01. 0625_s23_ms_42 Q: 4

Question	Answer	Marks
(a)	pressure decreases **AND** particles have smaller velocity / momentum / smaller E_K / kinetic energy (when temperature is lower)	**B1**
	lower rate / frequency of collision of particles	**B1**
	particles collide with smaller force **OR** smaller impulse change	**B1**

Question	Answer	Marks
(b)(i)	–273 (°C)	**B1**
(b)(ii)	(temperature at which) particles have least E_K / kinetic energy	**B1**
	lowest possible temperature	**B1**
(c)	200 cm^3	**A3**
	pV = constant **OR** $9.0 \times 10^4 \times 350 = 1.6 \times 10^5 \times V_2$	C1
	$V_2 = [9.0 \times 10^4 \times 350] / 1.6 \times 10^5$ **OR** $V_2 = 2.0 \times 10^N$ **OR** 1.97×10^N	C1

02. 0625_w23_ms_41 Q: 3

Question	Answer	Marks
(a)	particles (of liquid) are touching / close to each other	**B1**
	forces (of repulsion) between particles (of liquid) are large	**B1**
(b)(i)	$(\Delta p =)\ \rho g(\Delta)h$	**B1**
	1000 × 9.8 × 0.087 **OR** $(\Delta p =)$ 852.6 (Pa)	**B1**
(b)(ii)	12 N	**A2**
	$p = F / A$ **OR** $(F =)\ pA$ **OR** 850 × 0.014	C1
(b)(iii)	1.2 kg	**A2**
	$g = W / m$ **OR** $(m =)\ F / g$ **OR** 12 / 9.8	C1

03. 0625_w23_ms_43 Q: 4

Question	Answer	Marks
(a)(i)	absolute zero	**B1**
(a)(ii)	–196 (°C)	**A2**
	(absolute zero / 0 K) = –273 (°C)	C1
(b)	increased (pressure)	**B1**
	particles of gas move faster **OR** have more KE / momentum / velocity	**B1**
	any **two** from from: • more frequent collisions of particles (with walls) • particles collide (with walls) with a larger force **OR** larger impulse • (greater change in momentum of particles) causes greater force (on walls) • pressure = force / area	**B2**
(c)	(pressure =) 60 kPa **OR** 6.0×10^4 Pa	**A2**
	$p_1 V_1 = p_2 V_2$ **OR** (p_2 =) $p_1 V_1 / V_2$ **OR** pV = constant **OR** $p \propto 1 / V$ **OR** $1.2 \times 10^5 \times 0.5$ **OR** 6.0×10^n	C1

04. 0625_s22_ms_43 Q: 4

Question	Answer	Marks
(a)(i)	zig zag motion / random changes of direction	**B1**
	random length of path in each direction	**B1**

Question	Answer	Marks
(a)(ii)	any **four** from: • air molecules bombard smoke particles • air molecules are small (compared to smoke particles) / have small(er) mass • air molecules are very fast moving • air molecules move in random directions • (collisions exert unbalanced) forces on smoke particles	**B4**
(b)(i)	kinetic energy (and potential energy) of molecules increase (hence internal energy increases)	**B1**
(b)(ii)	bigger change in momentum of molecules OR molecules hit (the walls) harder	**B1**
	(molecules hit) more often / more frequently	**B1**

05. 0625_w22_ms_42 Q: 4

Question	Answer	Marks
(a)	*any three from*: • moving particles have momentum **OR** particles hit walls • momentum changes when particles hit walls • force exerted (by particles) due to (rate of) change of momentum • pressure is (total) force (of particles) per unit area (of wall).	**B3**
(b)	pressure increases	**M1**
	(there is a) greater change of momentum **OR** (particles exert) greater force (on same area) **OR** particles move faster **OR** particles have more KE	**A1**
(c)	(pressure =) 1.5×10^5 Pa	**A3**
	$p_1 V_1 = p_2 V_2$ **OR** (p_2 =) $p_1 V_1 / V_2$ **OR** pV = constant (for fixed m, fixed T)	C1
	(p_2 =) $9(.0) \times 10^4 \times 170 / 100$	C1

