Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Q1.

For an ideal gas $pV = NkT$ and $pV = \frac{1}{3}Nm\langle c^2\rangle$.

Use these relationships to show that the mean kinetic energy of a gas molecule is proportional to the absolute temperature.

(2)

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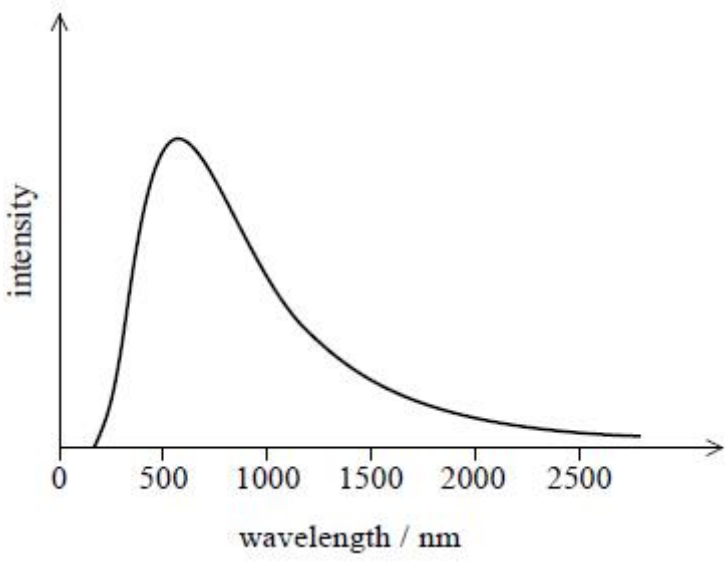
(Total for question = 2 marks)

Q2.

The diagram shows the radiation curve for a black body radiator. The diagram was obtained from experimental data.



Experimental curve

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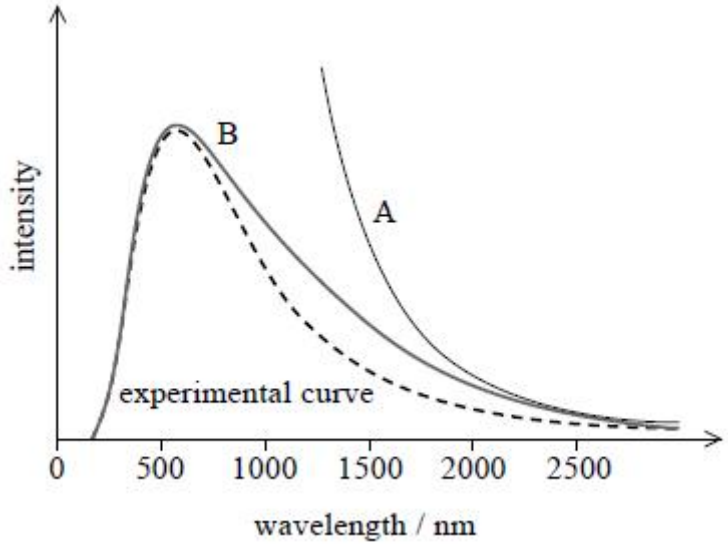
In the late 19th century, scientists struggled to explain this experimental curve. One model used ideas of classical physics and produced curve A. Another model incorporated the idea of energy quantisation in the mechanism of energy emission and produced curve B. Both curve A and curve B are shown below, with the experimental curve for comparison.



(i) Explain how energy quantisation applies to the emission of radiation of energy from a black body radiator.

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(ii) Assess the extent to which each model is successful at explaining the experimental curve.

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(Total for question = 6 marks)

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Q3.

A student is constructing a spreadsheet to calculate the radius *R* of some stars. To obtain the radius, the surface temperature *T* of the star must first be calculated. She is given values for the stars' luminosities *L* and the wavelengths λ_{max} at which peak energy emission occurs. Part of the spreadsheet is shown, *A* is the surface area of the star.

	A	B	C	D	E
1	λ_{max} / 10^{-7} m	T / 10^{3} K	L / 10^{27} W	A / 10^{19} m^2	R / 10^{9} m
2	6.85	4.23	0.039		0.41
3	5.74	5.05	0.384	1.04	0.91
4	3.56	8.14	3.385	1.36	1.04
5					

(a) Write an equation to show how the value in B2 is calculated.

(1)

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(b) Show that the value in D2 is about 0.2

(2)

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(c) The student was given the luminosity values to enter into column C.

Describe how astronomers could determine the luminosity of a star.

(2)

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(Total for Question = 5 marks)

Q4.

The molecules in a sample of gas have a mass of 5.0×10^{-26} kg.

Calculate the root-mean-square speed of gas molecules in the gas at 25 °C.

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(3)

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Root-mean-square speed = ...

(Total for question = 3 marks)

Q5.

The photograph shows a 'quiet boil' electric kettle. The makers of the kettle claim that it boils water with much less noise than a standard kettle.

A laboratory technician takes some measurements to compare a 'quiet boil' electric kettle with a standard electric kettle.

The table shows the results recorded by the technician.

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	Quiet boil kettle	Standard kettle
Mass of water / kg	1.20	1.20
Initial temperature of water / °C	10	10
Final temperature of water / °C	100	100
Potential difference / V	243	247
Current / A	11.9	11.8
Time taken to heat water to boiling point / s	168	172
Average sound intensity / mW m^{-2}	3.72	10.5

A student uses the values in the table to calculate the efficiency of each kettle at heating the water to boiling point. He calculates the efficiency of the 'quiet boil' kettle to be 0.93

Calculate the efficiency of the standard kettle.
specific heat capacity of water = 4180 J kg^{-1} K^{-1}

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Efficiency = ...

(b) The intensity of the sound produced by each kettle was measured with a sound meter which was 30.0 cm from the centre of the kettle.

Calculate the energy transferred by sound while the water in the standard kettle is brought to the boil. You may treat the kettle as a point source.

(4)

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Energy transferred = ...

(c) The label on the original packaging of the quiet boil electric kettle states, 'This kettle is much more efficient

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than a standard kettle because it produces less sound.'

Explain the extent to which this statement is supported by your calculations.

(2)

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(Total for question = 10 marks)

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