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: 20

Score: /10

Percentage: /100

Question 1

The peak wavelength of two lamps are compared. The first lamp has a filament in a vacuum with a temperature of 1200 K under normal working conditions. The second similar lamp is gas-filled and has a filament temperature of 2400 K.

What is an estimate for the ratio of the wavelength at which the maximum intensity of radiation is emitted by the vacuum lamp and the gas-filled lamp?

A. 16:1

B. 2:1

C. 1:8

D. 4:1

[1 mark]

Question 2

A black body has a total power radiated *P* and a surface area *A*. The surface area is reduced to one-quarter of *A* and the total power is increased to four times *P*.

What is the value of the peak wavelength?

A. $(1.5 \times 10^{-3}) \times \sqrt[4]{\frac{P}{A}}$

B. $(1.5 \times 10^{-3}) \times \sqrt{\frac{P}{A}}$

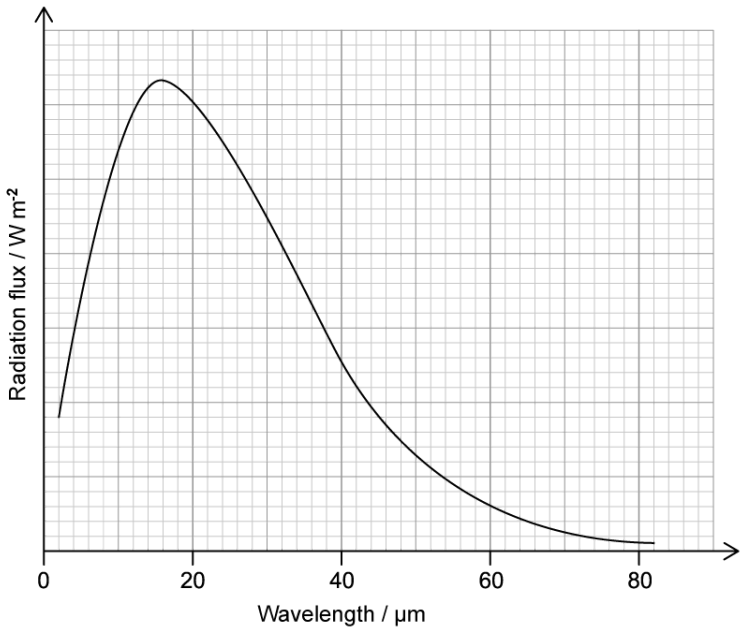
C. $2 \times \sqrt[4]{\frac{P}{A}}$

D. $(1.5 \times 10^{-3}) \times \left(\frac{P}{A}\right)^{-\frac{1}{4}}$

[1 mark]

Question 3

The radiation emitted from an asteroid is monitored and the following spectrum is obtained.



Which of the following is a sensible estimate for the temperature of the asteroid.

A. 1500 K

B. $\frac{375}{2}$ K

C. 4.8×10^{-8} K

D. $\frac{16}{3}$ K

[1 mark]

Question 4

The sun behaves as an approximate black-body radiator with peak energy radiation occurring at wavelength 51×10^{-8} m and a power of 4×10^{26} W.

What is the correct expression for the radius of the Sun?

A. $r = \frac{(17 \times 10^{21})}{\pi\sigma}$

B. $r = \sqrt{\frac{(17 \times 10^{21})}{\pi\sigma}}$

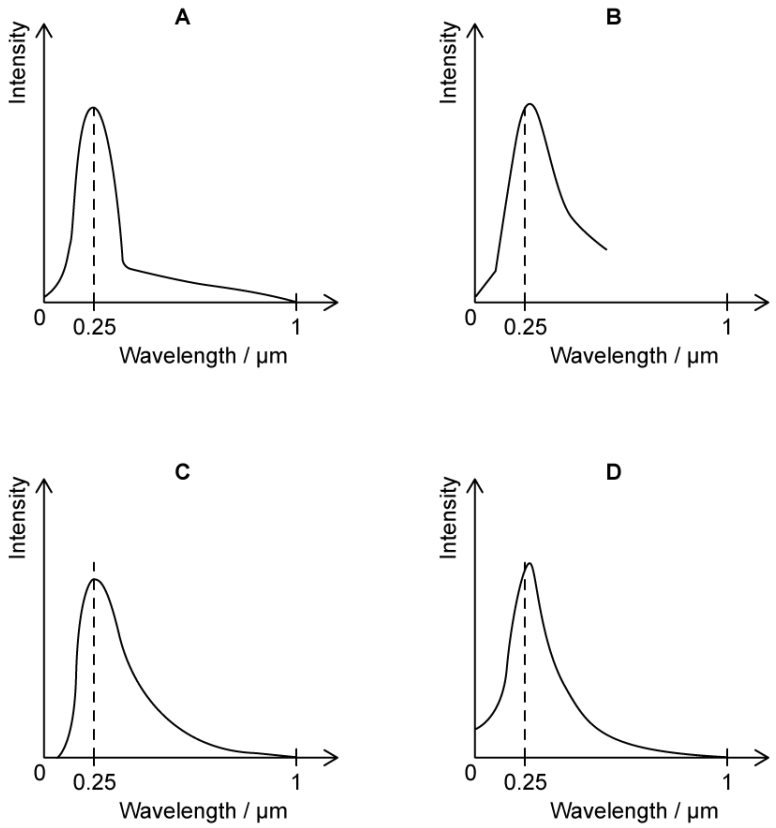
C. $r = \frac{(1 \times 10^{21})}{17\pi\sigma}$

