

Name: _____

Teacher: AF GS LK GaS SW

NESA Number: _____



ASCHAM SCHOOL

MATHEMATICS ADVANCED TRIAL EXAMINATION 2020

General Instructions

- Reading time – 10 minutes
- Working time – 3 hours
- Write using black pen
- Calculators approved by NESA may be used
- A reference sheet is provided at the back of this paper

Section I

10 marks

- Detach the Multiple Choice sheet from the back of this booklet.
Answer Questions 1–10 using the Multiple Choice sheet on page 43.
- Allow about 15 minutes for this section.

Section II

90 marks

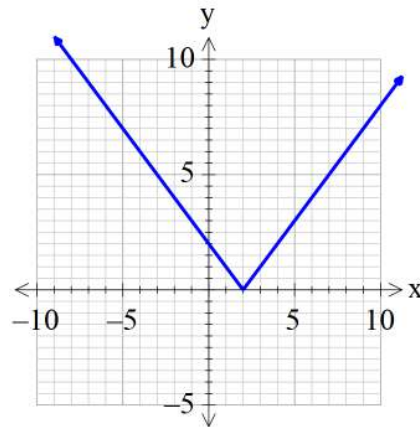
- Attempt Questions 11–34.
 - Allow about 2 hours 45 minutes for this section.
 - For questions in Section II, show relevant mathematical reasoning and/ or calculations.
 - Additional writing space is available on pages 37 to 42.
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Section I**10 marks****Attempt Questions 1 – 10****Allow about 15 minutes for this section**

Use the multiple-choice answer sheet at the back of this exam paper for Questions 1 – 10

- 1 What type of relation is shown in the graph below?

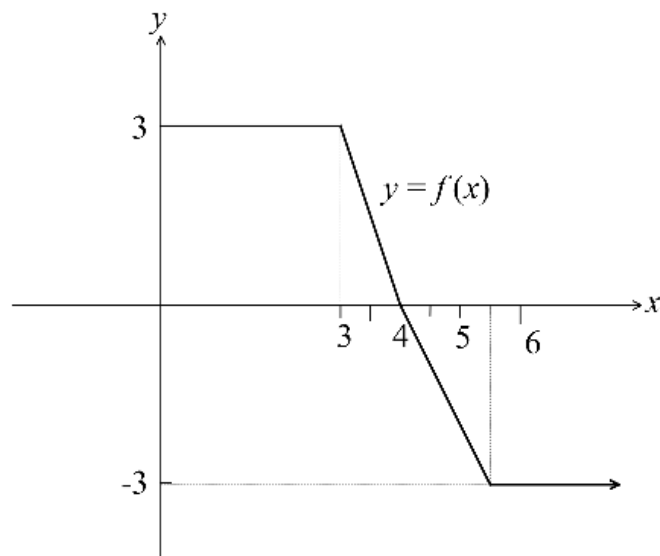


- (A) One-to-one
(B) One-to-many
(C) Many-to-one
(D) Many-to-many

2. What is the gradient of the normal to the tangent line $x - 2y + 1 = 0$?

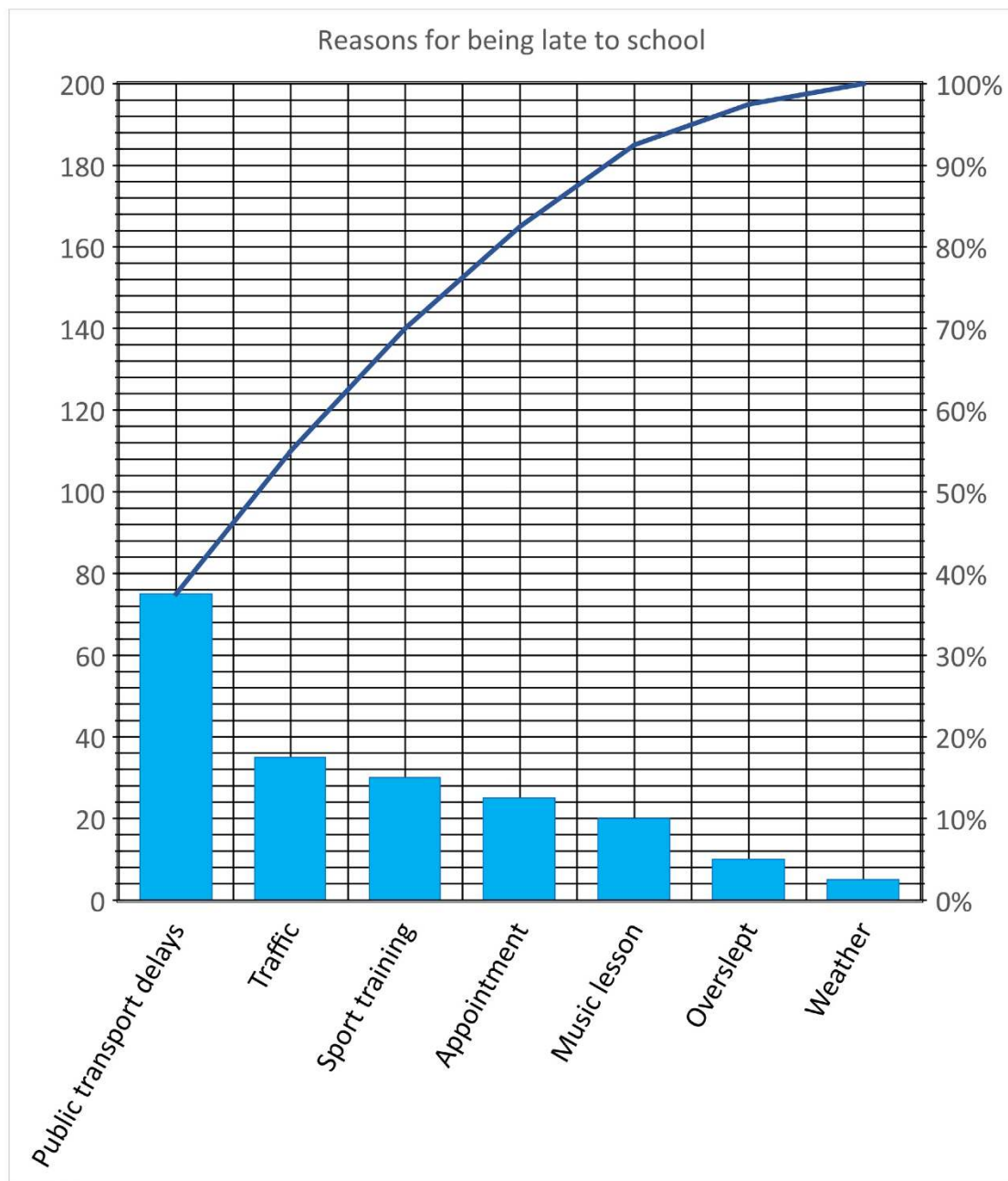
- (A) $-\frac{1}{2}$
(B) $\frac{1}{2}$
(C) -2
(D) 2

