Chapter 1

Equations and Inequalities

1.2 Setting Up Equations: Applications

1. Let A represent the area of the circle and r the radius.
The area of a circle is the product of π times the square of the radius. $A = \pi r^2$

2. Let C represent the circumference of a circle and r the radius.
The circumference of a circle is the product of π times twice the radius.
$C = 2\pi r$

3. Let A represent the area of the square and s the length of a side.
The area of the square is the square of the length of a side. $A = s^2$

4. Let P represent the perimeter of a square and s the length of a side.
The perimeter of a square is four times the length of a side.
$P = 4s$

5. Let F represent the force, m the mass, and a the acceleration.
Force equals the product of the mass times the acceleration.
$F = ma$

6. Let P represent the pressure, F the force, and A the area.
Pressure is the force per unit area.
$P = \frac{F}{A}$

7. Let W represent the work, F the force, and d the distance.
Work equals force times distance.
$W = Fd$

8. Let K represent the kinetic energy, m the mass, and v the velocity.
Kinetic energy is one-half the product of the mass and the square of the velocity.
$K = \frac{1}{2}mv^2$

9. $C =$ total variable cost, $x =$ number of dishwashers manufactured.
$C = 150x$

10. $R =$ total revenue, $x =$ number of dishwashers manufactured.
$R = 250x$

11.

Amount in Bonds	Amount in CD's	Total
x	$x-3000$	20,000

$$x+x-3000=20000$$
$$2x-3000=20000$$
$$2x=23000 \rightarrow x=11500$$

\$11,500 will be invested in bonds. \$8,500 will be invested in CD's.

12.

Amount for Sean	Amount for George	Total
x	$x-3000$	10,000

$$x+x-3000=10000$$
$$2x-3000=10000$$
$$2x=13000 \rightarrow x=6500$$

Sean will receive \$6500 and George will receive \$3500.

13.

Scott	Alice	Tricia	Total
x	$\frac{3}{4}x$	$\frac{1}{2}x$	900,000

$$x+\frac{3}{4}x+\frac{1}{2}x=900{,}000$$
$$\frac{9}{4}x=900{,}000$$
$$x=\frac{4}{9}(900{,}000) \rightarrow x=400{,}000$$

Scott receives \$400,000. Alice receives \$300,000. Tricia receives \$200,000.

14.

Canter	Carole	Total
x	$\frac{2}{3}x$	\$18

$$x+\frac{2}{3}x=18$$
$$\frac{5}{3}x=18 \rightarrow x=\frac{3}{5}(18) \rightarrow x=10.80$$

Canter pays \$10.80 and Carole pays \$7.20.

15.

	Dollars per hour	Number of hours worked	Money earned
Regular wage	x	40	$40x$
Overtime wage	$1.5x$	8	$(1.5x)(8)$

$$40x+(1.5x)(8)=442$$
$$40x+12x=442 \rightarrow 52x=442 \rightarrow x=\frac{442}{52}=8.50$$

Sandra’s regular hourly wage is \$8.50.

16.

	Dollars per hour	Number of hours worked	Money earned
Regular wage	x	40	$40x$
Overtime wage	$1.5x$	6	$(1.5x)(6)$
Sunday wage	$2x$	4	$8x$

$$40x+(1.5x)(6)+8x=342$$

Leah's regular hourly wage is $6.00.

$$40x+9x+8x=342 \rightarrow 57x=342 \rightarrow x=\frac{342}{57}=6$$

17. Let x represent the score on the final exam and construct the table

	Test1	Test2	Test3	Test4	Test5	Final Exam	Final Exam
score	80	83	71	61	95	x	x
weight	1/7	1/7	1/7	1/7	1/7	1/7	1/7

Compute the final average and set equal to 80.

$$\left(\frac{1}{7}\right)(80+83+71+61+95+x+x)=80$$

Now solve for x:

$$\left(\frac{1}{7}\right)(390+2x)=80$$

$$390+2x=560 \rightarrow 2x=170 \rightarrow x=85$$

Brooke needs to score an 85 on the final exam to get an average of 80 in the course.

