Problem 1: Srednicki 75.1
For an anomaly-free theory we demand that
\[ \text{tr}(T^a, T^b)T^c = 0. \] (1)
In this case, the matter fields carry $U(1)$ charge $Q_i$ and belong to representations of the non abelian group $G$. The above requirement then translates to following conditions:
- $G \times G \times G : \sum_i A(R_i) d^{abc} = 0$.
- $G \times G \times Q : \sum_i T(R_i)Q_i = 0$.
- $Q \times Q \times Q : \sum_i d(R_i)q_3 = 0$.

Problem 2: Srednicki 76.1
Using the free field expansion (55.11) for the vector field one can easily prove
\[ \epsilon_{\mu\nu\rho\sigma} (p, q) F_{\mu\nu}(z) F_{\rho\sigma}(z) |0\rangle = +8 \epsilon_{\mu\nu\rho\sigma} \epsilon^i_{\mu} p_\nu q_\rho \epsilon^i_{(p+q)z}. \] (2)
Multiplying both sides with $g_2/16\pi^2$ and using equation (76.14) yields equation (76.29).

Problem 3: Srednicki 77.1
We begin by noting the following useful identity
\[ \text{tr}(T^a T^b T^c) = \frac{1}{2} i T(R)f^{abc} + A(R)d^{abc}. \] (3)
The first term in (77.35) becomes
\[ \epsilon^{\mu\nu\rho\sigma} \text{tr}(T^a \partial_\mu (A_\nu \partial_\rho A_\sigma)) = \epsilon^{\mu\nu\rho\sigma} \text{tr}(T^a \partial_\mu A_\nu \partial_\rho A_\sigma) \] (4)
\[ = \epsilon^{\mu\nu\rho\sigma} \partial_\mu A_\nu^b \partial_\rho A_\sigma^c \text{tr}(T^a T^b T^c) \] (5)
\[ = A(R)\epsilon^{\mu\nu\rho\sigma} \partial_\mu A_\nu^b \partial_\rho A_\sigma^c d^{abc}. \] (6)
Here we used the previous identity and also the fact that the term with $f^{abc}$ cancels because it is contracted with a symmetric quantity. Next, the second
term in (77.35) is the derivative of
\[ \epsilon^{\mu
u\rho\sigma} A^b_c A^d \, \text{tr}(T^a T^b T^c T^d) = \frac{1}{2} \epsilon^{\mu
u\rho\sigma} A^b_c A^d \, \text{tr}(T^a T^b T^c T^d) \]
\[ = \frac{i}{2} \epsilon^{\mu
u\rho\sigma} A^b_c A^d \, \text{tr}(T^a T^b T^c) \]
\[ = -\frac{1}{4} T(R) \epsilon^{\mu
u\rho\sigma} A^b_c A^d \, f^{abe} f^{cde} \]
\[ + \frac{i}{2} A(R) \epsilon^{\mu
u\rho\sigma} A^b_c A^d \, d^{abe} f^{cde} \]

We observe that the first term can be completely antisymmetrized and therefore vanishes by the Jacobi identity. In conclusion, we see that both terms in (77.35) are proportional to \( A(R) \).

**Problem 4:** Srednicki 77.2
Starting from equation (77.7) we can arrive at equation (77.36) by noting the following two identities
\[ \epsilon^{\mu
u\rho\sigma} \partial_\mu \text{tr}(A_\nu A_\rho A_\sigma) = 3 \epsilon^{\mu
u\rho\sigma} \text{tr}(\partial_\mu A_\nu A_\rho A_\sigma), \quad (7) \]
and
\[ \text{tr}([A_\mu, A_\nu] [A_\rho, A_\sigma]) = A^a_\mu A^b_\nu A^c_\rho A^d_\sigma \text{tr}([T^a, T^b][T^c, T^d]) \]
\[ = -A^a_\mu A^b_\nu A^c_\rho A^d_\sigma f^{abe} f^{cde} \text{tr}(T^a T^b) \]
\[ = -T(R) A^a_\mu A^b_\nu A^c_\rho A^d_\sigma f^{abe} f^{cde}. \quad (8) \]

Using that the structure constant are completely antisymmetric, the second identity implies that
\[ \epsilon^{\mu
u\rho\sigma} \text{tr}([A_\mu, A_\nu] [A_\rho, A_\sigma]) = 0. \quad (11) \]
Hence we see that
\[ \frac{1}{4} \epsilon^{\mu
u\rho\sigma} \text{tr}(F_\mu F_\rho) = \frac{1}{4} \epsilon^{\mu
u\rho\sigma} \text{tr}(\partial_\mu A_\nu - ig[A_\mu, A_\nu])(\partial_\rho A_\sigma - ig[A_\rho, A_\sigma]) \]
\[ = \epsilon^{\mu
u\rho\sigma} \text{tr}\left(\partial_\mu A_\nu \partial_\rho A_\sigma - \frac{2}{3} ig \partial_\mu (A_\nu A_\rho A_\sigma)\right) \]
\[ = \epsilon^{\mu
u\rho\sigma} \partial_\mu \text{tr}(A_\nu \partial_\rho A_\sigma - \frac{2}{3} ig A_\nu A_\rho A_\sigma). \]

**Problem 5:** Srednicki 89.3
As we mentioned in the first problem, the left handed Weyl fermions of the Standard Model have the following quantum numbers
\[ (1, 2)_{-1/2} \oplus (1, 1)_{1} \oplus (3, 2)_{1/6} \oplus (3, 1)_{-2/3} \oplus (3, 1)_{1/3} \quad (12) \]
We see that all the anomalies cancel

- 3-3-3:
  \[ 0 + 0 + 2A(3) + A(\bar{3}) + A(\bar{3}) = 0 \]  
  (13)

- 3-3-1:
  \[ 0 + 0 + \frac{1}{6}T(3) - \frac{2}{3}T(\bar{3}) + \frac{1}{3}T(\bar{3}) = 0 \]  
  (14)

- 2-2-1:
  \[ -\frac{1}{2}T(2) + 0 + 3\frac{1}{6}T(2) + 0 + 0 = 0 \]  
  (15)

- 1-1-1:
  \[ 2 \left( -\frac{1}{2} \right)^3 + 1 + 3 \times 2 \left( \frac{1}{6} \right)^3 + 3 \left( -\frac{2}{3} \right)^3 + 3 \left( \frac{1}{3} \right)^3 = 0 \]  
  (16)

- 2-2-2:
  This anomaly is zero because the 2 is pseudoreal.

**Problem 6:**
One solution of axial anomaly of 2d QED can be found [here](#). Also one can easily guess the result:

\[ \partial_\mu J_\mu^A \propto \epsilon_{\mu\nu} F^{\mu\nu}. \]  
(17)