Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

In 2011, a tsunami was caused by a massive earthquake centred some distance off the coast of Japan. The tsunami caused a cooling system failure at the Fukushima Nuclear Power Plant. This resulted in a nuclear meltdown and radioactive materials were released into the surroundings.

A reservoir beside one of the reactor buildings contained a large volume of water. In 2013, this water was found to have an extremely high concentration of caesium-137.

Caesium-137 is a radioactive isotope of caesium.

The most common radionuclide amongst the fission products in the fuel was iodine-131, which decays with a half-life of 8.0 days to form a stable isotope of the gas xenon.

Deduce whether enough xenon would have collected in 32 days to exert a pressure of 1.0×10^5 Pa in a volume of 450 m^3. Assume that no gas escapes.

temperature = 20 °C

initial number of iodine nuclei = 1.25×10^{28}

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(Total for question = 6 marks)

Q2.

Aluminium is one of the most widely recycled metals. Aluminium cans are heated from room temperature until all the aluminium has melted. The molten aluminium is then used to make new cans. This process uses only 5% of

the energy needed to extract aluminium from raw materials.

On a website it is claimed that recycling one aluminium can of mass 14 g saves enough energy to listen to music on a mobile phone continuously for 7 days.

Assess the validity of this claim.

melting point of aluminium = 660 K
specific heat capacity of aluminium = 902 J kg^{-1} K^{-1}
specific latent heat of aluminium = 396 kJ kg^{-1}
room temperature = 293 K
mobile phone p.d. = 3.7 V
mobile phone current = 120 mA

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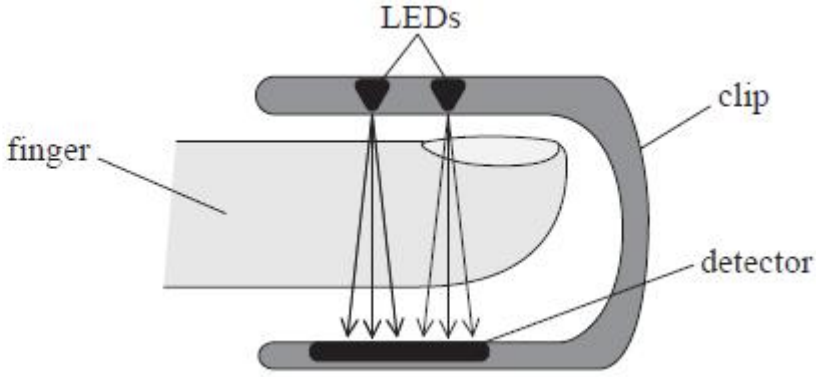
(Total for question = 6 marks)

Q3.

An oximeter is a device used in hospitals to monitor the oxygen level in a patient's blood.

In an oximeter, two light-emitting diodes (LEDs) are mounted opposite light sensors in a clip and attached to the patient's finger. One of the LEDs produces red light and the other produces infrared.