18. Let x represent the score on the final exam and construct the table

	Test1	Test2	Test3	Test4	Final Exam
score	86	80	84	90	x
weight	1/12	1/12	1/12	1/12	2/3

Note: The four tests account for 1/3 of the total average, so each test is worth $\frac{\left(\frac{1}{3}\right)}{4}=\frac{1}{12}$.

To determine the score Mike needs to earn a B, we compute the final average and set equal to 80.

$$\left(\frac{1}{12}\right)(86+80+84+90)+\left(\frac{2}{3}\right)x=80$$

Now solve for x: $\left(\frac{1}{12}\right)(340)+\left(\frac{2}{3}\right)x=80$

$$(12)\left(\left(\frac{1}{12}\right)(340)+\left(\frac{2}{3}\right)x\right)=(80)(12)$$

$$340+8x=960$$
$$8x=620 \rightarrow x=77.5$$

Mike must score 77.5 to earn a B.

To determine the score Mike needs to earn an A, we compute the final average and set equal to 90.

$$\left(\frac{1}{12}\right)(86+80+84+90)+\left(\frac{2}{3}\right)x=90$$

Now solve for x: $\left(\frac{1}{12}\right)(340)+\left(\frac{2}{3}\right)x=90$

$$(12)\left(\left(\frac{1}{12}\right)(340)+\left(\frac{2}{3}\right)x\right)=(90)(12)$$

$$340+8x=1080$$
$$8x=740 \rightarrow x=92.5$$

Mike must score 92.5 to earn an A.

19. Let x represent the original price of the house.
Then $0.15x$ represents the reduction in the price of the house.
original price – reduction = new price
$$x-0.15x=125{,}000$$
$$0.85x=125{,}000 \rightarrow x=147{,}058.82$$
The original price of the house was \$147,058.82.
The amount of the savings is 0.15(\$147,058.82) = \$22,058.82.

20. Let x represent the original price of the car.
Then $0.15x$ represents the reduction in the price of the car.
original price – reduction = new price
$$x-0.15x=8000$$
$$0.85x=8000 \rightarrow x=9411.76$$
The original price of the car was \$9411.76.
The amount of the savings is \$9411.76 – \$8000.00 = \$1411.76.

21. Let x represent the price the bookstore pays for the book (publisher price).
Then $0.35x$ represents the mark up on the book.
The selling price of the book is \$56.00.
publisher price + mark up = selling price

$$x + 0.35x = 56.00$$
$$1.35x = 56.00 \rightarrow x = 41.48$$

The bookstore pays \$41.48 for the book.

22. Let x represent the dealer's cost of the new car. $x = 0.85(\$12,000) = \$10,200$
If the dealer accepts \$100 over cost, then you will pay \$10,200 + \$100 = \$10,300.

23.

	Number of tickets sold	Price per ticket	Money earned
adults	x	4.75	$4.75x$
children	$5200 - x$	2.5	$(5200 - x)(2.5)$

money from adult tickets + money from children tickets = total receipts

$$4.75x + (5200 - x)(2.5) = 20,335$$
$$4.75x + 13,000 - 2.5x = 20,335$$
$$2.25x = 7335 \rightarrow x = \frac{7335}{2.25} = 3260$$

There were 3260 adult patrons.

24. $p =$ original price for the suit

$p - 0.30p = 0.70p =$ discounted price for the suit

$$0.70p = 399 \rightarrow p = \frac{399}{0.70} = 570$$

The suit originally cost \$570.

25. $l =$ length, $w =$ width

$2l + 2w = 60$ Perimeter $= 2l + 2w$

$l = w + 8$ The length is 8 more than the width.

$$2(w + 8) + 2w = 60$$
$$2w + 16 + 2w = 60$$
$$4w + 16 = 60 \rightarrow 4w = 44 \rightarrow w = 11 \text{ feet}, \; l = 19 \text{ feet}$$

26. $l =$ length, $w =$ width

$2l + 2w = 42$ Perimeter $= 2l + 2w$

$l = 2w$ The length is 8 more than the width.

$$2(2w) + 2w = 42$$
$$4w + 2w = 42 \rightarrow 6w = 42 \rightarrow w = 7 \text{ feet}, \; l = 14 \text{ feet}$$

27. Let x represent the amount of money invested in bonds.
Then $50{,}000 - x$ represents the amount of money invested in CD's.

