Mathematics 30-1 | Released Items

2017 Released Diploma Examination Items

Alberta Government

For further information, contact

Delcy Rolheiser, Math 30-1 Exam Manager, at
Delcy.Rolheiser@gov.ab.ca

Deanna Shostak, **Director of Diploma Programs**, at
Deanna.Shostak@gov.ab.ca

Provincial Assessment Sector: 780-427-0010.
To call toll-free from outside Edmonton, dial 310-0000.

The Alberta Education website is found at education.alberta.ca.

Contents

Introduction

The questions in this booklet are from the April 2017 Mathematics 30-1 Diploma Examination. Teachers may wish to use these questions in a variety of ways to help students develop and demonstrate an understanding of the concepts described in the *Mathematics 30-1 Program of Studies*. This material, along with the *Program of Studies*, *Information Bulletin*, and *Assessment Standards and Exemplars*, can provide insights that assist with decisions about instructional planning.

These questions are released in both English and French by the Provincial Assessment Sector.

Additional Documents

The Provincial Assessment Sector supports the instruction of Mathematics 30–1 with the following documents available online.

- *Mathematics 30–1 Information Bulletin* and *Mathematics 30–1 Assessment Standards and Exemplars*

- *Mathematics 30–1 Practice Tests*
  Some practice questions have been released for Mathematics 30–1.

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Mathematics 30-1 Diploma Examination
April 2017 – Blueprint Summary

The following table gives results for the machine-scored questions released from the examination and shows the percentage of students that answered each question correctly. For each question, the table also gives the correct response, the topic, the outcome, the standard, and the cognitive levels.

Topics		Standards	Cognitive Levels
RF	Relations and Functions	Acceptable	Conceptual
TRIG	Trigonometry	Excellence	Procedural
PCBT	Permutations, Combinations, and Binomial Theorem		Problem Solving

Question	Diff.*	Key	Topic	Outcome	Cognitive Level	Standard
MC1	66.3%	D	RF	2, 5	Conceptual	Acceptable
NR1	81.8%	321	RF	2, 5	Conceptual	Acceptable
MC2	80.1%	A	RF	3, 12	Conceptual	Acceptable
NR2	42.3%	126	RF	4	Procedural	Acceptable
MC3	48.4%	B	RF	4	Conceptual	Acceptable
MC4	78.0%	D	RF	6	Conceptual	Acceptable
NR3	67.9%	314, 344	RF	5, 6	Conceptual	Acceptable
MC5	59.1%	B	RF	7	Procedural	Acceptable
MC6	77.8%	B	RF	8	Procedural	Acceptable
MC7	34.3%	C	RF	8	Conceptual	Acceptable
MC8	71.2%	C	RF	9	Problem Solving	Acceptable
NR4	50.1%	13, 31	RF	9	Conceptual	Acceptable
MC9	60.7%	B	RF	10	Problem Solving	Acceptable
MC10	75.6%	B	RF	10	Problem Solving	Excellence
NR5	72.3%	4	RF	11	Problem Solving	Acceptable
MC11	64.0%	A	RF	12	Conceptual	Acceptable
NR6	44.5%	2.25	RF	12	Procedural	Acceptable
MC12	71.0%	C	RF	13	Conceptual	Acceptable
MC13	68.6%	D	RF	14	Conceptual	Excellence
MC14	76.6%	A	RF	14	Conceptual	Excellence

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Question	Diff.*	Key	Topic	Outcome	Cognitive Level	Standard
MC15	23.5%	A	RF	1	Problem Solving	Acceptable
NR7	61.4%	423	RF	1	Procedural	Acceptable
NR8	62.8%	10.5	TRIG	1	Problem Solving	Excellence
MC16	56.1%	C	TRIG	1, 2	Problem Solving	Acceptable
MC17	78.7%	B	TRIG	3	Procedural	Acceptable
NR9	57.7%	105	TRIG	2	Procedural	Acceptable
MC18	76.4%	D	TRIG	3	Conceptual	Acceptable
MC19	45.4%	A	TRIG	4	Problem Solving	Acceptable
MC20	71.5%	C	TRIG	4	Conceptual	Acceptable
MC21	76.7%	D	TRIG	5	Procedural	Acceptable
MC22	60.9%	D	TRIG	5	Problem Solving	Excellence
MC23	69.0%	C	TRIG	6	Problem Solving	Acceptable
MC24	63.1%	A	TRIG	6	Procedural	Excellence
NR10	35.9%	4775, 5774	PCBT	1	Problem Solving	Excellence
MC25	33.3%	D	PCBT	1	Problem Solving	Acceptable
MC26	66.6%	B	PCBT	2	Procedural	Acceptable
NR11	51.0%	30	PCBT	3	Problem Solving	Acceptable
MC27	57.7%	C	PCBT	3	Problem Solving	Excellence
NR12	49.4%	1890	PCBT	4	Procedural	Acceptable
MC28	65.5%	D	PCBT	4	Problem Solving	Excellence

*Difficulty—percentage of students answering the question correctly

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April 2017 – Released Items

Use the following information to answer question 1.

