



TOPIC TEST • IB PHYSICS

Thermal physics

Higher level

45 minutes

Instructions

- 5 questions, 30 marks, on B.1 to B.3 (HL: also B.4). Answer in the spaces provided.
- Total: 30 marks. Answer all questions.
- You need a clean copy of the IB physics data booklet and a calculator.
- Show your working: most marks go to the method, not to the final number.
- Sit it in one go, timed. Then mark it with the mark scheme, honestly.

Name

Date

Score

Every question in this test is new, written by Pietro Meloni in the style of the current papers, to check one topic of the syllabus under timed conditions. It is not IB material and not endorsed by the IB.



Mark scheme and the other tests: scan the code

1. A hiker camping in the mountains melts snow on a gas stove to get drinking water. A pan contains 0.60 kg of snow at a temperature of -12°C .

Quantity	Value
specific heat capacity of ice / $\text{J kg}^{-1} \text{K}^{-1}$	2100
specific latent heat of fusion of ice / J kg^{-1}	3.34×10^5

- (a) Calculate the energy needed to raise the temperature of the snow to 0°C and then to melt all of it. [3]

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- (b) The stove transfers thermal energy to the snow at a constant rate of 850 W. Calculate the minimum time needed to turn all the snow into water at 0°C . [1]

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- (c) While the snow is melting, its temperature stays at 0°C even though energy is still being supplied. Explain this in terms of the energy of the particles. [2]

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2. The glass bulb of an incandescent lamp is sealed and contains argon, which can be treated as an ideal gas. The internal volume of the bulb is $1.5 \times 10^{-4} \text{ m}^3$. When the lamp is switched off, the argon is at a temperature of 20°C and a pressure of $8.0 \times 10^4 \text{ Pa}$.

- (a) Calculate the number of argon atoms in the bulb. [2]

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- (b) When the lamp has been switched on for some time, the mean temperature of the argon is 160°C . The volume of the bulb does not change. Calculate the pressure of the argon. [2]

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- (c) Explain, using the kinetic model of an ideal gas, why the pressure of the argon increases when its temperature rises. [3]

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3. The Sun can be treated as a black body. The spectrum of the radiation emitted by the Sun has its peak at a wavelength of 5.0×10^{-7} m. The radius of the Sun is 6.96×10^8 m.

- (a) Calculate the surface temperature of the Sun. [1]

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- (b) Calculate the luminosity of the Sun. [2]

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- (c) The mean temperature of the Earth's surface is 288 K and its emissivity is 0.96.

- (i) Calculate the power radiated per unit area by the Earth's surface. [1]

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- (ii) Calculate the wavelength at which the radiation emitted by the Earth's surface has its peak, and state the region of the electromagnetic spectrum it belongs to. [1]

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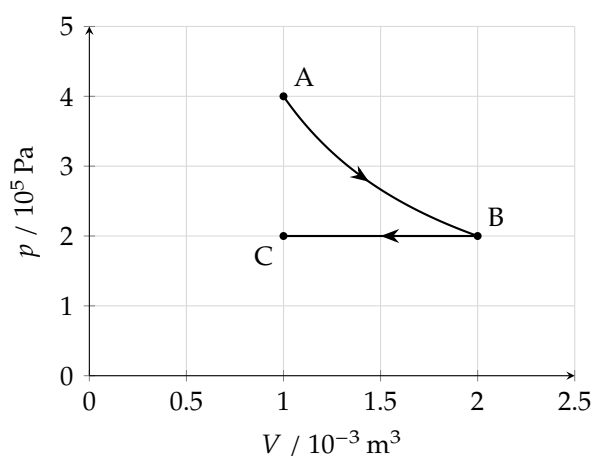
- (d) The mean solar power absorbed per unit area of the Earth's surface is about 170 W m^{-2} , much less than your answer to (c)(i). Explain, with reference to greenhouse gases, how the surface can still stay at a constant mean temperature. [2]

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4. A fixed mass of an ideal monatomic gas is in a cylinder closed by a piston. The gas is taken from state A to state B by an isothermal expansion, and then from state B to state C by a compression at constant pressure, as shown on the pressure–volume diagram.



- (a) The work done by the gas during the change $A \rightarrow B$ is 280 J. Explain why the thermal energy transferred to the gas during $A \rightarrow B$ is also 280 J. [2]

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- (b) For the change $B \rightarrow C$,

- (i) calculate the work done on the gas. [1]

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- (ii) calculate the change in the internal energy of the gas. [1]

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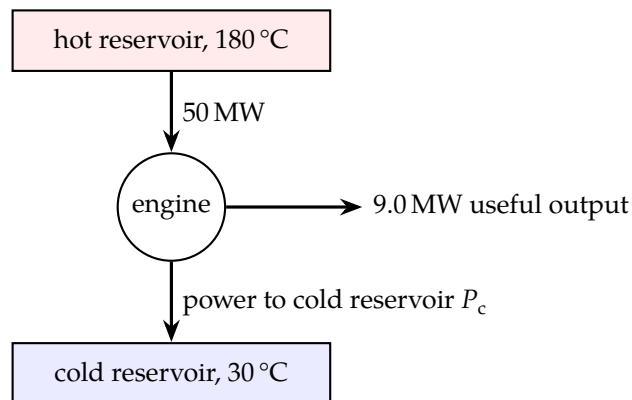
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- (iii) deduce the thermal energy transferred during $B \rightarrow C$, and state its direction. [1]

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5. A geothermal power station works as a heat engine. Hot water from underground provides the hot reservoir at 180°C , and river water provides the cold reservoir at 30°C . The diagram shows the energy flow each second when the station runs at full power.



(a) Calculate the efficiency of the power station. [1]

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(b) Calculate the Carnot efficiency for these two reservoirs. [1]

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(c) Calculate the change in the entropy of the cold reservoir in one second. [1]

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(d) Deduce, with reference to the change in the total entropy of the two reservoirs, that the operation of the station is consistent with the second law of thermodynamics.

[2]

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