	Principle	Rate	Time (yrs)	Interest
Bonds	x	0.15	1	$0.15x$
CD's	$50{,}000 - x$	0.07	1	$0.07(50{,}000 - x)$

Since the total interest is to be \$6,000, we have:

$$0.15x + 0.07(50{,}000 - x) = 6{,}000$$
$$(100)(0.15x + 0.07(50{,}000 - x)) = (6{,}000)(100)$$
$$15x + 7(50{,}000 - x) = 600{,}000$$
$$15x + 350{,}000 - 7x = 600{,}000$$
$$8x + 350{,}000 = 600{,}000 \rightarrow 8x = 250{,}000 \rightarrow x = 31{,}250$$

\$31,250 should be invested in bonds at 15% and \$18,750 should be invested in CD's at 7%.

28. Let x represent the amount of money invested in bonds.
Then $50{,}000 - x$ represents the amount of money invested in CD's.

	Principle	Rate	Time (yrs)	Interest
Bonds	x	0.15	1	$0.15x$
CD's	$50{,}000 - x$	0.07	1	$0.07(50{,}000 - x)$

Since the total interest is to be \$7,000, we have:

$$0.15x + 0.07(50{,}000 - x) = 7{,}000$$
$$(100)(0.15x + 0.07(50{,}000 - x)) = (7{,}000)(100)$$
$$15x + 7(50{,}000 - x) = 700{,}000$$
$$15x + 350{,}000 - 7x = 700{,}000$$
$$8x + 350{,}000 = 700{,}000 \rightarrow 8x = 350{,}000 \rightarrow x = 43{,}750$$

\$43,750 should be invested in bonds at 15% and \$6,250 should be invested in CD's at 7%.

29. Let x represent the amount of money loaned at 8%.
Then $12{,}000 - x$ represents the amount of money loaned at 18%.

	Principle	Rate	Time (yrs)	Interest
Loan at 8%	x	0.08	1	$0.08x$
Loan at 18%	$12{,}000 - x$	0.18	1	$0.18(12{,}000 - x)$

Since the total interest is to be \$1,000, we have:

$$0.08x + 0.18(12{,}000 - x) = 1{,}000$$
$$(100)(0.08x + 0.18(12{,}000 - x)) = (1{,}000)(100)$$
$$8x + 18(12{,}000 - x) = 100{,}000$$
$$8x + 216{,}000 - 18x = 100{,}000$$
$$-10x + 216{,}000 = 100{,}000 \rightarrow -10x = -116{,}000 \rightarrow x = 11{,}600$$

\$11,600 is loaned at 8% and \$400 is loaned at 18%.

30. Let x represent the amount of money loaned at 16%.
Then $1{,}000{,}000 - x$ represents the amount of money loaned at 19%.

	Principle	Rate	Time (yrs)	Interest
Loan at 16%	x	0.16	1	$0.16x$
Loan at 19%	$1{,}000{,}000 - x$	0.19	1	$0.19(1{,}000{,}000 - x)$

Since the total interest is to be $1,000,000(0.18), we have:

$$0.16x + 0.19(1{,}000{,}000 - x) = 1{,}000{,}000(0.18)$$
$$(100)\left(0.16x + 0.19(1{,}000{,}000 - x)\right) = 1{,}000{,}000(0.18)\,(100)$$
$$16x + 19(1{,}000{,}000 - x) = 1{,}000{,}000(18)$$
$$16x + 19{,}000{,}000 - 19x = 18{,}000{,}000$$
$$-3x + 19{,}000{,}000 = 18{,}000{,}000$$
$$-3x = -1{,}000{,}000 \rightarrow x = \$333{,}333.33$$

The loan officer should lend $333,333.33 at 16%.

31. Let x represent the number of pounds of Earl Gray tea.
Then $100 - x$ represents the number of pounds of Orange Pekoe tea.

	No. of pounds	Price per pound	Total Value
Earl Gray	x	\$5.00	$5x$
Orange Pekoe	$100 - x$	\$3.00	$3(100 - x)$
Blend	100	\$4.50	4.50(100)

$$5x + 3(100 - x) = 4.50(100)$$
$$5x + 300 - 3x = 450$$
$$2x + 300 = 450 \rightarrow 2x = 150 \rightarrow x = 75$$

75 pounds of Earl Gray tea must be blended with 25 pounds of Orange Pekoe.

