EST I – Math

Student's Name _____

National ID _____

Test Center _____

Duration: 90 minutes

Test sections: I- Calculators are not required, II – Calculator are required

45 Multiple Choice Questions and 13 Short Constructive Response Questions

Instructions:

- Place your answer on the answer sheet. Mark only one answer for each of the multiple choice questions.

- Write your final result only on the answer sheet for the constructive response questions.

- Avoid guessing. Your answers should reflect your overall understanding of the subject matter.

- Calculators are allowed. When a calculator is used, be aware of switching between radian mode and median mode.

- A formula sheet is available at the end of the booklet for your reference.

Section I
Calculators are not
required
(30 minutes)

1.

People who own a smartphone worldwide

Year	Number of People (in billions)
2016	2.3
2017	2.6
2018	2.9
2019	3.2
2020	3.5

The table above shows the number of people who owned a smartphone from the year 2016 to the year 2020. The number of people N (in billions) is a linear function of the number of years y from the year 2016. Which of the following expressions best describes N in terms of y?

A. $N = 0.3y$
B. $N = 0.3y + 2016$
C. $N = 0.3y + 2.3$
D. $N = 3.3y + 2.3$

2. $9x^2 + 18x - 3 = 0$

What is the average (arithmetic mean) of the two solutions of the equation given above?

A. -1
B. $-\frac{1}{6}$
C. $\frac{1+\sqrt{2}}{2}$
D. $\sqrt{2}$

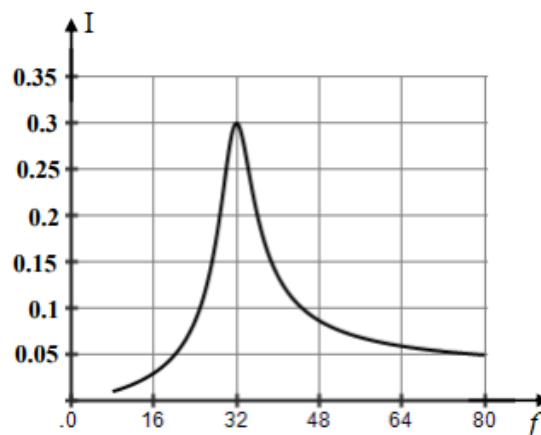**3.** In the complex number system, which of the following is equal to $3i(1 + i) - (1 - i)^2$?

(Note: $i = \sqrt{-1}$)

A. $-3 + i$
B. $-3 + 5i$
C. $3 + i$
D. $3 + 5i$

4. If $p(x) = x^2 - 7x + 5$ and $q(x) = -3x^3 - 7x^2 + 2x - 5$, which of the following expressions is equal to the difference $p(x) - q(x)$?

A. $4x^3 - 9x + 10$
B. $-3x^3 - 6x^2 - 5x$
C. $-3x^3 - 8x^2 + 9x - 10$
D. $3x^3 + 8x^2 - 9x + 10$

5.

In a certain electric circuit, the generator has an adjustable feature called the frequency. For different frequencies between 60 and 80 Hertz, one obtains different intensities of current flowing in the circuit measured in Amperes. The graph given above represents the variation of the effective value of the current as a function of the frequency. Which of the following values of the current can be attained by only one value of the frequency?

A. 0.04
B. 0.1
C. 0.23
D. 0.35

6.
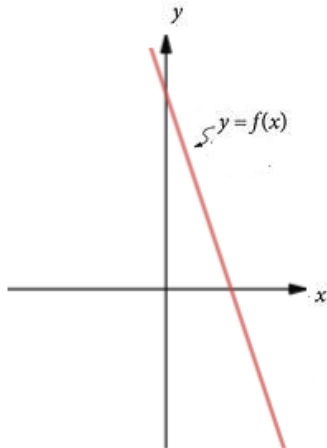
The graph shown above is that of a linear function f whose expression is given by $f(x) = cx + d$, where c and d are constants. Which of the following must be true about c and d?