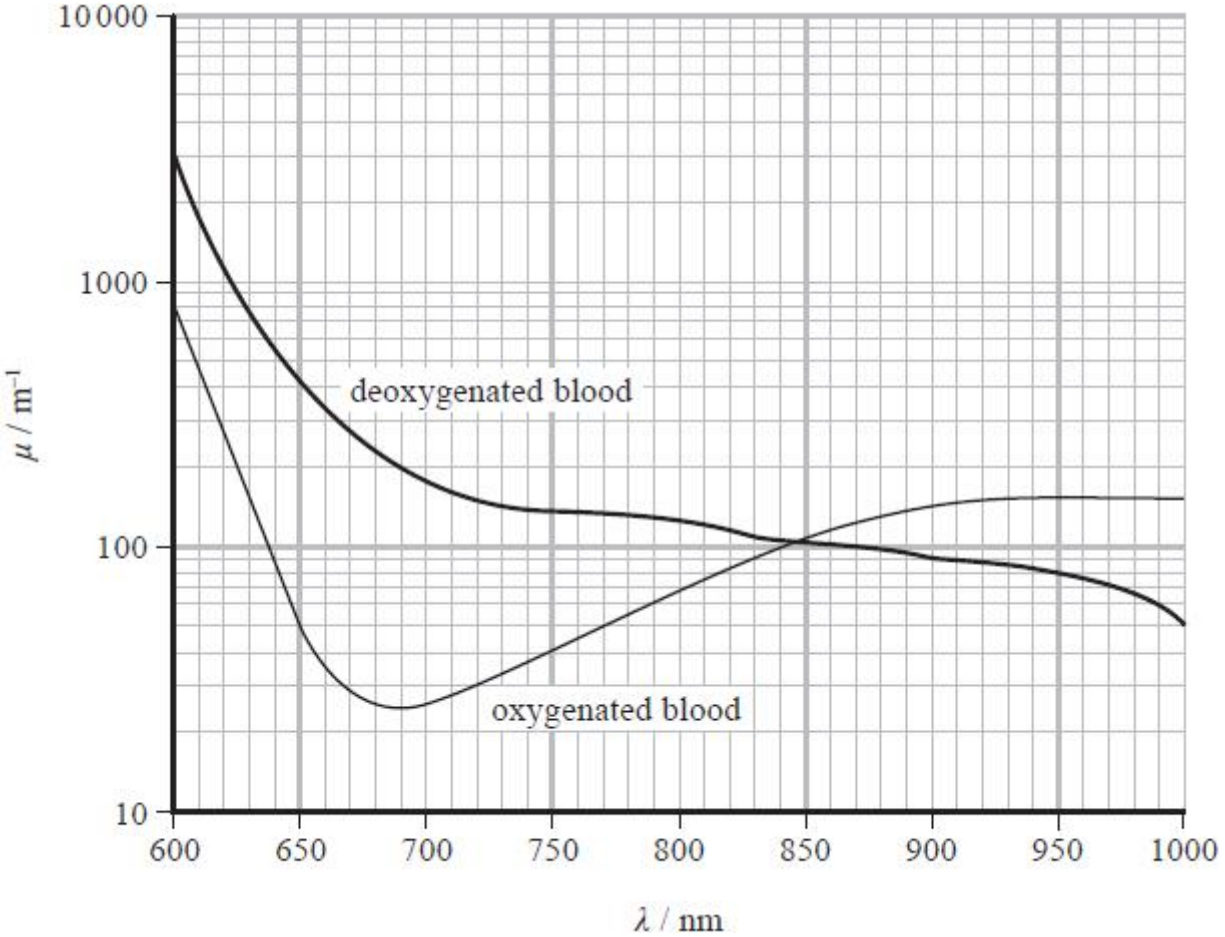
The intensity I of electromagnetic radiation received by the detector, after passing through a thickness x of blood, is given by

$$I = I_0^{e-\mu x}$$

where I_0 is the intensity that would have been received if the blood were not present and μ is the attenuation coefficient of blood.

The red LED emits visible light of wavelength 650 nm and the infrared LED emits infrared of wavelength 950 nm.

The graph shows how μ varies with wavelength λ for oxygenated blood and deoxygenated blood.



It is suggested that ambient light could affect the readings produced by the oximeter.

Halogen lamps have a filament temperature of 3200 K.

Deduce whether the light from such a lamp would have a significant effect on the oximeter readings.

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(Total for question = 3 marks)

Q4.

Star A has twice the radius of star B but only half the surface temperature.

The ratio of the luminosity of star A to luminosity of star B is

☒ **A** 1:4

- **B** 1:2
- **C** 2:1
- **D** 4:1

(Total for question = 1 mark)

Q5.

If the surface temperature of the Sun were to double, the rate at which energy from the Sun is received on the Earth would increase by a factor of

- **A** 2
- **B** 4
- **C** 8
- **D** 16

(Total for question = 1 mark)

Q6.

Latte is a type of coffee made with hot frothy milk. The milk is heated by pumping steam into it.

Calculate the maximum mass of milk that could be warmed to a temperature of 65 °C by absorbing 15 g of steam at 100 °C.

initial temperature of milk = 4.0 °C
specific heat capacity of milk = 3900 J kg^{-1} K^{-1}
specific heat capacity of water = 4200 J kg^{-1} K^{-1}
specific latent heat of vaporisation of water = 2.3 × 10^{6} J kg^{-1}

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Maximum mass = ...

(Total for question = 4 marks)