32. Let x represent the number of pounds of the first kind of coffee.
Then $100 - x$ represents the number of pounds of the second kind of coffee.

	No. of Pounds	Price per Pound	Total Value
First kind	x	\$2.75	$2.75x$
Second kind	$100 - x$	\$5.00	$5(100 - x)$
Blend	100	\$3.90	3.90(100)

$$2.75x + 5(100 - x) = 3.90(100)$$
$$2.75x + 500 - 5x = 390$$
$$-2.25x + 500 = 390 \rightarrow -2.25x = -110 \rightarrow x \approx 48.9$$

48.9 pounds of the first kind of coffee must be blended with 51.1 pounds of the second kind of coffee.

33. Let x represent the number of pounds of cashews.
Then $x+60$ represents the number of pounds in the mixture.

	No. of pounds	Price per pound	Total Value
cashews	x	\$4.00	$4x$
peanuts	60	\$1.50	1.50(60)
mixture	$x+60$	\$2.50	$2.50(x+60)$

$$4x+1.50(60)=2.50(x+60)$$

$$4x+90=2.50x+150 \rightarrow 1.5x=60 \rightarrow x=40$$

40 pounds of cashews must be added to the 60 pounds of peanuts.

34. Let x represent the number of caramels in the box.
Then $30-x$ represents the number of cremes in the box.

	No. of Pieces	Price per Piece	Total Value
caramels	x	\$0.25	$0.25x$
cremes	$30-x$	\$0.45	$0.45(30-x)$

$$\text{Profit}=\text{Revenue}-\text{Cost}$$

$$12.50-\left(0.25x+0.45(30-x)\right)=3.00$$

$$9.50=0.25x+13.50-0.45x$$

$$-4.00=-0.20x \rightarrow x=20$$

The box should contain 20 caramels and 10 cremes.

35. Let r represent the speed of the current.

	Rate	Time	Distance
Upstream	$16-r$	$\frac{20}{60}=\frac{1}{3}$	$\frac{16-r}{3}$
Downstream	$16+r$	$\frac{15}{60}=\frac{1}{4}$	$\frac{16+r}{4}$

Since the distance is the same in each direction:

$$\frac{16-r}{3}=\frac{16+r}{4}$$

$$4(16-r)=3(16+r)$$

$$64-4r=48+3r \rightarrow 16=7r \rightarrow r=\frac{16}{7}\approx 2.286$$

The speed of the current is approximately 2.286 miles per hour.

36. Let r represent the speed of the motorboat.

	Rate	Time	Distance
Upstream	$r-3$	5	$5(r-3)$
Downstream	$r+3$	2.5	$2.5(r+3)$

The distance is the same in each direction:

$$5(r-3)=2.5(r+3)$$

$$5r-15=2.5r+7.5 \rightarrow 2.5r=22.5 \rightarrow r=9$$

The speed of the motorboat is 9 miles per hour.

37. Let r represent the rate of the Metra commuter train.
Then $r+50$ represents the rate of the Amtrak train.

	Rate	Time	Distance
Metra train	r	3	$3r$
Amtrak train	$r+50$	1	$r+50$

$$\text{Amtrak distance} = \text{Metra distance} - 10$$
$$r+50 = 3r-10$$
$$60 = 2r \rightarrow r = 30$$

The Metra commuter train travels at a rate of 30 miles per hour.
The Amtrak train travels at a rate of 80 miles per hour.

38. Let r represent the rate of the slower car.
Then $r+10$ represents the rate of the faster car.

	Rate	Time	Distance
Slower Car	r	3.5	$3.5r$
Faster Car	$r+10$	3	$3(r+10)$

$$3.5r = 3(r+10)$$
$$3.5r = 3r+30 \rightarrow 0.5r = 30 \rightarrow r = 60$$

The slower car travels at a rate of 60 miles per hour. The faster car travels at a rate of 70 miles per hour. The distance is (70)(3) = 210 miles.