A. $c = d$
B. $c > d$
C. $c < d$
D. $c = 0$

7. Ryan wants to calculate the amount of time he spends on social media which, for him, includes only Instagram and Facebook. To do this he uses a formula $T = aI + bF$, where I is the number of hours he spends on Instagram every day, F is the number of hours he spends on Facebook every day, and T is the total number of hours he spends on social media every <u>week.</u> If he spends the same amount of time on Instagram every day and the same amount of time on Facebook every day, which of the following could be the value of $a + b$?

A. 7
B. 14
C. $\dfrac{1}{7}$
D. $\dfrac{1}{14}$

8.
$$3y = 12 - 3y$$
$$y + a = x - 1$$
$$y + a = x - 1$$

In the system of equations above, a is a constant and (x, y) is a solution, where $x = 3$. What is the value of a ?

A. -4
B. 0
C. 2
D. 4

9. If a is a solution of the equation $|2x - 4| = 5$, what is the distance between a and the point of coordinate 2 on the number line?

A. 0.5
B. 2.5
C. 4.5
D. 5

10. $ax - \dfrac{1}{2}y = c$

$$2x + 4y = 5$$
The system of equations above has infinitely many solutions. If a and c are constants, what is the value of c?

A. $-\dfrac{5}{8}$
B. $\dfrac{1}{4}$
C. $\dfrac{5}{4}$
D. $\dfrac{11}{4}$

11.

x	-3	-1	0	2	4	5	8
$f(x)$	2	1	4	7	-3	9	-5
$g(x)$	-7	8	-3	20	0	10	5

The table above shows some values of the two functions f and g. For what value of x is $g(f(x)) = x$?

A. -3
B. 0
C. 4
D. 8

4

12. Black holes are massive objects in the universe. The Schwarzschild Radius of a black hole is the maximum distance at which an object can escape the gravitational pull of the black hole. It is given by $R = \frac{2GM}{c^2}$, R is the Schwarzschild Radius, G is called the gravitational constant, M is the mass of the black hole, and c is the speed of light in vacuum. What is c in terms of G, M, and R?

A. $c = \sqrt{\frac{R}{2GM}}$

B. $c = \sqrt{2GMR}$

C. $c = \sqrt{\frac{GMR}{2}}$

D. $c = \sqrt{\frac{2GM}{R}}$

13. As a treat for the holidays, the principal of a school got a bucket of 120 cookies for the teachers. Every hour, when the principal checked the bucket, 4 of the cookies seemed to be missing. Which of the following expressions models the number of cookies C eaten by the teachers after T hours?

