A-Level Edexcel

PHYSICS

UNIT 5(IAL)

2020 — 2023

1 - (WPH11/5(IAL)_Summer_2020_Q3) - *Thermodynamics*

A closed container holds a mixture of two gases at a constant temperature.
Each molecule of gas X has a mass four times that of each molecule of gas Y.

What is the ratio $\frac{\text{r.m.s.velocity of molecules in gas X}}{\text{r.m.s.velocity of molecules in gas Y}}$?

☒ **A** $\frac{1}{4}$

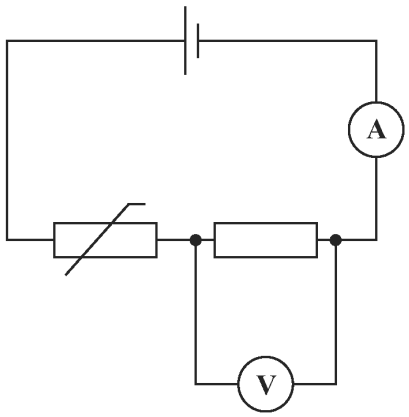
☒ **B** $\frac{1}{2}$

☒ **C** 2

☒ **D** 4

2 – (WPH11/5(IAL)_Summer_2020_Q4) – *Thermodynamics*

A negative temperature coefficient thermistor and a resistor are connected as shown.



The temperature of the thermistor decreases.

Select the row of the table that shows how the readings on the meters change.

	Ammeter	Voltmeter
☒ **A**	decreases	decreases
☒ **B**	decreases	increases
☒ **C**	increases	decreases
☒ **D**	increases	increases

3 – (WPH11/5(IAL)_Summer_2020_Q17) – *Thermodynamics*

According to the Football Association (FA) rules, the football used in a professional match should have a circumference of between 68.0 cm and 70.0 cm. The pressure of the air in the football must be between 60 kPa and 110 kPa above atmospheric pressure.

(a) A football was inflated with air at a temperature of 16.0 °C. When inflated, the circumference of the football was 68.5 cm and it contained 2.50×10^{23} molecules of air.

Deduce whether this football met the FA rules.

atmospheric pressure = 105 kPa

(6)

*(b) The pressure inside a football decreases as the temperature of the air inside falls. The volume of the ball remains constant.

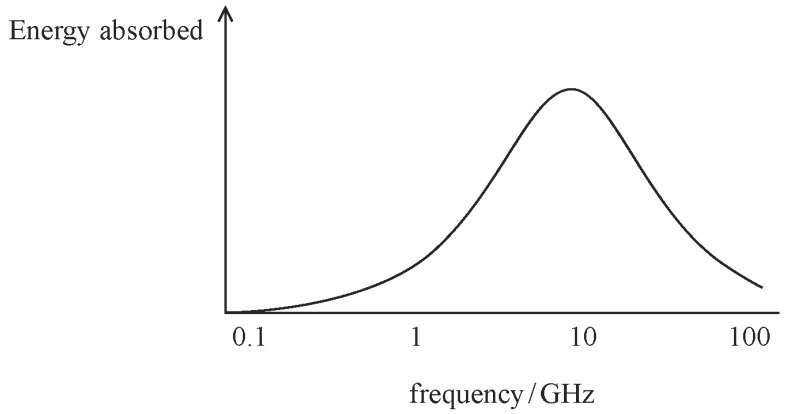
Explain why, in terms of the motion of the molecules.

(6)

4 – (WPH11/5(IAL)_Summer_2020_Q19) – *Thermodynamics*

Microwave ovens use microwave radiation at a frequency of 2.45 GHz to cook food. The absorption of microwave energy by water in the food causes a heating effect.

(a) The graph shows how the energy absorbed by a water molecule depends on the frequency of the radiation.



A website suggests that water molecules absorb energy because the microwaves produced by the oven cause the water molecules to resonate.

Comment on this suggestion.

(2)

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(b) The microwave radiation causes the water molecules to rotate.

(i) Explain how this cooks the food.

(3)

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(ii) Suggest why the transfer of energy from the microwaves may be less efficient for ice than for liquid water.