39. Let t represent the time it takes to do the job together.

	Time to do job	Part of job done in one minute
Trent	30	$\frac{1}{30}$
Lois	20	$\frac{1}{20}$
Together	t	$\frac{1}{t}$

$$\frac{1}{30}+\frac{1}{20}=\frac{1}{t} \rightarrow 2t+3t=60 \rightarrow 5t=60 \rightarrow t=12$$

Working together, the job can be done in 12 minutes.

40. Let t represent the time it takes April to do the job working alone.

	Time to do job	Part of job done in one hour
Patrice	10	$\frac{1}{10}$
April	t	$\frac{1}{t}$
Together	6	$\frac{1}{6}$

$$\frac{1}{10}+\frac{1}{t}=\frac{1}{6} \rightarrow 3t+30=5t \rightarrow 2t=30 \rightarrow t=15$$

It will take April 15 hours to paint the four rooms.

41. $l =$ length of the garden
$w =$ width of the garden

(a) The length of the garden is to be twice its width. Thus, $l = 2w$.
The dimensions of the fence are $l + 4$ and $w + 4$.
The perimeter is 46 feet, so:

$$2(l+4) + 2(w+4) = 46$$
$$2(2w+4) + 2(w+4) = 46$$
$$4w + 8 + 2w + 8 = 46$$
$$6w + 16 = 46 \rightarrow 6w = 30 \rightarrow w = 5$$

The dimensions of the garden are 5 feet by 10 feet.

(b) Area $= l \;\; w = 5 \;\; 10 = 50$ square feet.

(c) If the dimensions of the garden are the same, then the length and width of the fence are also the same $(l + 4)$. The perimeter is 46 feet, so:

$$2(l+4) + 2(l+4) = 46$$
$$2l + 8 + 2l + 8 = 46$$
$$4l + 16 = 46 \rightarrow 4l = 30 \rightarrow l = 7.5$$

The dimensions of the garden are 7.5 feet by 7.5 feet.

(d) Area $= l \;\; w = 7.5(7.5) = 56.25$ square feet.

42. $l =$ length of the pond
$w =$ width of the pond

(a) The pond is to be a square. Thus, $l = w$.
The dimensions of the fenced area are $w + 6$ on each side.
The perimeter is 100 feet, so:

$$4(w+6) = 100$$
$$4w + 24 = 100 \rightarrow 4w = 76 \rightarrow w = 19$$

The dimensions of the pond are 19 feet by 19 feet.

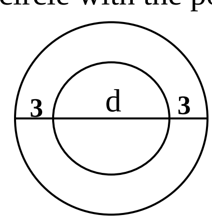
(b) The length of the pond is to be three times the width. Thus, $l = 3w$.
The dimensions of the fenced area are $w + 6$ and $l + 6$.
The perimeter is 100 feet, so:

$$2(w+6) + 2(l+6) = 100$$
$$2(w+6) + 2(3w+6) = 100$$
$$2w + 12 + 6w + 12 = 100$$
$$8w + 24 = 100 \rightarrow 8w = 76 \rightarrow w = 9.5 \rightarrow l = 3(9.5) = 28.5$$

The dimensions of the pond are 9.5 feet by 28.5 feet.

(c) If the pond is circular, the diameter is d and the diameter of the circle with the pond and the deck is $d + 6$. The perimeter is 100 feet, so:

$$\pi(d+6) = 100$$
$$\pi d + 6\pi = 100 \rightarrow \pi d = 100 - 6\pi \rightarrow d = \frac{100}{\pi} - 6 \approx 25.83$$



The diameter of the pond is 25.83 feet.

(d) Area of the square $= l \cdot w = 19(19) = 361 \text{ ft}^2$.

Area of the rectangle $= l \cdot w = 28.5(9.5) = 270.75 \text{ ft}^2$.

Area of the circle $= \pi r^2 = \pi\left(\frac{25.83}{2}\right)^2 \approx 524 \text{ ft}^2$.

The circular pond has the largest area.

43. Let t represent the time it takes for the defensive back to catch the tight end.

	Time to run 100 yards	Time	Rate	Distance
Tight End	12 sec	t	$\frac{100}{12}$	$\frac{100}{12}t$
Defensive Back	10 sec	t	$\frac{100}{10} = 10$	$10t$

Since the defensive back has to run 5 yards farther, we have:

$$\frac{100}{12}t + 5 = 10t$$
$$100t + 60 = 120t$$
$$20t = 60$$
$$t = 3 \quad \rightarrow \quad 10t = 30$$

The defensive back will catch the tight end at the 45 yard line.