A. C = 120 – 4T
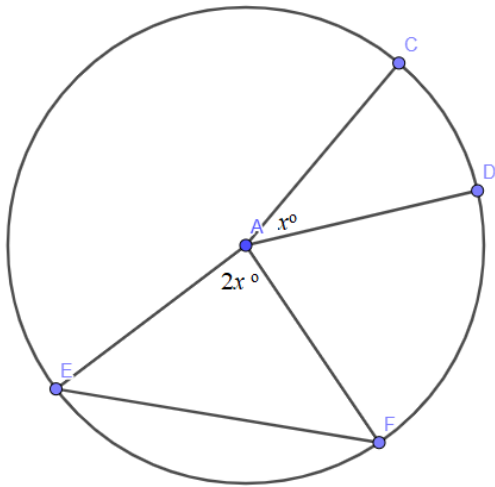**B.** C = 120 + 4T
C. C = – 4T
D. C = 4T

14.
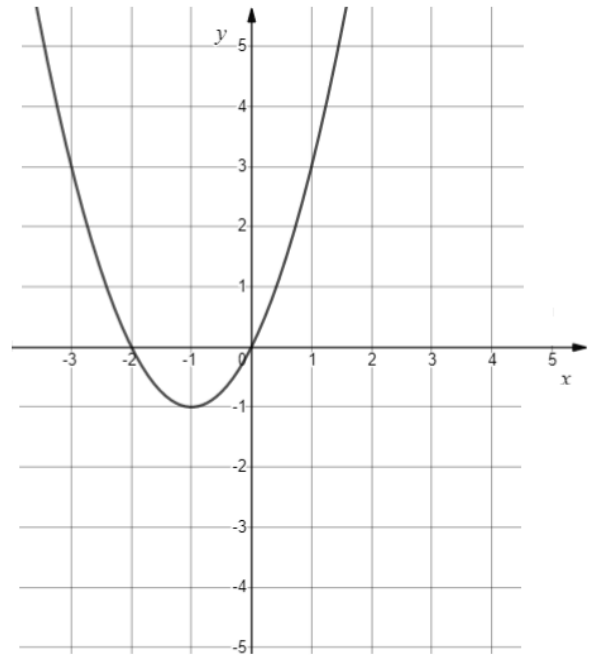
The graph of the function f in the xy-plane above is a parabola. Which of the following expressions defines f while showing the x-intercepts as constants or coefficients?

A. $f(x) = x(x + 2)$
B. $f(x) = (x + 1)(x + 2)$
C. $f(x) = x^2(x + 2)$
D. $f(x) = (x + 2)^2 - 1$

5

15.

In the given figure, A is the center of the circle. C, D, E, and F are points on the circle. If segments AE and EF have the same length, what is the measure of angle $\angle CAD$?

A. $15º$
B. $25º$
C. $30º$
D. $60º$

16. $13x - 7y = 12$

$7x - 13y = 6$

Based on the system of equations above, what is the value of $4x + 4y$?

17. If $\sqrt{2^m} = 8$, what is the value of $\sqrt{3^m}$?

18. What is the solution of the equation
$$x + 2(x + 1) + 3(x + 1)$$
$$= 3(x - 1) - x + 24 ?$$

19. If $(ax^2 + b)(2x - 1) = cx + 1$ for all values of x, what is the value of $\frac{b}{c}$?

20. If x and y are positive measures of acute angles, and $\sin(x - 20º) = \cos(y + 12º)$, what is a possible value of $x + y$? (Disregard the degree sign when gridding in your answer).

Section II
Calculators are required
(60 minutes)

1. If $4t - 10 = 11a$, and $a = -2$, what is the value of $10t - 10$?

   A. -40
   B. -8
   C. -3
   D. 1

2. Vanessa's company has a bonus policy. At the end of each month, based on his or her performance, every employee gets effort points. At the end of each year, each employee gets paid a fixed bonus amount of 400$ and an additional bonus of 50$ for each effort point earned by the employee. At the end of the year 2019, Vanessa got a bonus of 1000$. How many effort points had she earned during the year 2019?

   A. 2
   B. 2.375
   C. 12
   D. 200

3. The straight line m has an equation $y = 3x$. The point A of coordinates (1,3) is on m. The line p is perpendicular to m at point A. Which of the following points is on p?

   A. (3, 9)
   B. $(5, \frac{5}{3})$
   C. (3, 0)
   D. (0, 0)

4. In a certain board game, a player can make only horizontal and vertical moves with his or her piece on condition that the total number of moves does not exceed 40 moves out of which at least 10 are horizontal. Every horizontal move costs 5 points and every vertical move costs 3 points, and a player Sarah has only 800 points left. If h is the number of horizontal moves that Sarah can make, and v is the number of vertical moves Sarah can make, which of the following systems of inequalities best represents the situation?

   A. $h + v \geq 40$
      $h \leq 10$

      $5h + 3v \leq 800$

   B. $h + v \leq 40$
      $h \geq 10$

      $\frac{h}{5} + \frac{v}{3} \leq 800$

   C. $h + v \leq 40$
      $h \geq 10$

      $5h + 3v \leq 800$

   D. $h + v \geq 40$
      $h \geq 10$

      $\frac{h}{5} + \frac{v}{3} \geq 800$

8

5. A company decides to let its employees work from home. The employer gathers the workers and wants to distribute the work documents among the workers so they can take them home. When he gives 2 documents to each employee, 20 are left over. Instead, he decides to take one himself and give 3 to each employee. This time 9 are left over. What is the number of documents?