(2)

(c) 325 g of water at 25.0 °C is heated at full power in a microwave oven. After 225 s the temperature of the water is 85.0 °C.

power of microwave oven = 650 W
specific heat capacity of water = 4190 J $kg^{-1} K^{-1}$

(i) The manufacturer claims that the microwave oven has an efficiency of 90%.

Assess the validity of this claim.

(3)

(ii) The 325 g of hot water at 85.0 °C is poured into a polystyrene beaker containing 62.5 g of ice at 0.0 °C.

Calculate the final temperature of the mixture of water and melted ice.

latent heat of fusion of ice = 3.33×10^5 J kg^{-1}

(4)

Final temperature of mixture = ...

ANSWERS

1 – (WPH11/5(IAL)_Summer_2020_Q3) – *Thermodynamics*

	B is the correct answer A is not the correct answer as this is the ratio of the mean squared velocities C is not the correct answer as this is the inverse of the correct answer D is not the correct answer as this is the inverse of the ratio of the mean squared velocities	**(1)**

2 – (WPH11/5(IAL)_Summer_2020_Q4) – *Thermodynamics*

	A is the correct answer B is not the correct answer as there is a larger proportion of the total pd across the LDR C is not the correct answer as current in the circuit decreases D is not the correct answer as current in the circuit decreases and there is a larger proportion of the total pd across the LDR	**(1)**

3 – (WPH11/5(IAL)_Summer_2020_Q17) – *Thermodynamics*

(a)	Use of circumference = $2\pi r$	**(1)**	
	Use of $V = \frac{4\pi r^3}{3}$	**(1)**	
	Conversion of temperature to kelvin	**(1)**	
	Use of $pV = NkT$	**(1)**	
	Excess pressure calculated	**(1)**	
	Excess pressure is 79 kPa, so ball meets FA rules	**(1)**	**6**
	<u>Example of calculation</u> $r = \frac{0.685\ \text{m}}{2\pi} = 0.109\ \text{m}$ $V = \frac{4\pi}{3} \times (0.109\ \text{m})^3 = 5.42 \times 10^{-3}\ \text{m}^3$ $p = \frac{NkT}{V} = \frac{2.5 \times 10^{23} \times 1.38 \times 10^{-23}\ \text{J K}^{-1} \times (16+273)}{5.42 \times 10^{-3}\ \text{m}^3} = 1.84 \times 10^5\ \text{Pa}$ Excess pressure = 1.84×10^5 Pa – 1.05×10^5 Pa = 7.9×10^4 Pa (79 kPa)		

*** (b)**

This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for structure and lines of reasoning.

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning

IC points	IC mark	Max linkage mark	Max final mark
6	4	2	6
5	3	2	5
4	3	1	4
3	2	1	3
2	2	0	2
1	1	0	1
0	0	0	0

Indicative content

- As the temperature of the air decreases the average/mean kinetic energy of the molecules decreases
- So the (root mean square) velocity/speed of the molecules decreases
  Or (Since $E_k = \frac{p^2}{2m}$) the (average) momentum of the molecules decreases
- The change of momentum of a molecule during a collision with the container walls decreases
- The rate of collision of molecules with the walls of the container decreases
- So the rate of change of momentum decreases and so the force on the container walls decrease s
- Hence the pressure exerted by the gas decreases, since $p = F/A$

6

4 – (WPH11/5(IAL)_Summer_2020_Q19) – *Thermodynamics*

(a)	The natural frequency of the water molecule is about 10 GHz	(1)	
	The microwave radiation frequency (2.45 GHz) is not at/about the natural frequency of the water molecule and so this is not resonance **Or** The driving frequency is not is not at/about the natural frequency of the water molecule and so this is not resonance	(1)	**2**
(b)(i)	The (rotating) water molecules collide with other molecules (in the food)	(1)	
	There is a transfer of kinetic energy to (adjacent) molecules (in the food)	(1)	
	This increases the internal energy and hence the temperature of the food **Or** this increases the (average) kinetic energy (of the molecules) and hence the temperature of the food	(1)	**3**
(b)(ii)	Ice is a solid and so the molecules have fixed positions	(1)	
	This prevents the molecules in the solid ice from rotating **Or** only molecules in liquid water around the ice can rotate	(1)	**2**