

PHYSICS



EXAM QUESTION PACK

P1.3 PRESSURE

SCORE

/52

PERCENTAGE

%

STEMUP

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Gateway Physics A (9-1)

Pressure

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate
forename

Candidate
surname

Centre number

Candidate number

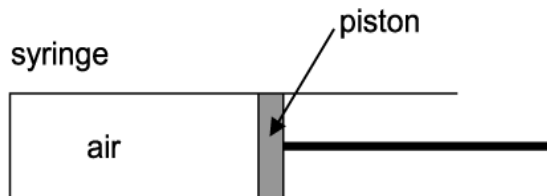
INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **52**.
- The total number of marks may take into account some 'either/or' question choices.

- 1 A syringe contains air.



The piston is pushed inwards.

How do the pressure and volume of the air in the syringe change?

	Pressure	Volume
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Your answer

[1]

- 2 A sealed can contains gas.

The can is heated and the pressure of the gas increases.

How do the gas particles cause this increase in pressure?

- A Their average distance apart increases.
- B They expand.
- C They hit each other more frequently.
- D They hit the can more frequently.

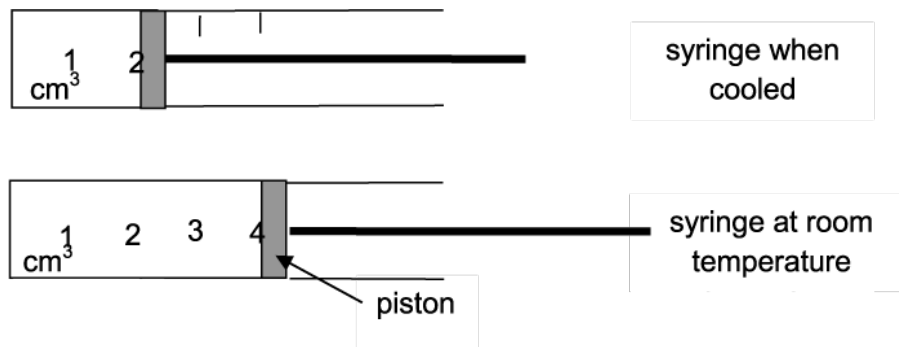
Your answer

[1]

3 A graduated syringe contains air.

It is put in a freezer to cool it down.

When it is removed from the freezer the piston has moved inwards.



The density of the air in the syringe when cooled is 2.4 kg/m^3 .

What was the density of the air at room temperature?

- A 0.6 kg/m^3
- B 1.2 kg/m^3
- C 2.4 kg/m^3
- D 4.8 kg/m^3

Your answer

[1]

4(a) A depth of 10 m of water exerts the same amount of pressure as the entire Earth's atmosphere which is ~ 120 km thick.

Suggest why.

[1]

(b) A diver takes some pressure readings.

Their results are in the table below.

