Part A **Questions 1 to 8**

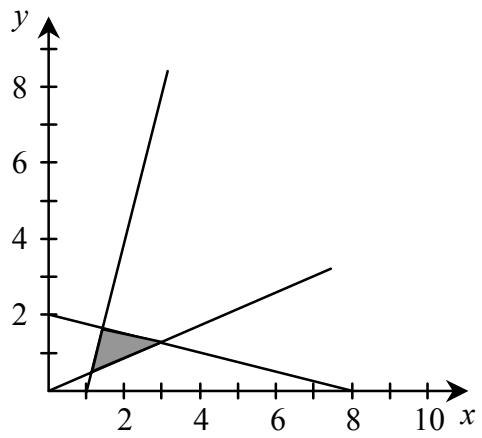
In the Answer Booklet, blacken the letter that corresponds to the answer chosen.

1 Given the following constraints

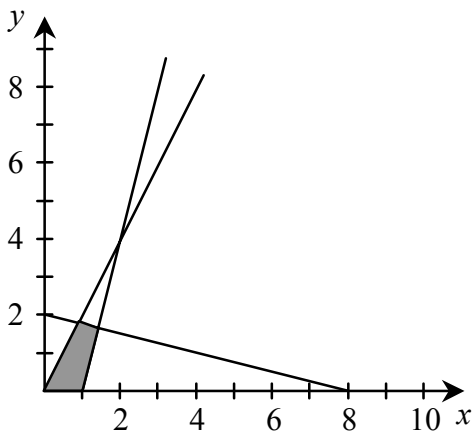
$$x \geq 0$$
$$y \geq 0$$
$$y \leq 4x - 4$$
$$y \leq -\frac{x}{4} + 2$$
$$y \leq \frac{x}{2}$$

Which graph below represents the solution to this system of inequalities?

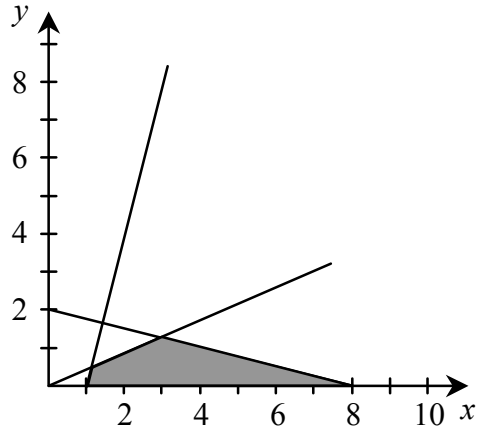
A)



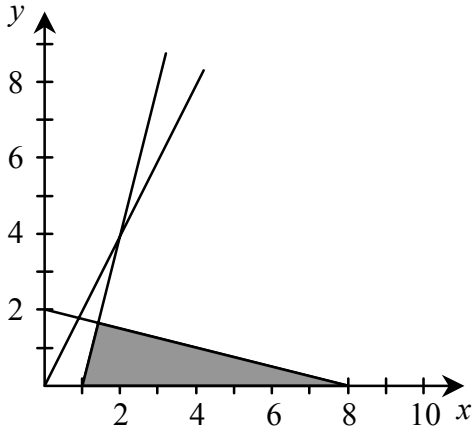
C)



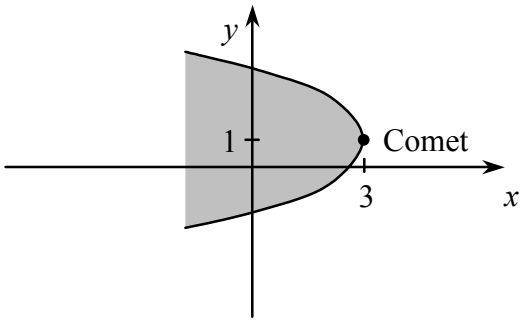
B)



D)



2 A comet travelling through space has a tail in the shape of a parabola. At a given time, the comet is located at (3, 1), the vertex of the parabola shown to the right. The distance from the parabola's vertex to its focus is 2 units.



Which inequality could describe the shaded region shown in the diagram above?