A. 44
B. 11
C. 10
D. 40

6. If $2z - 7(z - 1) \leq 1$ and z is an integer, what is the least possible value of z?

A. -2
B. 0
C. 2
D. 4

7. Due to the large demand on hand sanitizers, a small shop owner decided to increase the price of hand sanitizer by a fixed amount every day. If the price P (in dollars) of the hand sanitizer can be modeled by the equation: $P = 3.5\,D + 6$, where D is the number of days after the shop owner took the decision, which of the following is the best interpretation of the number 6 in the expression?

A. The increase in the price of the sanitizer per day.
B. The change in the price of sanitizer every day.
C. The price of the sanitizer after the shop owner stops increasing the price.
D. The price of the sanitizer before the large demand.

8. The graph d of a linear function f has a negative slope. Which of the following may be true about the graph n of a linear function g of slope 12?

I. n is perpendicular to d.
II. n is parallel to d.
III. n passes through the origin (0, 0)

A. Only I
B. Only II
C. I and III
D. II and III

9.
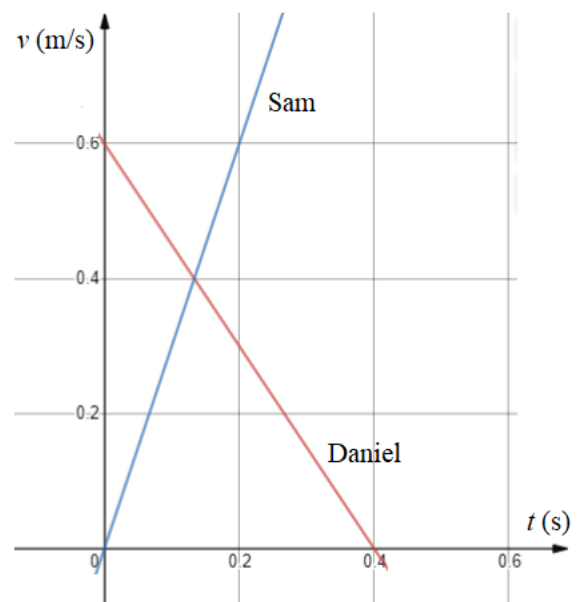
The given graph show the speeds v in meters per second (m/s) of Sam and Daniel, as they do their morning jogs, as a function of time t in seconds (s). The difference in the speeds of the two boys is how much less at t = 0.2s than it was initially?

A. 0 seconds
B. 0.3 seconds
C. 0.4 seconds
D. 0.6 seconds

10. If the average (arithmetic mean) of three numbers a, b, and c is 10, what is the average of a and b in terms of c?

A. $5 - 0.5c$

B. $15 - c$

C. $30 - 0.5c$

D. $15 - 0.5c$

11. The solution set of the equation $\sqrt{2x + 1} - x = -1$ is:

A. $\{0, 1, 4\}$

B. $\{1, 4\}$

C. $\{4\}$

D. $\{0\}$

12. In a certain village, the number of people doubles every three months. If there were 120 people in the village in March, which of the following equations should be solved to find when the population reaches 1500 assuming no deaths occur? (m represents the number of months)

A. $120(2)^{\frac{m}{3}} = 1500$

B. $120(2)^{3m} = 1500$

C. $2(120)^{\frac{m}{3}} = 1500$

D. $1500(2)^{\frac{m}{3}} = 120$

13. John owns a drone that has a radio range of 55 meters, that is the owner can control it only if the drone is within 55 meters from him. As John launches the drone, the drone flies off a distance D, measured in meters, given by the expression $D = 4t^2 + 20t$, where t is the time in seconds after the drone is launched. Assuming John stays where he is, at least how many seconds after being launched, does the drone get out of range?

A. 0 seconds

B. 1 second

C. 2 seconds

D. 3 seconds

14. The graph of the function h in the xy-plane contains the point $(2, 5)$ and has a y-intercept of -7 . The function g is defined by $g(x) = 3 - 2h(x)$. Which of the following points lie on the graph of g?