Depth of water (m)	Pressure (standard units)
0	1
10	2
20	3
30	4
40	5
50	6

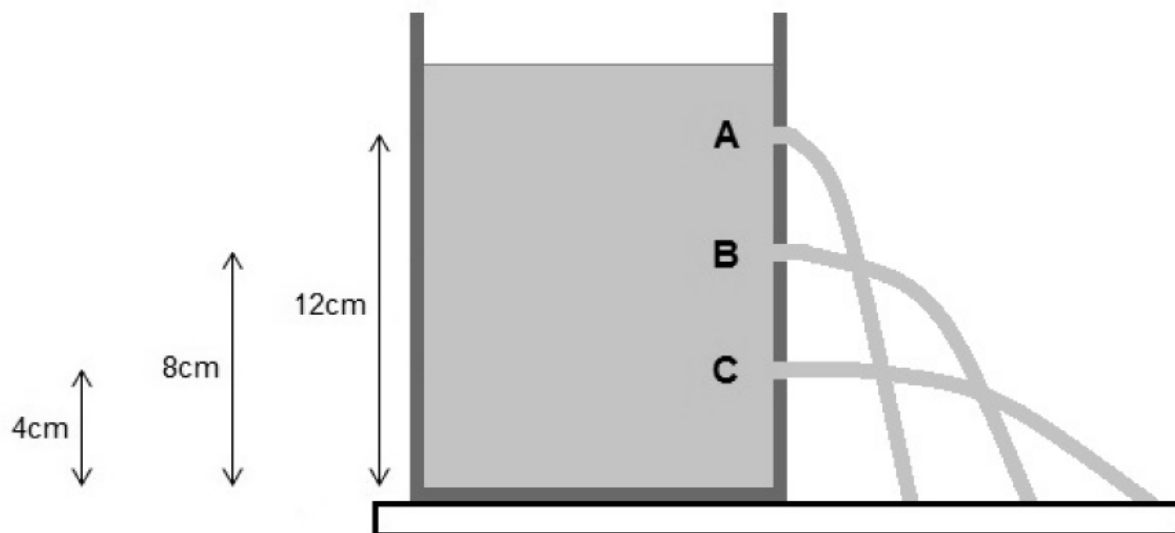
Use the data to describe the relationship between the depth of water and pressure.

[2]

(c) Suggest why there is pressure at 0 metres.

[1]

(d) A container of vegetable oil has 3 holes in it.



The vegetable oil has a density of $9.1 \times 10^2 \text{ kg/m}^3$.

Calculate the change in pressure from A to B.

Show your working and give your answer to 2 significant figures.

answer: _____ Pa

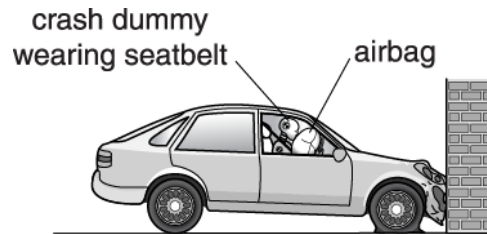
[4]

5 Scientists check the safety of cars by doing crash tests with crash dummies.

They use sensors to make measurements.

They put the sensors in the car and on the crash dummy.

Look at the diagram of a car crashing into a wall.



When the car hits the wall, a sensor triggers the fast release of a large amount of gas into the airbag.

The gas particles cause the airbag to inflate.

Explain, using ideas about momentum, how the gas particles create enough force to increase the pressure in the airbag.

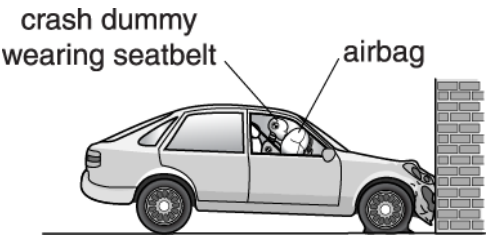
[2]

6(a) Scientists check the safety of cars by doing crash tests with crash dummies.

They use sensors to make measurements.

They put the sensors in the car and on the crash dummy.

Look at the diagram of a car crashing into a wall.



The crash dummy wears a seatbelt.

Just after the crash the dummy moves forward. A force then acts on the dummy.

What produces this force and what does the force do to the dummy's motion?

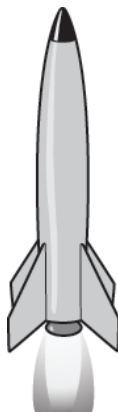
----- [1]

(b) On impact the airbag quickly inflates with gas.

