Diploma Programme
Programme du diplôme
Programa del Diploma

# Markscheme

# November 2025

# Physics

# Standard level

# Paper 2

11 pages

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

© International Baccalaureate Organization 2025

All rights reserved. No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without the prior written permission from the IB. Additionally, the license tied with this product prohibits use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, whether fee-covered or not, is prohibited and is a criminal offense.

More information on how to request written permission in the form of a license can be obtained from https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/.

© Organisation du Baccalauréat International 2025

Tous droits réservés. Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite préalable de l'IB. De plus, la licence associée à ce produit interdit toute utilisation de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, moyennant paiement ou non, est interdite et constitue une infraction pénale.

Pour plus d'informations sur la procédure à suivre pour obtenir une autorisation écrite sous la forme d'une licence, rendez-vous à l'adresse https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/.

© Organización del Bachillerato Internacional, 2025

Todos los derechos reservados. No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin la previa autorización por escrito del IB. Además, la licencia vinculada a este producto prohíbe el uso de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales—, ya sea incluido en tasas o no, está prohibido y constituye un delito.

En este enlace encontrará más información sobre cómo solicitar una autorización por escrito en forma de licencia: https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/.

**Subject Details: Physics SL Paper 2 Markscheme**
**Mark Allocation**
**Candidates are required to answer ALL questions. Maximum total = 50 marks**.

**1.** Each row in the "Question" column relates to the smallest subpart of the question.

**2.** The maximum mark for each question subpart is indicated in the "Total" column.

**3.** Each marking point in the "Answers" column is shown by means of a tick (✓) at the end of the marking point.

**4.** A question subpart may have more marking points than the total allows. This will be indicated by "**max**" written after the mark in the "Total" column. The related rubric, if necessary, will be outlined in the "Notes" column.

**5.** An alternative wording is indicated in the "Answers" column by a slash (*/*). Either wording can be accepted.

**6.** An alternative answer is indicated in the "Answers" column by "***OR***". Either answer can be accepted.

**7.** An alternative markscheme is indicated in the "Answers" column under heading ***ALTERNATIVE 1*** *etc*. Either alternative can be accepted.

**8.** Words inside chevrons **« »** in the "Answers" column are not necessary to gain the mark.

**9.** Words that are <u>underlined</u> are essential for the mark.

**10.** The order of marking points does not have to be as in the "Answers" column, unless stated otherwise in the "Notes" column.

**11.** If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the "Answers" column then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by ***OWTTE*** (or words to that effect) in the "Notes" column.

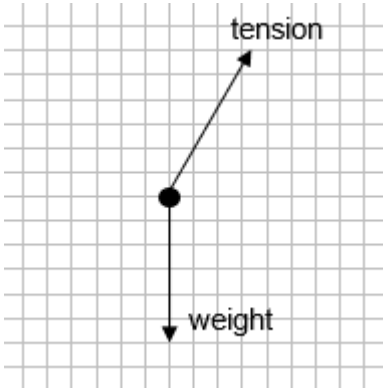
**12.** Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

**13.** Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script. "ECF acceptable" will be displayed in the "Notes" column.

**14.** CNA refers to a correct numerical answer.

**15.** Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the "Notes" column.

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| **1.** | **a** | | 3 ✓ | | **[1]** |
| **1.** | **b** | | Chooses 3->2 transition ✓<br>$\lambda = \frac{hc}{\Delta E}$ ✓<br><br>$\lambda = «\frac{1.24\times10^{-6}}{1.89} = »6.56\times10^{-7}\,\text{m}$<br><br>***OR***<br>$\lambda = «\frac{6.63\times10^{-34}\times3.0\times10^{8}}{1.89\times1.6\times10^{-19}} = »6.58\times10^{-7}\,\text{m}$ ✓ | *Ignore sign.*<br>*Award [3] for CNA (correct numerical answer)*<br>*Allow ECF from MP1 if they choose an incorrect transition*<br>*Do not penalize 657 nm*<br>*Award [1] max if they calculate a wavelength using a single energy level instead of a delta ΔE.* | **[3]** |