The graph of $y = f(x)$, shown below, is transformed into the graph of $g(x) = -f(x) + 4$.
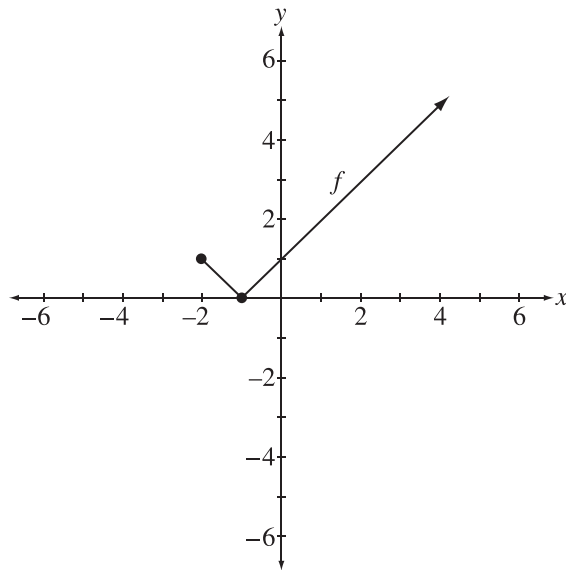
1. The range of $y = g(x)$ is

   A. $[-4, \infty)$

   B. $[4, \infty)$

   C. $(-\infty, -4]$

   D. $(-\infty, 4]$

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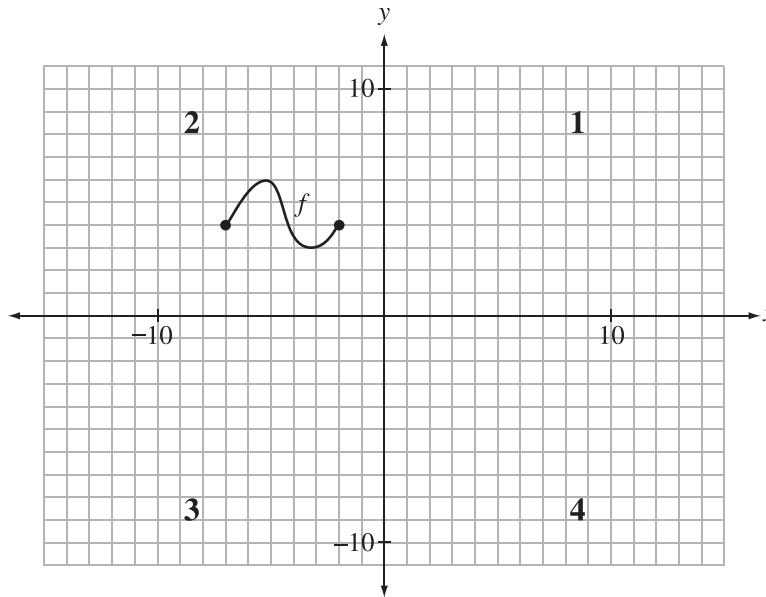The function $y = f(x)$ is drawn entirely in Quadrant 2 as shown below. Three new functions will be drawn that are transformations of $y = f(x)$.

Numerical Response

1. For each function below, identify the quadrant in which its graph will be completely drawn. A quadrant number may be used once, more than once, or not at all.

The graph of $g(x) = f(x) - 8$
will be drawn completely in Quadrant _____. (Record in the **first** column)

The graph of $h(x) = f(x + 8)$
will be drawn completely in Quadrant _____. (Record in the **second** column)

The graph of $m(x) = f(-x)$
will be drawn completely in Quadrant _____. (Record in the **third** column)

(Record your answer in the numerical-response section on the answer sheet.)

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Use the following information to answer question 2.

The function $P(x) = (x + 3)(2x + 1)(x - 2)$ is transformed to produce the new function $y = N(x)$, where $N(x) = P\left(\frac{1}{2}x\right)$.