- 3 Using the diagram below calculate $\int_0^6 f(x)dx$.



- (A) 6.75
- (B) 7.5
- (C) 10.5
- (D) 14.25
- 4 A set of data has a lower quartile of 22 and an upper quartile of 32. What is the maximum possible range for this set of data if there are no outliers?
- (A) 7
- (B) 10
- (C) 40
- (D) 47

5. Ascham School collected data on the reasons given by students for being late to school. The Pareto chart shows the data collected.



Approximately what percentage of students gave the reasons 'Traffic' or 'Sport training'?

- (A) 23%
- (B) 33%
- (C) 65%
- (D) 70%

6. Which of the following is a discrete probability distribution?

(A)

x	1	2	3	4
$P(X=x)$	0.23	0.16	0.35	0.25

(B)

x	1	2	3	4
$P(X=x)$	0.27	0.61	-0.31	0.43

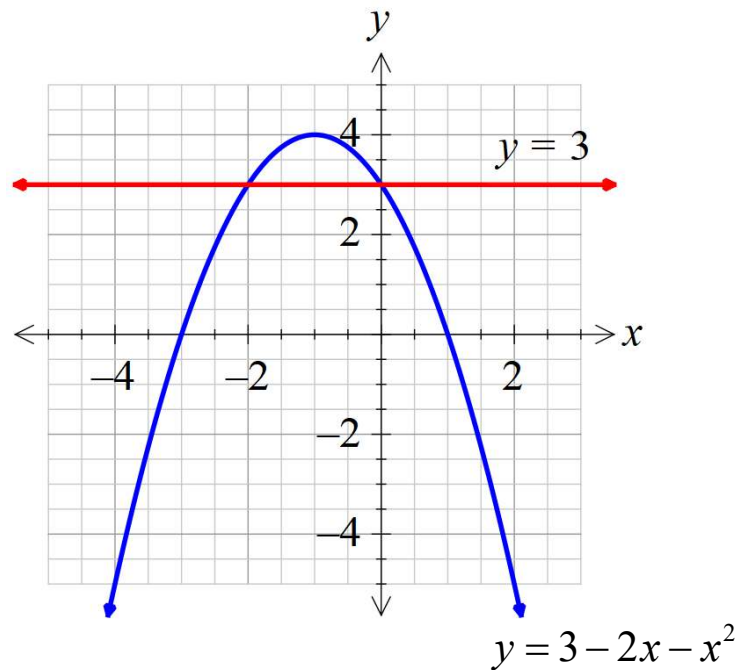
(C)

x	1	2	3	4
$P(X=x)$	0.14	0.32	0.48	0.07

(D)

x	1	2	3	4
$P(X=x)$	0.19	0.29	0.25	0.27

7. Use the graph below to solve the inequality $3 - 2x - x^2 < 3$.



(A) $x < 0$

(B) $-2 < x < 0$

(C) $x < -2$ or $x > 0$

(D) $x < -3$ or $x > 1$

8. The table shows the compounded values of \$1 at different interest rates over different periods.

Compounded values of \$1

<i>Number of periods</i>	<i>Interest rate per period</i>				
	1%	2%	3%	4%	5%
2	1.0201	1.0404	1.0609	1.0816	1.1025
4	1.0406	1.0824	1.1255	1.1699	1.2155
6	1.0615	1.1262	1.1941	1.2653	1.3401
8	1.0829	1.1717	1.2668	1.3686	1.4775
10	1.1046	1.2190	1.3439	1.4802	1.6289
12	1.1268	1.2682	1.4258	1.6010	1.7959

Percy hopes to have \$25 000 in 4 years to buy a car. He opens an account today which pays interest of 4% p.a., compounded every 6 months. Using the table, which expression calculates the minimum single sum that Percy needs to invest today to ensure he reaches his savings goal?

