Name: ______________________ ECE 2210 /00 homework DC1

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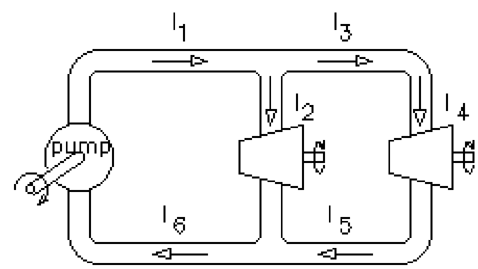
Scan your homework and convert to a pdf file. Turn in on Canvas. Homework is due by 11:59 p.m. on the due date.

The following problems are not meant to be hard. You should be able to do most of them in your head with no special formulas or calculations. In fact you should find them rather dumb and trivial. That's the point, I want to drill these concepts into your head so that you'll find them easy.

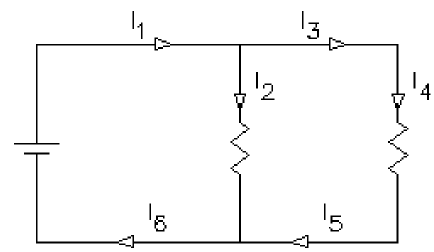
1. The figure at right shows a hydraulic system with a pump that converts rotational energy to fluid energy and two turbines which convert that energy back to rotational energy. Do NOT assume that the turbines are equal in size. This is a closed system containing an incompressible fluid with no places for that fluid to collect; i.e. flow in = flow out of any point or object. Kirchhoff's current law applies. The volumetric fluid flows are indicated by the arrows.



$I_1 := 0.01 \cdot \frac{m^3}{s}$ $I_2 := 0.007 \cdot \frac{m^3}{s}$

I_3 = ________ I_4 = ________ I_5 = ________ I_6 = ________

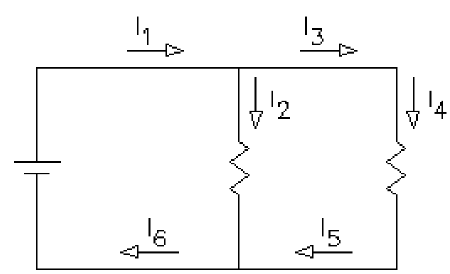
2. The figure at right shows an electrical circuit with a battery that converts chemical energy to electrical energy and two resistors which convert that electrical energy to heat energy. Do NOT assume that the resistors are equal in size. *All* electrical circuits are closed systems containing incompressible charges with no places for those charges to collect; i.e. flow in = flow out of any point or object. Kirchhoff's current law applies. . The electrical currents are indicated by the arrows.



$I_1 := 0.01 \cdot A$ $I_2 := 0.007 \cdot A$

I_3 = ________ I_4 = ________ I_5 = ________ I_6 = ________

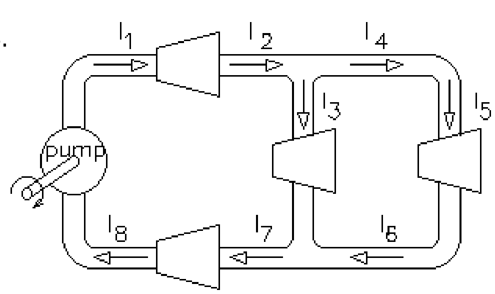
3. The figure at right shows a similar electrical circuit only now the electrical currents are indicated by the arrows next to the wires. This is a more common way to show the current flow because a little arrow in the wire is too easily confused with the electrical symbol for a diode. You'll learn about diodes later.



$I_2 := 20 \cdot mA$ $I_5 := 14 \cdot mA$

I_6 = ________ I_1 = ________ I_3 = ________ I_4 = ________

4.

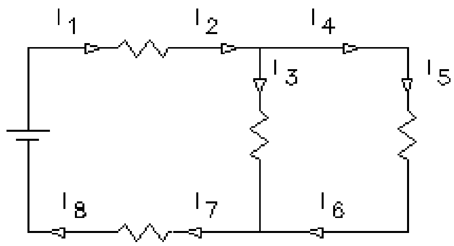


$I_3 := 0.004 \cdot \frac{m^3}{s}$ $I_5 := 0.001 \cdot \frac{m^3}{s}$ I_4 = ________

I_2 = ________ I_1 = ________ I_6 = ________

I_7 = ________ I_8 = ________

5.