2. The zeros of the function $y = N(x)$ will be

   A. $-6, -1, 4$

   B. $6, 1, -4$

   C. $-\frac{3}{2}, -\frac{1}{4}, 1$

   D. $\frac{3}{2}, \frac{1}{4}, -1$

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The graph of $y = f(x)$ is stretched vertically by a factor of $\frac{1}{9}$ about the *x*-axis, stretched horizontally by a factor of $\frac{1}{7}$ about the *y*-axis, and then translated 8 units down. These transformations can be described by the mapping notation $(x, y) \rightarrow (mx, ny + p)$. Possible values for *m*, *n*, and *p* are listed below.

Reference Number	Possible Values of *m*, *n*, and *p*
1	$\frac{1}{7}$
2	$\frac{1}{9}$
3	7
4	9
5	8
6	–8

Numerical Response

2. The reference numbers for the values of **m**, **n**, and **p** are, respectively,
_____, _____, and _____.

(Record your answer in the numerical-response section on the answer sheet.)

The function $y = f(x)$ is transformed to become the function $g(x) = 4f\big(b(x - 5)\big).$
The point $(4, 6)$ on the graph of $y = f(x)$ corresponds to the point $(7, 24)$ on the graph
of $y = g(x).$

3. The value of **b** is

    A. $\dfrac{1}{2}$

    B. 2

    C. $\dfrac{1}{3}$

    D. 3

4. If the graph of the function $y = f(x)$ is transformed into the graph of the inverse function, $y = f^{-1}(x),$ then an invariant point on the graph could have the coordinates

    A. $(0, 2)$
    B. $(2, 1)$
    C. $(3, 0)$
    D. $(4, 4)$

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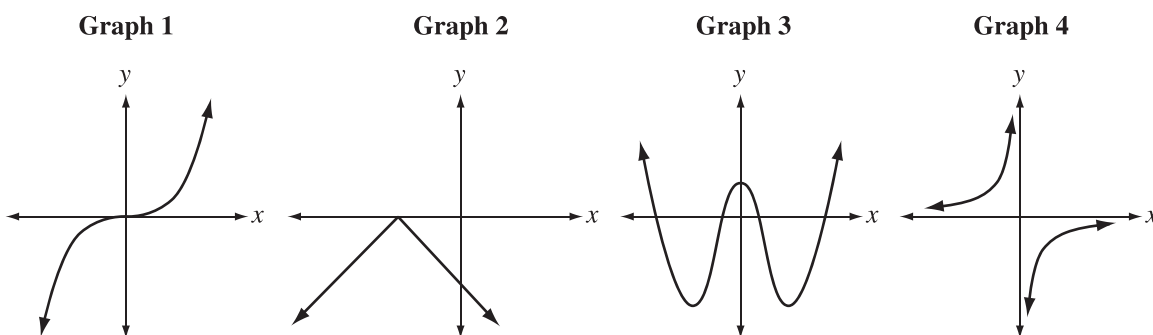
Use the following information to answer numerical-response question 3.

Three statements and the graphs of four different functions are provided below.

Statement I   The graph of $g(x)$ is the same as the graph of $g(-x)$.

Statement II   The graph of $h(x)$ is the same as the graph of $-h(-x)$.

Statement III The graph of $k(x)$ is the same as the graph of $k^{-1}(x)$.

Graph 1	Graph 2	Graph 3	Graph 4

Numerical Response

3. For each transformation statement above, identify the corresponding graph. A number may be used once, more than once, or not at all. (There is more than one correct answer.)

Statement I is true for Graph _____. (Record in the **first** column)

Statement II is true for Graph _____. (Record in the **second** column)

Statement III is true for Graph _____. (Record in the **third** column)

(Record your answer in the numerical-response section on the answer sheet.)

_____

5. A logarithmic form of the equation $4a^3 = b$, where $a > 1$, is

A. $\log_4\left(\dfrac{b}{a}\right) = 3$

B. $\log_a\left(\dfrac{b}{4}\right) = 3$

C. $\log_b(4a) = 3$

D. $\log_{4a}(b) = 3$

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6. If $\log_2 3 = a$ and $\log_2 10 = b$, then an expression for $\log_2 90$ is

　　A. $a^2 + b$

　　B. $2a + b$

　　C. $a^2 b$

　　D. $2ab$

Use the following information to answer question 7.

Two students were asked to simplify the expression $\left(2\log x + \log x^3\right)^3$. Their work is shown below.