44. Let x represent the number of highway miles.
Then $30{,}000 - x$ represents the number of city miles.

	No. of miles	Gallons per mile	Gallons used
highway	x	1/40	$\frac{1}{40}x$
city	$30{,}000 - x$	1/25	$(30{,}000 - x)\left(\frac{1}{25}\right)$

$$\frac{1}{40}x + (30{,}000 - x)\left(\frac{1}{25}\right) = 900$$
$$\frac{1}{40}x + 1200 - \frac{1}{25}x = 900$$
$$\frac{1}{40}x - \frac{1}{25}x = -300$$
$$\frac{25-40}{(40)(25)}x = -300 \rightarrow \frac{-15}{1000}x = -300$$
$$x = -300\left(\frac{1000}{-15}\right) = 20000$$

Therese can allow for 20,000 miles as a business expense.

45. Let x represent the number of ounces of pure water.
Then $x+1$ represents the number of gallons in the 60% solution.

	No. of gallons	Conc. of Antifreeze	Pure Antifreeze
water	x	0	0
100% antifreeze	1	1.00	1(1)
60% antifreeze	$x+1$	0.60	$0.60(x+1)$

$$0+1(1) = 0.60(x+1)$$

$$1 = 0.6x + 0.6 \rightarrow 0.4 = 0.6x \rightarrow x = \frac{4}{6} = \frac{2}{3}$$

$\frac{2}{3}$ gallon of pure water should be added.

46. Let x represent the number of liters to be drained and replaced with pure antifreeze.

	No. of Liters	Conc. of Antifreeze	Pure Antifreeze
Pure Antifreeze	x	1.00	x
Original Solution	$15-x$	0.40	$0.40(15-x)$
New Solution	15	0.60	0.60(15)

$$x + 0.40(15-x) = 0.60(15)$$

$$x + 6 - 0.40x = 9 \rightarrow 0.60x = 3 \rightarrow x = 5$$

5 liters should be drained and replaced with pure antifreeze.

47. Let x represent the number of gallons of water to be evaporated.

	No. of Gallons	Conc. of Salt	Pure Salt
Water	x	0.00	0
4% Salt	32	0.04	0.04(32)
6% Salt	$32-x$	0.06	$0.06(32-x)$

$$0 + 0.04(32) = 0.06(32-x)$$

$$1.28 = 1.92 - 0.06x \rightarrow 0.06x = 0.64 \rightarrow x = \frac{0.64}{0.06} = \frac{32}{3}$$

32/3 ounces of water need to be evaporated.

48. Let x represent the number of gallons of water to be evaporated.

	No. of Gallons	Conc. of Salt	Pure Salt
Water	x	0.00	0
3% Salt	240	0.03	0.03(240)
5% Salt	$240-x$	0.05	$0.05(240-x)$

$$0 + 0.03(240) = 0.05(240-x)$$

$$7.2 = 12 - 0.05x \rightarrow 0.05x = 4.8 \rightarrow x = \frac{4.8}{0.05} = 96$$

96 gallons of water need to be evaporated.

49. Let x represent the number of grams of pure gold.
Then $60-x$ represents the number of grams of 12 karat gold to be used.

	No. of grams	Conc. of gold	Pure gold
Pure gold	x	1.00	x
12 karat gold	$60-x$	$\frac{1}{2}$	$\frac{1}{2}(60-x)$
16 karat gold	60	$\frac{2}{3}$	$\frac{2}{3}(60)$

$$x+\tfrac{1}{2}(60-x)=\tfrac{2}{3}(60)$$

$$x+30-0.5x=40 \rightarrow 0.5x=10 \rightarrow x=20$$

20 grams of pure gold should be mixed with 40 grams of 12 karat gold.

50. Let x represent the number of atoms of oxygen.
$2x$ represents the number of atoms of hydrogen.
$x+1$ represents the number of atoms of carbon.

$$x+2x+x+1=45 \rightarrow 4x=44 \rightarrow x=11$$

There are 11 atoms of oxygen and 22 atoms of hydrogen in the sugar molecule.