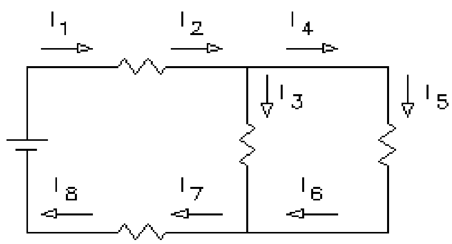


$I_3 := 4.5\cdot mA$ $I_5 := 1.2\cdot mA$ I_4 = __________

I_2 = __________ I_1 = __________ I_6 = __________

I_7 = __________ I_8 = __________

6. Again, a similar electrical circuit with the electrical current arrows in the more common position, next to the wires.

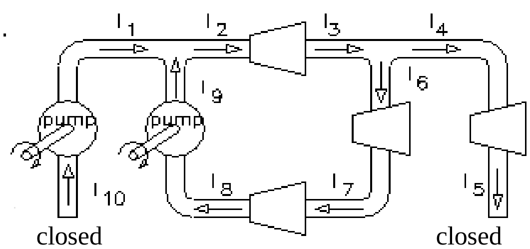


$I_6 := 0.03\cdot A$ $I_7 := 0.08\cdot A$ I_8 = __________

I_1 = __________ I_2 = __________ I_3 = __________

I_4 = __________ I_5 = __________

7.

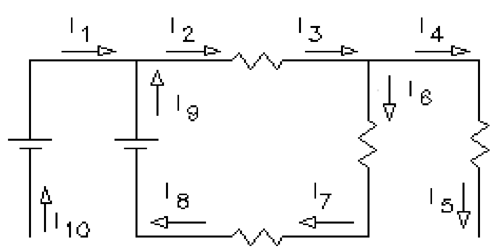


$I_9 := 0.04\cdot\frac{m^3}{s}$ I_1 = __________ I_2 = __________

I_3 = __________ I_4 = __________ I_5 = __________

I_6 = __________ I_7 = __________ I_8 = __________ I_7 = __________ I_{10} = __________

8.

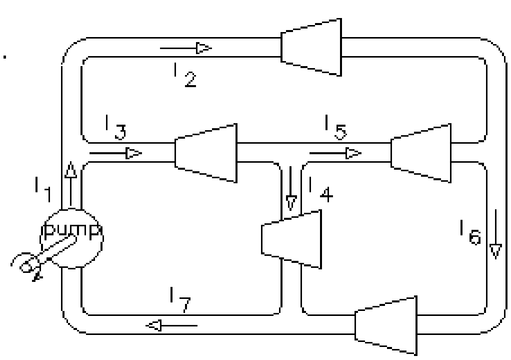


$I_9 := 0.06\cdot A$ I_1 = __________ I_2 = __________

I_3 = __________ I_4 = __________ I_5 = __________

I_6 = __________ I_7 = __________ I_8 = __________ I_7 = __________ I_{10} = __________

9.

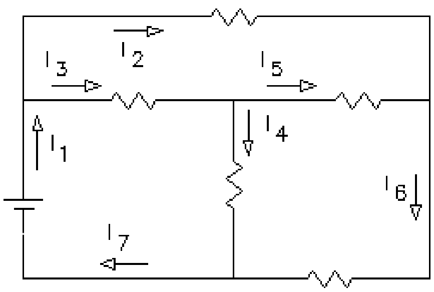


$I_4 := 0.05\cdot\frac{m^3}{s}$ $I_5 := 0.014\cdot\frac{m^3}{s}$ $I_6 := 0.03\cdot\frac{m^3}{s}$

I_1 = __________ I_2 = __________

I_3 = __________ I_7 = __________

10.

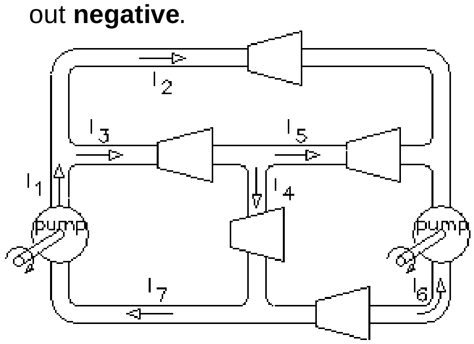


$I_4 := 20\cdot mA$ $I_5 := 10\cdot mA$ $I_6 := 22\cdot mA$

I_1 = __________ I_2 = __________

I_3 = __________ I_7 = __________

11. Careful here, there are now two pumps. Also, given the flow arrows shown, one or more of the flows must come out **negative**.



