WARMUP

$$\int_0^1 x^2\left(5-2x^3\right)^4 dx = \int_0^1 (5-2x^3)^4 \cdot \underline{x^2 dx}$$

$u = 5-2x^3$

$du = -6x^2\,dx$

$-\frac{1}{6}du = x^2 dx$

$$= -\frac{1}{6}\int_5^3 u^4\,du = \left(-\frac{1}{6}\cdot\frac{u^5}{5}\right)_5^3 = \left(-\frac{3^5}{30}\right) - \left(\frac{-5^5}{30}\right)$$

with definite integrals you can sub for the limits as well

↳ 0 and 1

$u = 5-2x^3$

when $x=1$, $u = 5-2\cdot 1^3 = 3$

$x=0$, $u = 5-2\cdot 0^3 = 5$

$$= -\frac{243}{30} + \frac{3125}{30}$$

$$= \frac{2882}{30} = \frac{1441}{15}$$

$$\int_0^{\frac{\pi}{3}} \sin(3x)\,dx = \frac{1}{3}\int_0^{\pi} \sin u\,du = \left[-\frac{1}{3}\cos u\right]_0^{\pi} = \left(-\frac{1}{3}\cos\pi\right) - \left(-\frac{1}{3}\cos 0\right)$$

$u = 3x$

$du = 3\,dx$

$\frac{1}{3}du = dx$

when $x = \frac{\pi}{3}$, $u = 3\cdot\frac{\pi}{3} = \pi$

when $x=0$, $u = 3\cdot 0 = 0$

$$= -\frac{1}{3}(-1) - \left(-\frac{1}{3}\right)(1)$$

$$= \frac{1}{3} + \frac{1}{3} = \frac{2}{3}$$

$$\int_0^3 x\sqrt{16+x^2}\,dx = \int_0^3 (16+x^2)^{\frac{1}{2}}\cdot x\,dx$$

$u = 16+x^2$

$du = 2x\,dx$

$\frac{1}{2}du = x\,dx$

$$= \frac{1}{2}\int_{16}^{25} u^{\frac{1}{2}}\,du = \frac{1}{2}\cdot\frac{u^{\frac{3}{2}}}{\frac{3}{2}} = \frac{1}{2}\cdot\frac{2}{3}u^{3/2}$$

when $x=3$, $u = 16+3^2 = 25$

$x=0$, $u = 16+0^2 = 16$

$$= \left[\frac{1}{3}(\sqrt{u})^3\right]_{16}^{25}$$

$$= \left(\frac{1}{3}\sqrt{25}^3\right) - \left(\frac{1}{3}\sqrt{16}^3\right)$$

$$\frac{1}{2}\cdot\frac{u^{\frac{3}{2}}}{\frac{3}{2}} = \frac{1}{3}\left(\sqrt{u}\right)^3$$

$$= \left(\frac{1}{3}\sqrt{16+x^2}^{\,3}\right)\Big|_0^3$$

$$= \frac{1}{3}\sqrt{25}^{\,3} - \frac{1}{3}\sqrt{16}^{\,3}$$

$$= \frac{1}{3}\cdot 125 - \frac{1}{3}\cdot 64$$

$$= \frac{125}{3} - \frac{64}{3} = \frac{61}{3}$$

23) $\int \sin^3\alpha\cos\alpha\, d\alpha = \int u^3\, du = \frac{u^4}{4} + C$

$u = \sin\alpha$

$du = \cos\alpha\, d\alpha$

$$= \frac{\sin^4\alpha}{4} + C$$

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