8	**A is the only correct answer ($\frac{1}{\sqrt{2}}$)** B is not the correct answer, as $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ C is not the correct answer, as $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ D is not the correct answer, as $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$	1

6	**A is the correct answer (1/4)** B is not correct because $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ C is not correct because $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ D is not correct because $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$	1

10	**D is the correct answer (s.h.c. of solid = s.h.c. of gas)** A is not correct because gradient for solid is greater than gradient for liquid B is not correct because gradient for solid is equal to gradient for gas C is not correct because gradient for solid is greater than gradient for liquid	1

8	**D is the only correct answer** A is not the correct answer, as the mean kinetic energy is the same for both gases B is not the correct answer, as the mean kinetic energy is the same for both gases C is not the correct answer, as He molecules are more massive than H molecules	(1)

Question Number	Answer	Mark
1	**B is the only correct answer** A is not the correct answer, as molecular potential energy increases C is not the correct answer, as molecular kinetic energy doesn't change and molecular potential energy increases D is not the correct answer, as molecular kinetic energy doesn't change	(1)

9	**C is the correct answer** A is not correct, as the pressure, volume and temperature of each gas is the same B is not correct, as the temperature of each gas is the same D is not correct, as the temperature and the number of molecules is the same for each gas	(1)

Question Number	Answer	Mark
16(a)	Use of $\rho = \frac{m}{V}$ (1) Use of $\Delta E = mc\Delta\theta$ (1) Use of $P = \frac{\Delta E}{\Delta t}$ (1) P = 1630 (W) [at least 3 sig fig required] (1) [rounded data may give 1640 W] [If reverse calculation shown then MAX 3 marks] [Do not allow intermediate rounding to less than 3 sig figs for m or ΔE] <u>Example of calculation</u> $m = 4.25 \times 10^{-4}\ \text{m}^3 \times 998\ \text{kg m}^{-3} = 0.424\ \text{kg}$ $\Delta E = 0.424\ \text{kg} \times 4190\ \text{J kg}^{-1}\text{K}^{-1} \times (100 - 22)\ \text{K} = 1.386 \times 10^5\ \text{J}$ $P = \frac{1.386 \times 10^5\ \text{J}}{85\ \text{s}} = 1631\ \text{W}$	4

16(b)	Use of $\Delta E = L\Delta m$	(1)	
	Use of $P = \frac{\Delta E}{\Delta t}$	(1)	
	$t = 440$ s (ecf from (a)) [show that value for P gives 449 s]	(1)	3
	Example of calculation $\Delta E = 0.75 \times 0.424 \text{ kg} \times 2.26 \times 10^6 \text{ J kg}^{-1} = 7.19 \times 10^5 \text{ J}$ $t = \frac{7.19 \times 10^5 \text{ J}}{1630 \text{ W}} = 441 \text{ s}$		

Question Number	Answer		Mark
19(a)	Use of $pV = NkT$	(1)	
	Use of 75%	(1)	
	$N = 2.4 \times 10^{21}$	(1)	3
	Example of calculation $N = \frac{pV}{kT} = \frac{0.75 \times 1.03 \times 10^5 \text{ Pa} \times 1.25 \times 10^{-4} \text{ m}^3}{1.38 \times 10^{-23} \text{ J K}^{-1} \times (290) \text{ K}} = 2.41 \times 10^{21}$		

19(b)	Use of $pV = NkT$ [Allow ratio of pressures equated to ratio of temperatures]	(1)	
	Conversion of temperature from Celsius to kelvin	(1)	
	Temperature of gas is 48°C < 60°C so statement is inaccurate **Or** Temperature of gas is 321 K < 333K so statement is inaccurate (ecf from (a) if candidates use N)	(1)	3
	Example of calculation $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ $T_2 = \frac{p_2}{p_1} \times T_1 = \frac{0.83}{0.75} \times 290 \text{ K} = 321 \text{ K}$ $\theta = 321 - 273 = 48$°C		

19(c)(i)	Use of $\lambda_{max}T = 2.898 \times 10^{-3}$ m K	(1)	
	Use of $L = \sigma A T^4$	(1)	
	$L = 42$ W	(1)	3
	Example of calculation $T = \frac{2.898 \times 10^{-3} \text{ m K}}{1100 \times 10^{-9} \text{ m}} = 2635 \text{ K}$ $L = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4} \times 1.55 \times 10^{-5} \text{ m}^2 \times (2635 \text{ K})^4$ $\therefore L = 42.4$ W		