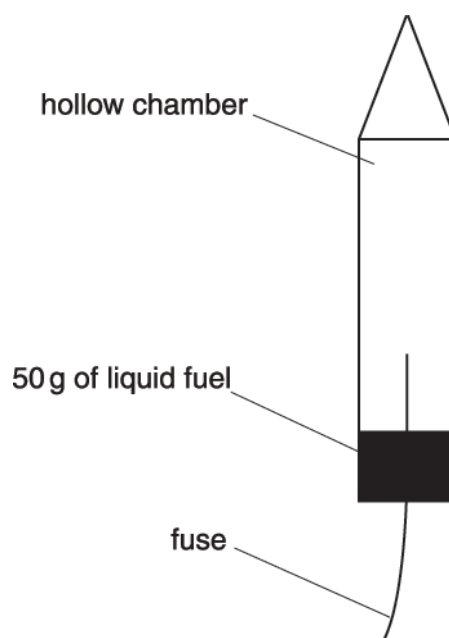
Explain how the gas particles produce a pressure to inflate the airbag.

----- [2]

7(a) Rockets use hot gases to make them move.



Look at the diagram of a simple rocket.



Denise lights the fuse of the rocket. The 50 g of fuel in the rocket ignites.

A very fast chemical reaction takes place which creates a large amount of hot gas.

The gas fills the hollow chamber.

The hot gas produces a high pressure inside the rocket.

Explain how the particles in the hot gas produce a high pressure in the rocket, making it move.

[2]

- (b) Denise re-launches the same rocket.

This time, the rocket contains 100 g of the same type of fuel.

The rocket lifts off and reaches a greater height than before.

Suggest why using more fuel produces a greater force and acceleration on the rocket.

[1]

- 8 These statements are about pressure and volume of a gas.

Which statement is correct?

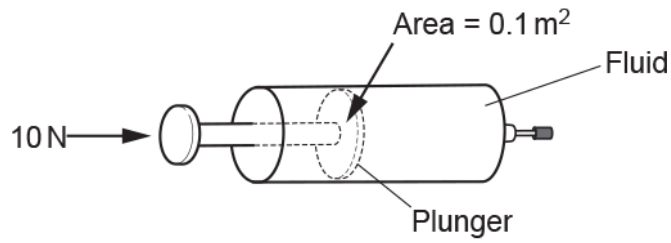
- A Volume doubles, pressure doubles
- B Volume doubles, pressure halves
- C Volume halves, pressure halves
- D Volume halves, pressure stays constant

Your answer

☐

[1]

- 9 A student tries to compress the fluid in a sealed syringe with a force of 10 N.



The area of the end of the syringe is 0.1 m^2 .

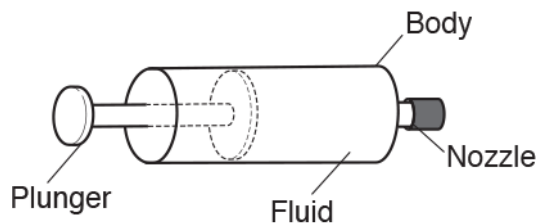
- (i) Calculate the pressure in the fluid.

Answer = ... Pa [3]

- (ii) Write down the direction of the force produced by the fluid on the plunger.

----- [1]

- 10 A fluid is compressed by pushing the plunger into the body of a sealed syringe.



Which of these statements is true?

- A There is a net force towards the plunger.
- B There is no force towards the nozzle.
- C There is a force parallel to all points on the surface of the fluid.
- D There is a force at 90° to all points on the surface of the fluid.

Your answer

☐

[1]

- 11 *The Earth contains a crust, mantle and core as shown in Fig. 22.1.

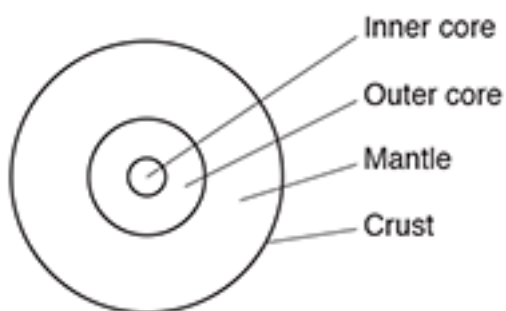


Fig. 22.1

Table 22.1 gives some data about seismic waves and the Earth.