06. 0625_m21_ms_42 Q: 4

	Answer	Marks
(a)	molecules strike walls	**B1**
	momentum (of molecules) changes / momentum = mass × velocity	**B1**
	force = rate of change of momentum	**B1**
	pressure = (sum of) force(s) / area / pressure = rate of change of momentum / area	**B1**

	Answer	Marks
(b)(i)	(p_2=) p_1V_1 / V_2	**A2**
	$p_1V_1 = p_2V_2$	C1
(b)(ii)	great<u>er</u>	**B1**
	molecules move fast<u>er</u> / have great<u>er</u> KE / molecules have great<u>er</u> momentum	**B1**
	(leads to) <u>more</u> frequent / hard<u>er</u> collisions (with walls) / great rate of change of momentum	**B1**

07. 0625_s21_ms_41 Q: 3

	Answer	Mark
(a)	molecules (already very) close / touching	**B1**
	(repulsive) forces (very) large	**B1**
(b)(i)	6.5×10^5 Pa	**A3**
	(p =) F / A in any form **or** 8800 / 0.016 **or** (F_{air} =)$1.0 \times 10^5 \times 0.016$	**C1**
	5.5×10^5 **or** 5.5×10^5 (+ 1.0×10^5) **or** (1600 + 8800) / 0.016	**C1**
(b)(ii)	pressure due to (increased height of) oil in cylinder mentioned **or** pressure (in liquid) increases as depth increases	**B1**
	to keep the upwards force constant **or** to lift the (extra) oil **or** to counteract / oppose the increased pressure / force / weight of the oil	**B1**
(b)(iii)	(initial) force has to be greater than 8800 N to start the motion **or** the upwards force (just) balances the weight (so no movement) **or** piston / oil has weight **or** friction (between moving parts)	**B1**

08. 0625_w21_ms_41 Q: 3

Question	Answer	Marks
(a)	any **three** of: they / molecules collide with inner surface momentum (of a molecule) changes / reverses force exerted / impulse force spread over area / surface **or** $p = F / A$	**B3**
(b)(i)	$(V_2 =)\ p_1V_1 / p_2$ in any form **or** $630 \times 1.0 \times 10^5 / 1.4 \times 10^5$	**C1**
	$450\ cm^3$ **or** $4.5 \times 10^{-4}\ cm^3$ **or** $0.45\ dm^3$	**A1**
(b)(ii)	any **two** of: <u>molecules</u> move more slowly / have less kinetic energy pressure (inside balloon) decreases **or** pressure is directly proportional to temperature **or** $p \propto T$ volume is directly proportional to temperature **or** $V \propto T$ molecular collisions less frequent molecular collisions less violent / hard / exert smaller impulse water / external pressure compresses balloon **or** water pressure greater (and balloon compressed)	**B2**

09. 0625_w21_ms_43 Q: 3

Question	Answer	Marks
(a)(i)		**B2**
	pressure in a <u>liquid</u> increases with depth OR pressure decreases (as bubble rises)	B1
	pressure (of gas) is inversely proportional to volume OR internal pressure greater than external pressure (momentarily) OR (air) molecules do not have to hit surface of bubble as frequently (to stop the bubble collapsing) OR the bubble is not as strongly compressed	B1
(a)(ii)	$0.50\ cm^3$	**A4**
	PV = constant, in any form	C1
	P (due to water) = ρgh, in any form	C1
	$[1.0 \times 10^5 + (1000 \times 10 \times 3.0)] \times 0.40 = [1.0 \times 10^5 + (1000 \times 10 \times 0.5)] \times V_2$	C1
(b)		**B2**
	paper is not compressed as much / less force on piston B	B1
	air can be compressed OR some of the energy is used to compress the air (instead of the paper)	B1