19(c)(ii)	The filament may not be a perfect black body emitter (of radiation) **Or** Some energy may be absorbed by the glass (of the bulb)	(1)	1
	Total for question 19		10

Question Number	Answer		Mark
15(a)	Use of $\Delta E = mL$	(1)	3
	Use of $\Delta E = mc\Delta\theta$	(1)	
	$\Delta E = 1.32 \times 10^{11}$ (J)	(1)	
	Example of calculation $\Delta E = 3.53 \times 10^5 \text{kg} \times 3.36 \times 10^5 \text{ J kg}^{-1} = 1.19 \times 10^{11} \text{ J}$ $\Delta E = 3.53 \times 10^5 \text{ kg} \times 2.09 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1} \times (0 - (-18)) \text{ K} = 1.33 \times 10^{10} \text{ J}$ $\Delta E = 1.19 \times 10^{11} \text{ J} + 1.33 \times 10^{10} \text{ J} = 1.319 \times 10^{11} \text{ J}$		

Question Number	Answer		Mark
15(b)	Surface area of top of ice floe calculated [453 m^2]	(1)	6
	Intensity at sea level calculated using 56% [767 W m^{-2}]	(1)	
	Use of $I = \frac{P}{A}$	(1)	
	Use of $P = \frac{\Delta W}{\Delta t}$	(1)	
	t = 4.4 days [4.3 days if "show that" value used] (ecf from (a)) **Or** $E = 2.10 \times 10^{11}$ J for 7 days	(1)	
	4.4 days is less than 7 days so claim is not correct **Or** $1.32 \times 10^{11} \text{ J} < 2.10 \times 10^{11}$ J so claim is not correct **Or** Correct conclusion based on comparison of candidate's calculated values	(1)	
	Example of calculation $P = 0.56 \times 1370 \text{ W m}^{-2} \times 453 \text{ m}^2 = 3.48 \times 10^5 \text{ W}$ $t = \frac{1.32 \times 10^{11} \text{ J}}{3.48 \times 10^5 \text{ J s}^{-1}} = 3.79 \times 10^5 \text{ s}$ $t = \frac{3.79 \times 10^5 \text{ s}}{8.64 \times 10^4 \text{ s day}^{-1}} = 4.39 \text{ days}$		
	Total for question 15		**9**

Question Number	Answer		Mark
15(a)	Energy is transferred from banana to liquid nitrogen	(1)	2
	The molecular potential energy of nitrogen molecules increases (as the nitrogen boils) **Or** This provides the latent heat of vaporisation (of the nitrogen) **Or** This provides the latent heat to change state (of the nitrogen)	(1)	

15(b)	Use of $\Delta E = mc\Delta\theta$	(1)	
	Use of $\Delta E = mL$	(1)	
	$m = 0.23$ kg, which is less that 0.5 kg so the teacher's estimate was inaccurate **Or** 9.9×10^4 J > 4.5×10^4 J so the teacher's estimate was inaccurate	(1)	3
	Example of calculation $\Delta E = 0.118 \text{ kg} \times 1.76 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1} \times (292 - 77.4) \text{ K} = 4.46 \times 10^4 \text{ J}$ $m = \frac{4.46 \times 10^4 \text{ J}}{1.98 \times 10^5 \text{ J kg}^{-1}} = 0.225 \text{ kg}$		
	Total for question 15		**5**

Question Number	Answer		Mark
13(a)	Upthrust on airship is equal to the weight of the airship	(1)	
	(so) resultant force on the airship is zero (so airship floats in the air) **Or** (vertically) balanced forces act on the airship	(1)	2
	If neither MP seen, max 1 mark for statement indicating that upwards force is equal to downwards force.		
13(b)	Use of $pV = NkT$	(1)	
	Conversion of temperature to K	(1)	
	Use of $M = Nm$	(1)	
	$M = 1200$ kg	(1)	4
	Example of calculation $N = \frac{pV}{kT} = \frac{1.08 \times 10^5 \text{ Pa} \times 7020 \text{ m}^3}{1.38 \times 10^{-23} \text{ m}^2 \text{ kg s}^{-2} \text{ K}^{-1} \times (273 + 25) \text{ K}} = 1.84 \times 10^{29}$ $M = 1.84 \times 10^{29} \times 6.64 \times 10^{-27} \text{ kg} = 1220 \text{ kg}$		
	Total for question 13		**6**