

# Thermal physics

## Question Paper 6

Level	A Level
Subject	Physics
Exam Board	OCR
Topic	Newtonian world and astrophysics
Sub-Topic	Thermal physics
Booklet	Question Paper 6

**Time Allowed:** 26 minutes

**Score:** / 21

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%



(ii) Calculate the volume of the gas at 90 °C.

volume = ..... m<sup>3</sup> [2]

(c) The mass of each gas molecule is  $4.7 \times 10^{-26}$  kg. Estimate the average speed of the gas molecules at 90 °C.

speed = ..... ms<sup>-1</sup> [3]

**[Total: 11]**

- 2 (a) A patient has an X-ray scan taken in hospital. The high-energy X-ray photons interact with the atoms inside the body of the patient.

Explain what is meant by a *photon* and state **one** of its main properties.

.....  
.....  
..... [2]

- (b) An X-ray tube operates using a 150 kV supply. X-ray photons are produced inside the tube when a beam of high-speed electrons accelerated from the cathode collide with the metal anode. About 99% of the total kinetic energy of the electrons at the anode is converted into heat energy which heats the anode. The remaining energy is transformed into the energy of the X-ray photons.

The current in the electron beam between the cathode and the anode is 4.8 mA.

- (i) Show that the number of electrons incident at the anode per second is  $3.0 \times 10^{16} \text{ s}^{-1}$ .

[1]

- (ii) The anode is made from metal of specific heat capacity  $140 \text{ J kg}^{-1} \text{ K}^{-1}$ . It has a mass of 8.6 g. The X-ray tube is switched on. Calculate the initial rate of increase of temperature of the anode.

rate of temperature increase = .....  $^{\circ}\text{C s}^{-1}$  [3]

- (iii) A single electron is responsible for producing an X-ray photon. Calculate the shortest wavelength of the X-rays produced from the X-ray tube.

wavelength = ..... m [2]

- (c) An X-ray scan of the heart and its blood vessels shows very poor contrast. Describe and explain a technique that can be used to reveal these blood vessels in an X-ray scan.

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..... [2]