- (A) 25000×1.3686
(B) $25000 \div 1.3686$
(C) 25000×1.1717
(D) $25000 \div 1.1717$

9. There will be 90 000 students sitting an examination. If their examination results form a normal distribution, how many students would be expected to score a result higher than 1 standard deviation below the mean?

- (A) 14 400
(B) 14 535
(C) 75 465
(D) 75 600

10. Consider the cumulative distribution function:

$$F(x) = \begin{cases} 0 & , (-\infty, 0) \\ \sin\left(\frac{x}{2}\right) & , [0, b] \\ 1 & , (b, \infty) \end{cases}$$

Find b .

- (A) $b = \frac{\pi}{2}$
- (B) $b = \pi$
- (C) $b = 2\pi$
- (D) $b = 4\pi$

End of Multiple Choice.

Mathematics Advanced**Section II Answer booklet****90 marks****Attempt Questions 11 – 35.****Allow about 2 hours and 45 minutes for this section.**

Instructions:

- Answer each question in the spaces provided. These spaces provide guidance for the expected length of response.
- Your responses should include relevant mathematical reasoning and/or calculations.
- Additional writing space is available on pages 39 to 42.

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Question 11 (2 marks)Solve $|5 - 2x| = 3$.**2**

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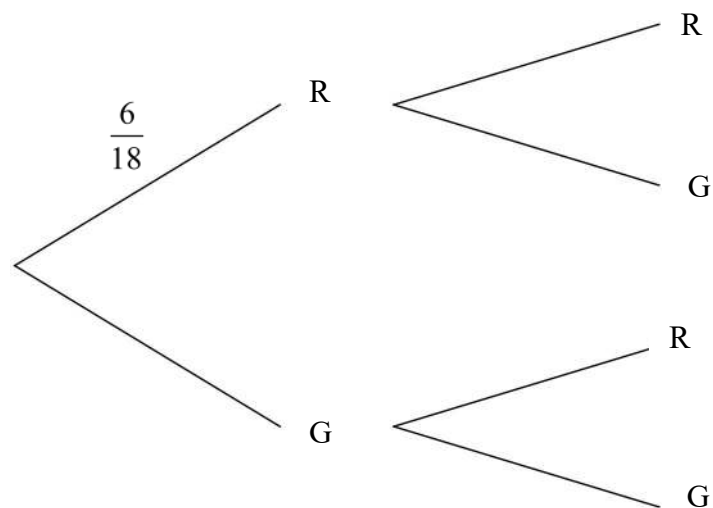
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Question 12 (3 marks)

In a bag there are 6 red marbles (R) and 12 green marbles (G). Two marbles are selected at random without replacement. A partially completed probability tree is shown.



Complete the probability tree and calculate the probability of selecting two marbles of different colours.

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Question 13 (2 marks)Differentiate $(e^x + x)^4$.**2**

Question 14 (3 marks)Given $f(x) = \frac{x}{\ln x}$, solve $f'(x) = 0$ in the domain $x > 0$, $x \neq 1$.**3**

Please turn over

Question 15 (2 marks)

A sector of angle $\frac{2\pi}{3}$ is cut out of a circular piece of paper of radius 10 cm and removed. The cut edges of the remaining paper are brought together to shape the paper into a cone. Find the exact circumference of the circular base of the cone. 2

Question 16 (4 marks)

Ali decides to turn her crochet hobby into a small not-for-profit business. She spends \$60 on equipment and estimates that it costs her \$16 to manufacture each crochet doll. She plans to sell each doll for \$20.