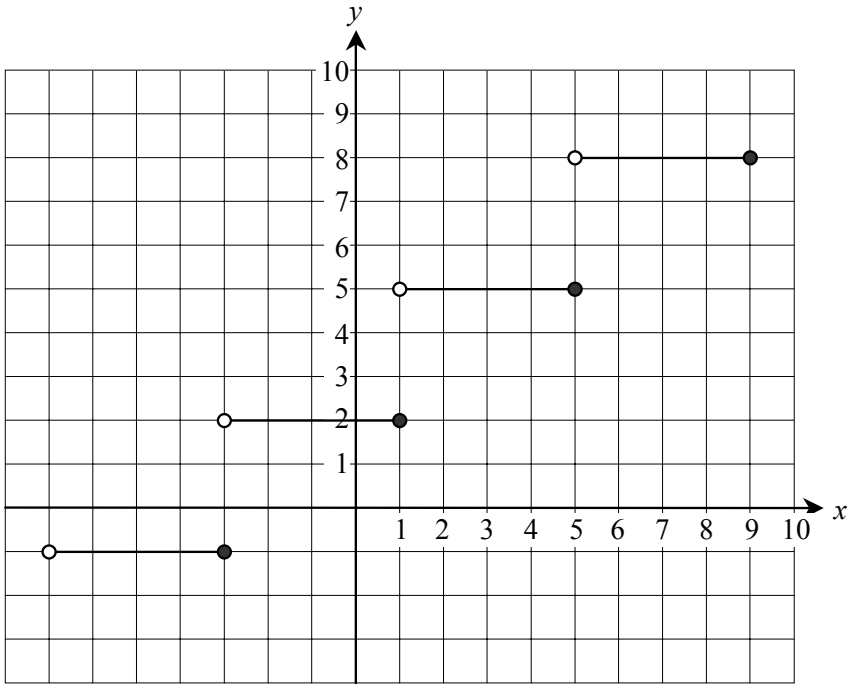
A) $(y-1)^2 \le 8(x-3)$

B) $(y-1)^2 \ge -8(x-3)$

C) $(y-1)^2 \le -8(x-3)$

D) $(y-3)^2 \le -8(x-1)$

3 **What is the rule of correspondence of the function graphed below?**



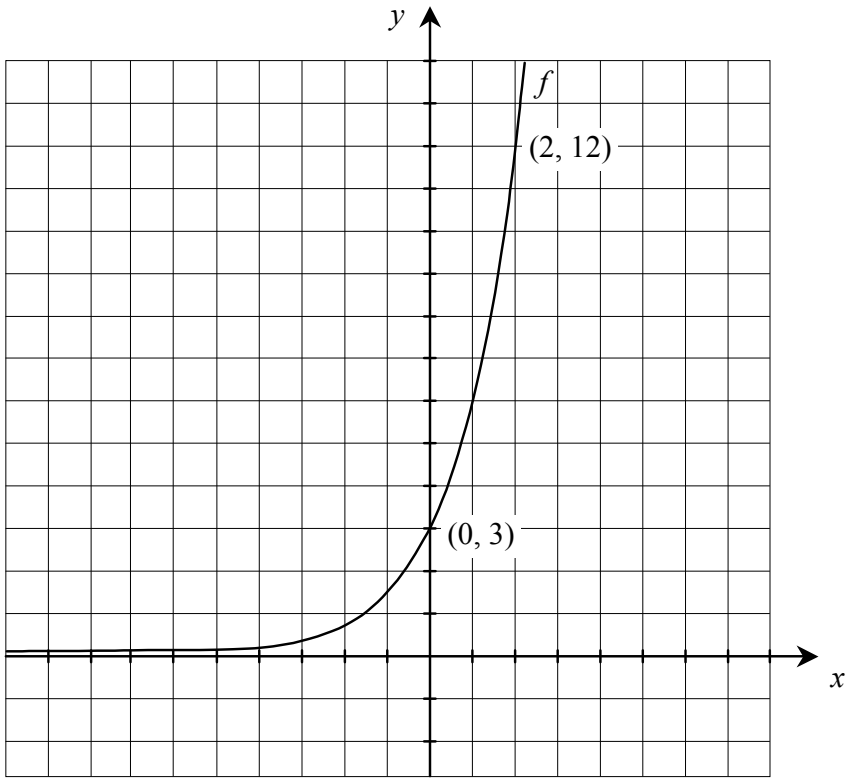
A) $f(x) = -3\left[\frac{-1(x-1)}{4}\right] + 2$

B) $f(x) = 3\left[\frac{-1(x-1)}{4}\right] + 2$

C) $f(x) = 3[4(x-1)] + 2$

D) $f(x) = -3\left[\frac{-1(x-1)}{4}\right] + 5$

4 Consider the graph of an exponential function f shown below, and function g defined by the rule of correspondence $g(x) = 3 \log x$.