51. Let t represent the time it takes for Mike to catch up with Dan.

	Time to run mile	Time	Part of mile run in one minute	Distance
Mike	6	t	$\frac{1}{6}$	$\frac{1}{6}t$
Dan	9	$t+1$	$\frac{1}{9}$	$\frac{1}{9}(t+1)$

Since the distances are the same, we have:

$$\tfrac{1}{6}t=\tfrac{1}{9}(t+1) \rightarrow 3t=2t+2 \rightarrow t=2$$

Mike will pass Dan after 2 minutes, which is a distance of $\frac{1}{3}$ mile.

52. Let t represent the time of flight with the wind.

	Rate	Time	Distance
With Wind	300 + 30	t	$330t$
Against Wind	300 – 30	$5-t$	$270(5-t)$

The distance is the same in each direction:

$$330t=270(5-t)$$

$$330t=1350-270t \rightarrow 600t=1350 \rightarrow t=2.25$$

The distance the plane can fly and still return safely is 330(2.25) = 742.5 miles.

53. Let t represent the time the auxiliary pump needs to run.

	Time to do job alone	Part of job done in one hour	Time on Job	Part of total job done by each pump
Main Pump	4	$\frac{1}{4}$	3	$\frac{3}{4}$
Auxiliary Pump	9	$\frac{1}{9}$	t	$\frac{1}{9}t$

Since the two pumps are emptying one tanker, we have:

$$\tfrac{3}{4}+\tfrac{1}{9}t=1 \to 27+4t=36 \to 4t=9 \to t=\tfrac{9}{4}=2.25$$

The auxiliary pump must run for 2.25 hours. It must be started at 9:45 a.m.

54. Let x represent the number of pounds of pure cement.
Then $x+20$ represents the number of pounds in the 40% mixture.

	No. of pounds	Conc. of Cement	Pure Cement
Pure Cement	x	1.00	x
25% Cement	20	0.25	0.25(20)
40% Cement	$x+20$	0.40	$0.40(x+20)$

$$x+0.25(20)=0.40(x+20)$$

$$x+5=0.4x+8 \to 0.6x=3 \to x=\frac{30}{6}=5$$

5 pounds of pure cement should be added.

55. Let t represent the time for the tub to fill with the faucets on and the stopper removed.

	Time to do job alone	Part of job done in one minute	Time on Job	Part of total job done by each
Faucets open	15	$\frac{1}{15}$	t	$\frac{t}{15}$
Stopper removed	20	$\frac{-1}{20}$	t	$\frac{-t}{20}$

Since one tub is being filled, we have:

$$\frac{t}{15}+\frac{-t}{20}=1 \to 4t-3t=60 \to t=60$$

60 minutes is required to fill the tub.

56. Let t be the time the 5 horsepower pump needs to run to finish emptying the pool.

	Time to do job alone	Part of job done in one hour	Time on Job	Part of total job done by each pump
5 hp Pump	5	$\frac{1}{5}$	$2+t$	$\frac{1}{5}(2+t)$
2 hp Pump	8	$\frac{1}{8}$	2	$\frac{1}{4}$

Since the two pumps are emptying one pool, we have:

$$\tfrac{1}{5}(2+t)+\tfrac{1}{4}=1 \to 4(2+t)+5=20 \to 8+4t+5=20 \to 4t=7 \to t=1.75$$

The 5 horsepower pump must run for an additional 1.75 hours or 1 hour and 45 minutes to empty the pool.

57. Burke's rate is $\frac{100}{12}$ meters/sec.

In 9.99 seconds, Burke will run $\frac{100}{12}(9.99) = 83.25$ meters.

Lewis would win by 16.75 meters.

58. Let x be the original selling price of the shirt.

$$\text{Profit} = \text{Revenue} - \text{Cost}$$

$$4 = x - 0.40x - 20 \rightarrow 24 = 0.60x \rightarrow x = 40$$

The original price should be \$40 to ensure a profit of \$4 after the sale.

If the sale is 50% off, the profit is:

$$40 - 0.50(40) - 20 = 40 - 20 - 20 = 0$$

At 50% off there will be no profit.

59. Answers will vary.

60. It is impossible to mix two solutions with a lower concentration and end up with a new solution with a higher concentration.