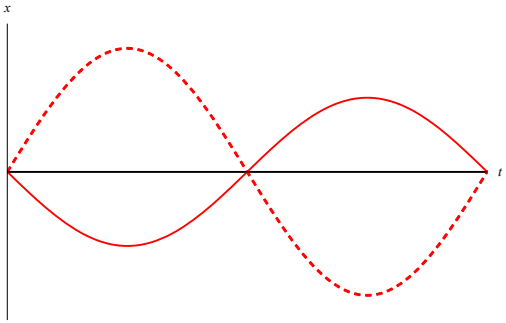
| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| 2. | a | i |  <br>Labelled vertical weight / W / mg / $F_g$ and tension / T / $F_T$ in approximately correct direction ✓<br>With vertical *T* component equal to weight ✓ | *Ignore other forces drawn for MP1* | **[2]** |
| 2. | a | ii | $T\sin 30^\circ = ma$<br>**OR**<br>$T\cos 30^\circ = mg$ ✓<br>$a = g\tan 30^\circ = 5.66 \approx 5.7\ \text{m s}^{-2}$ ✓ | *Accept reversed trig functions if 60º used.*<br>*Award [2] for CNA* | **[2]** |
| 2. | b | | The ball is in equilibrium / forces are balanced / net force is zero / no acceleration/ the vertical weight must be balanced by a vertical tension ✓<br><br>The angle is zero ✓ | *For MP2, accept an answer of 10º if from the students' answer it can be understood that they interpreted the vertical as the perpendicular line to the ceiling of the truck, so that their answer of 10º implies that the string is vertically downwards.* | **[2]** |

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| 2. | c | | $\mu mg = m\frac{v^2}{R}$ ✓<br><br>v = «$\sqrt{0.6 \times 9.8 \times 75}$» 21 $ms^{-1}$ ✓ | *Award [2] for a CNA.* | **[2]** |
| 2. | d | | **ALTERNATIVE 1**<br>KE $\frac{1}{2}\times 1400\times 15^2$ **OR** $1.6\times 10^5$ J ✓<br>Work done by drag force $520\times\pi\times 75$ **OR** $1.2\times 10^5$ J ✓<br>This is less than the KE so the truck will make it ✓<br><br>**ALTERNATIVE 2**<br>Truck decelerates at $\frac{520}{1400}$ **OR** 0.371$ms^{-2}$ ✓<br>Speed at gas station is $\sqrt{15^2 - 2\times 0.371\times\pi\times 75}$ **OR** 7.0$ms^{-1}$<br>***OR***<br>truck stops after a distance « $\frac{15^2}{2 \text{ x } 0.371}$ =» $303\ m$ ✓<br>Speed is not zero<br>***OR***<br>303 m > 75$\pi$<br>**OR**<br>303 m > 236 m ✓ | *Allow MP3 for a consistent conclusion if any previous calculation is wrong.* | **[3]** |

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| **3.** | **a** | | « $8.99\times10^{9}\times(\frac{9Q}{0.30^{2}}+\frac{Q}{0.06^{2}})=3.26\times10^{7}$ so » Q = 9.6x10$^{-6}$ ✓<br><br>C ✓ | | **[2]** |
| **3.** | **b** | **i** | $qvB=m\frac{v^{2}}{R}$ ✓<br>Hence answer | | **[1]** |
| **3.** | **b** | **ii** | Force is perpendicular to the velocity / F acts as centripetal / F does no work / F only changes direction of velocity ✓ | *Do not accept reference to centripetal acceleration only* | **[1]** |
| **3.** | **c** | | loss of energy / speed reduced ✓<br>so radius decreases ✓ | *MP2 scores only if MP1 is scored.* | **[2]** |

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| **4.** | **a** | **i** | 600 «counts per hr »✓ | | **[1]** |
| **4.** | **a** | **ii** | **ALTERNATIVE 1**<br>Subtract their background rate to 3000 to get the initial count rate<br>e.g. initial count rate 2400 counts per h ✓<br>Attempt to read t for $\frac{1}{2}$, $\frac{1}{4}$ or $\frac{1}{8}$ this initial count rate plus their background rate ✓<br>Half-life is 10 h ✓<br><br>**ALTERNATIVE 2**<br>Use of decay equation with $A_0$ = 3000 (their ai) and one point correctly read from graph ✓<br>calculate decay constant ✓<br>Use $half\ life = \frac{ln2}{\lambda}$ to get $T_{1/2}$ =10 h ✓ | *Allow ECF from a i)*<br><br>*Allow ECF from MP1, i.e.max [2] for answer of about 14 h if background rate not used*<br><br>*Accept 9 to 11 hours for MP3* | **[3]** |
| **4.** | **a** | **iii** | The BE «per nucleon» is greater for $^{204}_{82}Pb$ ✓<br>Because $^{204}_{82}Pb$ is more stable/tightly bound than $^{204}_{83}Bi$ ✓ | *Award [1] if they recognize Pb as more stable but conclude incorrectly.* | **[2]** |
| **4.** | **a** | **iv** | The alpha particles would be absorbed / have low penetration / short range / ✓ | | **[1]** |
| **4.** | **b** | | $\Delta m = 203.932254 - (203.928034 + 0.000549) = 3.671 \times 10^{-3}$ u ✓<br>$Q = 3.671 \times 10^{-3} \times 931.5 \approx 3.42$ MeV ✓ | *Allow ECF from MP1*<br>*Award [1] if electron mass is neglected and Q = 3.93 MeV or $6.30 \times 10^{-13}$ J*<br>*Award [2] for a CNA*<br>*Accept final answer in J ($5.48 \times 10^{-13}$)* | **[2]** |