Student A

	$\left(2\log x + \log x^3\right)^3$
Step 1	$\left(\log x^2 + \log x^3\right)^3$
Step 2	$\left(\log x^5\right)^3$
Step 3	$\log x^{15}$
Step 4	$15\log x$

Student B

	$\left(2\log x + \log x^3\right)^3$
Step 1	$8\log x^3 + \log x^9$
Step 2	$\log x^{24} + \log x^9$
Step 3	$\log x^{216}$
Step 4	$216\log x$

7. *Student A's **first** recorded error is in Step* ____*i*____ *, and Student B's **first** recorded error is in Step* ____*ii*____ *.*

The statement above is completed by the information in row

Row	***i***	***ii***
A.	2	1
B.	2	3
C.	3	1
D.	3	3

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The graph of each logarithmic function listed below, where $b > 1$, has a vertical asymptote.
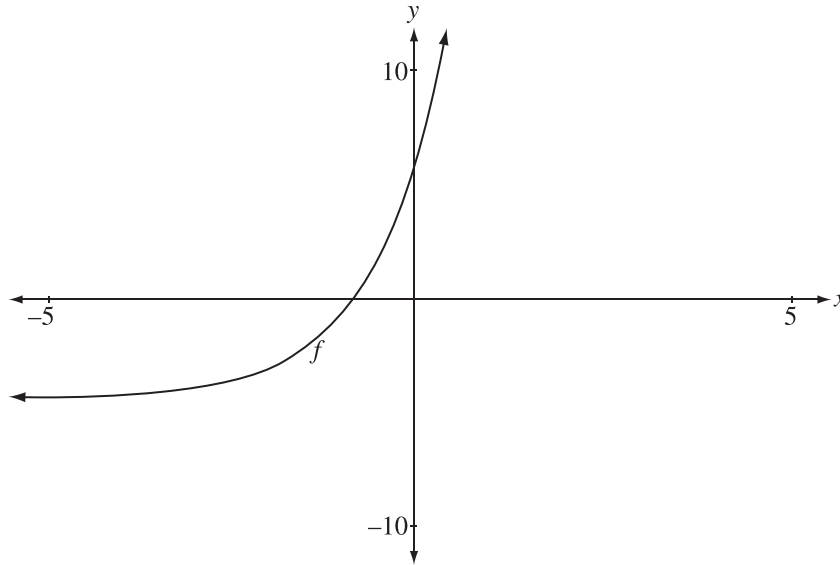
$$y = \log_b x$$

$$y = 2\log_b x$$

$$y = \log_b(2x)$$

$$y = \log_b x + 2$$

$$y = \log_b(x + 2)$$

8. The number of functions listed above that have an asymptote of $x = 0$ is

    A. 2

    B. 3

    C. 4

    D. 5

Carol sketched the graph of $f(x) = 3^{(x+2)} - 4,$ as shown below.

Carol also determined the following characteristics of the graph of $y = f(x).$

1	Domain
2	Range
3	x-intercept
4	y-intercept
5	Equation of the asymptote

Numerical Response

4. When $y = f(x)$ is vertically stretched about the x-axis by a factor of a, where $a > 1,$ the two characteristics above that will remain the **same** are numbered _____ and _____.

(Record **both digits** of your answer **in any order** in the numerical-response section on the answer sheet.)

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9. The value of x in the exponential equation $\left(\dfrac{a}{b}\right)^{(2x-3)} = \left(\dfrac{b^3}{a^3}\right)^{(x+4)}$, where

$a \neq b,\ a \neq 0,$ and $b \neq 0,$ is

A. -15

B. $-\dfrac{9}{5}$
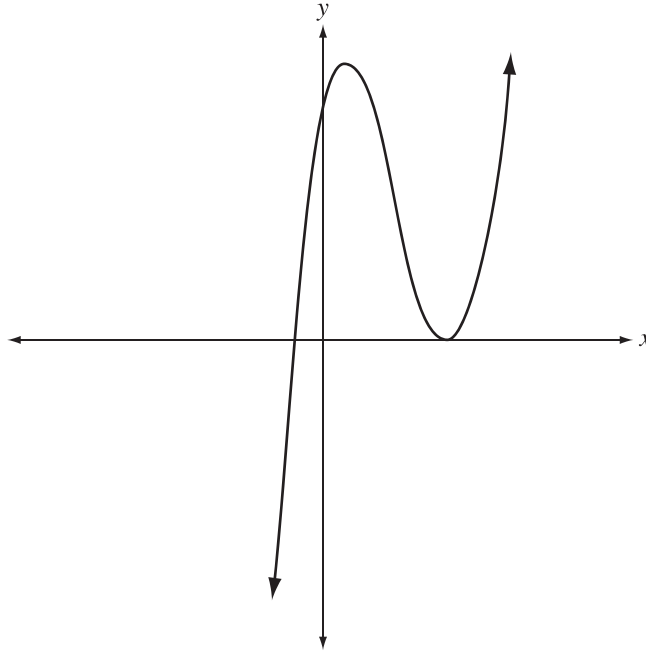
C. $\dfrac{7}{5}$

D. 7

Use the following information to answer question 10.

