

50 answers that get 0 marks

...and what to write instead

IB DP Physics (2025 syllabus, SL and HL) · Ahmed Gomaa · DP Physics Notebook ·
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How to use this booklet

Each card has an exam-style question, a common answer that scores **0 marks**, and the answer that gets the marks (one ✓ per mark). Cover the green answer, write your own, then check it. The words that earn the marks are the ones examiners look for.

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(HL) marks additional higher level topics. All questions are original, written in the style of IB exam questions. Not affiliated with the IBO.

Theme A · Space, time and motion

1

A.1 Kinematics

A ball is thrown straight up. State its acceleration at the highest point. [1]

0 MARKS

~~Zero, because the ball stops for a moment.~~

WRITE THIS · 1 MARK

- 9.8 m s^{-2} (g) downwards. ✓

Why? Only the velocity is zero at the top. Gravity still acts, so the acceleration is still g .

2

A.1 Kinematics

A ball is thrown at an angle. Air resistance is negligible. Describe the horizontal component of its velocity during the flight. [1]

0 MARKS

~~It decreases, because the ball slows down.~~

WRITE THIS · 1 MARK

- It stays constant; no horizontal force acts, so the horizontal acceleration is zero. ✓

Why? Only the vertical component changes. The horizontal and vertical motions are independent.

3

A.1 / A.2 Terminal speed

A skydiver falls at terminal speed. State and explain the resultant force on her. [2]

0 MARKS

~~There is no air resistance, because she has stopped speeding up.~~

WRITE THIS · 2 MARKS

- The resultant force is zero. ✓
- The drag force (air resistance) has increased until it equals her weight. ✓

Why? Drag is at its LARGEST at terminal speed, not zero. Zero acceleration means zero resultant force.

4

A.2 Forces

A book rests on a table. Identify the force that forms a Newton's third law pair with the weight of the book. [1]

0 MARKS

~~The normal force of the table on the book.~~

WRITE THIS · 1 MARK

- The gravitational force of the book on the Earth (upwards). ✓

Why? A third-law pair acts on TWO DIFFERENT objects and is the same type of force. Weight and normal force both act on the book.

5

A.2 Circular motion

A car goes round a bend at constant speed. Explain why the car is accelerating. [2]

0 MARKS

~~A centrifugal force pushes it outwards, so the forces are balanced.~~

WRITE THIS · 2 MARKS

- The direction of motion changes, so the velocity changes. ✓
- The acceleration is towards the centre of the circle, caused by a resultant (centripetal) force, here friction. ✓

Why? There is no outward force on the car. The resultant force points to the centre.

6

A.2 Momentum

Explain why an airbag reduces the injury to a driver in a crash. [2]

0 MARKS

~~The airbag reduces the change in momentum of the driver.~~

WRITE THIS · 2 MARKS

- The change in momentum is the same, but it happens over a longer time. ✓
- So the average force on the driver, $F = \Delta p / \Delta t$, is smaller. ✓

Why? The driver stops either way, so Δp cannot change. Only the time changes.

7

A.3 Work and energy

A box is carried horizontally across a room at a constant height. State the work done on the box by its weight. [1]

0 MARKS

~~Weight $\times$ distance moved, mgd .~~

WRITE THIS · 1 MARK

- Zero; the weight is perpendicular to the displacement. ✓

Why? Work = force $\times$ component of displacement in the direction of the force.

8

A.3 Energy

Define energy density of a fuel. [1]

0 MARKS

~~How much energy a fuel has.~~

WRITE THIS · 1 MARK

- The energy released per unit VOLUME of the fuel (J m^{-3}). ✓

Why? Say per unit volume. Energy per unit mass (J kg^{-1}) is called specific energy.

9

A.4 Rigid bodies (HL)

A spinning skater pulls her arms in and spins faster. Explain why. [2]

0 MARKS

~~She gains angular momentum when she pulls her arms in.~~

WRITE THIS · 2 MARKS

- There is no external torque, so her angular momentum $L = I\omega$ stays constant. ✓
- Her mass moves closer to the axis, so I decreases and ω increases. ✓

Why? Angular momentum is conserved. It does not increase.

