2.25 ?

87.5% can resubmit

5, 6, 9, 12, 16, 18, 25, 29

2.5

$$dE = \frac{1}{4\pi\varepsilon_0} \cdot \frac{dq}{\eta^2} \qquad \eta = \sqrt{z^2 + r^2}$$

$$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{\lambda \cdot r\, d\phi}{\sqrt{z^2+r^2}} \cdot \frac{z}{(z^2+r^2)} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{\lambda r \cdot d\phi \cdot z}{(z^2+r^2)^{3/2}}$$ ✓

$$= \frac{\lambda r z}{4\pi\varepsilon_0 (z^2+r^2)^{3/2}} \int_0^{2\pi} d\phi$$

$$\boxed{\vec{E} = \frac{2\pi r \lambda z}{4\pi\varepsilon_0 (z^2+r^2)^{3/2}}\,\hat{z}}$$ ✓

2.6

$\eta = \sqrt{z^2+r^2}$ $\qquad \lambda = \sigma\, dr$? ✗ units

$$E_{ring} = \frac{\cancel{2\pi} r (\sigma\, dr) z}{\cancel{4\pi}\, \varepsilon_0 (z^2+r^2)^{3/2}}$$ ✓

$dq = \sigma\, da$

$\boxed{= 2\pi\sigma r\, dr}$

$$E_{disk} = \frac{z\sigma}{2 \cdot \varepsilon_0} \int_0^R \frac{2r\, dr}{(z^2+r^2)^{3/2}} \qquad u = z^2+r^2, \quad du = 2r\, dr$$

$$= \frac{z\sigma}{2 \cdot 2\varepsilon_0} \int_{z^2}^{z^2+R^2} \frac{du}{u^{3/2}} = \frac{z\sigma}{4\varepsilon_0} \left[-2u^{-1/2}\right]_{z^2}^{z^2+R^2}$$

$$= \frac{-2z\sigma}{4\varepsilon_0} \left[\frac{1}{\sqrt{u}}\right]_{z^2}^{z^2+R^2} = \frac{-2z\sigma}{4\varepsilon_0} \left[\frac{1}{\sqrt{z^2+R^2}} - \frac{1}{\sqrt{z^2}}\right]$$

$$\boxed{E = \frac{\sigma}{2\varepsilon_0}\left[1 - \frac{z}{\sqrt{z^2+R^2}}\right]\hat{z}}$$ ✓

2.9 a) $\rho = \varepsilon_0 \nabla\cdot E = \varepsilon_0 \left(\frac{1}{r^2}\right)\frac{\partial}{\partial r}(r^2 \cdot kr^3) = \frac{\varepsilon_0}{r^2}(5kr^4) = \boxed{5kr^2\varepsilon_0}$ ✓

b) $Q = \varepsilon_0 \oint E\cdot da = \varepsilon_0 (kR^3)(4\pi R^2) = \boxed{4\pi R^5 \varepsilon_0}$ ✓

$Q = \int_0^R (5kr^2\varepsilon_0)(4\pi r^2 dr) = 20\pi\varepsilon_0 \int_0^R r^4 dr$

$= 20\pi\varepsilon_0 \left[\frac{1}{5}r^5\right]_0^R = \boxed{4\pi R^5 \varepsilon_0}$ ✓

Two ways ✓ Gauss' and $\int \rho d\tau$

2.12 $\oint \bar{E}\cdot d\bar{a} = \frac{Q_{enc}}{\varepsilon_0}$

$E\cdot(4\pi r^2) = \frac{1}{\varepsilon_0}\left(\frac{4}{3}\pi r^3\right)\rho$

$\boxed{E = \frac{r\rho}{3\varepsilon_0}\hat{r}}$ ✓

$E\,4\pi r^2 = \frac{1}{\varepsilon_0}\left(\frac{4}{3}\pi R^3\right)\rho$

$\boxed{E = \frac{\rho R^3}{r^2\varepsilon_0}\hat{r}}$

2.16 $\oint E\cdot da = \frac{Q_{enc}}{\varepsilon_0}$

i) $E(2\pi s l) = \frac{\rho(\pi s^2 l)}{\varepsilon_0} \Rightarrow \boxed{\vec{E} = \frac{\rho s}{2\varepsilon_0}\hat{s}}$ $\propto s\hat{s}$ ✓

ii) $E(2\pi s l) = \frac{\rho(\pi a^2 l)}{\varepsilon_0} \Rightarrow E = \frac{\rho a^2}{2\varepsilon_0 s}\hat{s}$ $\propto \hat{s}/s$

iii) $\vec{E} = 0$ ✓ $\rho_{enc} = 0$

2.18)

$$E = \frac{r\rho}{3\varepsilon_0}\hat{r} = \frac{\rho}{3\varepsilon_0}\mathbf{r}$$

clever!

$$E_+ = \frac{+\rho}{3\varepsilon_0}\mathbf{r} \quad \Rightarrow E = \frac{\rho r}{3\varepsilon_0} - \frac{\rho r}{3\varepsilon_0} + \frac{\rho d}{3\varepsilon_0}$$

$$E_- = \frac{-\rho}{3\varepsilon_0}(r-d)$$

$$\boxed{E = \frac{\rho d}{3\varepsilon_0}}$$

2.29) $v(r) = \frac{1}{4\pi\varepsilon_0}\int \frac{\rho(\vec{r}')}{\mathscr{r}}\,d\tau' \qquad \nabla^2 v = \frac{-\rho}{\varepsilon_0}$

$$\nabla^2 V = \frac{1}{4\pi\varepsilon_0}\nabla^2\int \frac{\rho(r')}{\mathscr{r}}\,d\tau' = \frac{1}{4\pi\varepsilon_0}(\rho(r'))\int \nabla^2\left(\frac{1}{\mathscr{r}}\right)d\tau'$$

$$= \frac{\rho(r')}{4\pi\varepsilon_0}\int \vec{\nabla}\cdot\nabla\left(\frac{1}{\mathscr{r}}\right)d\vec{\tau} = \frac{\rho(r')}{4\pi\varepsilon_0}\int \vec{\nabla}\cdot\left(-\frac{1}{\mathscr{r}^2}\hat{\mathscr{r}}\right)$$

$$= \frac{\rho(r')}{4\pi\varepsilon_0}\int_V -4\pi\,\delta^3(\vec{r})\,d\tau' = \boxed{\frac{-\rho(r')}{\varepsilon_0}}$$