8.2 Thermal Energy Transfer

Question Paper

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

Time allowed: 60

Score: /47

Percentage: /100

Question 1a

A takeaway drinks company are investigating different recyclable and reusable materials to keep both hot and cold drinks at a drinkable temperature for longer. Thermal energy transfers from hotter areas to cooler areas.

(a)
Place a tick (✓) next to the processes that transfer thermal energy.

Conduction	
Convection	
Expansion	
Radiation	
Rotation	

[3]

[3 marks]

Question 1b

The drinks company are trying to understand more about conduction.

(b)
Use the words below to complete the sentences to explain the process of conduction.

solids	**metals**	**gases**
hotter	**cooler**	**liquids**
plastics	**paper**	**wood**

(i)
Conduction is the main method of thermal transfer in _____.

[1]

(ii)
Two solids of different temperatures come in contact with one another and thermal energy is transferred from the _____ object to the _____ object.

[1]

(iii)
_____ are the best thermal conductors.

[1]

[3 marks]

Question 1c

Convection currents occur within fluids. The drinks company is trying to understand how a convection current could occur in a hot drink if heated from below.

(c)
Number the statements below from 1 - 4 to show the correct order for how a convection current forms in a hot drink.

	The hotter part of the fluid becomes less dense than the surrounding fluid.
	The hot fluid rises, and the cooler (surrounding) fluid moves in to take its place.
	The heated molecules gain kinetic energy and push each other apart, making the fluid expand.
	The hot fluid cools, contracts and sinks back down again.

[4]

[4 marks]

Question 1d

The drinks company are looking into reducing the thermal radiation emitted from their cups.

(d)
Place a tick (✓) next to the correct statements about thermal radiation.

All bodies, no matter what temperature, emit a spectrum of thermal radiation	
The cooler the object the more infrared radiation it emits in a given time	
Thermal radiation requires matter to propagate	
The higher the temperature of an object the greater the thermal motion of its atoms	

[2]

[2 marks]

Question 2a

Astronomers are investigating black body radiation.

(a)
Define black body radiation by using the correct words to complete the gaps in the sentence below.

An object that _____ all of the radiation incident on it and does not _____ or transmit any radiation.

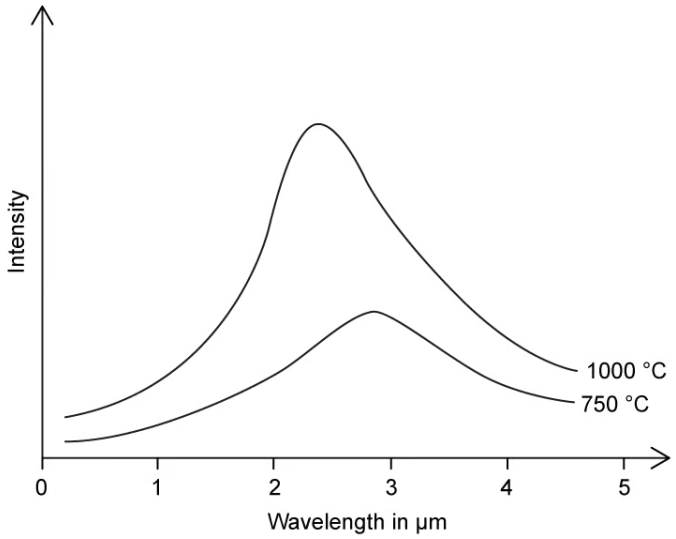
[2]

[2 marks]

Question 2b

The graph below shows a black body radiation curve.

(b)
Identify, by drawing a line, the peak intensity of the radiation.



[2]

[2 marks]

Question 2c

One of the stars the astronomers are observing emits radiation with a maximum wavelength $\lambda_{max} = 900 \times 10^{-9}$ m.

(c)
Use Wien's displacement law to calculate the temperature of the star.

[3]

[3 marks]

Question 2d

The Stefan-Boltzmann Law states that the power output of a black body depends on two factors.

(d)
Place a tick (✓) next to the two correct factors.

Mass	
Radius	
Surface temperature	
Core temperature	

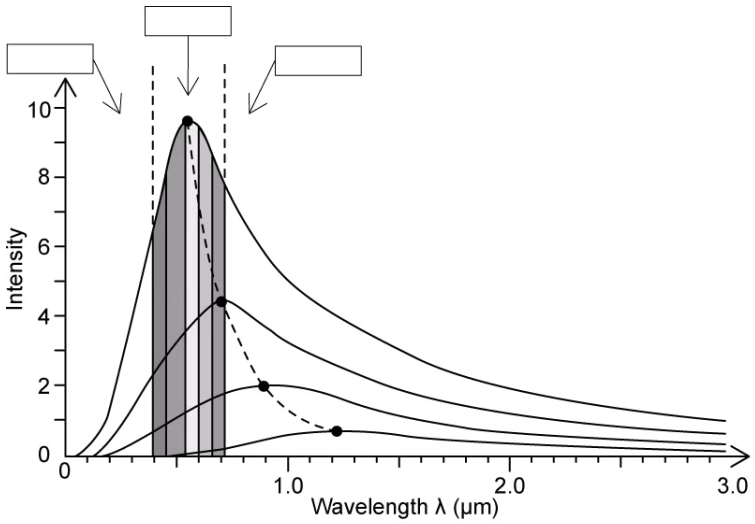
[2]

[2 marks]

Question 3a

Astronomers are using Wien's Law to predict the temperature of different stars. The intensity-wavelength graph below shows how thermodynamic temperature links to the peak wavelength for four different bodies.

(a)
Identify the visible, ultraviolet and infrared wavelengths by correctly labelling the sections of the graph.