	Density (g / cm^3)	P wave speed (km / s)	S wave speed (km / s)
Top of crust	2.2	5.55	3.25
Top of mantle	3.4	7.97	4.55
Top of outer core	9.9	8.10	-
Bottom of outer core	12.2	10.30	-

Describe what information the data in **Table 22.1** gives about the structure of the Earth.

In your answer you should explain any trends in the data in **Table 22.1**.

[6]

12 Which factor influences whether an object floats or sinks?

- A Size of object
- B Depth of water
- C Distance from the shore
- D Density of object

Your answer

[1]

13(a) A student investigates four gases.

Look at her data.

Gas	Pressure (Pa)	Volume (m ³)
A	5	0.5
B	10	0.4
C	20	0.2
D	40	0.2

Two readings are for the same mass of the same gas at a constant temperature.

Which two readings are for the **same mass** of the **same gas** at a constant temperature?

Use calculations in your answer.

[3]

(b) The student investigates another gas at **constant volume**.

Explain, using ideas about particles, how temperature affects gas pressure.

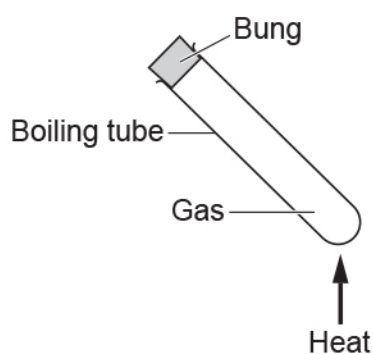
[3]

(c) Calculate the pressure at the bottom of a 0.5 m tall measuring cylinder filled with a liquid.

Density of the liquid = 1100 kg / m^3 .

Pressure = ... Pa [3]

14 A sealed boiling tube contains gas.



The boiling tube is heated.

What happens?

- A The particles in the gas evaporate.
- B The particles in the gas expand.
- C The particles in the gas move faster.
- D The particles in the gas move slower.

Your answer

[1]

15 A cylinder contains a gas.

The volume of the gas is halved and the temperature remains the same.

What happens to the pressure of the gas?

- A It remains the same.
- B It halves.
- C It doubles.
- D It quadruples.

Your answer

[1]

16 Which statement explains why atmospheric pressure changes as you climb up a mountain?

- A Number of air molecules above you decrease the further you move from the centre of the Earth.
- B Density of air increases the further you move from the centre of the Earth.
- C Gravity increases the further you move from the centre of the Earth.
- D Temperature decreases the further you move from the centre of the Earth.

Your answer

[1]

17 What is the change in pressure when a diver moves from a depth of 3.0 m to a depth of 8.0 m?

Assume gravitational field strength on Earth = 10 N / kg and water density = 1000 kg / m^3 .

Use an equation from the data sheet to help you.

- A 30 000 Pa
- B 50 000 Pa
- C 80 000 Pa
- D 110 000 Pa

Your answer

[1]

- 18 A boat can be made out of concrete.
Explain why a concrete boat floats but a lump of concrete sinks.

[3]

- 19(a) Complete the sentences to explain how volume and pressure are related.

Use words from the list.

You can use each word once, more than once, or not at all.

doubled halved the same

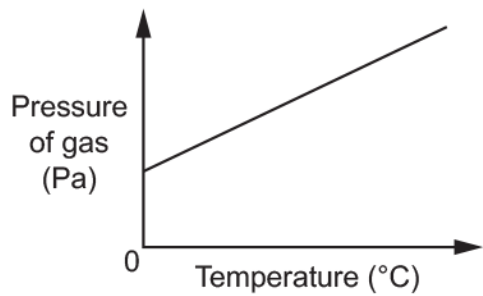
If the volume of a gas is halved, the number of collisions per second between the gas

particles and the container is

The pressure is

[2]

- (b) A student investigates how temperature and pressure of a gas are linked. The student measures the pressure of a gas as its temperature increases. The results are plotted on a graph.