Which expression represents $(g \circ f)(x)$?

A) $(g \circ f)(x) = 3(2)^{3 \log x}$

B) $(g \circ f)(x) = 3 \log 2(3)^x$

C) $(g \circ f)(x) = 3 \log 3(2)^x$

D) $(g \circ f)(x) = 3 \log 6^x$

5 Consider $\log \frac{100\sqrt[3]{t}}{s^4}$, where ($\log s = a$) and ($\log t = b$).

Which of the following is an equivalent expression?

A) $2 + b^{\frac{1}{3}} - a^4$

B) $2 + \frac{1}{3}b - 4a$

C) $\frac{2b^{\frac{1}{3}}}{a^4}$

D) $2b^{\frac{1}{3}} - a^4$

6 Vector u = (2, -5) makes an angle of 40° with vector v whose magnitude is 7.8 units.

To the nearest tenth, what is the scalar product (dot product) of $\vec{u}$ and $\vec{v}$?

A) 27.0 units

B) 27.4 units

C) 32.2 units

D) 42.0 units

7 A sample of Mr. Laird's students' marks on the mid-term math test is shown below:

58	59	62	67	67	68	69
70	83	83	87	92	93	

In the sample, George's Z-score is 1.570. The class average is 73.692 and the standard deviation is 12.298. Two students who wrote the test several days later were given marks of 75 and 66.

What will George's new Z-score be when the two new marks are included with the other marks in the sample?

A) 1.570

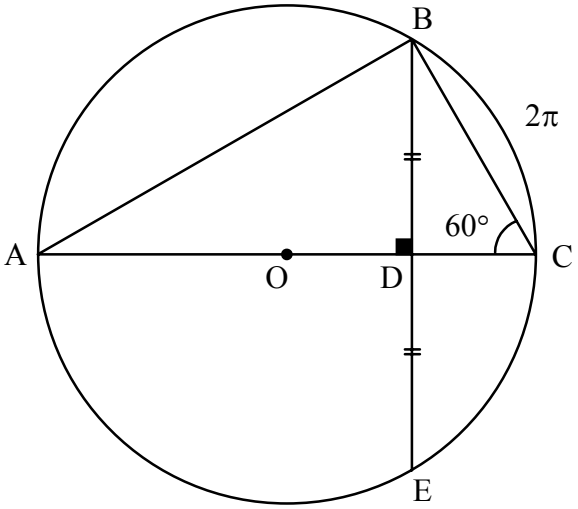
B) 1.620

C) 1.667

D) 1.706

8 Triangle ABC is inscribed in the circle with centre O that is located on segment AC. Segments BD and DE are equal in length.

$m\overset{\frown}{BC} = 2\pi$ cm



What is the length of chord BE?

A) $6\sqrt{3}$ cm

B) $6\pi\sqrt{3}$ cm

C) $12\sqrt{3}$ cm

D) $3\sqrt{3}$ cm

Part B **Questions 9 to 15**

Write your answer in the space provided in the answer booklet.
Show your work, where required.

9 A rocket is shot into the air by a submarine located at the vertex of the following square root function:

$$f(x) = 3\sqrt{-x - 5} - 2$$

The rocket follows the path of the square root function.

What is the range of $f^{-1}(x)$?

10 Given the rational function $f(x) = \frac{-3(x - 2)}{2x - 6}$.

What are the domain and range of $f(x)$?