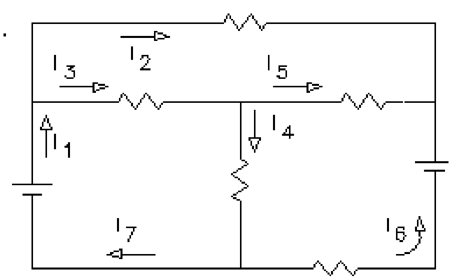
$I_2 := 0.005\cdot\frac{m^3}{s}$ $I_6 := 0.03\cdot\frac{m^3}{s}$ $I_7 := 0.015\cdot\frac{m^3}{s}$

I_1 = __________ I_3 = __________

I_4 = __________ I_5 = __________

12. What does a negative fluid flow physically mean?

13.



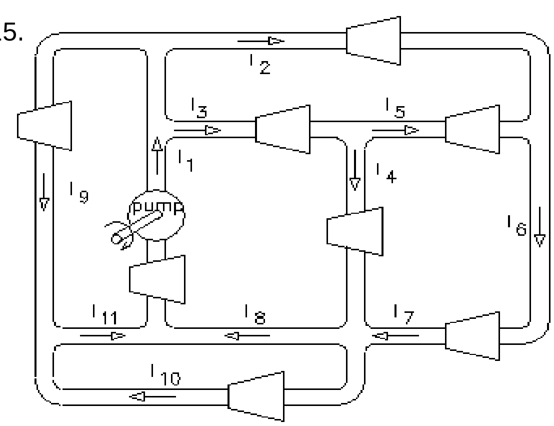
$I_1 := 0.01\cdot A$ $I_5 := -20\cdot mA$ $I_6 := 35\cdot mA$

I_2 = __________ I_3 = __________

I_4 = __________ I_7 = __________

14. What does a negative electrical current physically mean?

15.



$I_4 := 0.05\cdot\frac{m^3}{s}$ $I_5 := 0.03\cdot\frac{m^3}{s}$ $I_7 := 0.045\cdot\frac{m^3}{s}$

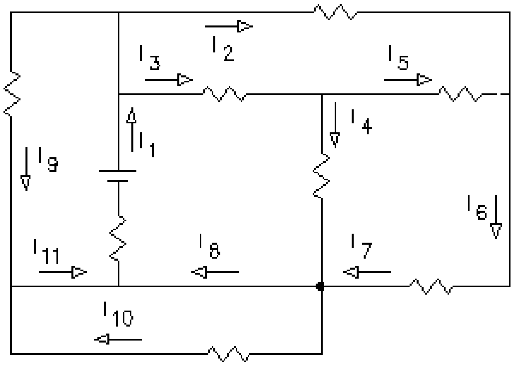
$I_9 := 0.06\cdot\frac{m^3}{s}$ I_1 = __________

I_2 = __________ I_3 = __________

I_6 = __________ I_8 = __________

I_{10} = __________ I_{11} = __________

16.



$I_1 := 100 \cdot mA$ $\quad I_2 := 50 \cdot mA$ $\quad I_3 := 30 \cdot mA$

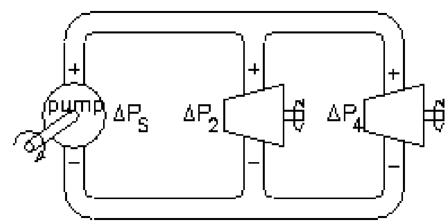
$I_6 := 66 \cdot mA$ $\quad I_4 =$ ________

$I_5 =$ ________ $\quad I_7 =$ ________

$I_8 =$ ________ $\quad I_9 =$ ________

$I_{10} =$ ________ $\quad I_{11} =$ ________

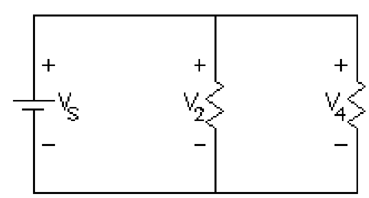
17. The figure at right shows the pressure differentials across elements in a hydraulic system. The side indicated by the + sign is the higher pressure side. Conversely, - indicates the lower pressure. ΔP_S is the pressure difference supplied by the pump (S for **S**ource). ΔP_2 is the pressure difference driving the left turbine and ΔP_4 is the pressure difference driving the right turbine. Assume no pressure losses or discontinuities in the pipes, joints, or corners; i.e. all connected pipes are at exactly the same pressure. Finally, the fluid has no mass, so gravity and Bernoulli can go take a hike.



