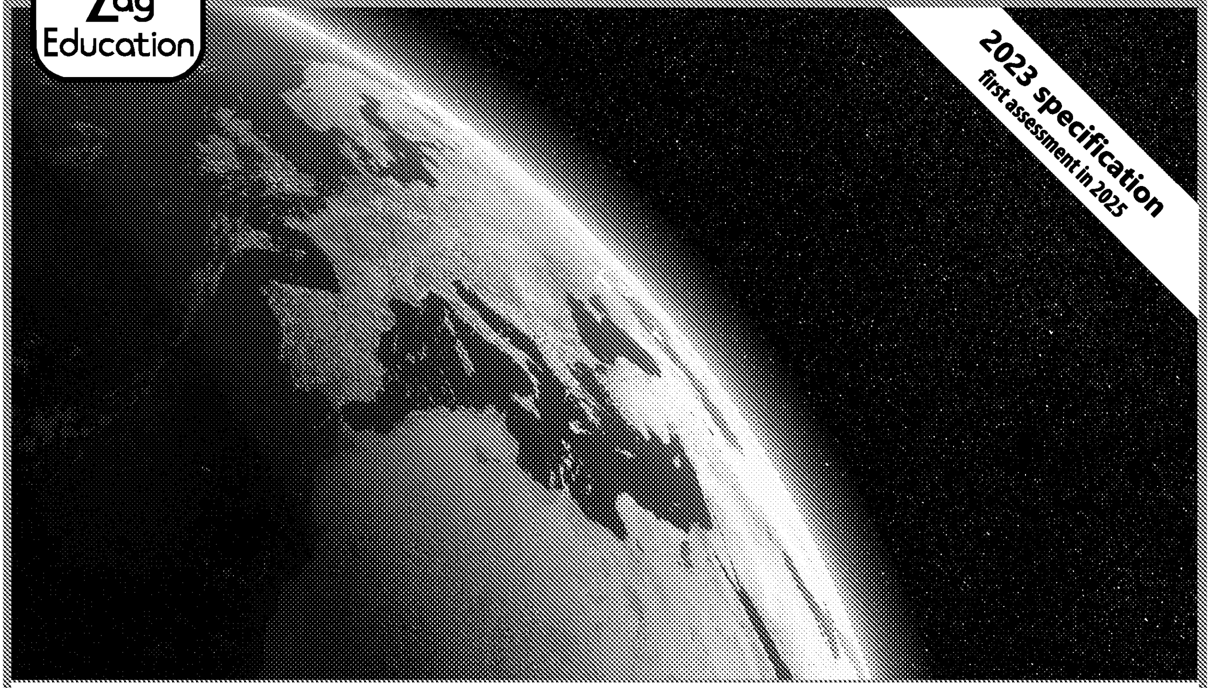
Physics International Baccalaureate Diploma Programme


2023 specification
first assessment in 2025

Topic Tests
for IB Physics
B. The Particulate Nature of Matter

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Teacher's Introduction

These topic tests have been designed to help you and your students assess their knowledge of a topic after you have taught each part of **Theme B – The Particulate Nature of Matter (Topics B.1–B.5)** for the **IB Physics Diploma Programme (standard level and higher level)**. This part of the course includes the following topics:

1. Thermal energy transfers
2. Greenhouse effect
3. Gas laws
4. Thermodynamics **(Additional Higher Level)**
5. Current and circuits

Each topic test closely follows the content of the specification and includes:

- **Multiple-choice questions**: These are not in exam style, and the purpose of these is to test different elements, knowledge and skills from the specification in a variety of styles. Question types include general recall, explanation of key concepts, and application questions.
- **Structured-answer questions**: Where appropriate, topics may contain one or more extended-response questions to prepare students for what they might meet in the exam, and to test exam skills. Question types include long-form explanations, match-ups, copy and complete and fact recall.

Mathematical skills are also covered in these topic tests.

The table below shows the content, specification reference and number of marks allocated to each test.
Tests have been provided in both write-on and non-write-on format.

Topic	Test title	Marks per section	Total marks
B.1 Thermal energy transfers	Multiple-choice questions	12	36
	Structured-answer section	24	
B.2 Greenhouse effect	Multiple-choice questions	10	31
	Structured-answer section	21	
B.3 Gas laws	Multiple-choice questions	10	30
	Structured-answer section	20	
B.4 Thermodynamics **(Additional Higher Level)**	Multiple-choice questions	10	30
	Structured-answer section	20	
B.5 Current and circuits	Multiple-choice questions	12	37
	Structured-answer section	25	

Tests have been designed to take approximately 30–40 minutes to complete. Students are able to see the number of marks awarded for each question, allowing them to gauge the level of detail they will require for the answers. Full answers with marks are included at the end of each test. Additionally, it makes the resource a suitable tool for students to use independently.

