Assigned problems for Lecture 1 are listed below (corrections and updates are highlighted in yellow). The questions occur in the following editions of "Physical Chemistry" by P.W. Atkins:

10th edition	9th edition	8th edition

Question 1.01

n/a	n/a	n/a

These are problems from the 7th edition (1.4) that was discontinued from the 8th edition onwards.

(a) A sample of air occupies 1.0 L at 25 °C and 1.00 atm. What pressure is needed to compress it to 100 cm^3 at this temperature?

(b) A sample of carbon dioxide gas occupies 2.0 dm^3 at 20 °C and 104 kPa. What pressure is needed to compress it to 250 cm^3 at this temperature?

Question 1.02

1A.2	1.2	1.2

1A.2(a) A perfect gas undergoes isothermal compression, which reduces its volume by 2.20 dm^3. The final pressure and volume of the gas are 5.04 bar and 4.65 dm^3, respectively. Calculate the original pressure of the gas in (i) bar, (ii) atm.

1A.2(b) A perfect gas undergoes isothermal compression, which reduces its volume by 1.80 dm^3. The final pressure and volume of the gas are 1.97 bar and 2.14 dm^3, respectively. Calculate the original pressure of the gas in (i) bar, (ii) torr.

Question 1.03

n/a	n/a	n/a

These are problems from the 7th edition (1.7) that was discontinued from the 8th edition onwards.

(a) To what temperature must a 1.0 L sample of a perfect gas be cooled from 25 °C in order to reduce its volume to 100 cm^3?

(b) To what temperature must a sample of a perfect gas of volume 500 mL be cooled from 35 °C in order to reduce its volume to 150 cm^3?

Question 1.04

1A.4	1.4	1.4

1A.4(a) A sample of 255 mg of neon occupies 3.00 dm^3 at 122 K. Use the perfect gas law to calculate the pressure of the gas.

1A.4(b) A homeowner uses 4.00×10^3 m^3 of natural gas in a year to heat a home. Assume that natural gas is all methane, CH_4, and that methane is a perfect gas for the conditions of this problem, which are 1.00 atm and 20 °C. What is the mass of gas used?

Question 1.05

1A.7	1.7	1.7

1A.7(a) In an attempt to determine an accurate value of the gas constant, R, a student heated a container of volume 20.000 dm^3 filled with 0.251 32 g of helium gas to 500 °C and measured the pressure as 206.402 cm of water in a manometer at 25 °C. Calculate the value of R from these data. (The density of water at 25 °C is 0.997 07 g cm^{-3}; the construction of a manometer is described in Exercise 1.6(a).)

1A.7(b) The following data have been obtained for oxygen gas at 273.15 K. The density of oxygen at 273.15 K is 0.001344 g cm^{-3}. Calculate the best value of the gas constant R from them and the best value of the molar mass of O_2.

p/atm	0.750 000	0.500 000	0.250 000
$V_m/(dm^3\,mol^{-1})$	29.9649	44.8090	89.6384

Clarifications:

Question 1.05

1A.7	1.7	1.7

The molar volume is given incorrectly in the first column, it should be 29.8649 not 29.9649. I did the problems from the 6th edition (where this is correct) and for some reason, this mistake has not been noticed in the 7th to 10th editions.

A-list solutions for 1.01 and 1.03

E1.4(a) Boyle's law [1.6] provides the basis for the solution.

Since $pV = \text{constant}$, $p_f V_f = p_i V_i$

Solving for p_f, $p_f = \dfrac{V_i}{V_f} \times p_i$

$$V_i = 1.0\,\text{L} = 10\overline{00}\,\text{cm}^3, \qquad V_f = 100\,\text{cm}^3, \qquad p_i = 1.00\,\text{atm}$$

$$p_f = \frac{10\overline{00}\,\text{cm}^3}{100\,\text{cm}^3} \times 1.00\,\text{atm} = 10 \times 1.00\,\text{atm} = \boxed{10\,\text{atm}}$$

E1.7(a) Charles's law in the form $V = \text{constant} \times T$ [1.9] may be rewritten as $\dfrac{V}{T} = \text{constant}$ or $\dfrac{V_f}{T_f} = \dfrac{V_i}{T_i}$

Solving for T_f, $T_f = \dfrac{V_f}{V_i} \times T_i$, $V_i = 1.0\,\text{L}$, $V_f = 100\,\text{cm}^3$, $T_i = 298\,\text{K}$

$$T_f = \left(\frac{100\,\text{cm}^3}{1000\,\text{cm}^3}\right) \times (298\,\text{K}) = \boxed{30\,\text{K}}$$

B-list solutions for 1.01 and 1.03

E1.4(b) Boyle's law applies.

$$pV = \text{constant} \quad \text{so} \quad p_f V_f = p_i V_i$$

$$p_f = \frac{p_i V_i}{V_f} = \frac{(104\,\text{kPa}) \times (2000\,\text{cm}^3)}{(250\,\text{cm}^3)} = \boxed{832\,\text{kPa}}$$

E1.7(b) Charles's law applies.

$$V \propto T \quad \text{so} \quad \frac{V_i}{T_i} = \frac{V_f}{T_f}$$

and $T_f = \frac{V_f T_i}{V_i} = \frac{(150\,\text{cm}^3) \times (35 + 273)\,\text{K}}{500\,\text{cm}^3} = \boxed{92.4\,\text{K}}$