Explain how temperature and pressure are linked.

Use the graph to support your answer.

[2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			C	1	
			Total	1	
2			D	1	
			Total	1	
3			B	1	
			Total	1	
4	a		Water is much denser than air / AW (1)	1	
	b		Pressure increases as depth increases (1) Each 10 metres of depth increases pressure by 1 AW (1)	2	ALLOW direct / linear relationship
	c		It is the pressure of the atmosphere / AW (1)	1	
	d		Recall of 'g' (1) Substitution into equation (1) 364 / 360 (1) 2 significant figures quoted / 360 (1)	4	9.8 or 10 m/s ² ALLOW 356.72 (3)
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5			any two from (fast air) particles hit bag (causing force) [1] (more) frequent collisions (with wall of bag) [1] change in momentum causes a force / pressure [1] BUT change in momentum of particles (hitting the bag) causes a force / pressure [2]	2	ignore collisions between air particles ignore references to momentum of car allow $\text{force} = \frac{\text{change in momentum}}{\text{time}}$ [1] Examiner's Comments This answer relied on a qualitative understanding of how particles create pressure on the walls of an air bag. Most candidates did not refer to collisions with the bag and very few gave the idea of increased collisions. Momentum changes were rarely mentioned with clarity. Weaker answers mixed up the collision of the car with the particles in the bag. They often thought that the momentum from the car crash directly filled the air bag with gas. Good answers described the particles as colliding with the walls of the bag and this change in momentum provided a force which pushes the bag out. Some used the formula $\text{force} = \text{rate of change of momentum}$ and structured their answers around it.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6	a		idea that the force is caused by the seat belt slowing the dummy down [1]	1	allow air bag or steering wheel or dash board or windscreen stops slows down the dummy [1] Examiner's Comments This about the action of safety features in a car was not well answered across the ability range Very few recognised that the force applied by the seat belt or air bag slowed he passenger down. Many answers were poorly described in terms of the dummy jolting forwards.
	b		particles move/ AW or spread out [1] particles hit inside (surface) of airbag / AW [1]	2	allow moving particles push the bag outwards [2] Examiner's Comments This about the action of safety features in a car was not well answered across the ability range Most candidates had little idea about the kinetic theory of gases when applied to an air bag. This area was very unfamiliar to almost all candidates.
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a		particles hit rocket walls / AW (1) causing force / thrust / AW (1)	2	But particles colliding with each other (0) Allow particles collide with each other and walls (1) ignore pressure / upthrust Reward higher level answers in terms of action and reaction: eg particles move downwards to produce an equal and opposite force on the rocket (2) Examiner's Comments Many mentioned collisions of gas particles but avoided the key idea of particles colliding with the rocket walls [1] thereby producing a force [1].
	b		more force and acceleration because of: • more frequent collisions / more energetic collisions / twice as many collisions (1) or • faster particles / more particles / more energy / more momentum (1)	1	but more frequent collisions between gas particles scores (0) allow more frequent collisions between gas particles and walls (1) allow higher level answers in terms of kinetic theory (1) ignore pressure ignore more gas allow force applied for longer giving greater acceleration (1) Examiner's Comments Most gained the mark here by explaining in terms of more particles or energy [1].
			Total	3	
8			B ✓	1 (AO1.2)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
9		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (Pa) award 3 marks pressure = force ÷ area ✓ = 10 ÷ 0.1 ✓ = 100 (Pa)✓	3 (AO1.2) (AO2.1) (AO2.1)	<u>Examiner's Comments</u> Many candidates were not able to recall the equation $P = F/A$. Some candidates did recall the equation and correctly calculated the pressure in the fluid as 100 Pa. A common misconception was using the equation $P = F \times A$ to calculate the pressure as 1 Pa.
		ii	at right angles/perpendicular/90° (to the plunger)	1 (AO1.1)	ALLOW to the left opposite to the force from the plunger <u>Examiner's Comments</u> Many answers here bore no relationship to the diagram: Any clear indication of direction including 'left' or 'at right angles' or 'perpendicular/90° to the plunger' were accepted. Ambiguous and inappropriate directions such as 'to the east' were not credited.
			Total	4	
10			D ✓	1 (AO1.2)	<u>Examiner's Comments</u> About two thirds of candidates gave the correct answer D. A common incorrect response was 'C'.