The topic tests are suitable for a classroom assessment, revision aid or homework task and are, therefore, suitable for use immediately after a topic is completed in class or at the end of teaching the course.

It is recommended that students have access to a calculator to complete the questions.

We hope you find these tests useful during your teaching.

December 2023

B.1 Thermal energy transfers

Multiple-choice questions

1. Which of the following is **not true** for a gas?
   A. A gas does not have a fixed shape or definite volume
   B. Increasing the temperature increases the number of collisions bet
   C. All the gas molecules in a container move at the same velocity
   D. There are no forces between gas molecules except during collisio

2. What [illegible] units of density?
   A. $m\ kg^{-3}$ ☐
   B. $m\ kg^{-2}$ ☐
   C. $kg\ m^{-2}$ ☐
   D. $kg\ m^{-3}$ ☐

3. What is -148 °C represented using the Kelvin scale (rounded to the ne
   A. 125 K ☐
   B. 115 K ☐
   C. 124 K ☐
   D. 114 K ☐

4. A change in temperature in degrees Celsius is 43 °C. What is the sam using the Kelvin scale?
   A. 22 K ☐
   B. 43 [illegible]
   C. 15[illegible] ☐
   D. 316 K ☐

5. What is the length of a square container holding a liquid with density
   Assume the liquid fills the container completely.
   A. 74.1 m ☐
   B. 4.2 m ☐
   C. 4.47 m ☐
   D. 66.7 m ☐

6. Which of the following is **true** when the internal energy of a system is
   A. Potential energy increases
   B. Potential energy decreases ☐
   C. Kinetic energy increases ☐
   D. Kinetic energy decreases ☐

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7. Which of the following best describes a property of solids?
   - A. Weakly charged particles with little repulsion ☐
   - B. Strong intermolecular forces ☐
   - C. No fixed shape or volume ☐
   - D. Low internal energy ☐

8. A block of ice is melted. Which of the following is **true** during the ph
   - A. Mass increases ☐
   - B. Temperature is constant ☐
   - C. Specific heat capacity decreases ☐
   - D. Specific latent heat increases ☐

9. How much heat is required to heat 250 g of water from 28 °C to 54 °C
of water is 4200 J kg^{-1} K^{-1}.
   - A. 2.73×10^4 J ☐
   - B. 2.73×10^7 J ☐
   - C. 6.4×10^{-1} J ☐
   - D. 6.4×10^2 J ☐

10. An ice block takes in 1.5 kJ of energy when it is melted. What is the m
The specific latent heat of fusion is 3.3×10^5 J kg
    - A. 2.2×10^2 kg ☐
    - B. 2.2×10^5 kg ☐
    - C. 4.5×10^{-3} kg ☐
    - D. 4.5×10^{-6} kg ☐

11. A group of particles are found in a container at room temperature (25
kinetic energy of the particles (rounded to one decimal place)?
    - A. 6.2×10^{-21} J ☐
    - B. 4.1×10^{-21} J ☐
    - C. 4.8×10^{-22} J ☐
    - D. 3.2×10^{-22} J ☐

12. Three bodies, A, B and C, are placed in direct contact with each other.
temperature, body B is at 400 K and body C is also at room temperatu
heat flow in the system?
    - A. From body B to body A and body C ☐
    - B. From body A and body C to body B ☐
    - C. From body A to body C no heat flow to B ☐
    - D. No heat flow ☐

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Structured-answer section

1. a) (i) Match the key term to its definition.

1. Conduction

2. Convection

[illegible] Radiation

A. Thermal
two bod
the temp
in betwe

B. The tran
a hotter

C. Heat tra
groups o

Two square bodies of the same size and material but different te
direct contact with each other. The temperatures of block A and
100 K respectively.

(ii) It is predicted that when the blocks reach thermal equilibriu
Describe what happens in terms of thermal energy transfers.

....

....

....

....

(iii) The length of one body is 0.5 m. Calculate the value of the te
the two bodies respectively.

(iv) The rate of thermal energy transfer is given as:

$$\frac{\Delta Q}{\Delta t} = kA\frac{\Delta T}{\Delta x}$$

Calculate the material conductivity if the rate of thermal ene
explicitly stating the units.

