Q1.

2	(a)	speck of light	B1	
		that moves haphazardly/randomly/jerkily/etc.	B1	[2]
	(b)	randomness of collisions would be 'averaged out'	B1	
		so less (haphazard) movement	B1	[2]
		(do not allow 'more massive so less movement')		

Q2.

3	(a)	sum of (random) kinetic and potential energies	M1	
		of the atoms/molecules of the substance	A1	[2]
	(b) (i)	potential energy unchanged as atoms remain in same positions	M1	
		allow 'reduced because atoms slightly closer together'		
		vibrational kinetic energy reduced because temperature lower	M1	
		so internal energy less	A1	[3]
	(ii)	potential energy increases because separation increases	M1	
		kinetic energy unchanged because temperature unchanged	M1	
		so internal energy increases	A1	[3]

Q3.

4	(a)	mass per unit volume (*ratio idea must be clear, not units*)	B1	[1]
	(b) (i)	pressure is same at the surface of mercury		
		because at same horizontal level	B1	[1]
	(ii)	$h\rho g$ is same for both	B1	
		$53 \times 10^{-2} \times 1.0 \times 10^{3} \times g = 71 \times 10^{-2} \times \rho \times g$	C1	
		$\rho = 7.5 \times 10^{2}$ kg m^{-3}	A1	[3]

Q4.

3	(a)	mass / volume (ratio idea essential)	B1	[1]
	(b) (i)	mass = $Ah\rho$	B1	[1]
	(ii)	pressure = force/area	B1	
		weight (of liquid)/force (on base) = $Ah\rho g$	B1	
		pressure = $h\rho g$	A0	[2]
	(c) (i)	ratio = 1600 or 1600:1	A1	[1]
	(ii)	ratio = $\sqrt[3]{1600}$	C1	
		= 11.7 (*allow 12*)	A1	[2]

(d) (i) density of solids and liquids are (about) equal — B1 [1]

(ii) strong forces: fixed volume — B1
rigid forces: retains shape / does not flow / little deformation — B1 [2]
(allow 1 mark for fixed volume, fixed shape)

Q5.

4 (a) (i) solid has fixed volume and fixed shape/incompressible — B1 [1]

(ii) gas fills any space into which it is put — B1 [1]

(b) atoms/molecules have (elastic) collisions with the walls (of the vessel) — B1
momentum of atom/molecule changes — B1
so impulse (on wall)/force on wall — B1
random motion/many collisions (per unit time) gives rise to (constant) force/pressure — B1 [4]

(c) spacing (much) greater in gases than in liquids/about ten times — C1
either spacing depends on $1/\sqrt[3]{\rho}$
or ratio of spacings is about 8.8 — A1 [2]

Q6.

6 (a) any two of:
large number of molecules / atoms / particles
molecules in random motion
no intermolecular forces
elastic collisions
time of collisions much less than time between collisions
volume of molecules much less than volume of containing vessel — B1 + B1 [2]

(b) molecules collide with the walls
change in momentum of molecules implies force (on molecules)
molecules exert equal and opposite force on wall
pressure is averaging effect of many collisions
(*any three statements, 1 each*) — B3 [3]

Q7.

7	**(a)**	density in solids and liquids similar	M1	
		spacing in solids and liquids about the same	A1	
		density in gases <u>much</u> less as spacing in gases much greater	B1	[3]
	(b)	density = mass / volume	C1	
		mass = 1.67×10^{-27} kg and volume = $4/3\ \pi\ r^3$	C1	
		density = $(1.67 \times 10^{-27}) / 4/3 \times \pi \times (1.0 \times 10^{-15})^3$		
		= 3.99×10^{17} kg m^{-3}	A1	[3]
	(c)	atoms / molecules composed of large amount of empty space / nucleus has very small volume compared to volume of atom / space between atoms in a gas is very large	B1	[1]

Q8.

3	**(a)**	$V = h \times A$		
		$m = V \times \rho$	B1	
		$W = h \times A \times \rho \times g$	B1	
		$P = F / A$	B1	
		$P = h\rho g$		
		P is proportional to h if ρ is constant (and g)	B1	[4]
	(b)	density changes with height	B1	
		hence density is not constant with link to formula	B1	[2]

Q9.

4	**(a)**	pressure = force / area (normal to force)	A1	[1]
	(b)	molecules/atoms/particles in (constant) random/haphazard motion	B1	
		molecules have a <u>change</u> in momentum when they collide with <u>the walls</u>	M1	
		(force exerted on molecules) therefore force on the walls	A1	
		reference to average force from many molecules/many collisions	A1	[4]
	(c)	elastic collision when <u>kinetic</u> energy conserved	B1	
		temperature constant for gas	B1	[2]

Q10.

4	**(a)**	apparatus: cell with particles e.g. smoke (container must be closed)		B1	
		diagram showing suitable arrangement with light illumination and microscope		B1	[2]
	(b)	specks / flashes of light		M1	
		in random motion		A1	[2]
	(c)	cannot see what is causing smoke to move hence molecules smaller than smoke particles		(B1)	
		continuous motion of smoke particles implies continuous motion of molecules		(B1)	
		random motion of particles implies random motion of molecules		(B1)	
				max. 2	[2]

Q11.