A town's population is increasing at a constant rate of 2.6% per year. This year on January 1, the population of the town was 16 000.

10. The minimum number of complete years from January 1 that it will take for the town's population to exceed 20 000 is

A. 8

B. 9

C. 10

D. 11

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The polynomial function $y = x^3 - 7x^2 + bx + 2b, \ b \in N,$ shown below, has a factor of $(x + 1).$

Numerical Response

5. When this polynomial function is written as $y = (x + 1)(x - a)^2, \ a \in N,$ the value of **a** is _____ .

(Record your answer in the numerical-response section on the answer sheet.)

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Given the polynomial function $P(x) = a(x - b)^2(x - c)^3$, where $a < 0$, $b > 0$, and $c > 0$, a student makes the following observations about the graph of $P(x)$.

    1   The graph extends up into Quadrant 2 and down into Quadrant 4.

    2   The function has a maximum value.

    3   There are exactly two x-intercepts.

    4   The y-intercept is negative.

11.   The two observations above that are correct are numbered

    A.   1 and 3

    B.   1 and 4
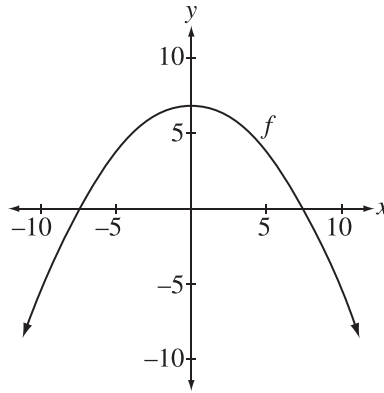
    C.   2 and 3

    D.   2 and 4

Numerical Response

6. The cubic polynomial function $y = P(x)$ has zeros of –3, 1, and 2. If $P(0) = -12$, then the value of $P\left(\dfrac{3}{2}\right)$, to the nearest hundredth, is _____ .

(Record your answer in the numerical-response section on the answer sheet.)

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The graph of $y = f(x)$ is shown below.
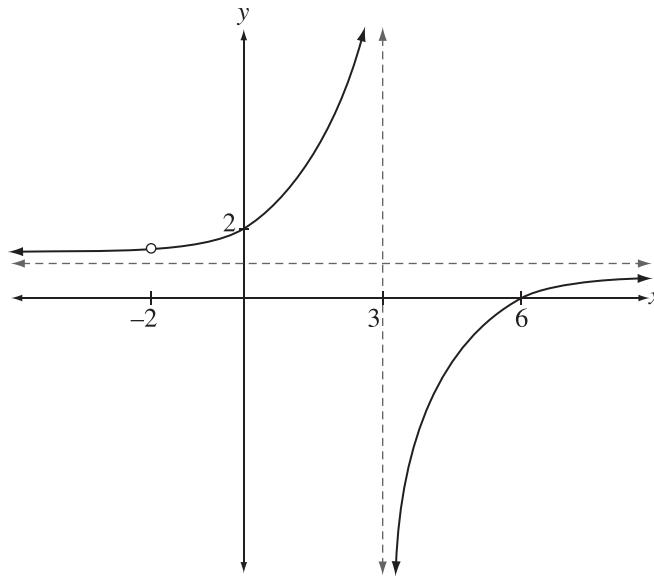

12. *When comparing the graph of $y = f(x)$ with the graph of the transformation $y = \sqrt{f(x)}$, the x-intercepts are* ___**i**___ *and the y-intercept is* ___**ii**___ *.*

The statement above is completed by the information in row

Row	*i*	*ii*
A.	different	different
B.	different	the same
C.	the same	different
D.	the same	the same

To go back after using an internal link, simultaneously press and hold Alt ← (in some browsers).

The graph of a function is shown below.

