

Name of the Student: _____

Max. Marks : 24 Marks

Time : 24 Minutes

Q1.

- (a) A 2.0 kW heater is used to heat a room from 5 °C to 20 °C. The mass of air in the room is 30 kg. Under these conditions the specific heat capacity of air = 1000 J kg⁻¹ K⁻¹.

Calculate

- (i) the gain in thermal energy of the air,

- (ii) the minimum time required to heat the room.

(4)

- (b) State and explain **one** reason why the actual time taken to heat the room is longer than the value calculated in part (a)(ii).

(2)

(Total 6 marks)

Q2.

An electric shower heats the water flowing through it from 10°C to 42°C when the volume flow rate is 5.2 × 10⁻⁵ m³ s⁻¹.

- (a) (i) Calculate the mass of water flowing through the shower each second.

density of water = 1000 kg m⁻³

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- (ii) Calculate the power supplied to the shower, assuming all the electrical energy supplied to it is gained by the water as thermal energy.

specific heat capacity of water = $4200 \text{ J kg}^{-1} \text{ K}^{-1}$.

(4)

- (b) A jet of water emerges horizontally at a speed of 2.5 m s^{-1} from a hole in the shower head. The hole is 2.0 m above the floor of the shower. Calculate the horizontal distance travelled by this jet. Assume air resistance is negligible.

(3)

(Total 7 marks)

Q3.

A diffraction grating was used to measure the wavelength of a certain line of a line emission spectrum.

- (a) The grating had 600 lines per millimetre. The angle of diffraction of the second order line was 35.8° .

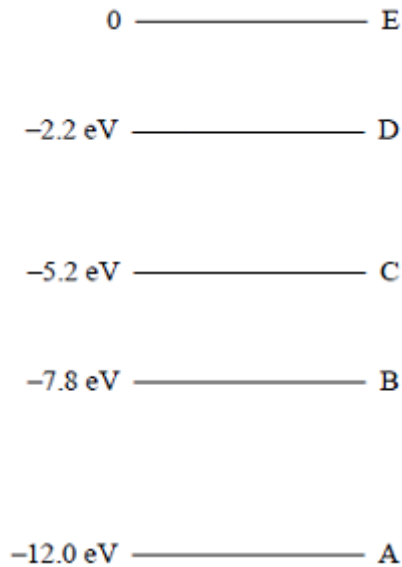
- (i) Calculate the wavelength of this line.

(ii) Calculate the energy, in eV, of a photon of this wavelength.

(5)

(b) The line emission spectrum observed in part (a) was produced by a hot gas.

(i) The energy level diagram for the atoms that produced the line spectrum is shown in the diagram below. Mark on the diagram a vertical arrow to show the electron transition between the two levels that produced photons of energy 6.8 eV.



(ii) The temperature of the gas was 5000K. Show that the mean kinetic energy of a gas atom at this temperature is 0.65 eV.

(iii) Describe how the atoms of a gas produce a line emission spectrum and explain why the gas at a temperature of 5000K can produce a line of the wavelength calculated in part (a)(i).

You may be awarded marks for the quality of written communication in your answer.

(6)
(Total 11 marks)