A. $(0, -7)$

B. $(2, 17)$

C. $(0, 17)$

D. $(-7, 3)$

Questions 15 to 17 refer to the following information.

Number of Covid-19 cases according to age

The histogram shown summarizes the number of people who got infected by the Covid-19 virus according to their age in Lebanon. The survey was done over 11,200 people.

Number of Cases
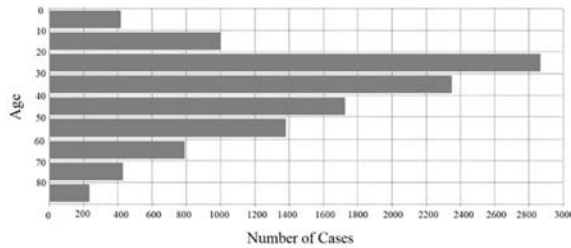
15. Based on the information shown in the graph, which of the following is the most likely median age of those infected by the virus?

A. 23
B. 31
C. 56
D. 68

16. Which of the following is closest to the ratio of the number of infected people below the age of 10 to those above the age of 80?

A. $\dfrac{10}{80}$
B. $\dfrac{215}{410}$
C. $\dfrac{410}{215}$
D. $\dfrac{80}{10}$

17. If 15% of the tests performed in each age group to identify the people who were infected gave wrong results, which of the following gives the closest estimate to the number cases in the age range 20 to 30 who are actually healthy (rounded to the nearest whole number)?

A. 431
A. 1680
B. 2440
C. 9520

18.

| 46	55	60	65	71	71	76	80	86
88	89	90	92	95	98	100	100	100

The table above shows the scores of 18 students on an online history exam. Due to technical issues, the score of the 19th student was not added to the list. The professor adds the score and finds out that doing so increases the median score. Which of the following is the most likely score of the 19th student?

A. 74
B. 86
C. 87
D. 88

19. In a certain chip manufacturing company, there are three operating machines A, B, and C. Every day, Machine A produces 30% more chips than machine B, and machine B produces twice as many chips as machine C. If on any particular day machine A produces x chips, what is the total number of chips produced by machines A, B, and C combined on that day in terms of x?

A. $x + 1.3x + 2.6x$
B. $x + 0.3x + 0.6x$
C. $x + \dfrac{x}{0.3} + \dfrac{x}{0.6}$
D. $x + \dfrac{x}{1.3} + \dfrac{x}{2.6}$

11

Questions 20 to 22 refer to the following information

Years since 2012

$y = -56.429x + 525.71$
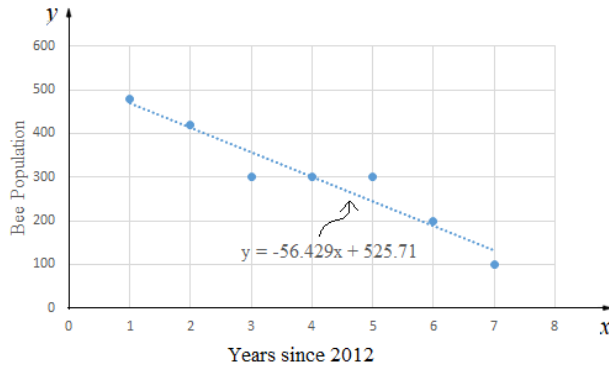
The scatterplot above shows the Bee population in a certain farm for every year since 2012. A line of best fit and its equation are also shown.

20. Which of the following is the best interpretation of the value -56.429 in the equation of the line of best fit?

   A. The average increase in the number of bees each year.
   B. The average decrease in the number of bees every 525.71 years.
   C. The average decrease in the number of bees each year.
   D. The number of bees present in the beginning.

21. Which of the following is closest to the difference in the actual population number of bees and the number predicted by the line of best fit in 2017?