11 **Solve the following logarithmic equation:**

$$\log (x + 3) + \log (2x - 7) = \log (2x - 1)$$

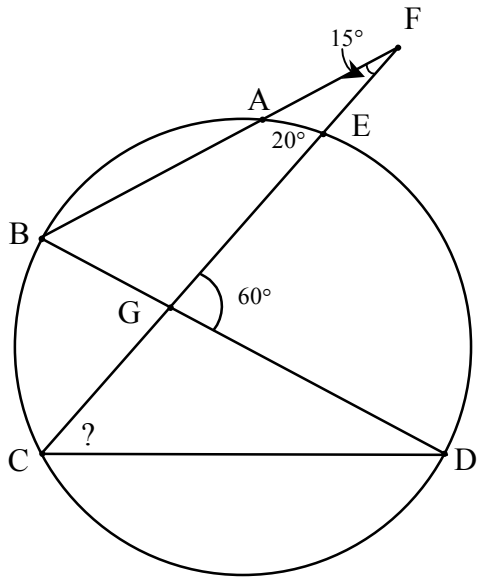
12 In the given diagram,

$m \angle CFB = 15°$

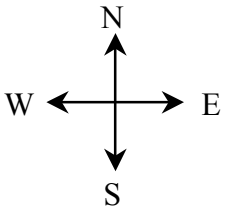
$m \angle DGE = 60°$

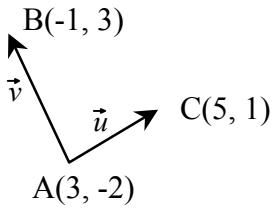
$m \overset{\frown}{EA} = 20°$

What is the degree measure of $\angle DCE$?



13 On a computer screen, an alien ship was travelling at a very rapid speed. When it reached point A(3, -2), it suddenly exploded with one piece moving to point B(-1, 3) and the other to point C(5, 1).





What is the sum of vectors *u* and *v*?
Give the magnitude of the resultant vector to the nearest unit, and its direction to the nearest degree.

14 Given the following trigonometric equation:

$$2 \sin^2 x + 3 = 9 \cos x, \quad x \in [0, 2\pi]$$

What exact values of *x* satisfy this equation?

15 **Prove the following trigonometric identity.**

$$\frac{\sec \theta}{\tan \theta + \cot \theta} \equiv \sin \theta$$

Show all your work.

Part C **Questions 16 to 25**

- Show all your **work** as well as your **answer**. The work shown is taken into consideration when marks are awarded.
- Your written information must be legible, complete, and clearly stated in correct language so the marker understands exactly what you have done.

Even if your answer is correct, no marks will be given unless acceptable work is shown.

16 Murray plans a trip to New York in July. In order to save money, he works at two different part-time jobs on weekends. At the first job, he works a minimum of 10 hours per month and at the second, a maximum of 40 hours per month. Murray must work at least 30 hours per month but no more than 60 hours per month. He must work at least as many hours at the second job as he does at the first. He makes $6.30 an hour at the first job and $8 an hour at the second job.

Let x: number of hours per month at first job
y: number of hours per month at second job

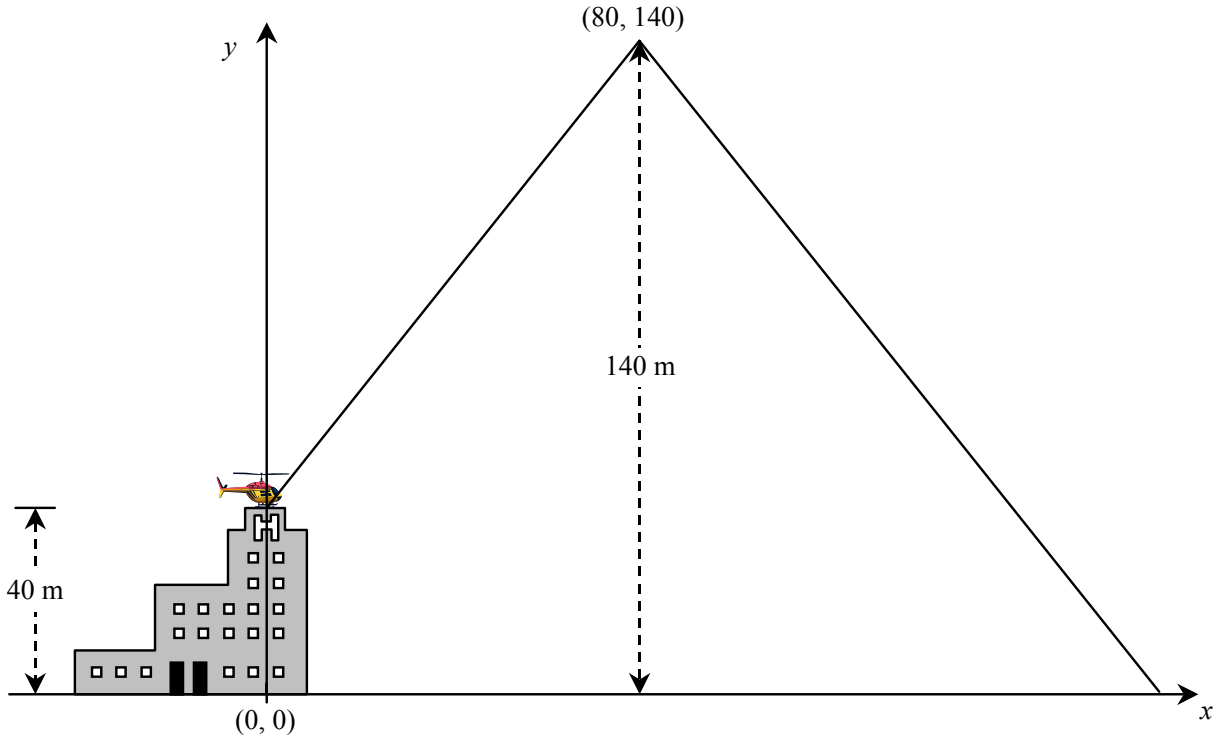
The initial constraints for this situation are:

$$x \geq 10$$
$$y \leq 40$$
$$y \geq 0$$
$$x + y \geq 30$$
$$x + y \leq 60$$
$$y \geq x$$

Because of a shortage of employees, Murray was later advised that he could increase the number of hours he worked at the second job.

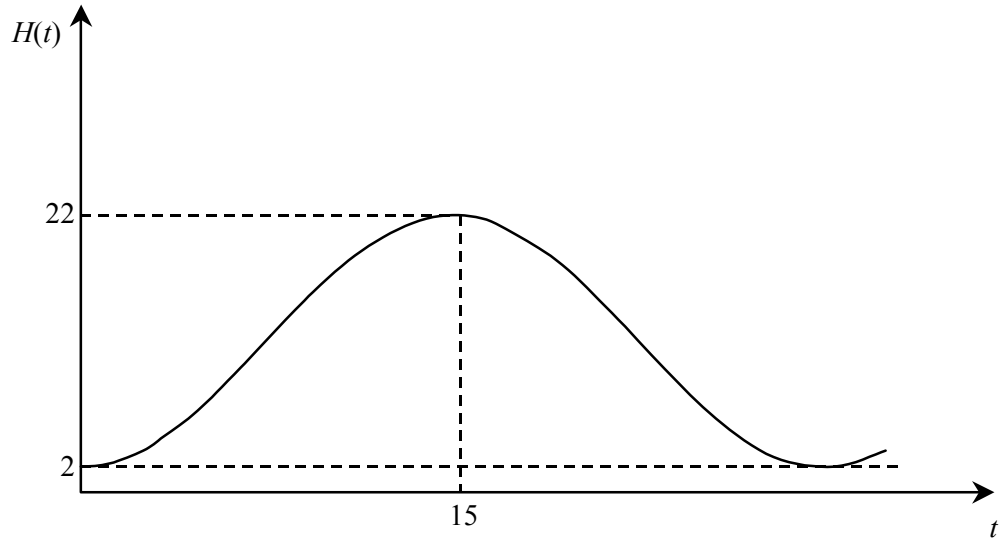
By how much did Murray's maximum possible salary increase because of the employee shortage?

17 During an emergency flight, a helicopter left the roof of a 40-metre tall hospital. The helicopter flew at a constant speed and reached a maximum height of 140 meters after 80 seconds. Then, the helicopter descended to the ground at the same speed as it had ascended. The helicopter's flight can be represented by an absolute value function.



After how many seconds was the helicopter at an altitude of 60 m during its ascent and descent?

