D 5.49 The PMOS transistor in the circuit of Fig. P5.49 has $V_t = -0.5$ V, $\mu_p C_{ox} = 100\ \mu A/V^2$, $L = 0.18\ \mu m$, and $\lambda = 0$. Find the values required for W and R in order to establish a drain current of 180 μA and a voltage V_D of 1 V.

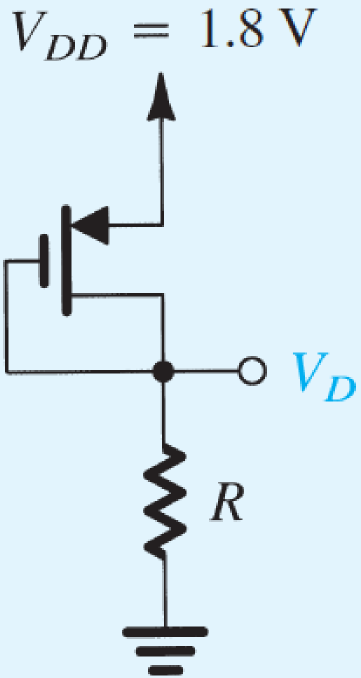

Figure P5.49

5.47 The transistor in the circuit of Fig. P5.47 has $k_n' = 0.4\text{ mA/V}^2$, $V_t = 0.4$ V, and $\lambda = 0$. Show that operation at the

D 5.50 The NMOS transistors in the circuit of Fig. P5.50 have $V_t = 0.5$ V, $\mu_n C_{ox} = 250\ \mu\text{A/V}^2$, $\lambda = 0$, and $L_1 = L_2 = 0.25\ \mu$m. Find the required values of gate width for each of Q_1

SIM = Multisim/PSpice; * = difficult problem; ** = more difficult; *** = very challenging; D = design problem

and Q_2, and the value of R, to obtain the voltage and current values indicated.

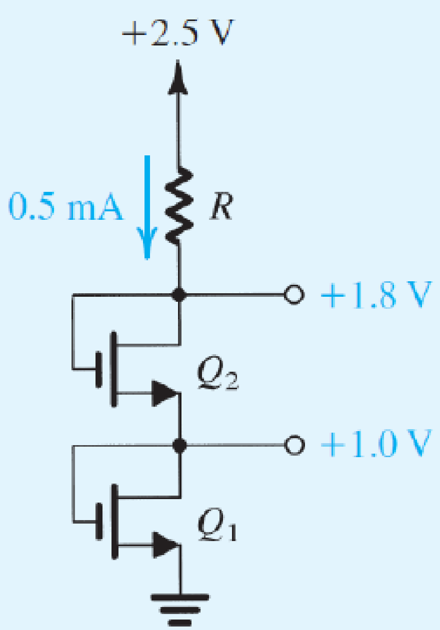

Figure P5.50

the drain current is 0.5 mA and the drain voltage is +7 V. If the transistor is replaced with another having $V_t = 1.5$ V with $k_n'(W/L) = 1.5\text{ mA/V}^2$, find the new values of I_D and V_D. Comment on how tolerant (or intolerant) the circuit is to changes in device parameters.

D 5.53 Using a PMOS transistor with $V_t = -1.5$ V, $k_p'(W/L) = 4\text{ mA/V}^2$, and $\lambda = 0$, design a circuit that resembles that in Fig. 5.24(a). Using a 10-V supply, design for a gate voltage of +6 V, a drain current of 0.5 mA, and a drain voltage of +5 V. Find the values of R_S and R_D. Also, find the values of the resistances in the voltage divider feeding the gate, assuming a 1-μA current in the divider.

5.54 The MOSFET in Fig. P5.54 has $V_t = 0.4$ V, $k_n' = 500\ \mu\text{A/V}^2$, and $\lambda = 0$. Find the required values of W/L and of R so that when $v_I = V_{DD} = +1.3$ V, $r_{DS} = 50\ \Omega$ and transistor that conducts $i_C = 1$ mA with $v_{EB} = 0.70$ V. How much larger is it?

6.26 While Fig. 6.5 provides four possible large-signal equivalent circuits for the *npn* transistor, only two equivalent circuits for the *pnp* transistor are provided in Fig. 6.11. Supply the missing two.