10

A.5 Relativity (HL)

Define proper time interval. [1]

0 MARKS

~~The real time, measured by an observer at rest.~~

WRITE THIS · 1 MARK

- The time between two events measured in the reference frame in which the two events happen at the same place. ✓

Why? Every observer is at rest in their own frame. The key idea is "same place".

Theme B · The particulate nature of matter

11

B.1 Thermal energy

Ice at 0 °C is heated and melts. Explain why its temperature does not rise. [2]

0 MARKS

~~The heat is lost to the surroundings.~~

WRITE THIS · 2 MARKS

- The energy supplied increases the potential energy of the particles (it breaks some of the bonds and increases the separation of the particles). ✓
- The mean kinetic energy of the particles does not change, so the temperature stays the same. ✓

Why? Temperature measures the mean kinetic energy. During melting the energy goes into potential energy.

12

B.1 Thermal energy

Define specific heat capacity. [1]

0 MARKS

~~The amount of heat a substance can hold.~~

WRITE THIS · 1 MARK

- The energy needed to raise the temperature of 1 kg (unit mass) of a substance by 1 K. ✓

Why? Say "unit mass" and "1 K". Without them there is no mark.

13

B.1 Thermal energy

State what the temperature of a gas measures. [1]

0 MARKS

~~The amount of heat in the gas.~~

WRITE THIS · 1 MARK

- The average (mean) kinetic energy of the particles of the gas. ✓

Why? Heat is energy that is TRANSFERRED. An object does not "contain heat".

14

B.2 Greenhouse effect

Explain how greenhouse gases keep the Earth's surface warmer. [3]

0 MARKS

~~Greenhouse gases trap the heat.~~

WRITE THIS · 3 MARKS

- The Earth's surface emits infrared radiation. ✓
- Greenhouse gases in the atmosphere absorb some of this infrared radiation. ✓
- They re-emit it in all directions, so some goes back to the surface. ✓

Why? "Trap" scores nothing. Say absorb and re-emit, and say it is infrared.

15

B.3 Gas laws

Use the molecular model to explain why the pressure of a gas rises when it is heated at constant volume. [3]

0 MARKS

~~The molecules expand and take up more space.~~

WRITE THIS · 3 MARKS

- The mean kinetic energy, and so the mean speed, of the molecules increases. ✓
- The molecules hit the walls more often and with a larger change in momentum per collision. ✓
- So the force on the walls per unit area (the pressure) increases. ✓

Why? Molecules do not get bigger. They get faster.

16

B.3 Gas laws

A fixed mass of gas at constant volume is heated from 20 °C to 40 °C. State the factor by which the pressure changes. [1]

0 MARKS

~~The pressure doubles.~~

WRITE THIS · 1 MARK

- $p \propto T$ in kelvin: 313 K / 293 K ≈ 1.07 . ✓

Why? Always change °C to K in gas-law questions.

17

B.4 Thermodynamics (HL)

A gas is compressed adiabatically. State and explain what happens to its temperature. [2]

0 MARKS

~~It stays the same, because no thermal energy enters the gas.~~

WRITE THIS · 2 MARKS

- $Q = 0$, and work is done ON the gas (W is negative in $Q = \Delta U + W$). ✓
- So ΔU is positive: the internal energy and the temperature increase. ✓

Why? Adiabatic means $Q = 0$, not $\Delta T = 0$. Constant temperature is ISOTHERMAL.

18

B.4 Thermodynamics (HL)

State the second law of thermodynamics in terms of entropy. [1]

0 MARKS

~~Entropy always increases.~~

WRITE THIS · 1 MARK

- The total entropy of an ISOLATED system never decreases. ✓

Why? The entropy of a fridge's inside can decrease. "Isolated" earns the mark.

19

B.5 Circuits

Compare the current flowing into a lamp with the current flowing out of it. [1]

0 MARKS

~~Less current flows out, because the lamp uses some up.~~

WRITE THIS · 1 MARK

- They are the same: charge is conserved. The lamp transfers energy, not charge. ✓

Why? Current is not used up. Energy is.

20

B.5 Circuits

Define the emf of a cell. [1]

0 MARKS

~~The voltage of the battery, the force that pushes the current.~~

WRITE THIS · 1 MARK

- The work done (energy transferred) per unit charge by the cell in moving charge round the complete circuit. ✓

Why? Emf is not a force. It is energy per unit charge ($\text{J C}^{-1} = \text{V}$).