10. 0625_w21_ms_43 Q: 4

Question	Answer	Marks
		B4
	(temperature of air increases) so molecules move faster / their <u>KE</u> increases	B1
	molecules collide <u>with walls</u> of container and <u>change</u> momentum	B1
	greater change of momentum when temperature is higher OR collisions more frequent OR harder collisions OR force = rate of change of momentum	B1
	(higher force and hence) higher pressure	B1

11. 0625_s20_ms_41 Q: 3

(a)	liquid levels in the two limbs of the tube are equal	B1
(b)	molecules collide with the walls (of the container)	B1
	momentum of molecules changes (reverses)	B1
	this causes a force AND force spread out (over area of walls)	B1
(c)(i)	$(p_2 =)\ p_1V_1 / V_2 = 1.0 \times 10^5 \times 60 / 50$	C1
	1.2×10^5 Pa	A1
(c)(ii)	$p_2 = p_{atm} + h\rho g$ OR $1.2 \times 10^5 - 1.0 \times 10^5$ OR 2.0×10^4 OR $(\rho =)\ 2.0 \times 10^4 / (0.15 \times 10)$	C1
	1.3×10^4 kg m^{-3}	A1

12. 0625_w20_ms_43 Q: 4

Question	Answer	Marks
(a)	A liquid B solid C gas	B2
(b)	average distance between molecules greater (in gas)	B1
	(attractive) forces between molecules lower or zero in gas	B1
(c)(i)	$p_1V_1 = p_2V_2$ in any form OR $0.9 \times 10^5 \times 3400 = 2.5 \times 10^5 \times V_2$	C1
	$(V_2 =)\ p_1V_1 \div p_2$ OR $(V_2 =)\ 0.9 \times 3400 \div 2.5$	C1
	1200 cm^3	A1
(c)(ii)	pressure increases	B1
	molecules move / collide faster OR have greater momentum	B1
	molecules collide more frequently (with piston) OR with greater change in momentum	B1

13. 0625_m19_ms_42 Q: 5

(a)	0 °C and 100 °C	B1
(b)(i)	**1** Has uniform / linear expansion OR Has equal expansion for each degree of temperature rise	B1
	2 Has <u>capillary</u> / <u>tube</u> of constant cross-sectional area / diameter / radius / bore / width / thickness	B1
(b)(ii)	(Compared with thermometer B) A has a <u>capillary</u> / <u>tube</u> of greater cross-section / diameter / radius / width OR A contains a liquid with less expansion per degree / unit temp. rise OR A is longer than B OR A has a smaller bulb	B1
(b)(iii)	(Compared with thermometer D) C (has capillary / tube that is) narrower / of smaller cross-section / thinner OR has a larger bulb OR bulb containing more liquid OR contains a liquid with greater expansion per degree / unit temp. rise OR contains alcohol instead of mercury	B1

(c)(i)	Diagram to show: Three wires labelled e.g. copper, iron, copper or with symbols for metals OR metal A, metal B, metal A	B1
	One junction between different metals	B1
	Connections to voltmeter / ammeter / galvanometer identified by V, A, G, mV, mA or arrow in a circle	B1
(c)(ii)	Measurement of: a (very) high or (very) low temperature OR a rapidly varying temperature OR a high range of temperature If values given, more than 300 °C; less than –200 °C	B1

14. 0625_m19_ms_42 Q: 7

(a)	**1.** Solid to liquid	B1
	2. Liquid to gas / vapour	B1
(b)	(Neighbouring) molecules of solid have (strong) forces of attraction between them OR Gas molecules have no / weak forces of attraction between them	B1
	Easier to increase separation of gas molecules (than solid molecules) (gas expands more easily so) gas molecules move farther apart	B1
(c)	PV = constant OR $P_1V_1 = P_2V_2$ OR $0.012 \times 1.8 \times 10^6 = V_2 \times 1.0 \times 10^5$	C1
	$V_2 = 0.216\ m^3$ OR $0.22\ m^3$	A1
	(Volume of escaped gas = 0.22 – 0.012 =) $0.21\ m^3$	B1