			Total	1	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
11	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed description of the structure of the Earth AND Detailed explanation of the trends in Table 22.1. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Description of the structure of the Earth. AND Explanation of the trends in Table 22.1. OR Detailed description of the structure of the Earth. OR Detailed explanation of the trends in Table 22.1. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) A basic description of the structure of the Earth. OR A basic description of the trends in Table 22.1. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6 (AO 2×3.1a) (AO 2×3.2a) (AO 2×2.1)	AO3.1a Analyse information and ideas to interpret some basic trends in data • density increases as depth increases • speed (of P/S waves) increases as density increases • speed (of P/S waves) increases as depth increases AO2.1 Apply knowledge and understanding of scientific ideas to explain trends in the data • Earth contains layers • velocity changes at a boundary • as density changes at a boundary • particles more tightly packed • P is longitudinal, S is transverse AO3.2a Analyse information and ideas to make judgements about the structure of the Earth • core has highest density • core has highest speed for P waves • S waves do not travel through the core • so the outer core is a liquid • pressure highest in core / $P = \rho gh$ • pressure and so density increase with depth • large change in density between mantle and outer core <u>Examiner's Comments</u> This was the Level of Response question, targeted up to Grade 9, and assessed AO2 and AO3. There was a wide range of marks achieved and the question discriminated well. Very few candidates did not achieve any credit. The majority of candidates were able to describe some basic trends in the table for density and speed of P and S waves. More detailed responses also included a description of the structure of the Earth for Level 2.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					Many excellent responses from the more able candidates at Level 3 included: • trends in the data identified and explained • linking facts about P and S waves to an explanation of why the outer core is liquid. Poor quality of communication, including contradictions or the same facts repeated a number of times, prevented some candidates from achieving a higher mark. Exemplar 2 Describe what information the data in Table 22.1 gives about the structure of the Earth. In your answer you should explain any trends in the data in Table 22.1. P waves are longitudinal and travel through both solid and liquids but S waves are transverse and only travel through solids. There is no data for the wave speed of S waves through the top of the outer core and the bottom so the core must be made of liquid, however both waves can travel through the crust and the mantle as there is data for ^{speed through} them. The density of the layers of the earth decreases down the table so the density of the earth must decrease from the surface of the crust to the centre of the inner core. The speed of both P waves and S waves increase down the table as well. P waves travel faster in denser material as the particles are closer together so they carry the wave to each other faster. ^{analysing the data} therefore backs up that the density of the earth increases towards the centre. This response achieved Level 3, 6 marks. The candidates included a detailed description of the structure of the Earth, including ideas about density and the liquid outer core. There is also a detailed explanation of the trends shown in the table.
			Total	6	
12			D ✓	1 (AO1.1)	Examiner's Comments This was well known by nearly all candidates who gave D as their answer.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13	a		Pressure is inversely proportional to volume OR $pV = \text{constant}$ for a particular gas OR for any of the gases calculation of $p \times V$ ✓ For gas B: $10 \times 0.4 = 4$ <u>and</u> for gas C: $20 \times 0.2 = 4$ OR Pressure of C is double the pressure of B <u>and</u> volume of C is half the volume of B ✓ B and C ✓	3 (AO3.2b) (AO3.1a) (AO3.2b)	NOTE could be written next to table <u>Examiner's Comments</u> This question required candidates to use the data in the table which was generally well answered by all candidates. Higher ability candidates clearly stated that pressure is inversely proportional to volume and then went on to state that pressure $\times$ volume = constant. Most candidates then calculated for each gas pressure $\times$ volume before stating that B and C were the same. A few candidates demonstrated that doubling the pressure halved the volume and gained full credit with the appropriate conclusion.

