(2 - \frac{3}{1+2t}\right) dt + \int_{\frac{1}{4}}^{1} \left(2 - \frac{3}{1+2t}\right) dt$	1	Correct set up of integral to find distance.
	$= -\left[2t - \frac{3}{2}\ln(1+2t)\right]_0^{\frac{1}{4}} + \left[2t - \frac{3}{2}\ln(1+2t)\right]_{\frac{1}{4}}^{1}$	1	Correct integration of v.
	$= -\left[\frac{1}{2} - \frac{3}{2}\ln\left(\frac{3}{2}\right) - 0\right] + \left[2 - \frac{3}{2}\ln 3 - \left(\frac{1}{2} - \frac{3}{2}\ln\left(\frac{3}{2}\right)\right)\right]$		
	$= -\frac{1}{2} + \frac{3}{2}\ln\left(\frac{3}{2}\right) + 2 - \frac{3}{2}\ln 3 - \frac{1}{2} + \frac{3}{2}\ln\left(\frac{3}{2}\right)$		
	$= 1 - \frac{3}{2}\ln 3 + 3\ln\left(\frac{3}{2}\right)$ $= 0.5684768913$ ≈ 0.568 m	1	Correct answer in log form.

	Question 16 Solutions	Marks	Allocation of marks
(b)			
	In $\Delta\ ABX$ and square $ABCD$: AB is a common side. $BX = AB$ (sides in equilateral Δ) $CB = AB$ (sides in square) $\therefore\ CB = BX$ $\therefore\ \Delta CBX$ is isosceles	1	Identifying ΔCBX as isosceles.
	$\angle XCB = \angle BXC$ (*base* angles in isosceles Δ) $\angle XBA = 60°$ (angles in equilateral Δ) $\angle ABC = 90°$ (angles in square) $\therefore\ \angle\ XBC = 150°$ $\angle XCB + \angle BXC = 180\ -\ \angle XBC$ (angle sum of Δ) $\therefore\ \angle XCB = \angle BXC = 15°$	1	Correct calculation of size of $\angle BXC$.
	$\angle ACX = \angle ACB - \angle XCB$ $\angle ACB = 45°$ (diagonal AC bisects angle in square) $\therefore\ \angle ACX = 45°\ - 15°$ $= 30°$ $= 2\ \times \angle BXC.$ $\angle AXC = \angle AXB - \angle BXC$ $= 60° - 15°$ $= 45°$ $= 3 \times \angle BXC$ $\therefore\ \angle AXC + \angle ACX = 3 \times \angle BXC + 2 \times \angle BXC$ $= 5 \times \angle BXC$	1	Correct calculation of size of $\angle ACX$ and $\angle AXC$.
(c)	(i) Using similar triangles: $\frac{y}{12} = \frac{8-x}{8}$ $y = 12\frac{8-x}{8}$ $= \frac{3}{2}(8-x)$ 	1	Correct use of similar triangles to show relationship between side lengths.

	Question 16 Solutions	Marks	Allocation of marks
	(ii) $V = \pi r^2 h$ $= \pi x^2 \times \frac{3}{2}(8 - x)$ $= \frac{3}{2}\pi x^2(8 - x).$	1	Correct use of formula for volume of cylinder.
	(iii) Stationary points at $V' = 0$ $V = 12\pi x^2 - \frac{3}{2}\pi x^3$ $V' = 24\pi x - \frac{9}{2}\pi x^2$ Let $V' = 0$ $24\pi x - \frac{9}{2}\pi x^2 = 0$ $3\pi x\left(8 - \frac{3}{2}x\right) = 0$ $x = 0$ or $8 = \frac{3}{2}x$ $16 = 3x$ $x = \frac{16}{3}$	1	Correct value of x.
	To check if this is a maximum, look at V'' $V'' = 24\pi - 9\pi x$ At $x = \frac{16}{3}$ $V'' = 24\pi - 9\pi \times \frac{16}{3}$ $= 24\pi - 48\pi$ < 0 $\therefore$ maximum volume when $x = \frac{16}{3}$ cm.	1	Proof that this is a maximum turning point.