   A. 13
   B. 56
   C. 100
   D. 525

22. According to the line of best fit, in which year is the population of bees most likely predicted to drop to zero?

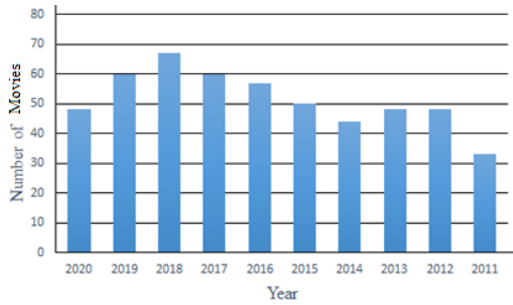   A. 2013
   B. 2019
   C. 2021
   D. 2023

23.

Time (minutes)
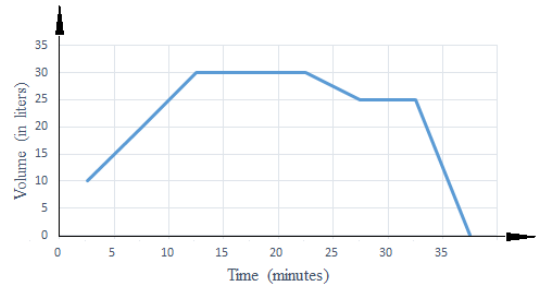
The graph above represents the volume of oil in a certain container over the course of about 37.5 minutes. The container has a small hole through which oil leaks occasionally, and so a certain amount is occasionally added by the owner. Which of the following statements about the situation can be true?

   A. Oil is not leaking from the container after 30minutes.
   B. Oil is being added to the container at the same rate at which it is leaking between 12.5 and 22.5 minutes.
   C. Oil is leaking from the container without any amount being added between 27.5 and 32.5 minutes
   D. The rate at which oil is added is the same at which oil is leaking between 2.5 and 12.5 minutes.

12

24.

The graph above shows the number of action movies made each year from 2011 to 2020. The greatest increase in the number of action movies took place between which two of the following years?

A. 2011 and 2012
B. 2012 and 2013
C. 2017 and 2018
D. 2019 and 2020

25. A certain pharmaceutical company wants to test the efficiency of a vaccine that it recently developed against a certain virus. For this purpose, they administer the vaccine to 10 people from each neighborhood where the virus had been detected. They do this for 40 neighborhoods where the virus was detected, and discover that among the 400 subjects, only 15 got sick when exposed to the virus after receiving the vaccine. Which of the following statements can be true?

A. If the entire country is vaccinated, only 3.75% are expected to get sick.
B. The vaccine is effective against the virus.
C. The sample was not chosen randomly and so it calls into question the results obtained.
D. The sample size was too large.

26. 15, 5, 10, 12, 13, 15, 17, 40, 31, x
If the range of the list above is 29, which of the following can be the value of x? (34,2)

I. 2
II. 34

A. Only I
B. Only II
C. Both I and II
D. Neither I nor II

27.
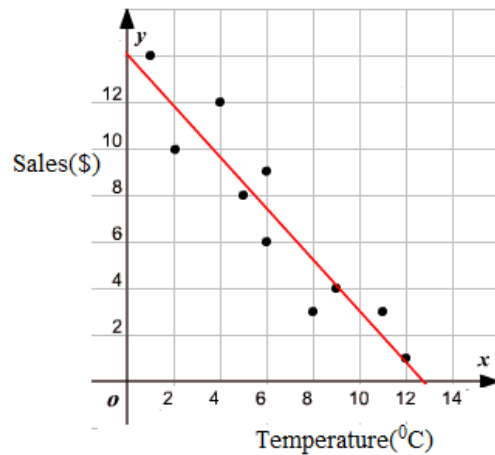
The graph above shows the sales in dollars of the local mall at different temperatures in degrees Celsius on a certain day. Which of the following is closest to the equation of the line of best fit?
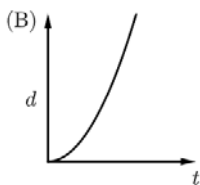
A. $y = -1.1x + 14$
B. $y = 1.1x$
C. $y = -1.1x + 12$
D. $y = -1.8x + 14$

28. An athlete runs every morning for 2 hours straight. On each day, as he progresses, he gets tired and starts slowing down little by little. Which of the following graphs best depicts the distance d covered by the athlete starting from home during the 2 hours he runs every morning as a function of time t?
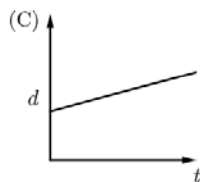
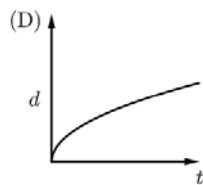**A.**
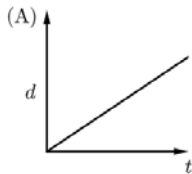
B.