5	**(a)**	metal: crystalline / lattice / atoms in regular pattern		B1	
		(atoms in regular) pattern that repeats itself (within crystal)		B1	[2]
		polymer: long chains of atoms / molecules		B1	
		chain consists of 'units' that repeat themselves		B1	[2]
	(b) **(i)**	e.g. latex is soft / not strong / flows / ductile		B1	
		elastic limit easily exceeded		B1	[2]
		(*allow any two sensible comments, 1 each*)			
	(ii)	more solid / does not flow / stronger / higher ultimate tensile stress			
		more brittle			
		elastic limit much higher			
		increased toughness			
		(*any two, 1 each*)		B2	[2]

Q12.

5	**(a)**	haphazard / random / erratic / zig-zag movement		M1	
		of (smoke) particles (*do not allow molecules / atoms*)		A1	[2]
	(b)	motion is due to unequal / unbalanced collision rates (on different faces)		B1	
		(unequal collision rate due to) random motion of (gas) molecules / atoms		B1	[2]
	(c) *either*	collisions with air molecules average out		M1	
		this prevents haphazard motion		A1	[2]
	or	particle is more massive / heavier / has large inertia	(M1)		
		collisions cause only small movements / accelerations	(A1)		

Q13.

2 **(a)** **(i)** e.g. (phase) change from liquid to gas / vapour
thermal energy required to maintain constant temperature ..... B1 [1]
(*do not allow 'convert water to steam'*)

(ii) e.g. evaporation takes place at surface B1
boiling takes place in body of the liquid B1
e.g. evaporation occurs at all temperatures B1
boiling occurs at one temperature ..... B1 [4]

(b) **(i)** volume = $(\frac{48}{4.5}=)$ 10.7 cm^3 ..... A1 [1]

(ii) **1** volume = $10.7 / (6.0 \times 10^{23})$
= 1.8×10^{-23} cm^3 ..... A1 [1]
2 separation = $\sqrt[3]{(1.8 \times 10^{-23})}$
= 2.6×10^{-8} cm ..... A1 [1]

[Total: 8]

Q14.

2 crystalline: atoms / ions / particles in a regular arrangement / lattice
long range order / orderly pattern B1
(lattice) repeats itself (1)
polymer: long chain molecules / chains of monomers B1
some cross-linking between chains / tangled chains (1)
amorphous: disordered arrangement of molecules / atoms / particles B1
any ordering is short-range (1)
(*three 'B' marks plus any other 2 marks*) B2 [5]

Q15.

1 **(a)** density = mass / volume B1 [1]

(b) density of liquids and solids same order as spacing similar / to about 2× density of gases much less as spacing much more B1
or density of gases much lower hence spacing much more B1 [2]

(c) **(i)** density = $68 / [50 \times 600 \times 900 \times 10^{-9}]$ C1
= 2520 (allow 2500) kg m^{-3} A1 [2]

(ii) $P = F / A$ C1
$= 68 \times 9.81 / [50 \times 600 \times 10^{-6}]$ C1
$= 2.2 \times 10^4$ Pa A1 [3]

Q16.

3 **(a)** pressure = force / area B1 [1]

(b) molecules collide with object / surface and rebound B1
molecules have change in momentum hence force acts B1
fewer molecules per unit volume on top of mountain / temperature is less hence lower speed of molecules B1
hence less pressure A0 [3]

(c) **(i)** $\rho = m / V$ C1
$W = V\rho g = 0.25 \times 0.45 \times 9.81 \times 13600$ C1
$= 15000$ (15009) N A1 [3]

(ii) $p = W / A$ (or using $p = \rho g h$) $= 15009 / 0.45$
$= 3.3 \times 10^4$ Pa A1 [1]

(iii) pressure will be greater due to the air pressure (acting on the surface of the liquid) B1 [1]

Q17.

3 **(a)** metal: regular / repeated / ordered arrangement / pattern / lattice or long range order (of atoms / molecules / ions) B1
polymer: tangled chains (of atoms / molecules) or long chains (of atoms / molecules / ions) B1
amorphous: disordered / irregular arrangement or short range order (of atoms / molecules / ions) B1 [3]

(b) metal: straight line or straight line then curving with less positive gradient B1
polymer: curve with decreasing gradient with steep increasing gradient at end B1 [2]

Q18.

1 volume = $\pi (14 \times 10^{-3})^2 \times 12 \times 10^{-3}$ ($=7.389 \times 10^{-6}$ m^3) C1
density = mass / volume [any subject] C1
mass = $6.8 \times 10^3 \times 7.389 \times 10^{-6} = 0.0502$
weight = mg C1
$= 0.0502 \times 9.81 = 0.49$ N (mark not awarded if not to **two** s.f.) A1 [4]