13. The function, in factored form, that **best** describes the graph above is

A. $y = \dfrac{x - 6}{x - 3}$

B. $y = \dfrac{x - 6}{(x + 2)(x - 3)}$

C. $y = \dfrac{(x + 2)(x - 1)}{(x + 2)(x - 3)}$

D. $y = \dfrac{(x + 2)(x - 6)}{(x + 2)(x - 3)}$

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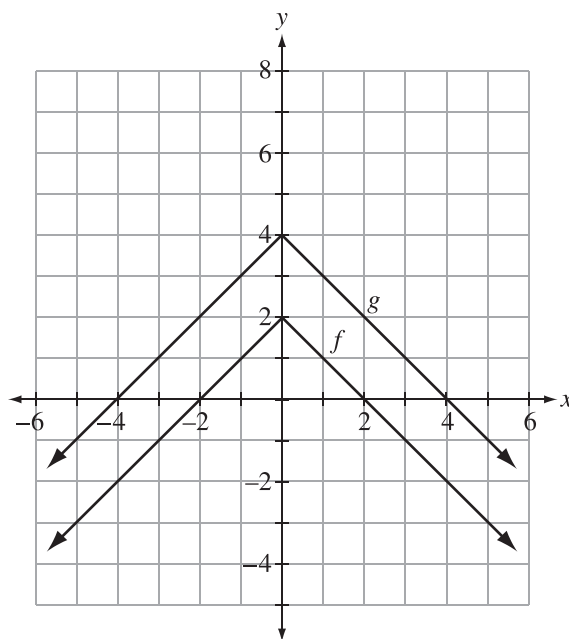
The function $f(x) = \dfrac{x-1}{x^2+x-2}$ is a rational function.

14. Which of the statements below describing this function is true?

A. The point of discontinuity is at $\left(1, \dfrac{1}{3}\right)$.

B. The point of discontinuity is at $\left(-2, \dfrac{1}{3}\right)$.

C. The vertical asymptote has the equation $x = 1$.

D. The horizontal asymptote has the equation $y = -2$.

Use the following information to answer question 15.

The graphs of two absolute value functions, $y = f(x)$ and $y = g(x)$, are shown below.

15. If $h(x) = (f \cdot g)(x)$, then the range of the graph of $h(x)$ is

A. $y \geq -1$
B. $y \leq -1$
C. $y \geq 8$
D. $y \leq 8$

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If $f(x) = x^2 + 3x + 5$ and $g(x) = 2x - 1$, then $(f \circ g)(x)$ can be expressed in the form $ax^2 + bx + c$, where a, b, and c are whole numbers.

Numerical Response

7. The value of

a is _____ (Record in the **first** column)

b is _____ (Record in the **second** column)

c is _____ (Record in the **third** column)

(Record your answer in the numerical-response section on the answer sheet.)

A maple leaf is caught between a car's windshield and the windshield wiper. The windshield wiper is 50 cm in length and sweeps through an angle of 145°. The leaf traces a 100 cm long arc across the windshield as shown below.
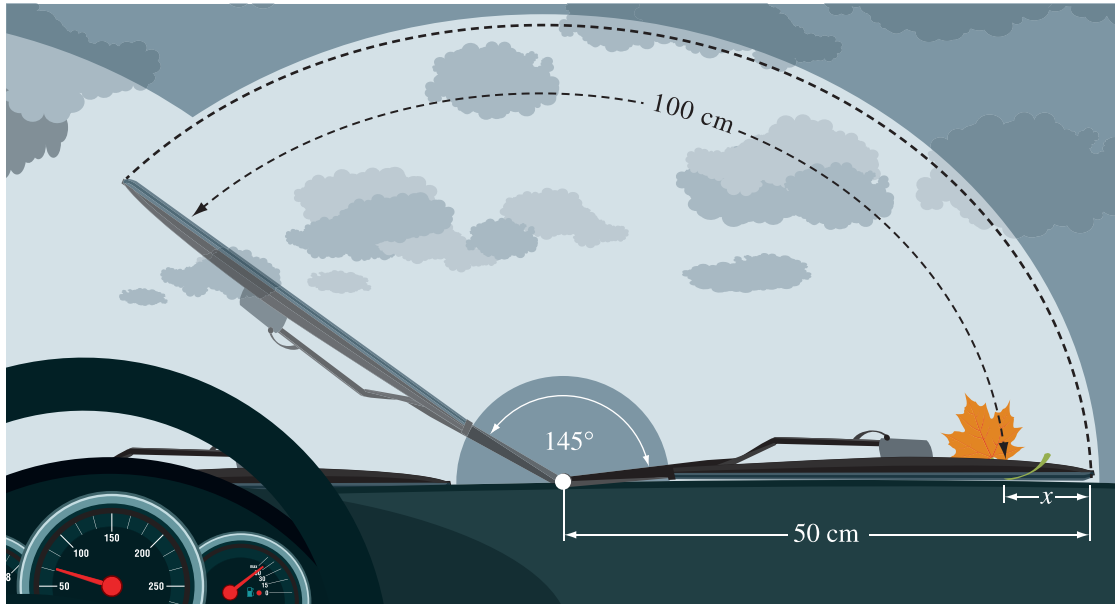
Numerical Response