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	For an increase in temperature / heating of gas: gas particles / molecules / atoms have a higher (average) speed / more (kinetic) energy OR ✓ They collide more frequently / often with the walls (of container) / container AW ✓ Bigger force (over same area) equals greater pressure ✓	3 (AO3 x1.1)	Direction of temperature change must be clear ALLOW move faster for higher (average) speed ALLOW linked to increase/decrease of KE if temperature change not explicit ALLOW bigger change in momentum <u>Examiner's Comments</u> There were a range of marks in this question. Candidates needed to be able to explain either how an increase in temperature affects the gas pressure or a decrease in temperature affects the gas pressure. The direction of the temperature change needed to be clear. Most candidates realised that an increase in temperature resulted in the gas molecules having more kinetic energy and thus a higher average speed. Candidates were then expected to state that the molecules collided more frequently with the walls of the container. Often, "frequently" was omitted from candidates' answers. The final mark was for stating that the more frequent collisions resulted in a large force over the same area which causes a greater pressure. Some candidates correctly explained the larger force in a greater rate of change of momentum.  AfL Candidates should be encouraged to practise explaining physics concepts in terms of the effect of increasing a quantity on another quantity.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5500 (Pa) award 3 marks pressure due to a column of liquid (Pa) = height of column (m) x density of liquid (kg/m³) x g (N/kg) / P = hpg (no mark – on formula sheet) g = 10 (N/kg) ✓ P = 0.5 x 1100 x 10 ✓ P = 5500 (Pa) ✓	3 (AO1.1) (AO2.1) (AO2.1)	ALLOW three marks for 5390 Pa if g=9.8 N/kg or 5395.5 Pa if g=9.81 N/kg is used ALLOW 9.8(1) N/kg <u>Examiner's Comments</u> Most of the candidates correctly selected an equation from the data sheet and used an appropriate value for <i>g</i>. Candidates who did not gain credit for this question, tended to just multiply 0.5 by 1100. By understanding that the unit of pressure is Pa or N / m², candidates should be able to reason that m × kg / m³ is not valid.
			Total	9	
14			C ✓	1 (AO1.1)	
			Total	1	
15			C ✓	1 (AO2.1)	
			Total	1	
16			A	1 (AO1.1)	
			Total	1	
17			B	1 (AO2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
18			Any three from: Boat has bigger upthrust/buoyancy force (compared to weight of lump) / ORA / AW ✓ Upthrust on boat is equal to weight of boat / resultant force is zero / AW ✓ Weight of water displaced by the boat is equal to the weight of the boat / AW ✓ (Overall) density of the boat includes the air / ORA / AW ✓ (Overall) density of the boat (and air) is less than the density of the water / ORA / AW ✓	3 (AO3x2.1)	ALLOW upthrust on lump is less than weight of lump / there is a resultant force (acting downwards) ALLOW weight of water displaced by lump is less than weight of lump / AW ALLOW hollow for air ALLOW maximum of 1 mark for boat is hollow / contains air / ORA / AW
			Total	3	
19	a		Doubled ✓ Doubled ✓	2 (AO1.1 x 2)	
	b		Any two from: As temperature increases, pressure increases / AW ✓ Linear /straight line relationship ✓ Higher temperature means more (frequent) collisions (between particles and container) / AW ✓	2 (AO1.1.x 2)	ALLOW higher temperature means bigger pressure DO NOT ALLOW <i>T</i> & <i>P</i> in wrong order DO NOT ALLOW (directly) proportional relationship ALLOW pressure goes up at the same rate as temperature IGNORE idea of more collisions with other particles
			Total	4	