(a) Write equations for the cost C , and income I , for the sale of x items. 2

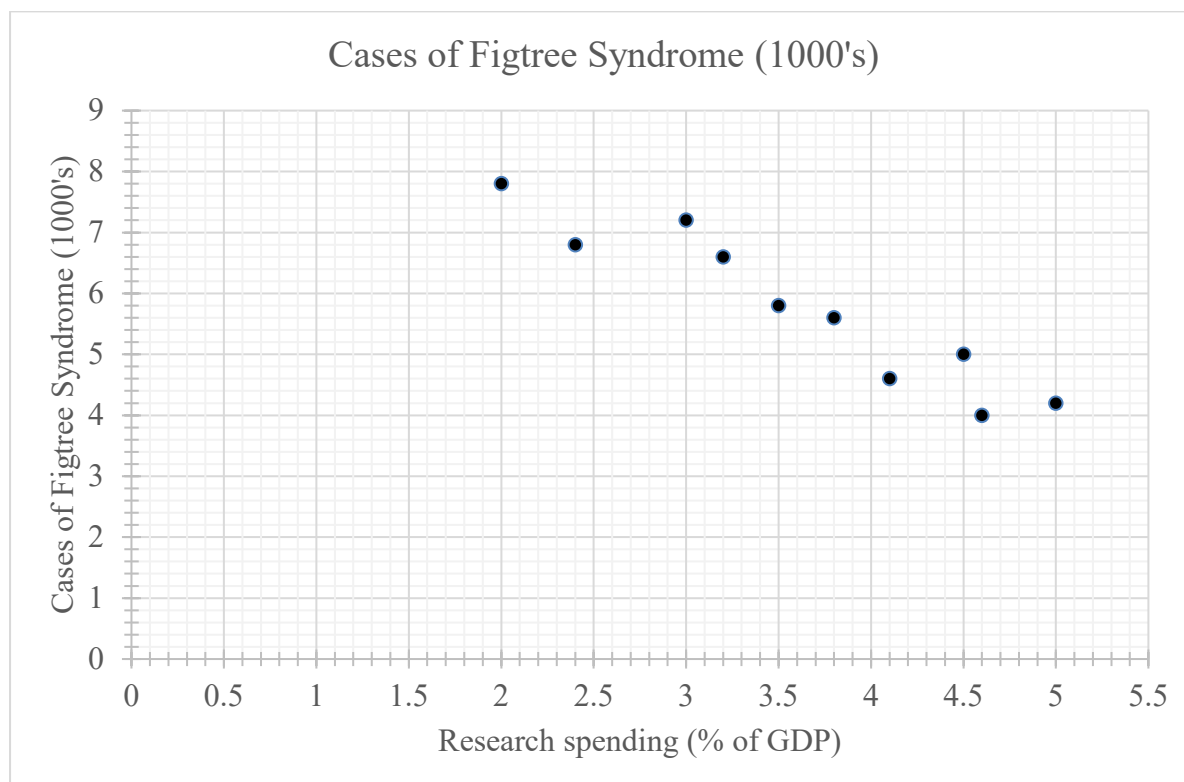
(b) Solve the equations simultaneously to determine the number of dolls Ali needs to sell to break even. 2

Question 17 (2 marks)

Figtree Syndrome is a rare disease that causes memory and concentration problems in young people.

Below is a table and a scatterplot showing the relationship between funds spent in finding a cure, as a percentage of a country's Gross Domestic Product (GDP), and the number of cases diagnosed in 10 different countries.

Research spending (% of GDP)	2.0	2.4	3.0	3.2	3.5	3.8	4.1	4.5	4.6	5.0
Cases of Figtree Syndrome (1000's)	7.8	6.8	7.2	6.6	5.8	5.6	4.6	5.0	4.0	4.2



(a) Determine Pearson's correlation coefficient for this data correct to 3 decimal places. **1**

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(b) Find the least squares regression line for this data. Round your values to 3 significant figures. **1**

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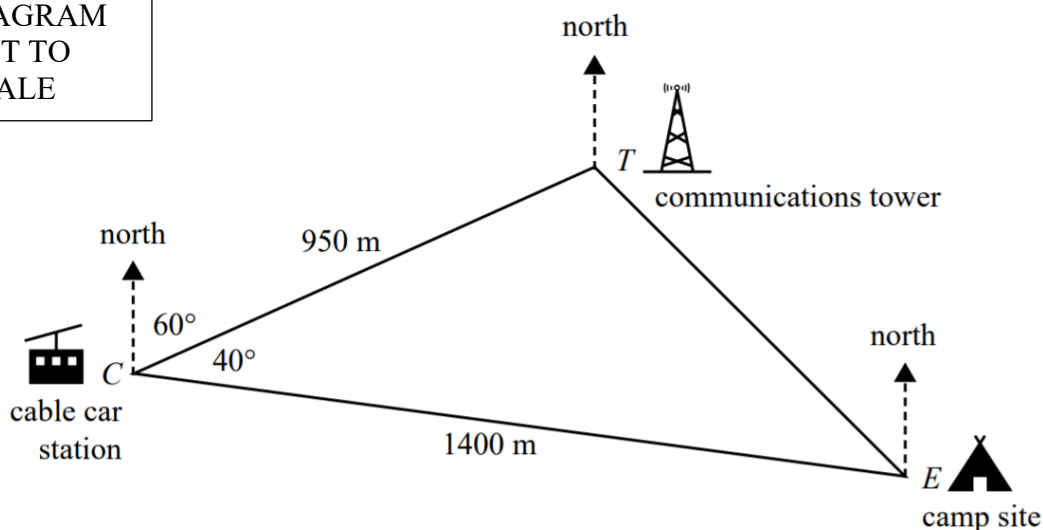
Question 18 (6 marks)

There are plans to construct a series of straight paths at the top of a mountain. The paths will connect three landmarks: the cable car station C , the communications tower T and a camp site E , as shown in the diagram. The length of the path from C to T is 950 m and the length of the path from C to E is 1400 m.

The bearing of the tower from the cable car station is 060° .

The bearing of the camp site from the cable car station is 100° .