8. The distance from the leaf to the end of the windshield wiper, *x* in the diagram above, to the nearest tenth of a centimetre, is _____ cm.

(Record your answer in the numerical-response section on the answer sheet.)

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The point $(\log_b \sqrt{b}, y)$, where $b > 0$, $b \neq 1$, is on the terminal arm of angle θ drawn in standard position on the unit circle.

16. An angle that could be co-terminal with angle θ is

    A. $\dfrac{11\pi}{6}$

    B. $\dfrac{13\pi}{6}$

    C. $\dfrac{13\pi}{3}$

    D. $\dfrac{14\pi}{3}$

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17. The **exact** value of $\sin\left(\dfrac{\pi}{3}\right) + \cos^2\left(\dfrac{5\pi}{6}\right)$ is

    A. $\dfrac{2\sqrt{3} + 1}{4}$

    B. $\dfrac{2\sqrt{3} + 3}{4}$

    C. $\dfrac{2\sqrt{3} - 1}{4}$

    D. $\dfrac{2\sqrt{3} - 3}{4}$

Use the following information to answer numerical-response question 9.

Points $A\left(\dfrac{\sqrt{3}}{2}, \dfrac{1}{2}\right)$ and $B\left(-\dfrac{\sqrt{2}}{2}, \dfrac{\sqrt{2}}{2}\right)$ are two points on the unit circle.

Numerical Response

9. If Point O $(0, 0)$ is the centre of the unit circle, then the measure of the smallest angle, AOB, in degrees, is _____°.

(Record your answer in the numerical-response section on the answer sheet.)

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18. Two trigonometric ratios that each equal $-\dfrac{2}{\sqrt{3}}$ are

A. $\sec\left(\dfrac{7\pi}{6}\right)$ and $\csc\left(\dfrac{\pi}{3}\right)$

B. $\sec\left(\dfrac{4\pi}{3}\right)$ and $\csc\left(\dfrac{5\pi}{3}\right)$

C. $\sec\left(\dfrac{5\pi}{6}\right)$ and $\csc\left(\dfrac{2\pi}{3}\right)$

D. $\sec\left(\dfrac{5\pi}{6}\right)$ and $\csc\left(\dfrac{5\pi}{3}\right)$

Use the following information to answer question 19.

The number of squirrels, N, living in a particular area can be modelled by the function $N(t) = a\cos[b(t-c)] + d$, where t is the time in months since measurements began. At 5 months, the squirrel population reached the first maximum of 200; and at 12 months, the squirrel population reached the first minimum of 110.

19. Which of the following rows identifies the values of **a** and **b** for the function above?

Row	Value of a	Value of b
A.	45	$\dfrac{\pi}{7}$
B.	45	$\dfrac{2\pi}{7}$
C.	155	$\dfrac{\pi}{7}$
D.	155	$\dfrac{2\pi}{7}$

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The graph of $f(x) = \sin\left(x - \dfrac{\pi}{2}\right) + 2$ has been transformed to become the graph of $g(x)$. The partial graphs of $f(x)$ and $g(x)$ are shown below.
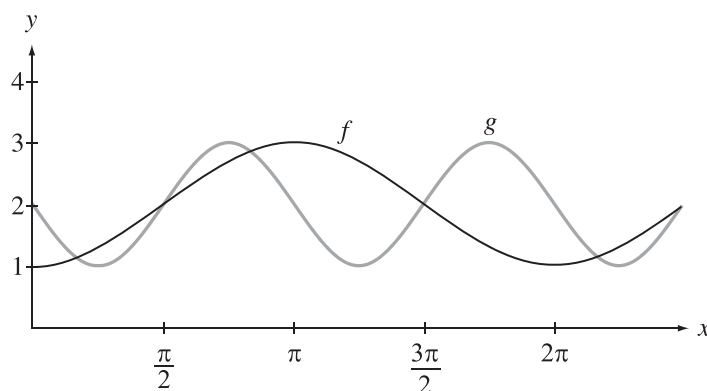
A single parameter in the equation of $f(x)$ is changed to produce the graph of $g(x) = a\sin\left[b(x - c)\right] + d$.

