Physics 217 Problem Set #1

Due Tuesday, 2 September 2025, in Box.

Submit your solutions by uploading an electronic, or at least legibly-scanned, pdf copy to your personal PHYS 217 Box folder. Note that cell-phone pictures are not usually legible, nor produced in pdf.

Submission, completeness, and correctness will be noted for problems with numbers not bearing asterisks – 1-6 here – and will add to your Class-Participation grade. You will start these problems in Workshop. You may collaborate with classmates on their solution, inside or outside of class. List in your solutions the names of the classmates with whom you collaborated.

Problems marked with an asterisk – 7*, 8*, and 9* here – will be graded in detail and comprise part of your Homework grade. These are solo efforts; you may not collaborate with classmates on their solution.

1-6 Griffiths 1.10, 1.11, 1.15, 1.18, 1.27, 1.28

7*. a. Show that rotation about the x axis, represented by the matrix

$$\boldsymbol{R} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\phi & \sin\phi \\ 0 & -\sin\phi & \cos\phi \end{pmatrix} ,$$

is a unitary transformation.

b. Show that $\sum_{i=1}^{3} R_{ij} R_{ik} = \delta_{jk}$.

8*. Dyads themselves are of course dyadic too. Derive the Cartesian 3-D matrix representations of the nine dyads: $\hat{\boldsymbol{x}}\hat{\boldsymbol{x}}$, $\hat{\boldsymbol{x}}\hat{\boldsymbol{y}}$, ..., $\hat{\boldsymbol{z}}\hat{\boldsymbol{z}}$.

9*. Consider the radial vector $\boldsymbol{r} = r\hat{\boldsymbol{r}}$ and the dyadic $\vec{\boldsymbol{D}} = \hat{\boldsymbol{x}}\hat{\boldsymbol{x}} + \hat{\boldsymbol{y}}\hat{\boldsymbol{y}} + \hat{\boldsymbol{z}}\hat{\boldsymbol{z}}$. Determine $\boldsymbol{r} \cdot \left(\vec{\boldsymbol{D}} \cdot \boldsymbol{r}\right)$ and $\left(\boldsymbol{r} \cdot \vec{\boldsymbol{D}}\right) \cdot \boldsymbol{r}$. Is there ambiguity in writing $\boldsymbol{r} \cdot \vec{\boldsymbol{D}} \cdot \boldsymbol{r}$?

10*. Determine the gradient of r.

11*. Regard the rotation matrix $\boldsymbol{R}$ in problem 7 as a rank-2 tensor, and find its cusp and rotation vector.