DIAGRAM
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SCALE



- (a) What is the length of the straight path between the communications tower T and the campsite E ? Give your answer correct to two significant figures.

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Question 18 continues on the next page.

Question 18 continued...

(b) Use your answer from (a) to find the true bearing of the camp site E from the communications tower T .

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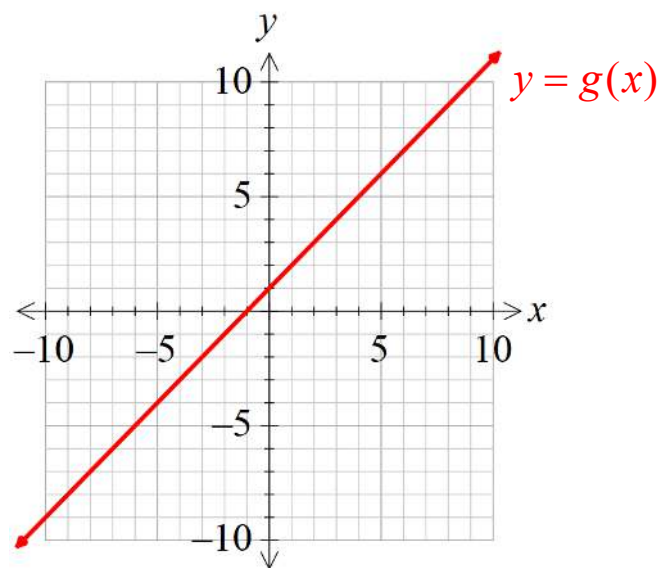
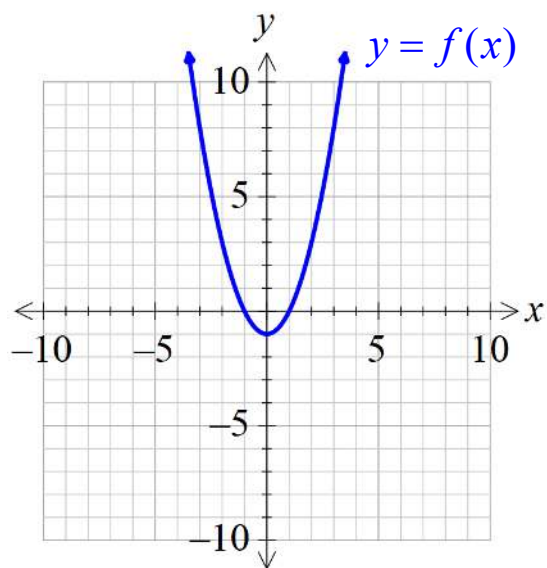
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Question 19 (1 mark)

Consider the functions $f(x)$ and $g(x)$ whose graphs are displayed below.



Find the value of $g(f(-2))$.

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Question 20 (3 marks)

Differentiate $\sqrt{x}(1-2x)^5$.

3

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Question 21 (3 marks)

Solve $2\sin 2x + \sqrt{3} = 0$ in the domain $[0, 2\pi]$.

3

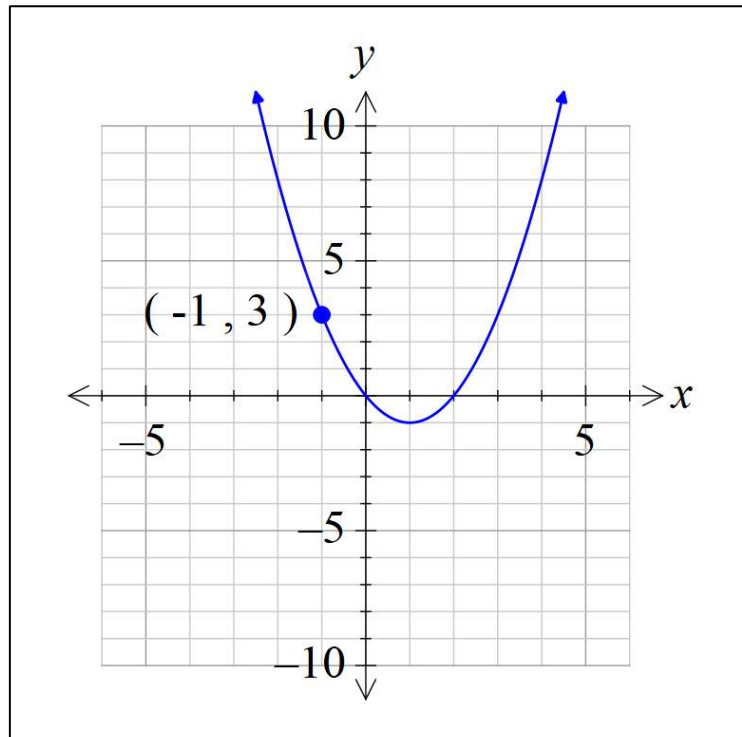
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Question 22 (3 marks)

Consider the two identical graphs of $f(x)$ below. On the same set of axes, sketch the graphs:

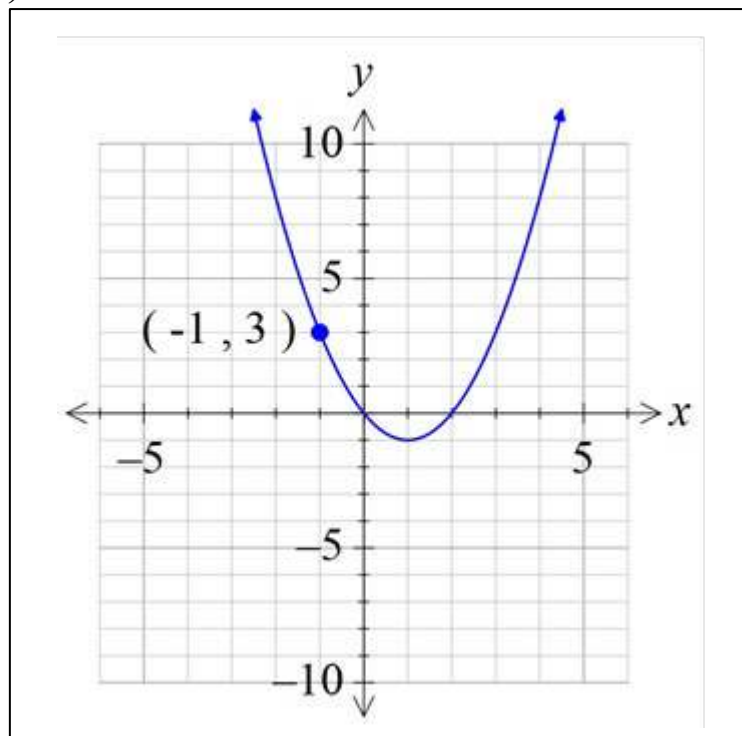
(a) $y = -2f(x)$

1



(b) $y = f\left(\frac{x}{2} + 2\right)$

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Question 23 (2 marks)

Find the value(s) of k , where $k \neq 0$, given that $x^2 + 8kx + k = 0$ has two equal roots. **3**

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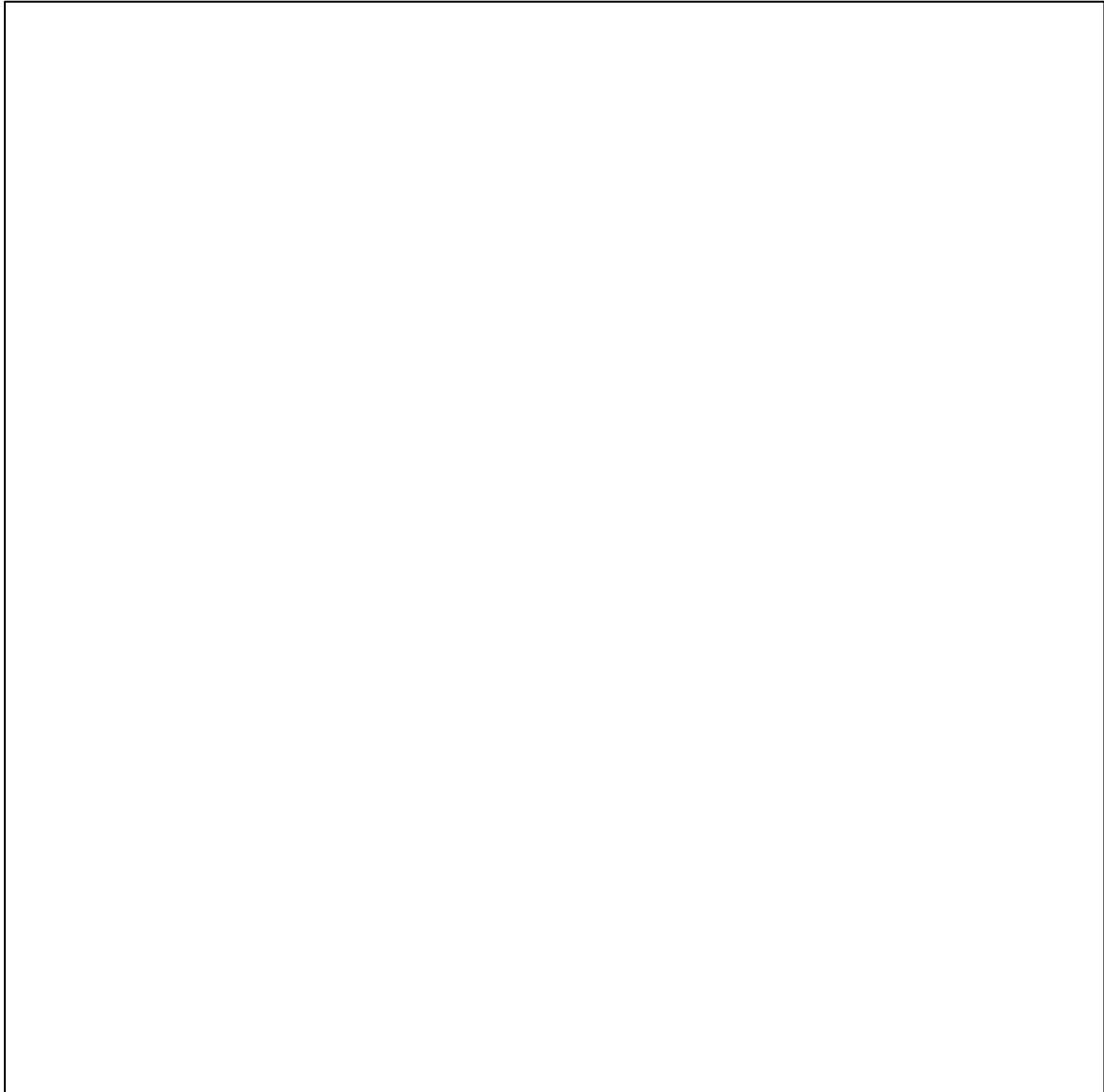
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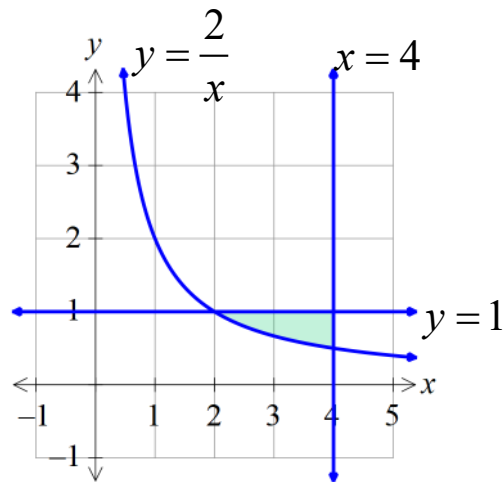
Question 24 continued...