20. *The change can be described as the parameter* ____*i*____ *having a new value of* ____*ii*____ .

The statement above is completed by the information in row

Row	i	ii
A.	c	$\dfrac{1}{2}$
B.	c	$\dfrac{\pi}{2}$
C.	b	2
D.	b	π

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21. The general solution to the equation $2\cos\theta + \sqrt{3} = 0$ is

A. $\theta = \dfrac{\pi}{6} + 2n\pi$ and $\theta = \dfrac{11\pi}{6} + 2n\pi,\ n \in I$

B. $\theta = \dfrac{\pi}{3} + 2n\pi$ and $\theta = \dfrac{5\pi}{3} + 2n\pi,\ n \in I$

C. $\theta = \dfrac{2\pi}{3} + 2n\pi$ and $\theta = \dfrac{4\pi}{3} + 2n\pi,\ n \in I$

D. $\theta = \dfrac{5\pi}{6} + 2n\pi$ and $\theta = \dfrac{7\pi}{6} + 2n\pi,\ n \in I$

22. The values of x that satisfy the equation $2\sin^2 x = -\sin x$ for the interval $[-\pi, \pi)$ are

A. $-\dfrac{2\pi}{3}, \dfrac{2\pi}{3}$

B. $-\dfrac{\pi}{6}, -\dfrac{5\pi}{6}$

C. $-\dfrac{2\pi}{3}, -\dfrac{\pi}{2}, \dfrac{\pi}{2}, \dfrac{2\pi}{3}$

D. $-\pi, -\dfrac{5\pi}{6}, -\dfrac{\pi}{6}, 0$

23. The expression $\sin\left(\dfrac{\pi}{2} - \theta\right) + \cos\left(\dfrac{\pi}{2} + \theta\right)$ is equivalent to the expression

A. $2\sin\theta$
B. $2\cos\theta$
C. $\cos\theta - \sin\theta$
D. $\cos\theta + \sin\theta$

24. The expression $\dfrac{1 + \cos(2\theta)}{\sin(2\theta)}$, where $\theta \neq \dfrac{n\pi}{2},\ n \in I,$ is equivalent to the expression

A. $\cot\theta$
B. $\tan\theta$
C. $1 + \cot(2\theta)$
D. $1 + \tan(2\theta)$

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For a particular four-digit bank code, the first and last digits must be odd, and the second digit cannot be 4. Digits cannot be used more than once. To determine the total number of different possible bank codes, a student showed the following calculation:

$$\underline{\ a\ } \times \underline{\ b\ } \times \underline{\ c\ } \times \underline{\ d\ }$$

where *a*, *b*, *c*, and *d* refer to the number of possible values for the code's first, second, third, and fourth digits, respectively.

Numerical Response

10. The values of *a*, *b*, *c*, and *d* are, respectively, _____, _____, _____, and _____.
(There is more than one possible answer.)

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

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25. For a picture, 3 girls and 3 boys are being arranged in a line such that girls and boys alternate. The number of different arrangements of the children for the picture is

  A. 20
  B. 24
  C. 36
  D. 72

26. The number of 6-letter arrangements of the letters in the word **VERIFY** in which the letters **E** and **R** are next to each other, but not necessarily in that order, is

  A. 360
  B. 240
  C. 120
  D. 48

Use the following information to answer numerical-response question 11.

A physical education teacher in a high school has made up a schedule for the 15 intramural teams in the school. She has decided to split the teams into 3 divisions of 5 teams each. Each team must play each of the other teams in its division once. Teams in one division do **not** play against teams in other divisions.

Numerical Response

11. The total number of games that are scheduled is _____ .

(Record your answer in the numerical-response section on the answer sheet.)

_____

27. If a committee of 3 is to be selected from a group of 15 students and 6 teachers, then the number of different possible committees that have **at most** 1 teacher is

A. 630
B. 875
C. 1 085
D. 1 260

Numerical Response

12. In the expansion of $\left(x + \sqrt{3}\right)^{10}$, written in descending powers of x, the coefficient of the fifth term, to the nearest whole number, is _____ .

(Record your answer in the numerical-response section on the answer sheet.)

28. The middle term in the expansion of $\left(a^2 + a^3\right)^6$, written in ascending powers of a, is

A. $15a^{16}$
B. $15a^{54}$
C. $20a^5$
D. $20a^{15}$