

Week 1 Bonusaufgaben

1. i.

$$N = \iiint_V \rho \, dV = \rho V$$

ii.

$$\rho = 10^{28} m^{-3}$$

$$V = 61.3 \times (10^{-2} m)^3 = 61.3 \times 10^{-6} m^3$$

$$\begin{aligned} N &= 61.3 \times 10^{-6} \times 10^{28} \\ &= 61.3 \times 10^{22} \text{ Ladungstraeger} \end{aligned}$$

2. Antwort: **c**

3. i. Zylinderkoordinaten

$$r = \sqrt{3^2 + 5^2} = \sqrt{34}$$

$$\varphi = \arctan\left(\frac{5}{3}\right) = 1.03 \text{ rad}$$

$$z = 2$$

ii. Kugelkoordinaten

$$2 = r \cos(\vartheta)$$

$$3 = r \sin(\vartheta) \cos(\varphi)$$

$$5 = r \sin(\vartheta) \sin(\varphi)$$

$$\frac{3}{\cos(\varphi)} = \frac{5}{\sin(\varphi)}$$

$$\tan(\varphi) = \frac{5}{3}$$

$$\varphi = \arctan\left(\frac{5}{3}\right) = 1.03 \text{ rad}$$

$$\frac{2}{\cos(\vartheta)} = \frac{3}{\sin(\vartheta) \cos(\varphi)}$$

$$\tan(\vartheta) = \frac{3}{2 \cos(\varphi)}$$

$$\vartheta = \arctan\left(\frac{3}{2 \cos(\varphi)}\right) = 1.24 \text{ rad}$$

4. $r = \text{constant}$

$$F := \frac{Q}{4\pi r^2} \vec{e}_r$$

$$\Psi := \int_0^{2\pi} \int_0^\pi r^2 \sin(\vartheta) \overrightarrow{F(r, \vartheta, \varphi)} \cdot d\vartheta d\varphi$$

$$= \frac{Qr^2}{4\pi r^2} \int_0^{2\pi} \int_0^\pi \sin(\vartheta) \vec{e}_r \cdot d\vartheta d\varphi$$

$\vec{e}_r \cdot d\vartheta d\varphi$ is 1, as they are always parallel.

$$= \frac{Q}{4\pi} \int_0^{2\pi} (-\cos(\pi)) - (-\cos(0)) d\varphi = \frac{Qr^2}{4\pi r^2} \int_0^{2\pi} 2 d\varphi$$

$$= \frac{Qr^2}{4\pi r^2} ((4\pi) - (0)) = \frac{4\pi Q}{4\pi} = Q$$