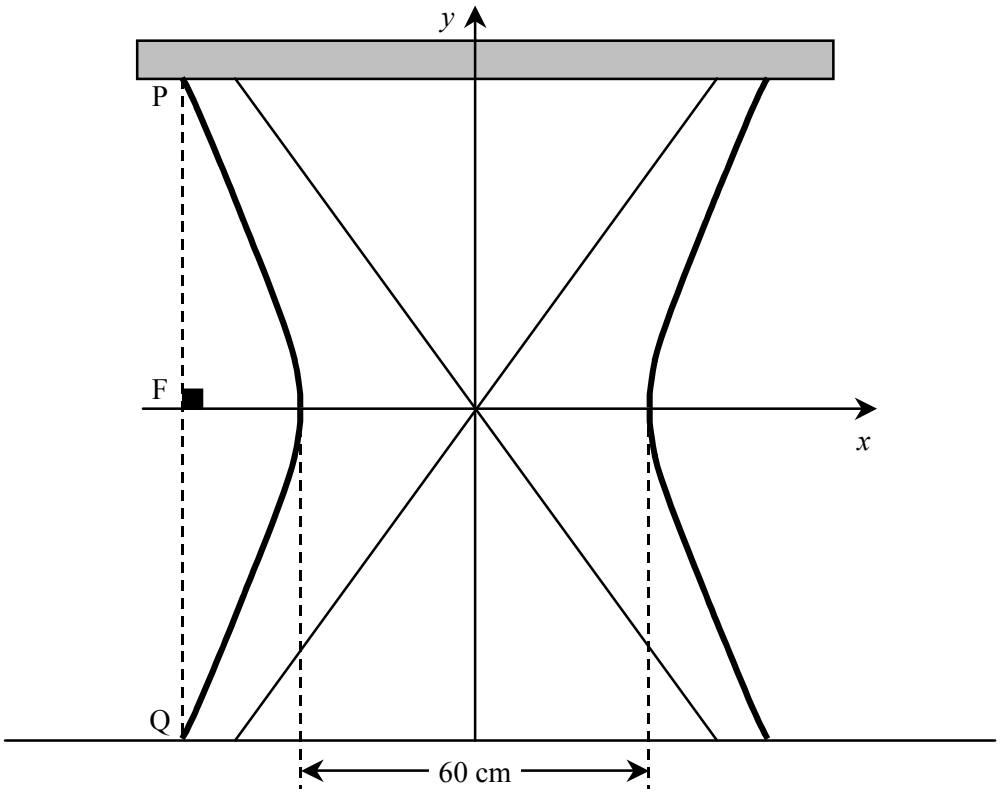
18 Tom's ride on the Ferris wheel at *La Ronde* can be described by the graph of the sinusoidal function shown below. The graph represents the height of Tom's seat above the ground, in metres, as a function of the time, t, in seconds. The distance between the minimum and maximum heights of Tom's seat is 20 metres. Tom's seat reaches its first maximum height 15 seconds after the Ferris wheel begins to turn.



How many metres above ground is Tom's seat 20 seconds after the Ferris wheel begins to turn?
(Assume Tom's seat started from rest at the bottom of the Ferris wheel.)

19 Silven is renovating the basement of his home. He has purchased a large table saw from National Tire, illustrated below. The legs of the table follow the pattern of the branches of a hyperbola. The foci of the hyperbola are 100 cm apart, and the transverse axis measures 60 cm.

Segment PQ, the height of the table saw leg, is perpendicular to the transverse axis and passes through the focus F of the hyperbola.

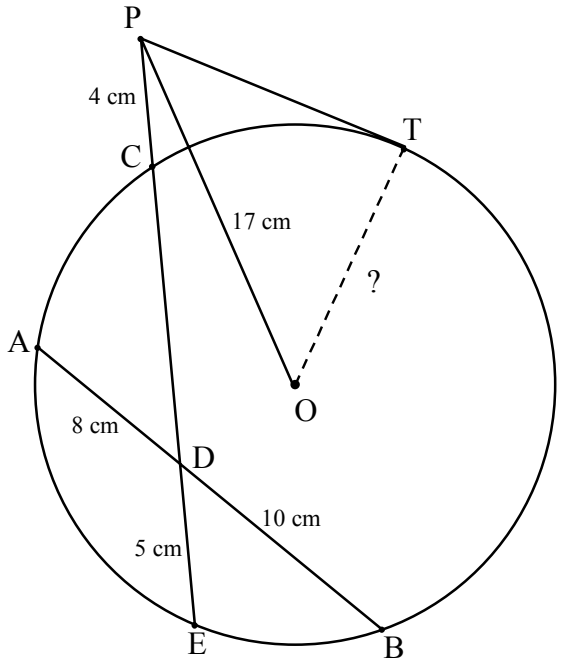


What is the measure of $\overline{PQ}$?