C.

D.

29. In the xy−plane, A is the point of coordinates (3,6) and B is the point of coordinates (3,10). If C is the circle of diameter $\overline{AB}$, which of the following is the equation of C?
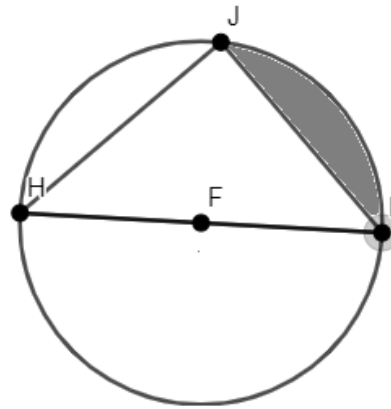
A. $(x-3)^2 + (y-8)^2 = 16$
B. $(x-3)^2 + (y+8)^2 = 4$
C. $(x+3)^2 + (y+8)^2 = 16$
D. $(x-3)^2 + (y-8)^2 = 4$

30.

In the given figure, F is the center of the circle, and J,H, and I are points on the circle, and FI = 4 If $\angle$JHI = $\angle$JIH = 45°, what is the area of the shaded region?

A. $16\pi - 32$
B. $8\pi - 16$
C. $4\pi - 8$
D. $2\pi - 4$

SPR (Student Produced Responses)

31. In a chemistry lab, an apparatus is adjusted to measure the mass of gas released during a chemical reaction. The mass M (in grams) of gas produced by the chemical reaction at time t (in seconds) after the reaction starts is given by $M = 1.61t + 3.95$. For every 10 seconds, what is the increase in the mass of gas released?

32. At a certain carnival booth, a trivia game can be played according to the following rule: the player wins 10 gold coins just for participating in the game; he then wins 3 gold coins for each correct answer and loses 1 gold coin for each wrong answer. At the end of the game when the time is up, the player gains money according to the equivalence: 1 gold coin = $3. If Jad makes 4 mistakes and gains $153 at the end of the game, how many correct answers does he have?

14

33. If $f(x) = (2 - x)(x + 4)$ and $g(x) = f(x - 10)$ are functions whose graphs are parabolas in an xy-plane, what is the y-coordinate of the vertex of the parabola represented by g?

34. $\frac{x}{x+2} - \frac{1}{2} = x - 2$

What is the positive solution of the equation given above?

35. Distance covered by data as it is transferred between different parts of a large computer is measured in light-nanoseconds (lns). 1 light-nanosecond is equivalent to 29.9cm. If a certain data is transferred at the rate of 19 centimeters every second, what disance, in lns, does the data cover in 3 seconds? (Round your answer to the nearest tenths).

36.

	Smart phones	Laptops	Tablets	Total
Elementary	150	230	120	500
Intermediate	250	100	80	430
Secondary	300	220	100	620
Total	700	550	300	1550

A school asks each of its 1550 students whether they use a smartphone, a laptop, or a tablet during online learning. The table above summarizes the results. If a student is selected at random, what is the probability that he or she doesn't use a tablet knowing that he or she is not in the secondary section? (Round your answer to the nearest tenth).

37.

In the given figure, ABC is a triangle right at B, segment ED is parallel to AB, BC = 24, and AC = 26. If ED = 8, what is the length of $\overline{EC}$?

38. In the year 1990, 12000 tourists visited country X. Due to bad weather conditions, the number of tourists visiting country X started decreasing by 10% per year. How many more tourists visited country X in the year 1993 than the year 2000? (Give the answer to the nearest whole number).

15