

Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic : 9_Thermodynamics

Name of the Student: _____

Max. Marks : 21 Marks

Time : 21 Minutes

Q1.

A data book contains the following information for ethanol.

latent heat of fusion = 109 kJ kg^{-1}

latent heat of vaporisation = 838 kJ kg^{-1}

545 J is transferred from a sample of ethanol when it condenses.

Which of the following shows how to calculate the mass of ethanol that condenses?

(1)

- A $545 \div 109\ 000$
- B $545 \div 838\ 000$
- C $109\ 000 \div 545$
- D $838\ 000 \div 545$

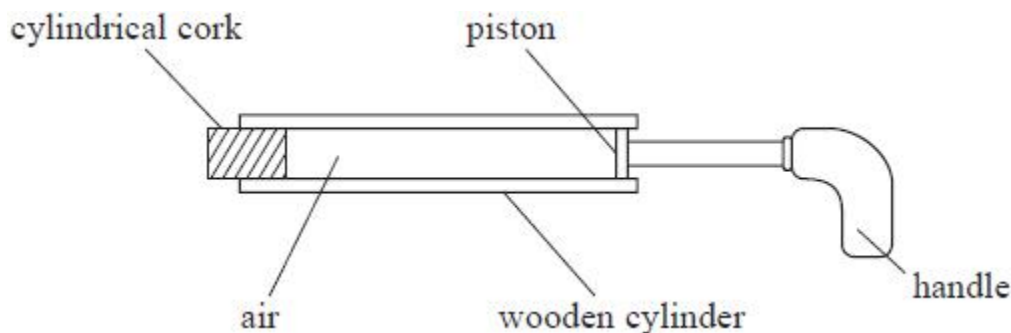
(Total for question = 1 mark)

Q2.

The photographs show a wooden pop gun before and after the cork is popped.



The diagram shows a cross-section through the pop gun.



Initially the piston is at the right-hand end of the cylinder, as shown. Then the cork is pushed into the other end of the cylinder.

When the handle is pushed in, the pressure of the air in the cylinder increases. This exerts an additional force on the cork.

Once the additional force is sufficient to overcome the frictional force between the cork and the cylinder, the cork is pushed out.

Calculate the root mean square speed of the molecules of air in the cylinder before the handle is pushed in.

average mass of molecule of air = 4.8×10^{-26} kg

temperature of air = 19°C

(2)

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Root mean square speed =

(Total for question = 2 marks)

Q3.

Betelgeuse is our greatest red giant. It has a luminosity of 4.49×10^{31} W and emits radiation with a peak energy emission occurring at wavelength of 850 nm.

Show that Betelgeuse has a surface temperature of about 3000 K. Hence calculate the ratio of the radius of Betelgeuse, r_B to the radius of the Sun, r_S .

$$r_S = 6.95 \times 10^8 \text{ m}$$

(5)

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Q4.

The light emitted from a star is due to the energy released by fusion reactions taking place in the core of the star. Our Sun is a main sequence star with a luminosity of 3.85×10^{26} W.

An analysis of the Sun's spectrum gives $\lambda_{\max} = 502$ nm

Use the data provided to calculate the radius of the Sun.

(4)

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Radius of the Sun =

(Total for question = 4 marks)

Q5.

When a large potential difference is applied to a discharge tube, the gas in the discharge tube emits coloured light. When this light is passed through a diffraction grating, an emission spectrum which is made up of a series of lines of different wavelengths may be seen.

The photographs show the spectra produced from a tube containing hydrogen and a tube containing helium.

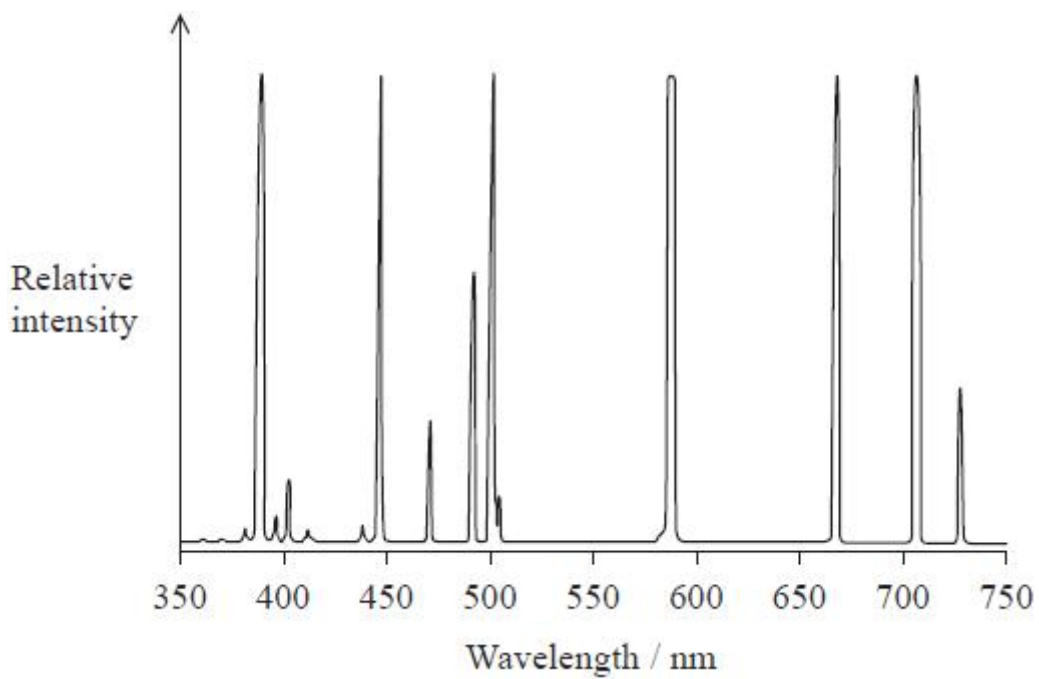
Hydrogen:



Helium:



The graph shows the relative intensities of different wavelengths of light in the spectrum of a sample of helium.



The graph shows that the lines are not at a single wavelength. This effect is known as thermal Doppler broadening and occurs because of the random motion of the helium atoms.

(i) Explain why the thermal motion of the helium atoms causes the broadening of the spectral lines.

(2)

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(ii) The width of a line may be used to determine the speed of the atoms in the gas and hence the temperature of the gas.

The spectral line with wavelength 587 nm for a particular tube containing helium has a width of 6×10^{-3} nm.

(1) Show that this corresponds to a speed, for a helium atom, of about 1500 m s^{-1} .

(2)

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(2) Assuming that this is the root mean square speed for the helium ($\text{He } 4$) atoms in the tube, calculate the temperature of the gas in the tube.

(3)

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Q6.

The absolute temperature scale is a theoretical scale proposed by Lord Kelvin.

On this scale, zero is the temperature at which

- A all gases become liquids.
- B an ideal gas would exert no pressure.
- C the Celsius temperature is $-373\text{ }^{\circ}\text{C}$.
- D water freezes.

(Total for Question = 1 mark)

Q7.

When energy is supplied to a substance, changes in the average molecular kinetic energy (E_k) and the average molecular potential energy (E_p) can occur.

When energy is supplied to an ideal gas

- A both E_k and E_p increase.
- B E_k may increase.
- C E_p may increase.
- D E_k increases but E_p decreases.

(Total for Question = 1 mark)