Round your answer to the nearest tenth.

20 In the given circle with centre O, segment PT is tangent to the circle at point T.

m $\overline{AD}$ = 8 cm
m $\overline{DB}$ = 10 cm
m $\overline{DE}$ = 5 cm
m $\overline{OP}$ = 17 cm
m $\overline{PC}$ = 4 cm



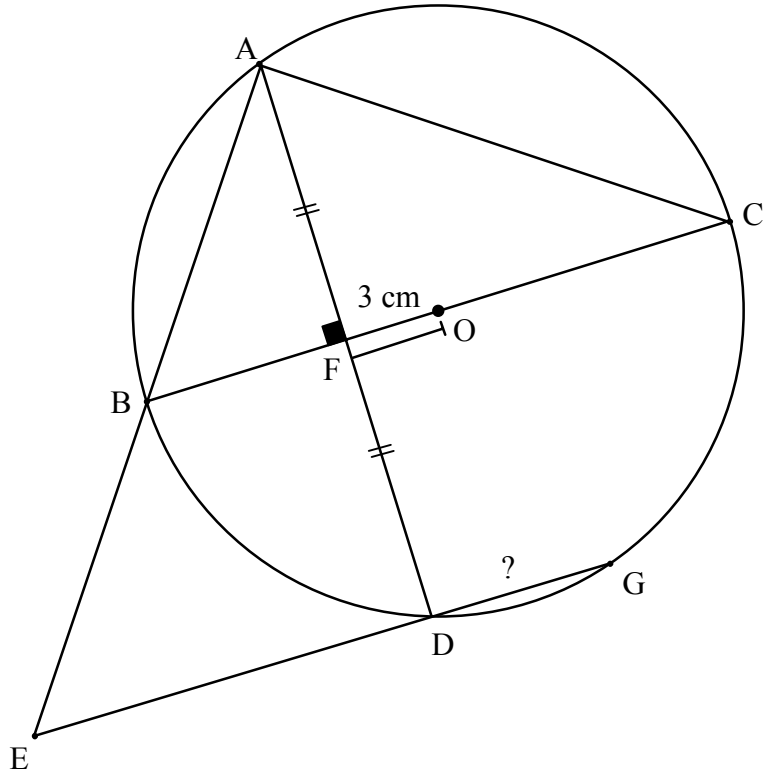
What is the measure of the radius of the circle?

Round your answer to the nearest tenth of a centimetre.

21 Consider the circle with centre O and radius 12 cm, shown below.

Point F is located on $\overline{BC}$, 3 cm from the centre.

$\overline{AF}$, an altitude to $\overline{BC}$, is congruent to $\overline{FD}$ and $\Delta ABF \sim \Delta AED$.



What is the measure of segment DG, to the nearest centimetre?

22 A high school physics class investigated the relationship between the force applied to a spring and the extension in the length of the spring. The table below displays some of the results produced by the students.

Force (N)	Extension (cm)
2.5	5.4
2.75	6.8
3.0	7.5
3.25	8.2
3.50	8.34
3.75	8.5
4.0	10.2
4.25	10.24

One of the students in the class predicted the spring would have an extension of approximately 15.54 cm if a force of 6.25 N would be applied to the spring.

Is this prediction consistent with the data collected by the rest of the class?

Justify your answer using appropriate statistical analysis. Note that you are not required to draw a graph on the axes provided. A method of solution using a graphing calculator is acceptable.

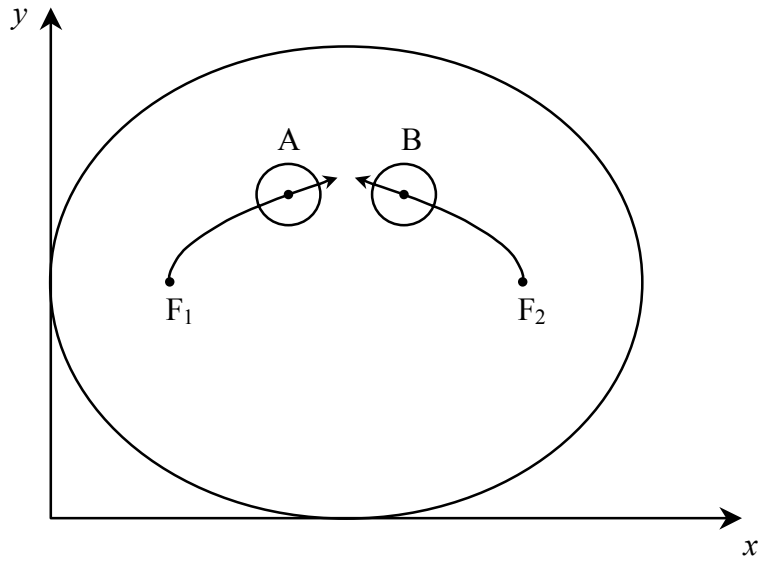
23 In 1991, Albert invested $4000. In 1999, his investment had grown to $5474.28. He eventually was able to triple his initial investment.