D. $r = (17 \times 10^{21})\pi\sigma$

[1 mark]

Question 5

Rigel A in the constellation of Orion is a massive blue variable star with a peak wavelength of 0.25 μm.



Which of the graphs shows the intensity of radiation emitted by Rigel A against the wavelength of that radiation?

[1 mark]

Question 6

A double-glazed window filled with argon has an area of 3 m^2. The outdoor temperature is 8 °C and the indoor temperature 21 °C.

Glazing Type	U-value/ W m^{-2} K^{-1}
Single Glazing	4.8
Double Glazing (Air Filled)	2.7
Double Glazing (Argon Filled)	1.7
Triple Glazing (Argon Filled)	1.3

What is the rate of heat loss in watts through the window?

A. 19.8 W

B. 31.2 W

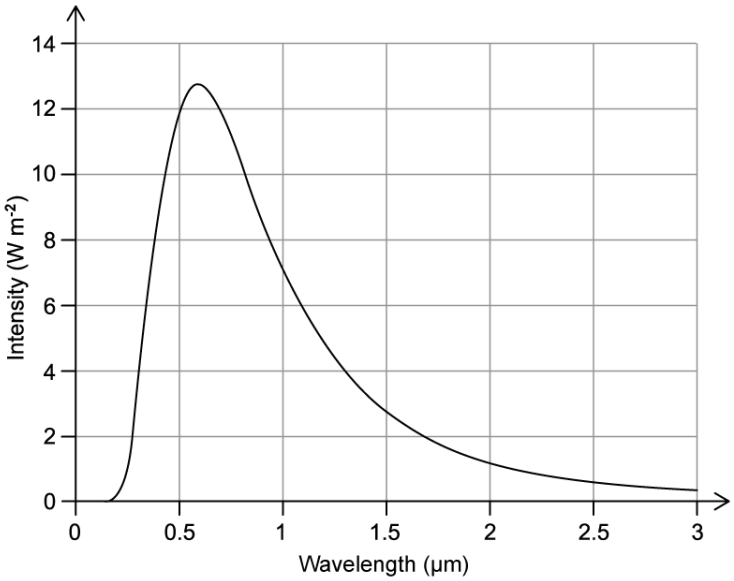
C. 66.3 W

D. 87.2 W

[1 mark]

Question 7

The graph shows the variation with wavelength of the intensity from a unit area of a black body.

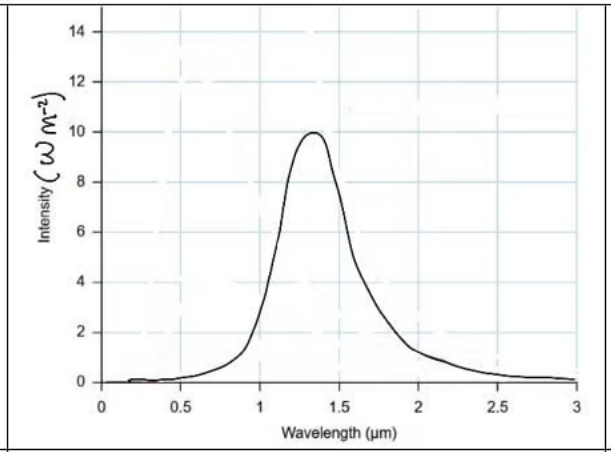


The area and temperature of the black body are both reduced by one-quarter of their original value.

