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**Practice**

Add the polynomials.

1.  $(4x^2 + 4x + 1) + (4x + 20)$

3.  $(5x^3 - 6x + 10) + (x^3 + 10x - 9)$

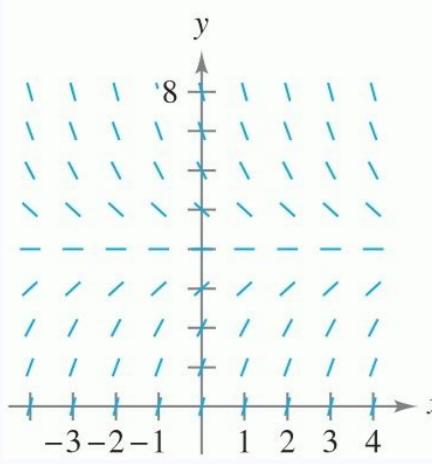
#7 Revolving → circular washers cross-sections  
 $A(x) = \pi[(y+2)^2 - (y)^2] = \pi(y^2 + 4y + 4 - y^2)$   
 $V = \int_0^2 A(x) dx = \int_0^2 (y^2 + 4y + 4 - y^2) dy = \pi \left[ \frac{y^3}{3} + 2y^2 + 4y - \frac{y^3}{3} \right]_0^2$   
 $= \pi \left[ \frac{8}{3} + 8 - \frac{8}{3} \right] - (0) = \pi \left( \frac{16}{3} \right) = \boxed{\frac{16\pi}{3}}$

#8 Cross-sections → washers  
 $A(x) = \pi[(x+3)^2 - (x^2 + 1)^2] = \pi(x^2 + 6x + 9 - x^4 - 2x^2 - 1)$   
 $V = \int_{-1}^2 A(x) dx = \int_{-1}^2 (-x^4 - x^2 + 6x + 8) dx$   
 $\text{Limits of Int: } x+3 = x^2+1 \quad x = 3 \\ 0 = x^2 - x - 2 \quad x = -2 \\ (x-2)(x+1) \\ x=2, x=-1$   
 $V = \int_{-1}^2 \pi \left[ \frac{x^5}{5} - \frac{x^3}{3} + 3x^2 + 8x \right] dx$   
 $= \pi \left[ \left( \frac{-32}{5} - \frac{8}{3} + 12 + 16 \right) - \left( \frac{1}{5} + \frac{1}{3} + 3 - 8 \right) \right]$   
 $= \pi \left( \frac{144}{5} \right) = \boxed{\frac{144\pi}{5}}$

#9 Cross-sections → washers  
 $A(x) = \pi[(6-\sqrt{x})^2 - 2^2] = \pi(36 - 12\sqrt{x} + x - 4)$   
 $V = \int_0^4 \pi (x - 12\sqrt{x} + 32) dx = \pi \left[ \frac{x^2}{2} - 8x^{3/2} + 32x \right]_0^4$   
 $= \pi [(128 - 512 + 512) - 0] = \boxed{128\pi}$

#10 Cross-sections → equilateral triangles (A =  $\frac{1}{2}bh$ )  
 $b = -3x^2 + 3 = -3(x^2 - 1)$   
 $h = \sqrt{3}(\frac{1}{2}x^2 + \frac{1}{2}) = \frac{\sqrt{3}}{2}(x^2 + 1)$   
 $A(x) = \frac{1}{2}(-3)(x^2 - 1)(-\frac{\sqrt{3}}{2})(x^2 + 1) = \frac{9\sqrt{3}}{4}(x^4 - 2x^2 + 1)$   
 $\text{Limits of Int: } -3x^2 + 3 = 0 \quad x^2 = 1 \quad x = \pm 1$   
 $V = \int_{-1}^1 \frac{9\sqrt{3}}{4}(x^4 - 2x^2 + 1) dx = \frac{9\sqrt{3}}{4} \int_{-1}^1 (x^4 - 2x^2 + 1) dx$   
 $= \frac{9\sqrt{3}}{4} \left[ \frac{x^5}{5} - \frac{2x^3}{3} + x \right]_{-1}^1 = \frac{9\sqrt{3}}{4} \left[ \left( \frac{1}{5} - \frac{2}{3} + 1 \right) - \left( -\frac{1}{5} + \frac{2}{3} - 1 \right) \right]$   
 $= \frac{9\sqrt{3}}{4} \left( \frac{16}{15} \right) = \boxed{\frac{12\sqrt{3}}{5}}$

$\frac{dy}{dx} = 4 - y$



#11 Cross-sections → rectangles (A = bh)  
 $b = -3x^2 + 3 = -3(x^2 - 1) \quad A(x) = -3(x^2 - 1)(-\frac{3}{2})(x^2 + 1) = \frac{9}{2}(x^4 - 2x^2 + 1)$   
 $h = \frac{1}{2}(-3x^2 + 3) - \frac{3}{2}(x^2 - 1) = \frac{3}{2}(1 - x^2)$   
 $V = \int_{-1}^1 \frac{9}{2}(x^4 - 2x^2 + 1) dx = \frac{9}{2} \int_{-1}^1 (x^4 - 2x^2 + 1) dx = \frac{9}{2} \left[ \frac{x^5}{5} - \frac{2x^3}{3} + x \right]_{-1}^1 = \frac{9}{2} \left[ \left( \frac{1}{5} - \frac{2}{3} + 1 \right) - \left( -\frac{1}{5} + \frac{2}{3} - 1 \right) \right] = \frac{9}{2} \left( \frac{16}{15} \right) = \boxed{\frac{144}{5}}$

Calculator FR:

a) Rate = Derivative = slope!!