Jocelyn, Albert's brother, also invested a sum of money at the same interest rate. In the number of years it took Albert to triple his initial investment, Jocelyn's investment grew to $15 000.

What was the difference between Albert's initial investment and Jocelyn's initial investment? (Round your final answer to the nearest dollar.)

24 A graphic artist created a design that will be placed on the box of a new brand of chocolates. The design is defined by an ellipse, two circles, and two square root functions.

The equation of the ellipse is $\frac{(x-10)^2}{100} + \frac{(y-8)^2}{64} = 1$, and the equations of the circles are $(x-8)^2 + (y-11)^2 = 1$
and $(x-12)^2 + (y-11)^2 = 1$.



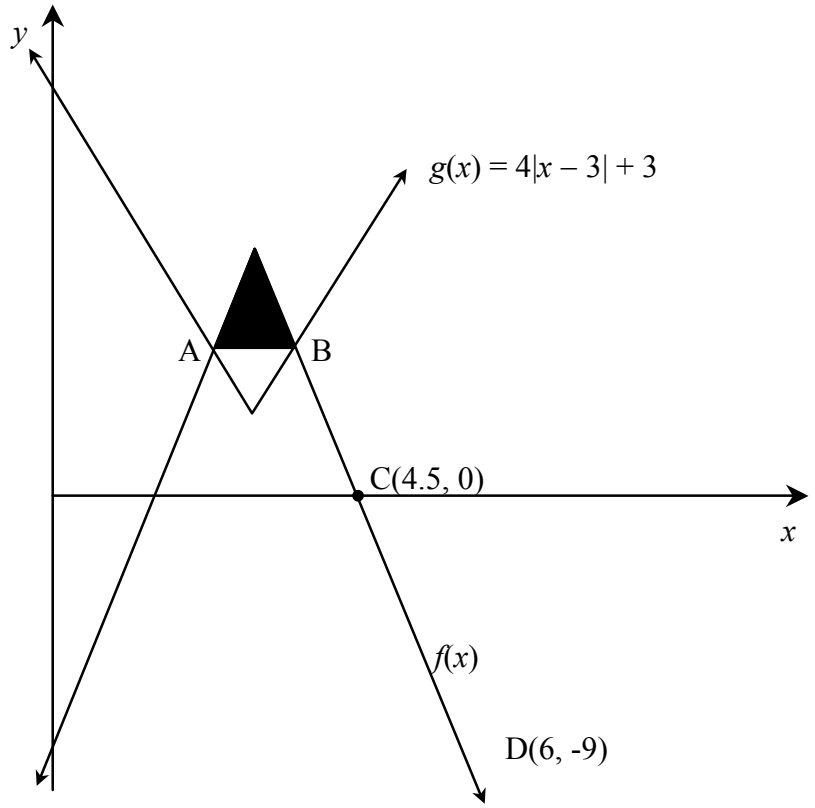
The vertices of the square root functions coincide with the foci F_1 and F_2 of the ellipse. Each of the square root functions passes through the centre of one of the circles, as shown in the diagram above.

What is the rule of the square root function whose vertex is F_2?

25 The logo below was created using two absolute value functions represented by $f(x)$ and $g(x)$. The logo has an axis of symmetry passing through the vertices of $f(x)$ and $g(x)$.

$$g(x) = 4|x - 3| + 3$$

Points A and B represent the points of intersection between $f(x)$ and $g(x)$. Point C(4.5, 0) is one of the zeros of $f(x)$ and $f(x)$ passes through point D(6, -9).



What is the area of the shaded triangular region in the logo