(c) It turns to liquid phase and then to vapour phase. The fusion and boiling points are where the horizontal line on $P-T$ diagram at the constant pressure of 10 atm intersects the fusion and vaporisation curves.

(d) It will not exhibit any clear transition to the liquid phase, but will depart more and more from ideal gas behaviour as its pressure increases.

Chapter 12

12.1 16 g per min

12.2 934 J

12.4 2.64

12.5 16.9 J

12.6 (a) 0.5 atm (b) zero (c) zero (assuming the gas to be ideal) (d) No, since the process (called free expansion) is rapid and cannot be controlled. The intermediate states are non-equilibrium states and do not satisfy the gas equation. In due course, the gas does return to an equilibrium state.

12.7 15%, 3.1×10^9 J

12.8 25 W

12.9 450 J

12.10 10.4

Chapter 13

13.1 4×10^{-4}

13.3 (a) The dotted plot corresponds to 'ideal' gas behaviour; (b) $T_1 > T_2$; (c) 0.26 J K^{-1}; (d) No, 6.3×10^{-5} kg of H_2 would yield the same value

13.4 0.14 kg

13.5 5.3×10^{-6} m^3

13.6 6.10×10^{26}

13.7 (a) 6.2×10^{-21} J (b) 1.24×10^{-19} J (c) 2.1×10^{-16} J

13.8 Yes, according to Avogadro's law. No, v_{rms} is largest for the lightest of the three gases; neon.

13.9 2.52×10^3 K

13.10 Use the formula for mean free path :

$$\bar{l} = \frac{1}{\sqrt{2}\pi n d^2}$$

where d is the diameter of a molecule. For the given pressure and temperature $N/V = 5.10 \times 10^{25}$ m^{-3} and = 1.0×10^{-7} m. $v_{rms} = 5.1 \times 10^2$ m s^{-1}.

collisional frequency = $\frac{v_{rms}}{\bar{l}} = 5.1 \times 10^9 \text{ s}^{-1}$. Time taken for the collision = $d / v_{rms} = 4 \times 10^{-13}$ s.

Time taken between successive collisions = l / $v_{rms} = 2 \times 10^{-10}$ s. Thus the time taken between successive collisions is 500 times the time taken for a collision. Thus a molecule in a gas moves essentially free for most of the time.

13.11 Nearly 24 cm of mercury flows out, and the remaining 52 cm of mercury thread plus the 48 cm of air above it remain in equilibrium with the outside atmospheric pressure (We assume there is no change in temperature throughout).

13.12 Oxygen

13.14 Carbon[1.29 Å]; Gold [1.59 Å]; Liquid Nitrogen [1.77 Å]; Lithium [1.73 Å]; Liquid fluorine[1.88 Å]

Chapter 14

14.1 (b), (c)

14.2 (b) and (c): SHM; (a) and (d) represent periodic but not SHM [A polyatomic molecule has a number of natural frequencies; so in general, its vibration is a superposition of SHM's of a number of different frequencies. This superposition is periodic but not SHM].

14.3 (b) and (d) are periodic, each with a period of 2 s; (a) and (c) are not periodic. [Note in (c), repetition of merely one position is not enough for motion to be periodic; the entire motion during one period must be repeated successively].

14.4 (a) Simple harmonic, $T = (2\pi/\omega)$; (b) periodic, $T = (2\pi/\omega)$ but not simple harmonic; (c) simple harmonic, $T = (\pi/\omega)$; (d) periodic, $T = (2\pi/\omega)$ but not simple harmonic; (e) non-periodic; (f) non-periodic (physically not acceptable as the function $\rightarrow \infty$ as $t \rightarrow \infty$.

14.5 (a) 0, +, + ; (b) 0, –, – ; (c) –, 0,0 ; (d) –, –, – ; (e) +, +, + ; (f) –, –, –.

14.6 (c) represents a simple harmonic motion.

14.7 A = $\sqrt{2}$ cm, $\phi = 7\pi/4$; B = $\sqrt{2}$ cm, $a = \pi/4$.

14.8 219 N

14.9 Frequency 3.2 s^{-1}; maximum acceleration of the mass 8.0 m s^{-2}; maximum speed of the mass 0.4 m s^{-1}.

14.10 (a) $x = 2 \sin 20t$
(b) $x = 2 \cos 20t$
(c) $x = -2 \cos 20t$