15. 0625_s19_ms_41 Q: 3

(a)	(air) molecules / they move / collide	B1
	(air) molecules / they collide with cube / (upper) surface (of cube) / wall	B1
	impulse exerted (on surface) **OR** momentum change (of molecules)	B1
(b)(i)	$p = h\rho g$ in any form **OR** ($p =$) $h\rho g$ **OR** $0.028 \times 1500 \times 10$	C1
	420 Pa	A1
(b)(ii)	$F = pA$ in any form words, symbols or numbers **OR** ($F =$) pA **OR** 420×4.0^2 **OR** 420×0.040^2 **OR** 420×16 **OR** $420 \times 1.6 \times 10^{-3}$	C1
	0.67 N	A1
(c)(i)	$W = Fd$ in any form words, symbols or numbers **OR** ($W =$) Fd **OR** 0.67×0.034	C1
	0.023	A1
(c)(ii)	lifting liquid as well **OR** friction between liquid and container / pipe	B1

16. 0625_w19_ms_41 Q: 3

(a)	force × time (for which it acts)	B1
(b)(i)	$v = I/m$ **or** 0.019 / 0.00011 in any form words, symbols or numbers **or** (v =) I/m 170 m / s	C1 A1
(b)(ii)	$KE = ½mv^2$ in any form words, symbols or numbers **or** (KE =) $½mv^2$ $0.50 \times 0.00011 \times 170^2$ 1.6 J **or** 1.7 J	C1 C1 A1
(c)	**accept** reverse comments if clearly about how the molecular structure of a solid differs from that of a liquid (molecules / they) have an irregular arrangement / not ordered / random arrangement (molecules / they) are (slightly) further apart (on average) (molecules / they are) not fixed in place	 B1 B1 B1

17. 0625_w19_ms_42 Q: 3

(a)	they / molecules collide with walls	B1
	change of momentum causes force (to be exerted on walls)	B1
	pressure = force / area (so pressure is exerted on walls)	B1
(b)	pV = constant or $p_1 V_1 = p_2 V_2$ in any form	C1
	$p_1 \times 820 = 20\,000 \times 330$ OR (p_1 =) $20\,000 \times 330 / 820$	C1
	(p_1 =) 8000 Pa	A1

18. 0625_w19_ms_43 Q: 4

	Solids – molecules in lattice arrangement	B1
	solids – strong forces between molecules	B1
	liquids – molecules not fixed in place OR molecules have an irregular arrangement OR molecules (slightly) further apart (on average) than in solids OR spaces between the molecules	B1
	liquids – (average) forces too weak to keep molecules in a definite pattern OR forces just enough to hold molecules in the bulk of the liquid	B1
	gases – molecules far apart	B1
	gases – weak / no forces between molecules (except during collisions)	B1

19. 0625_m18_ms_42 Q: 5

(a)(i)	Sketch showing straight lines with sudden changes of direction	B1
(a)(ii)	Any 3 marks from 4 points:	
	Air molecules move in random / different directions	B1
	Smoke particles are hit	B1
	by air molecules	B1
	Change direction at each collision OR undergo Brownian motion	B1
(b)	F = (mv – mu) / t in any form OR Impulse = mv – mu	C1
	$= 20 \times 4.2 / 60$	C1
	1.4 N	A1

20. 0625_s18_ms_41 Q: 4

(a)(i)	(Molecules) vibrate	**1**
(a)(ii)	random/haphazard/in all directions	**1**
	Any **one** of: with high speed freely zig-zag in straight lines	**1**
(b)	(Molecules) collide with walls (of box) **OR** (Molecules) rebound from walls (of box)	**1**
	Change of momentum (occurs)	**1**
	force (on walls) = (total) change of momentum per second	**1**
	Pressure = (total) force ÷ (total) area (of walls)	**1**