$\Delta P_S := 12 \cdot \frac{N}{m^2} = 12 \cdot Pa$ $\quad \Delta P_2 =$ ________ $\quad \Delta P_4 =$ ________

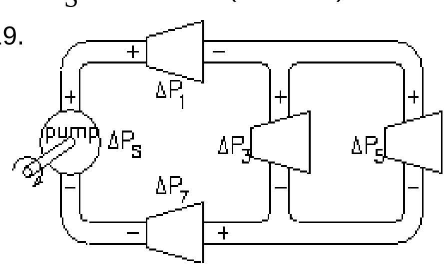
Yes, I know that these are ridiculously low pressures for a hydraulic system.

18. The figure at right shows the voltage differentials across elements in an electrical circuit. The side indicated by the + sign is the higher voltage side. Conversely, - indicates the lower voltage. V_S is the voltage supplied by the battery. V_2 is the voltage across the left resistor and V_4 is the voltage across the right resistor. You may assume no voltage drops across any of the wires or connections in practically *all* electrical schematics; i.e. all connected wires are at exactly the same voltage (electrical potential).



$V_S := 12 \cdot V$ (V = volts) $\quad V_2 =$ ________ $\quad V_4 =$ ________

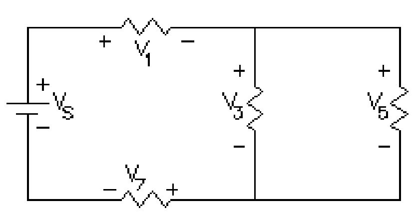
19.



$\Delta P_S := 400 \cdot kPa$ $\quad \Delta P_1 := 180 \cdot kPa$ $\quad \Delta P_3 := 100 \cdot kPa$

$\Delta P_5 =$ ________ $\quad \Delta P_7 =$ ________

20.



$V_1 := 10 \cdot V$ $\quad V_5 := 3 \cdot V$ $\quad V_7 := 2 \cdot V$

$V_S =$ ________ $\quad V_3 =$ ________

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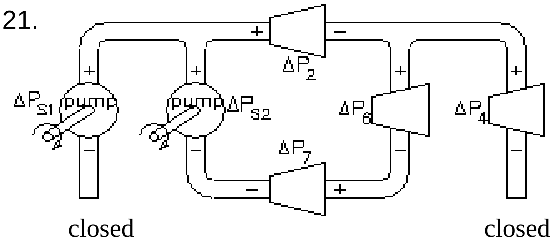
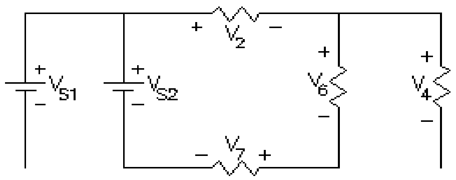
21.



$\Delta P_{S1} := 200\cdot kPa$ $\Delta P_{S2} := 150\cdot kPa$ $\Delta P_{2} := 50\cdot kPa$ $\Delta P_{6} := 60\cdot kPa$

ΔP_{4} = __________ ΔP_{7} = __________

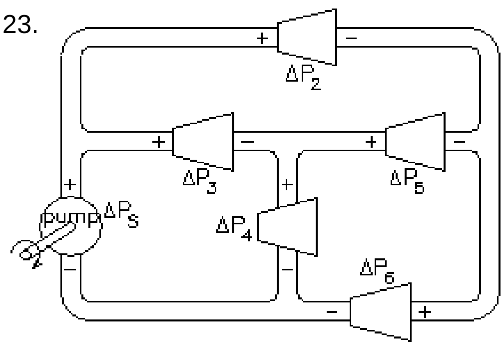
22.



$V_{S1} := 6\cdot V$ $V_{2} := 2\cdot V$ $V_{6} := 2.4\cdot V$ $V_{7} := 3.2\cdot V$

V_{S2} = __________ V_{4} = __________

23.