- (c) Sketch the graph of $y = 3 + 2x^2 - x^4$ showing stationary points, points of inflection and intercepts. **3**



Question 25 (3 marks)

Consider the region bounded by $y = 1$, $x = 4$ and the curve $y = \frac{2}{x}$.



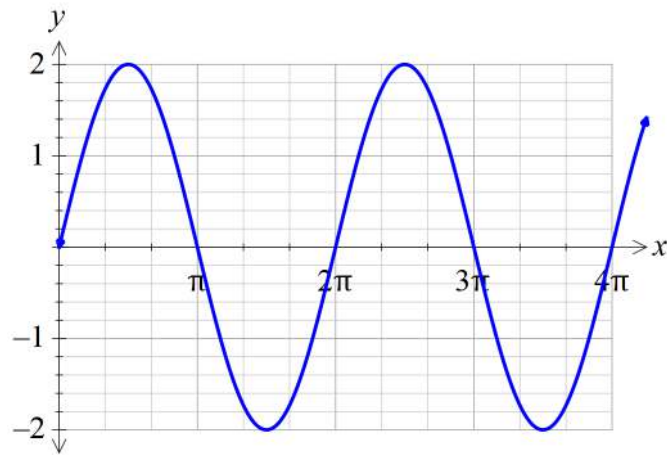
Determine the exact area of the shaded region.

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[illegible]

Question 26 (2 marks)

The graph below corresponds to a trigonometric function $f(x) = k \cos(x + b)$. Find one pair of possible values for k and b .

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Question 27 (2 marks)

Differentiate 3^{x^2} .

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Question 28 (3 marks)

Kelly has been offered two part-time jobs at local furniture shops. At furniture shop X she receives a retainer of \$300 per week plus \$200 for each lounge suite sold. At furniture shop Y she receives a retainer of \$450 per week plus \$100 for each lounge suite sold. Past weekly sales of lounge suites indicate the following probability distribution.

Number of lounge suites	0	1	2	3	4	5
Probability	0.1	0.2	0.5	0.15	0.04	0.01

- (a) Find the expected number of lounge suites sold per week. Give your answer to the nearest whole. **1**

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- b) Find the variance for this data. **1**

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- (c) Which furniture shop job should Kelly take? Justify your answer by referring to the weekly pay Kelly expects to earn based on your result from part (a). **1**

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[illegible]

Question 30 (7 marks)

The drop-bear population is endangered. On January 1, 2003 there were only 1000 drop-bears left in the wild. The drop-bear natural reproductive cycle allows for a population increase of 5% per year. However, every year 100 drop-bears are poached by illegal hunters.

(a) Show that the drop-bear population remaining after two years is given by the expression:

$$T_2 = 1000 \times (1.05)^2 - 100 \times (1.05 + 1). \quad 2$$

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(b) Find an expression for T_n , the number of drop-bears remaining after n years. 2

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Question 30 continues on the next page.

Question 30 continued...

(c) What is the drop-bear population on January 1, 2008?

1

(d) During what calendar year will the drop-bears become extinct if no interventions are put in place?

2

Question 31 (6 marks)

The length of time (in minutes) that a person in the Sydney metropolitan area has to wait for an ambulance to arrive after contacting '000' is a continuous probability distribution function defined by:

$$f(x) = \begin{cases} ax(10-x), & 0 \leq x \leq 10 \\ 0, & \text{otherwise} \end{cases}$$

- (a) Show that the value of a is $\frac{3}{500}$.

