PROOF OF FORMULA 3.225.2

$$\int_1^\infty \frac{(x-1)^{1-p}}{x^3}\,dx = \frac{p(1-p)\pi}{2\sin \pi p}$$

Let $t = 1/x$ to obtain

$$\int_1^\infty \frac{(x-1)^{1-p}}{x^3}\,dx = \int_0^1 t^p(1-t)^{1-p}\,dt.$$

The integral representation

$$B(a,b) = \int_0^1 t^{a-1}(1-t)^{b-1}\,dt$$

shows that the last integral is

$$B(p+1, 2-p) = \frac{\Gamma(p+1)\Gamma(2-p)}{\Gamma(3)}.$$

The identities $\Gamma(a+1) = a\Gamma(a)$ and $\Gamma(a)\Gamma(1-a) = \pi/\sin \pi a$ simplify the answer.