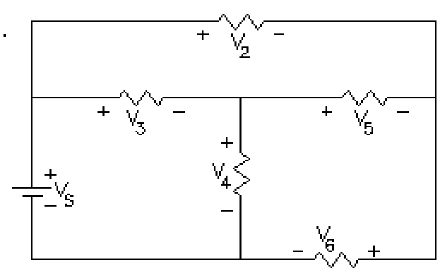
$\Delta P_{3} := 120\cdot kPa$ $\Delta P_{4} := 80\cdot kPa$ $\Delta P_{6} := 110\cdot kPa$

ΔP_{S} = __________ ΔP_{2} = __________

ΔP_{5} = __________

24. What does a negative pressure difference physically mean?

25.

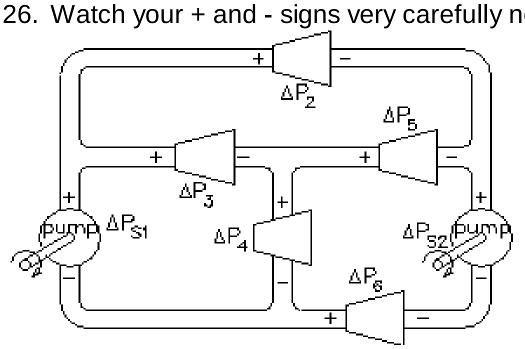


$V_{3} := 2.3\cdot V$ $V_{5} := 0.5\cdot V$ $V_{6} := 3.2\cdot V$

V_{S} = __________ V_{2} = __________

V_{4} = __________

26. Watch your + and - signs very carefully now.

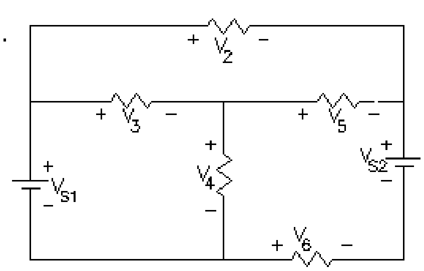


$\Delta P_{2} := 140\cdot kPa$ $\Delta P_{3} := 230\cdot kPa$ $\Delta P_{4} := 50\cdot kPa$ $\Delta P_{6} := 210\cdot kPa$

ΔP_{S1} = __________ ΔP_{S2} = __________

ΔP_{5} = __________

27.



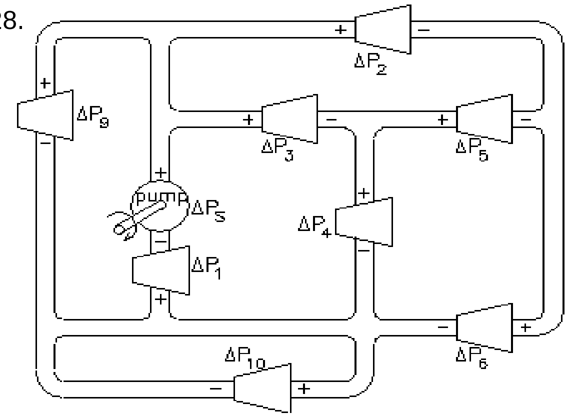
$V_{S1} := 14\cdot V$ $V_{S2} := 3\cdot V$ $V_{2} := 6\cdot V$ $V_{3} := 4\cdot V$

V_{4} = __________ V_{5} = __________

V_{6} = __________

Think about the current through the 2nd battery. What is happening to that battery?

28.



$\Delta P_1 := 200\cdot kPa$ $\Delta P_2 := 1100\cdot kPa$

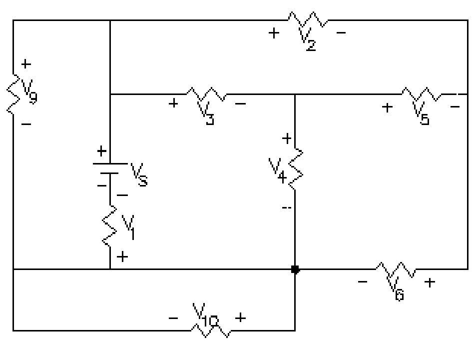
$\Delta P_3 := 600\cdot kPa$ $\Delta P_9 := 1800\cdot kPa$

ΔP_S = __________ ΔP_4 = __________

ΔP_5 = __________ ΔP_6 = __________

ΔP_{10} = __________

29.



