1. **Answer:** 15  
**Solution:** Let $d$ be the length of one lap in miles. Then he needs to complete the four laps in $\frac{4d}{10} = \frac{2d}{5}$ hours. He has already spent $\frac{3d}{9} = \frac{d}{3}$ hours on the first three laps, so he has $\frac{2d}{5} - \frac{d}{3} = \frac{d}{15}$ hours left. Therefore, he must maintain a speed of $\boxed{15}$ mph on the final lap.

2. **Answer:** $\frac{10}{11}$  
**Solution:** After removing $x$ from 10, and then increasing that amount by 10%, we must end up with at least the amount we started with, 10 pounds. That is, the maximum value of $x$ must satisfy $\frac{11}{10} (10 - x) = 10$. Solving for $x$, we get that $x = \boxed{\frac{10}{11}}$.

3. **Answer:** 8960  
**Solution:** All of Karl’s favorite quadratics take the form $(x - r)(x - 17)$, where $0 \leq r \leq 34$. The sum of the coefficients of any polynomial can be determined by evaluating the polynomial at $x = 1$. This gives $16r - 16$. Summing over $r = 0$ to $r = 34$, we get $\sum_{r=0}^{34} (16r - 16) = 16 \cdot \frac{34 \cdot 35}{2} - 16 \cdot 35 = \boxed{8960}$.

4. **Answer:** $\frac{68}{3}$  
**Solution:** Substituting $x = 2$, we get that $f(2) + 2f(6) = 4$. Substituting $x = 6$, we get that $f(6) + 2f(2) = 36$. Solving for $f(2)$ and $f(6)$ gives us that $f(6) = -\frac{28}{3}$ and $f(2) = \boxed{\frac{68}{3}}$.

5. **Answer:** 168  
**Solution:** We have that $b$ is a valid number if and only if $(x^2 + 2x + 3) - (bx - 17) = x^2 + (2 - b)x + 20$ has exactly one real root. This means that $2 - b = \pm 2\sqrt{20}$, so $b = 2 \pm 2\sqrt{20}$. $b_1^2 + b_2^2$ is therefore $2(2^2) + 2(2\sqrt{20})^2 = 8 + 160 = \boxed{168}$.

6. **Answer:** $\frac{1 + \sqrt{13}}{2}$  
**Solution:** Note that $x^4 - x^3 - 5x^2 + 2x + 6 = (x^4 - 5x^2 + 6) - x(x^2 - 2) = (x^2 - 2)(x^2 - x - 3)$. The two largest candidate roots are therefore $\sqrt{2}$ and $\frac{1 + \sqrt{13}}{2}$. Note that $\sqrt{13} > 3$, so $\frac{1 + \sqrt{13}}{2} > 2 > \sqrt{2}$, so therefore the largest root is $\boxed{\frac{1 + \sqrt{13}}{2}}$.

7. **Answer:** $\frac{546}{5}$  
**Solution:** Observe that $f(a) = \sqrt{20x + a}$ is an increasing function in $a$, so the only way that $f(f(a)) = a$ can be true is if $f(a) = a$. Solving $\sqrt{20x + 13} = 13$, we obtain $x = \boxed{\frac{546}{5}}$.

8. **Answer:** $-11/3$  
**Solution:** Let $f(x) = 4x^2 + 15x + 17, g(x) = x^2 + 4x + 12$, and $h(x) = x^2 + x + 1$. Then, the
Solution: Applying the identity 

\[ \omega = 1 + \omega^2 + \omega^3 + \ldots + \omega^{12}. \]

we find that 

\[ \omega^2 = \omega^2 + \omega^4 + \omega^6 + \omega^8 + \omega^{10} + \omega^{12}. \]

We find that 

\[ \omega^2 = 2 + \omega + \omega^2 + \omega^3 + \omega^4 + \omega^5 + \omega^6 + \omega^7 + \omega^8 + \omega^9 + \omega^{10} + \omega^{11} + 2(\omega + \omega^2 + \omega^3 + \omega^4 + \omega^5 + \omega^6 + \omega^7 + \omega^8 + \omega^9). \]

Applying the identity \( z + z^2 + z^3 + \ldots + z^{12} = -1 \), we arrive at \( \omega^2 = -1 - \omega + 2(3 - 1) = 3 - \omega \),

and the solutions to the quadratic are \( \omega = \frac{-1 \pm \sqrt{13}}{2} \).