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| **5.** | **a** | **i** | **ALTERNATIVE 1**<br>One mole contains $6.02\times10^{23}$ atoms and has mass 63.5 g ✓<br>Mass of one atom is $\frac{63.5\times10^{-3}}{6.02\times10^{23}}=1.055\times10^{-25}\approx1.1\times10^{-25}$ kg ✓<br><br>**ALTERNATIVE 2**<br>The atom has mass 63.5 u ✓<br>I.e. $63.5\times1.661\times10^{-27}=1.055\times10^{-25}\approx1.1\times10^{-25}$ kg ✓ | *Award full marks for a CNA*<br><br>*Accept similar calculation for a mass of 0.4 kg (n = 6.3)* | **[2]** |
| **5.** | **a** | **ii** | Volume of copper = $\frac{0.0635}{8940}$ ✓<br><br>V = « $\frac{0.0635}{\left(8940\times6.02\times10^{23}\right)}$ » = $1.2\times10^{-29}\,\mathrm{m}^3$ ✓ | *Award full marks for a CNA*<br><br>*Accept similar calculation for a mass of 0.4 kg* | **[2]** |
| **5.** | **a** | **iii** | Side of cube $a=\sqrt[3]{1.180\times10^{-29}}=2.277\times10^{-10}\approx2\times10^{-10}$ m ✓ | *Allow ECF from a ii*<br><br>*Award the mark for the CNA* | **[1]** |
| **5.** | **b** | | Q « = mL= 0.400 x 206 x $10^3$ » = 82.4kJ ✓ | | **[1]** |

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| **5.** | **c** | | Internal energy is greater in the liquid phase ✓<br>in liquid the intermolecular potential energy is greater / the separation is greater / energy has been added✓<br>kinetic energy is unchanged / temperature is the same / internal energy is the sum of kinetic and potential energies✓ | | **[3]** |
| **5.** | **d** | **i** | wave «created by the hammer» is reflected / two «identical» waves in opposite directions✓<br>the right and left waves superpose / add up / interfere ✓ | *Accept reference to constructive and destructive interference in MP2* | **[2]** |
| **5.** | **d** | **ii** | Antinodes at both ends, a node in the middle ✓ | *Accept only one wave or wave and envelope, either solid or broken lines.* | **[1]** |
| **5.** | **d** | **iii** | Opposite line i.e. phase difference of $\pi$ ✓<br>Smaller amplitude, ✓<br>  | *Labelling not necessary*<br><br>MP2 only scores if MP1 scores | **[2]** |
| **5.** | **e** | **i** | The standing wave is longitudinal/sand moves horizontally / sand is pushed/vibrates<br>**OR**<br>there are nodes and antinodes ✓<br>« sand moves» away from antinodes/ to nodes ✓ | | **[2]** |

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| **5.** | **e** | **ii** | **ALTERNATIVE 1**<br>Wavelength in air is $2d$ (= 3.6 cm) ✓<br>Frequency of wave in copper is the same as that in the air in the tube ✓<br>$\frac{v_{Cu}}{2L} = \frac{v_{air}}{2d}$ ✓<br>$v_{Cu} = \frac{L}{d} \times v_{air} = \frac{34}{1.8} \times 330 = 6.2 \times 10^3$ m s$^{-1}$ ✓<br><br>**ALTERNATIVE 2**<br>Wavelength in air is $2d$ (= 3.6 cm) ✓<br>$f = \frac{330}{3.6 \times 10^{-2}} = 9.167 \times 10^3$ Hz ✓<br>$\lambda_{Cu} = 68$ cm ✓<br>$v_{Cu} = 9167 \times 0.68 = 6.2 \times 10^3$ m s$^{-1}$ ✓ | Award [4] for a CNA<br><br>Allow ECF from wrong wavelengths | **[4]** |