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b) It is found that the predicted values do not exactly match the obs
Give **two** reasons why this might be the case.

1. ....

....

2. ....

....

2. a) Fill in the blanks in the paragraph below.

A perfect (i) ________________ emits radiation across the whole elect

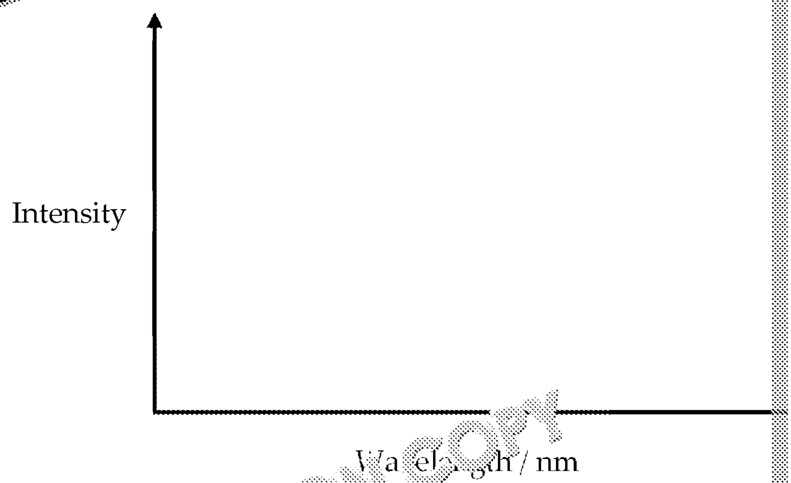
The (ii) ________________ per unit area is related to the temperature

The peak wavelength emitted is found using (iii) ________________ w

and peak wavelength are (iv) ________________.

b) (i) A distant planet can be assumed to be a perfect black body.
wavelength emitted if the absolute temperature of this plane

(ii) Complete the set of axes to show the emission spectrum of th



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(iii) The luminosity is related to the apparent brightness of the
of the distant planet, given it has a radius of 8000 m. Assume

(iv) Hence, calculate the apparent brightness of the distant plane
[illegible] 3 × 10^7 m.

3. Describe how convection currents are formed in liquids. It may help

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Space for diagram

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Preview of Questions Ends Here

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B.2 Greenhouse effect

Question		Answer
		Multiple-choice questions
1		A – Ultraviolet light
2		C – 2.19×10^{-8} W m^{-2}
3		D – 1096.77 W m^{-2}
4		A – Higher
5		D – Average amount of sunlight reaching Earth's surface per unit a
6		C – S/[illegible]
7		[illegible] aerosols
8		C – The molecular energy levels of carbon dioxide
9		C – 1.62×10^{-2} J m^{-2}
10		D – Reduce the burning of fossil fuels
		Structured-answer section
1 a)	**(i)**	**ANY ORDER FOR THE MAIN GREENHOUSE GASES:** (i), (ii), (iii), (iv) Methane [1], water vapour [1], carbon dioxide [1], n (v) Infrared [1] (vi) Solar [1]
	(ii)	Burning fossil fuels releases main greenhouse gases to atmosphere [These gases absorb and re-emit IR radiation [1] Earth radiates IR radiation [1] As more greenhouse gases are released, more heat is trapped [1]
b)		**30 % reflected:** $1.8 \times 10^{17} \times 0.3 = 5.4 \times 10^{16}$ W m^{-2} [1] **60 % reflected:** $1.8 \times 10^{17} \times 0.6 = 1.08 \times 10^{17}$ W m^{-2} [1] **Total:** $5.4 \times 10^{16} + 1.08 \times 10^{17} = 1.62 \times 10^{17}$ W m^{-2} [1]
c)		Cloud formations are different [1] Angle of incidence of solar radiation changes with latitude [1]
2 a)		Albedo = (total scattered power) / (total incident power) [1]
b)		**Area of a square:** $(3 \times 10^{-2})^2 = 9 \times 10^{-4}$ [1] Power radiated per unit area = $5.67 \times 10^{-8} \times 1000^4 \times 0.6 = 34\,020$ W m Power radiated = $34\,020 \times 9 \times 10^{-4} = 30.62$ W [1]
c)		**ANY ONE OF THE FOLLOWING:** Surface is facing the source directly [1] **OR** surface is uniform [1]
3		**ANY TWO OF THE FOLLOWING:** Bending [1] Stretching [1] **OR** vibrating [1]

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