$P'(t) = \frac{P(8) - P(6)}{8-6} = \frac{402 - 210}{2} = 95.5 = \boxed{95.5 \text{ people per hour}}$

$\therefore \frac{1}{8} \int_6^8 P(t) dt = \frac{1}{8} \left[ \frac{1}{2}(0+94) + \frac{3}{2}(94+160) + \frac{5}{2}(160+210) + \frac{7}{2}(210+402) \right] = \frac{1}{8} (14168) = \boxed{183.5}$

Explanation: There was an average of 183.5 people in line each hr.

$\therefore P(12) = P(8) - \int_8^{12} S(t) dt = 402 - \int_8^{12} (t^3 - 36t^2 + 420t - 1508) dt = 402 - 948 = \boxed{300 \text{ people still in line}}$

↓ ((you need to graph S(t)) &amp; find the max))

People were being let into the store most quickly at t=10 because that is when there is a maximum on the graph of S(t). ∵ the rate would be the highest at that time.

Previous Material  
#12  $f(b) - f(a) = f'(c)$  #14  $y^4 = 1 - \sec^2 x \Big|_{x=\pi/4} = 1 - \sec^2(\pi/4) = 1 - 2 = -1$   
 $b-a$   
 $b = (0)x^2$   
 $x^2 = 1 \quad x = \pm 1$   
 $y(\pi/4) = \frac{\pi}{4} - \tan(\pi/4) = \frac{\pi}{4} - 1 = \frac{\pi-4}{4}$   
 $y - \left( \frac{\pi-4}{4} \right) = -1 \left( x - \frac{\pi}{4} \right)$   
OR  $y = -x + \frac{\pi}{2} - 1$

#13  $f(b) - f(a) = \frac{\int_a^b f(x) dx}{b-a}$  #15  $\lim_{x \rightarrow 0} \frac{1}{x} \text{ BUT NEATS D/L}$  #16  $\boxed{0}$   
 $= \frac{\int_0^\pi \sin x dx}{\pi - 0} = \frac{-\cos x \Big|_0^\pi}{\pi} = \frac{2}{\pi}$   
Low to High  
 $\therefore \lim_{x \rightarrow 0} \frac{\sin x}{x} = \frac{2}{\pi}$

#17  $\int_1^4 \frac{14}{(4x+2)^2} dx$  #18  $\int_2^4 \frac{1}{2(x^2+1)^2 + 6x^2(2x+3)(x^2+1)}$   
 $\uparrow$   
 $\therefore \text{Integrate by parts}$

$$23. y = \sin^2 (\cos kx)$$

**Solution :** Given  $y = \sin^2(\cos kx)$

$$\text{Let } u = \cos kx \Rightarrow y = \sin^2 u$$

$$\therefore \frac{du}{dx} = -k \sin kx \text{ and}$$

$$\frac{dy}{dx} = 2 \sin u \cdot \frac{d}{du}(\sin u) = 2 \sin u \cos u$$

$$\text{Now } \frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$$

$$\begin{aligned}
 &= 2 \sin u \cos u \times (-k \sin kx) \\
 &= -k \sin 2u \sin kx \quad [\because u = \cos kx] \\
 &= -k \sin 2(\cos kx) \cdot \sin kx \\
 &= -k \sin kx \cdot \sin 2(\cos kx)
 \end{aligned}$$

$$24. \quad y = (1 + \cos^2 x)^6$$

**Solution :** Given  $y = (1 + \cos^2 x)^6$

$$\text{Let } u = 1 + \cos^2 x \Rightarrow y = u^{\frac{1}{2}}$$

$$\therefore \frac{du}{dx} = 2 \cos x (-\sin x)$$

$$\frac{dy}{dx} = 6u^5$$

$$\text{Now } \frac{dy}{l} = \frac{dy}{h} \times \frac{du}{l}$$

$$= \frac{dx}{dt} = \frac{dx}{dt}$$

$$= -6u^5 (-\sin 2x)$$

$$y = \frac{e^{3x}}{1 + e^x}$$

**Solution :** Given  $y = \frac{e^x}{1+e^x}$

$$\begin{aligned}
 & \text{using quotient rule,} \\
 \frac{dy}{dx} &= \frac{(1+e^x) \cdot \frac{d}{dx}(e^{3x}) - e^{3x} \cdot \frac{d}{dx}(1+e^x)}{(1+e^x)^2} \\
 &= \frac{(1+e^x) \cdot e^{3x} \cdot 3 - e^{3x} (0+e^x)}{(1+e^x)^2} \\
 &= \frac{3e^{3x} + 3e^{4x} - e^{4x}}{(1+e^x)^2} = \frac{3e^{3x} + 2e^{4x}}{(1+e^x)^2}
 \end{aligned}$$

Using quotient rule,

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