$V_S := 18\cdot V$ $V_3 := 6\cdot V$ $V_4 := 8\cdot V$ $V_5 := 2\cdot V$

V_1 = __________ V_2 = __________

V_6 = __________ V_9 = __________

V_{10} = __________

Answers

1. $I_3 = I_4 = I_5 := 0.003\cdot\frac{m^3}{s}$, $I_6 := 0.01\cdot\frac{m^3}{s}$

2. $I_3 = I_4 = I_5 := 0.003\cdot A$, $I_6 := 0.01\cdot A$

3. $I_6 = I_1 := 34\cdot mA$, $I_3 = I_4 := 14\cdot mA$

4. $I_4 = I_6 := 0.001\cdot\frac{m^3}{s}$, $I_1 = I_2 = I_7 = I_8 := 0.005\cdot\frac{m^3}{s}$

5. $I_4 = I_6 := 1.2\cdot mA$, $I_1 = I_2 = I_7 = I_8 := 5.7\cdot mA$

6. $I_1 = I_2 = I_8 := 80\cdot mA$, $I_3 := 50\cdot mA$, $I_4 = I_5 := 30\cdot mA$

7. $I_1 = I_{10} = I_4 = I_5 := 0\cdot\frac{m^3}{s}$, $I_2 = I_3 = I_7 = I_8 := 0.04\cdot\frac{m^3}{s}$

8. $I_1 = I_{10} = I_4 = I_5 := 0\cdot A$, $I_2 = I_3 = I_7 = I_8 := 0.06\cdot A$

9. $I_1 = I_7 := 0.080\cdot\frac{m^3}{s}$, $I_2 := 0.016\cdot\frac{m^3}{s}$, $I_3 := 0.064\cdot\frac{m^3}{s}$

10. $I_1 = I_7 := 42\cdot mA$, $I_2 := 12\cdot mA$, $I_3 := 30\cdot mA$

11. $I_1 := 0.015\cdot\frac{m^3}{s}$, $I_3 := 0.010\cdot\frac{m^3}{s}$, $I_4 := 0.045\cdot\frac{m^3}{s}$, $I_5 := -0.035\cdot\frac{m^3}{s}$

12. Actual flow is in direction opposite to the arrow direction.

13. $I_2 := -15\cdot mA$, $I_3 := 25\cdot mA$, $I_4 := 45\cdot mA$, $I_7 := 10\cdot mA$

14. "

15. $I_1 := 0.155\cdot\frac{m^3}{s}$, $I_2 := 0.015\cdot\frac{m^3}{s}$, $I_3 := 0.080\cdot\frac{m^3}{s}$, $I_6 := 0.045\cdot\frac{m^3}{s}$, $I_8 := 0.095\cdot\frac{m^3}{s}$, $I_{10} := 0\cdot\frac{m^3}{s}$, $I_{11} := 0.060\cdot\frac{m^3}{s}$

16. $I_4 := 14\cdot mA$, $I_5 := 16\cdot mA$, $I_7 := 66\cdot mA$, $I_8 := 80\cdot mA$, $I_9 := 20\cdot mA$, $I_{10} := 0\cdot mA$, $I_{11} := 20\cdot mA$

17. $\Delta P_2 = \Delta P_4 := 12\cdot Pa$

18. $V_2 = V_4 := 12\cdot V$

19. $\Delta P_5 := 100\cdot kPa$, $\Delta P_7 := 120\cdot kPa$

20. $V_S := 15\cdot V$, $V_3 := 3\cdot V$

21. $\Delta P_4 := 0\cdot kPa$, $\Delta P_7 := 40\cdot kPa$

22. $V_{S2} := 7.6\cdot V$, $V_4 := 0\cdot V$

23. $\Delta P_S := 200\cdot kPa$, $\Delta P_2 := 90\cdot kPa$, $\Delta P_5 := -30\cdot kPa$

24. The actual + & - should be reversed from those on drawing

25. $V_S := 6\cdot V$, $V_2 := 2.8\cdot V$, $V_4 := 3.7\cdot V$

26. $\Delta P_{S1} := 280\cdot kPa$, $\Delta P_{S2} := 350\cdot kPa$, $\Delta P_5 := -90\cdot kPa$

27. $V_4 := 10\cdot V$, $V_5 := 2\cdot V$, $V_6 := -5\cdot V$ battery is charging

28. $\Delta P_S := 2000\cdot kPa$, $\Delta P_4 := 1200\cdot kPa$, $\Delta P_5 := 500\cdot kPa$, $\Delta P_6 := 700\cdot kPa$, $\Delta P_{10} := 0\cdot kPa$

29. $V_1 := 4\cdot V$, $V_2 := 8\cdot V$, $V_6 := 6\cdot V$, $V_9 := 14\cdot V$, $V_{10} := 0\cdot V$