2

[illegible]

Question 31 continues on the next page.

(b) Find the cumulative distribution function.

2

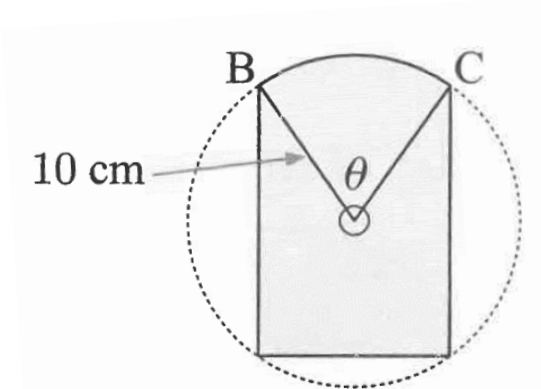
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2

[illegible]

Question 32 (5 marks)

A circular piece of tinplate of radius 10 cm has three segments removed, leaving the shaded shape as illustrated. The angle θ is measured in radians.



- (a) Show the remaining shaded area is given by $A = 50(\theta + 3 \sin \theta)$ cm². **2**

[illegible]

Question 32 continues on the next page.

(b) Find the angle θ so that the area of the shaded shape is a maximum. Answer correct to 2 decimal places. **3**

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Question 33 (4 marks)

A number of people participated in a Swimming Championship and swim times were normally distributed. Swimmers who took longer than 16.5 minutes to complete the swim were disqualified. About 16% of swimmers were disqualified. The mean time to complete the race was 15 minutes.

(a) Find the standard deviation of swim times for this race.

1

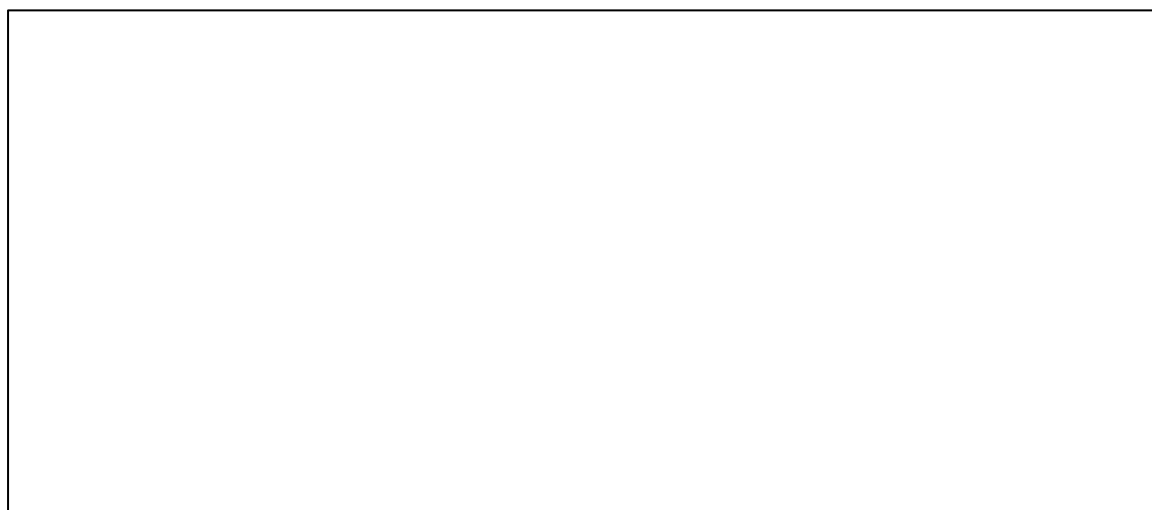
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(b) Sketch the normal distribution curve for this information.

1

(c) The fastest 1% of swimmers immediately qualify to move forward to the next level of competition.

Use the probability tables for the standard normal distribution provided on pages 33 and 34 to determine the qualifying time.

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For use with Question 33**Probabilities table for the standard normal distribution for z-scores from -3.49 to 0.**

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
-0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

*For use with Question 33***Probabilities table for the standard normal distribution for z-scores from 0 to 3.49.**

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Question 34 (7 marks)

A small-sized home swimming pool contains 100 kL of water when full. A water pump cycles the water in and out of the pool through a filter for cleaning and treatment.

The flow rate of the volume of water that the pump filters in and out of the swimming pool in kilolitres per minute (kL/min) is given by:

$$\frac{dV}{dt} = -0.3 \sin \frac{\pi t}{30}$$

- (a) At 9:45 am the swimming pool is full and the pump is switched on. What is the first time after 9:45 am at which the flow rate is zero? **2**

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- b) Find an expression for the volume (V) of water in the pool after t minutes. **3**

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Question 34 continues on the next page.

Question 34 continued...

- c) Find the minimum volume of water in the pool during the pumping cycle. Leave your answer in terms of π . **2**

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- END OF EXAM -

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This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

SECTION I**Mathematics Multiple Choice Answer Sheet****10 Marks**

This sheet must be handed in separately. Detach it from the question paper.

Shade the correct answer:

- | | | | | |
|-----|-------------------------|-------------------------|-------------------------|-------------------------|
| 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 ☐ |

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