8.2 Thermal Energy Transfer

Question Paper

Course	DP IB Physics
Section	8. Energy Production
Topic	8.2 Thermal Energy Transfer
Difficulty	Hard

Time allowed: 60

Score: /47

Percentage: /100

Question 1a

(a)

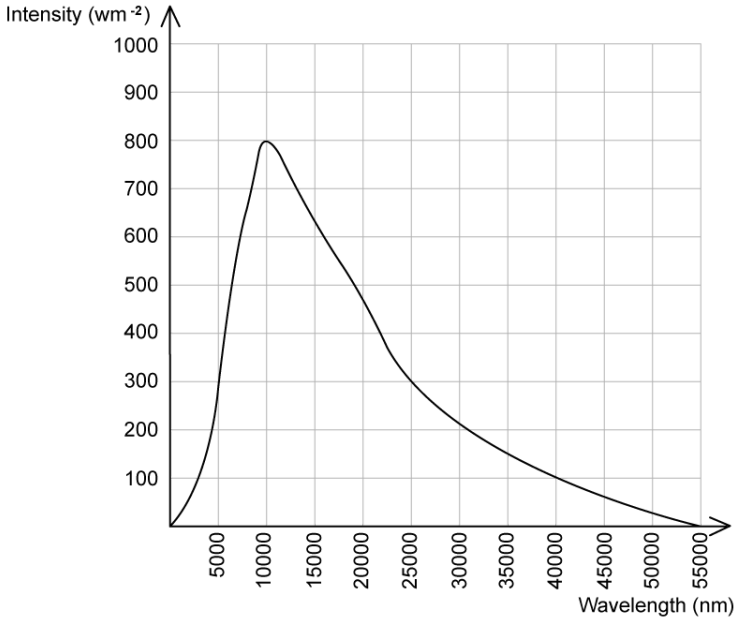
Suggest how the temperature of a black body can be estimated.

[2]

[2 marks]

Question 1b

The spectrum of radiation emitted by a sample of glacier ice is examined.



(b)

Calculate the temperature of the radiation emitted by the ice.

[2]

[2 marks]

Question 1c

(c)

(i)
Order fresh snow and ocean ice from lowest to highest in terms of their albedo.

[1]

(ii)
Give a reason for your answer.

[1]

[2 marks]

Question 1d

(d)
Suggest why the values of the intensity of incident radiation upon the Earth's surface are expected to rise as the climate changes.

[5]

[5 marks]

Question 2a

One possible model of climate change is that the Earth will eventually have no atmosphere.

(a)

(i)
Draw a suitable diagram to illustrate this model.

[1]

(ii)
Evaluate this model.

[2]

[3 marks]

Question 2b

(b)
Obtain an expression for the average intensity of light at the surface of the Earth in terms of albedo and the solar constant.

[4]

[4 marks]

Question 3a

A team of engineers are designing solar panels to power a Mars Rover on the surface of Mars.

(a)
Derive an expression for the intensity of radiation at a distance, r emitted from a point source.

[2]

[2 marks]

Question 3b

A planned Mars Rover will be powered using several solar panels each with dimensions of 2700 × 4900 mm. The equipment is tested on Earth at a point where the albedo of Earth's atmosphere is 0.390. The following additional information is available:

- The radiant power of the Sun is 3.90×10^{26} W
- The average radius of Earth's orbit around the Sun is 1.50×10^{11} m
- Orbital radius between Mars and the Sun = 2.3×10^{11} m
- Absorbed solar radiation on Mars = 493 W m^{-2}

(b)
Determine the ratio

$$\frac{P_M}{P_E}.$$

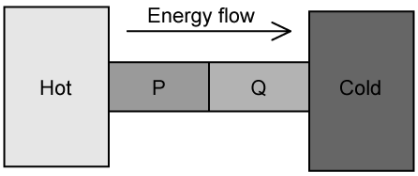
Where P_M is the power of solar radiation incident on the solar panel on Mars and P_E is the power of solar radiation incident on the solar panel on Earth.
Assume that the Sun is at its highest point and the light from the Sun is normally incident on the panel.

[6]

[6 marks]

Question 4a

A regular cuboid is made up of two materials, P and Q. The cuboid's dimensions are uniform throughout P and Q. The cylinder is placed in contact with a hot and cold source such that energy is conducted between them.



(a)
State and explain whether the following values are equal for the cylinder:

(i)
The energy flow rates through P and Q.

[1]

(ii)
The temperature difference across P and the temperature difference across Q.

[1]

[2 marks]

Question 4b

The following data are available for two metallic elements.

Silver	Gold
Density = 10.49 g cm^{-3}	Density = 19.3 g cm^{-3}
Relative atomic mass = 107.8682	Relative atomic mass = 196.9665

(b)

(i)
Determine whether silver or gold is a better conductor of electricity.

[4]

(ii)
State the assumption made in the calculation from part (i).

[1]

[5 marks]

Question 4c

(c)
Compare and contrast onshore and offshore winds both during the day and at night.

[4]

[4 marks]

Question 4d

A car engine has a malfunction with some of its internal components overheating.

(d)
Analyse the ways that the different types of car component can cool down.

[3]

[3 marks]

Question 5a

An industrial kiln is used for 'firing' ceramic and pottery items at very high temperatures.

The kiln emits electromagnetic radiation of peak wavelength, $\lambda_{max} = 3.75 \times 10^{-6}$ m and has a surface area of 150 m^2.

(a)
Calculate the energy radiated per second.

[4]

[4 marks]

Question 5b

(b)
Justify each of the following safety features in the kiln by referring to thermal energy transfer.

(i)
The installation of chimneys and vents.

[1]

(ii)
Air space created below and around the kiln.

[1]

(iii)
Shiny reflective surfaces fixed around the inside of the exterior walls.

[1]

[3 marks]