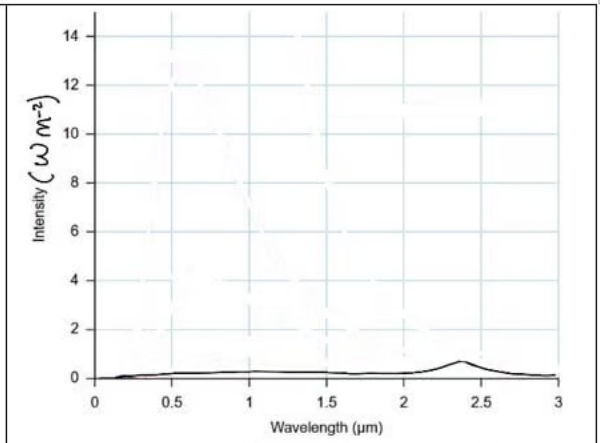
Which graph now shows the correct variation with wavelength of the intensity from a unit area of the black body?

The scale on the horizontal and vertical axis on all graphs in this question is constant.

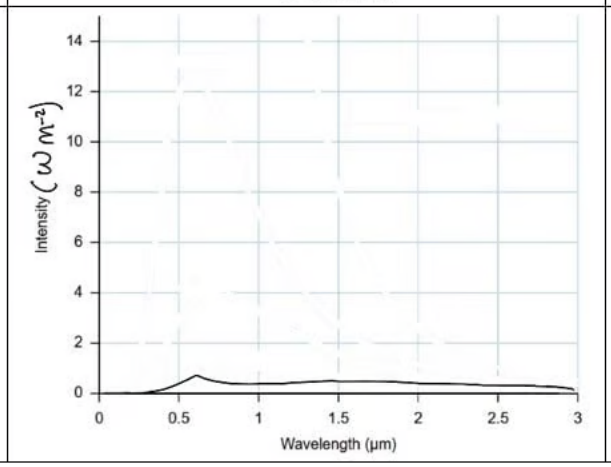
A.



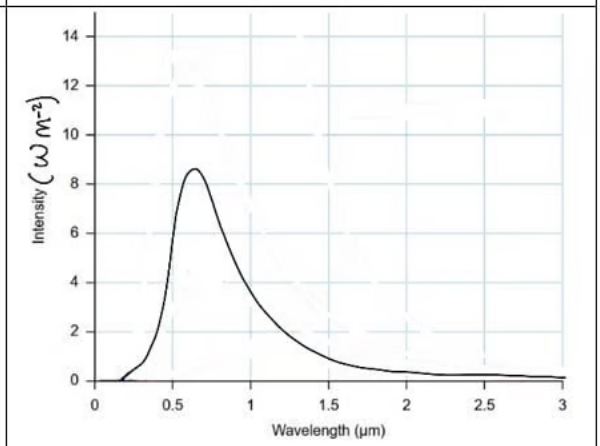
C.



B.



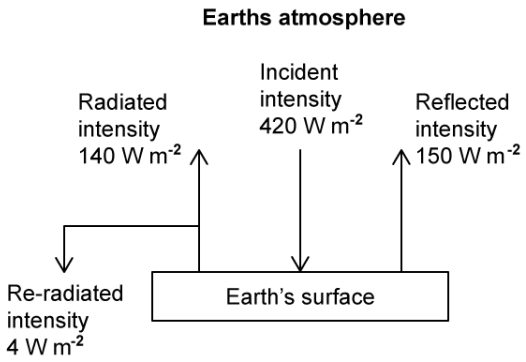
D.



[1 mark]

Question 8

The diagram shows a simplified model of the energy balance of the Earth.



What is the albedo of the Earth according to this model?

A. $\frac{1}{3}$

B. $\frac{5}{14}$

C. $\frac{145}{212}$

D. $\frac{29}{42}$

[1 mark]

Question 9

During a freak weather event, the average intensity of light received on Earth was $5 \times 10^{-5}\ W\,m^{-2}$. The average albedo was 0.8 and the average emissivity was $\frac{2}{3}$.

Assume that $\sigma = 6 \times 10^{-8}\ W\,m^{-2}\,K^{-4}$

What was the average temperature of the Earth during the event?

A. $(16)^{\frac{1}{4}}\ K$

B. $(250)^{\frac{1}{4}}\ K$

C. $(10\,000)^{\frac{1}{4}}\ K$

D. $(390\,625)^{\frac{1}{4}}\ K$

[1 mark]

Question 10

The average intensity of radiation from the Sun received on Earth is $320\ W\,m^{-2}$ where the albedo is 0.25.

Scientists predict that quadrupling the amount of Carbon Dioxide in the Earth's atmosphere will result in a change in the albedo of the Earth by 0.02.

What will be the new intensity of the light reflected from the Earth's surface back into space?

A. $225 W\,m^{-2}$

B. $300\ W\,m^{-2}$

C. $326.4\ W\,m^{-2}$

D. $425\ W\,m^{-2}$

[1 mark]