6.27 By analogy to the *npn* case shown in Fig. 6.9, give the equivalent circuit of a *pnp* transistor in saturation.

Section 6.2: Current–Voltage Characteristics

6.28 For the circuits in Fig. P6.28, assume that the transistors have very large β. Some measurements have been made on these circuits, with the results indicated in the figure. Find the values of the other labeled voltages and currents.

6.29 Measurements on the circuits of Fig. P6.29 produce labeled voltages as indicated. Find the value of β for each transistor.

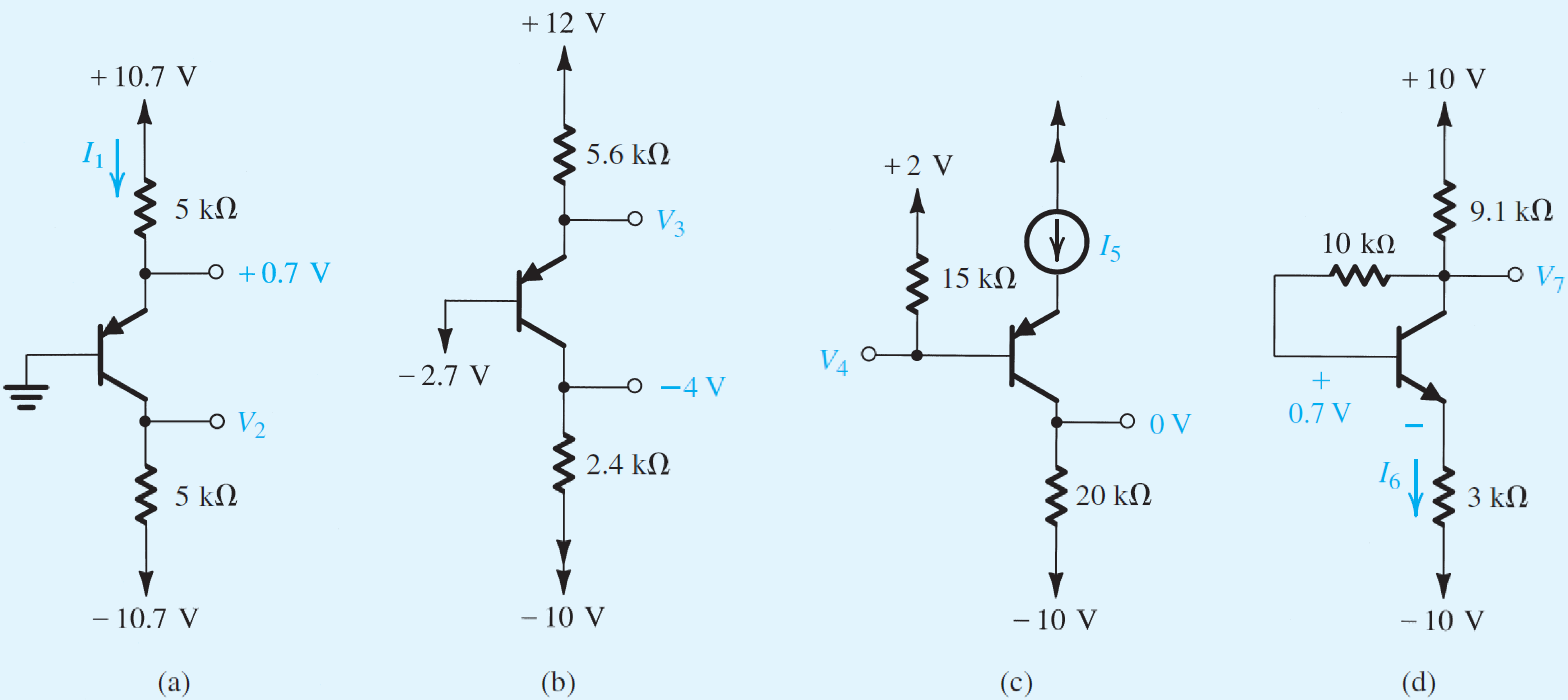

Figure P6.28

6.56 A single measurement indicates the emitter voltage of the transistor in the circuit of Fig. P5.56 to be 1.0 V. Under the assumption that $|V_{BE}| = 0.7$ V, what are V_B, I_B, I_E, I_C, V_C, β, and α? (*Note:* Isn't it surprising what a little measurement can lead to?)