[2]

[2 marks]

Question 3b

(b)

Identify the statements that are associated with Wien's Law, by placing a tick (✓) in the correct box.

The lower the temperature of a body, the shorter the wavelength it emits at the peak intensity.	
The black body radiation curve for different temperatures peaks at a wavelength which is inversely proportional to the temperature.	
The higher the temperature of a body, the greater the intensity of the radiation at each wavelength.	
The minimum wavelength is proportional to $\frac{1}{T}$.	

[2]

[2 marks]

Question 3c

The astronomers are considering the Earth's surface-atmosphere system and whether this will affect the calculated temperature of stars detected on Earth.

(c)
Use the text in the box to complete the sentences below, describing the Earth's Surface-Atmosphere system.

Carbon monoxide	**transfer**	**Sun**
Greenhouse gases	**constant**	**space**

(i)
The Earth's energy balance depends on how much energy is incoming from the _____ and how much energy is returned to _____.

[1]

(ii)
If incoming and outgoing energy are in balance, the Earth's temperature will remain _____.

[1]

(iii)
This system can be used to create models that help climate scientists predict temperature fluctuations based on concentrations of _____ _____.

[1]

[3 marks]

Question 3d

The equation for The Stefan-Boltzmann Law is:

$$P = \sigma A T^4$$

(d)
Calculate the total power emitted by a star when the surface area is $4 \times 10^{20}\ m^3$ and the absolute temperature 4500 K.

[2]

[2 marks]

Question 4a

Environmentalists are considering the Sun's rays and the amount of energy received at the surface of the Earth's atmosphere.

(a)
Define the solar constant by placing a tick (✓) in the correct box.

The amount of solar radiation across visible wavelengths that is incident in one second on one square meter at the mean distance of the Earth from the Sun	
The amount of solar radiation across all wavelengths that is incident in one minute on one square meter at the mean distance of the Earth from the Sun	
The amount of solar radiation across all wavelengths that is incident in one second on one square meter at the mean distance of the Earth from the Sun	
The amount of solar radiation across all wavelengths that is incident in one second on one square meter at the maximum distance of the Earth from the Sun	

[1]

[1 mark]

Question 4b

The solar constant varies year-round for two main reasons.

(b)
State the two reasons by completing the gaps in the sentences below.

(i)
The Earth has an _____ orbit around the Sun.

[1]

(ii)
The Sun's output _____ during its 11-year sunspot cycle.

[1]

[2 marks]

Question 4c

In an experiment looking at solar energy, the total incident power is 1500 W. The albedo of green grass is 0.25.

(c)
Calculate the total scattered power when this light is incident on green grass.

[2]

[2 marks]

Question 4d

Emissivity relates objects to a black body.

(d)
Choose the correct statements about emissivity by placing a tick (✓) next to them.

Calculations of the emissivity assume that the black body is at the same temperature as the object	
Calculations of the emissivity assume that the black body has smaller dimensions than the object	
For a perfect black body, emissivity is equal to 1	
Emissivity = $\frac{\text{total scattered power}}{\text{total incident power}}$	

[3]

[3 marks]

Question 5a

Climate change scientists are looking to reduce the number of greenhouse gasses in the atmosphere.

(a)
Identify the gases that are greenhouse gases by placing a tick (✓) next to them.

Carbon monoxide	
Carbon dioxide	
Methane	
Sulphur dioxide	

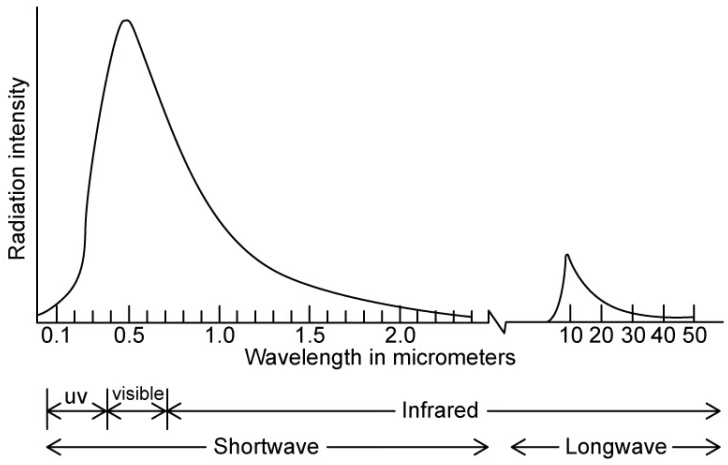
[2]

[2 marks]

Question 5b

Greenhouse gases have a natural frequency that falls within one region of the electromagnetic spectrum.

(b)
Use the graph to identify this region.



[1]

[1 mark]

Question 5c

There are many mechanisms that can increase the effect of global warming.

(c)
Use the words below to complete the sentences to explain how the rate of global warming can be increased.

decrease	**insoluble**	**increase**
carbon dioxide	**emissivity**	**heat absorption**
carbon monoxide	**evaporate**	**solubility**
melt	**albedo**	**water vapour**

(i)
Ice and snow will melt leading to a _____ in _____ and hence, an increased rate of _____ _____.

.

[1]

(ii)
The _____ of carbon dioxide in the sea will decrease, leading to an increase in atmospheric _____ _____ concentration.

.

[1]

(iii)
Surface water will _____. This will lead to an increase in atmospheric _____ _____ concentration.

.

[1]

[3 marks]

Question 5d

As a result of small increases in the temperature of the Earth runaway chain reactions can cause catastrophic climate change.

(d)
Identify these chain reactions by placing a tick (✓) next to them.

Rise in sea level due to the melting of ice	
Fall in sea level due to the evaporation of seawater	
Heatwaves	
Heavy Flooding	
Tornadoes	

[3]

[3 marks]