21. 0625_s18_ms_42 Q: 4

(a)(i)	atoms drawn close to each other and in rows	**1**
(a)(ii)	atoms drawn far apart and randomly positioned	**1**
(b)(i)	(atoms) vibrate/oscillate	**1**
(b)(ii)	attractive forces between atoms/molecules (in the rock) **OR** energy/work to separate atoms/molecules	**1**
	force (applied must be large enough) to overcome forces between atoms/molecules **OR** work/energy (large) enough to separate atoms/molecules	**1**
(c)	helium spreads/diffuses/moves freely/collides with air (molecules)	**1**
	the helium atoms travel in all directions/randomly/at high speed	**1**
	OR helium rises	**(1)**
	helium has low density **OR** He atoms high speed	**(1)**

22. 0625_s18_ms_43 Q: 3

(a)(i)	(p =) $h \times \rho \times g$ or $5.0 \times 1000 \times 10$	**C1**
	50 000 (Pa)	**C1**
	(total pressure = 50 000 + 1.0×10^5 =) 1.5×10^5 Pa	**A1**
(a)(ii)	1.5×10^5 Pa	**B1**
(b)	(rises because) density of gas is less than density of **OR** resultant upward force on bubble	**B1**
	(as bubble rises) pressure (of gas in bubble) decreases	**B1**
	(volume of bubble increases because) $p \times V$ = constant **OR** $V \propto 1 \div p$	**B1**

23. 0625_s18_ms_43 Q: 5

(a)(i)	path shows three or more straight line sections	B1
	with sudden changes of direction **and** at least two different lengths	B1
(a)(ii)	air molecules travelling in random (directions)	B1
	collide with the smoke particle	B1
(b)	(average) speed of the molecules decreases	B1
	molecules collide less often (on the piston and the walls of the cylinder)	B1
	smaller momentum change molecules (on collision)	B1
	piston now has a greater force on its right-hand side **OR** pressure less than atmospheric	B1

24. 0625_s17_ms_42 Q: 4

(a)	impulse/change of momentum (of molecules) during collision	B1
	{force (to change momentum) of molecules OR molecules hitting walls} (causes pressure)	B1
(b)	more (frequent) collisions with walls	B1
	greater (total) force (caused by molecules) OR reduced area OR grater (rate) change of momentum (of molecules)	B1
(c)	$p_1V_1 = p_2V_2$ in any form OR (p_2 =) p_1V_1 / V_2	C1
	($p_2 = 500 \times 1.1 \times 10^5 / 200$ =) 2.8×10^5 Pa	A1
	Total:	**6**

25. 0625_s17_ms_43 Q: 6

(a)	molecules/they move/collide	B1
	molecules/they move/collide with walls	B1
	change of momentum OR force on area	B1
(b)(i)	pV = constant OR $p_1V_1 = p_2V_2$	B1
(b)(ii)1	100 (kPa) OR 1.0×10^5 (Pa)	M1
	Pa OR kPa	A1
(b)(ii)2	(p =)50 (kPa)	C1
	3700 m < p < 3900 m	A1
	Total:	**8**

26. 0625_w17_ms_41 Q: 4

(a)	Atoms collide with wall (and rebound) OR atoms rebound from wall	**B1**
	(Atoms) undergo change of momentum	**C1**
	Force on wall = (total) rate of change of momentum (of atoms) OR = change of momentum (of atoms) per second OR = change of momentum (of atoms) / time	**A1**
(b)(i)	Fewer atoms per unit volume OR density of gas less	**B1**
	Rate of collision (with walls of balloon) decreases OR Fewer collisions per unit area	**B1**
(b)(ii)	PV = constant OR $P_1V_2 = P_2V_2$ OR (P_2 =) P_1V_1 / V_2 OR $1.0 \times 10^5 \times 9.6 / 12$	**C1**
	8.0×10^4 Pa	**A1**

27. 0625_w17_ms_43 Q: 4

(a)	molecules of solid arranged in lattice / in organised pattern / without gaps / orderly / fixed structure	**B1**
(b)(i)	glass heated first **or** at first liquid not heated / does not expand / takes time (to heat up) **or** glass poor conductor	**B1**
	glass expands	**B1**
	capacity / volume of flask increases	**B1**
(b)(ii)	liquid (starts to) warms up	**B1**
	liquid expands more than the solid / glass	**B1**