Theme C · Wave behaviour

21

C.1 Simple harmonic motion

State the defining condition for simple harmonic motion. [2]

0 MARKS

~~Motion that repeats, moving back and forth.~~

WRITE THIS · 2 MARKS

- The acceleration is proportional to the displacement from the equilibrium position, ✓
- and is directed towards the equilibrium position ($a = -\omega^2 x$). ✓

Why? A bouncing ball repeats too, but it is not SHM. Give both parts.

22

C.1 Simple harmonic motion

State where the acceleration of a simple harmonic oscillator is greatest. [1]

0 MARKS

~~At the equilibrium position, where it moves fastest.~~

WRITE THIS · 1 MARK

- At the maximum displacement (the amplitude), where the speed is zero. ✓

Why? $a = -\omega^2 x$: largest x gives largest acceleration. At equilibrium the acceleration is zero.

23

C.1 Simple harmonic motion

The amplitude of a simple harmonic oscillator is doubled. State the effect on the period.

[1]

0 MARKS

~~The period doubles, because it has twice as far to go.~~

WRITE THIS · 1 MARK

- No change: in SHM the period does not depend on the amplitude. ✓

Why? With a larger amplitude the maximum speed (ωA) is larger too, so the time stays the same.

24

C.2 Wave model

Describe a longitudinal wave. [1]

0 MARKS

~~A wave that travels along a straight line.~~

WRITE THIS · 1 MARK

- The particles of the medium oscillate parallel to the direction in which the wave transfers energy. ✓

Why? Every wave travels in a line. Compare the oscillation with the direction of energy transfer.

25

C.2 Wave model

A sound wave passes from air into water. State and explain what happens to its frequency. [2]

0 MARKS

~~It increases, because sound travels faster in water.~~

WRITE THIS · 2 MARKS

- The frequency stays the same. ✓
- It is set by the source. The speed increases, so the wavelength increases ($v = f\lambda$). ✓

Why? At a boundary the speed and the wavelength change. The frequency does not.

26

C.3 Wave phenomena

Light from two slits forms bright fringes on a screen. Explain how a bright fringe forms. [3]

0 MARKS

~~The waves meet and add up.~~

WRITE THIS · 3 MARKS

- The waves from the two slits superpose. ✓
- They arrive in phase (path difference = $n\lambda$). ✓
- So there is constructive interference. ✓

Why? Name all three: superposition, phase (or path difference) and constructive interference.

27

C.3 Wave phenomena

State the condition for a wave to diffract significantly through a gap. [1]

0 MARKS

~~The gap must be very small.~~

WRITE THIS · 1 MARK

- The width of the gap must be similar to (of the same order as) the wavelength. ✓

Why? "Small" compared with what? Compare with the wavelength.

28

C.4 Standing waves

Compare the energy transfer by a standing wave with that by a travelling wave. [1]

0 MARKS

~~Both transfer energy along the string.~~

WRITE THIS · 1 MARK

- A standing wave has no net transfer of energy along the medium; a travelling wave transfers energy. ✓

Why? In a standing wave the energy stays between the nodes.

29

C.4 Resonance

State what is meant by resonance. [1]

0 MARKS

~~When an object vibrates very strongly.~~

WRITE THIS · 1 MARK

- When the driving frequency equals the natural frequency of the system, the amplitude of the oscillations is greatest. ✓

Why? Name the two frequencies and say they are equal.

30

C.5 Doppler effect

A siren moves towards you. Explain why you hear a higher frequency. [2]

0 MARKS

~~The sound travels faster towards you.~~

WRITE THIS · 2 MARKS

- The source moves towards you between emitting wavefronts, so the wavefronts reaching you are closer together (shorter wavelength). ✓
- The speed of sound is unchanged, so the frequency you hear is higher ($f = v/\lambda$). ✓

Why? The speed of sound depends on the air, not on the source.

Theme D · Fields

31

D.1 Gravitational fields (HL)

Define escape speed. [1]

0 MARKS

~~The speed needed to escape gravity.~~

WRITE THIS · 1 MARK

- The minimum speed an object needs to reach infinity (escape the field) with no further energy supplied. ✓

Why? Three key words: minimum, infinity, no further energy.

32

D.1 Gravitational fields

Define gravitational field strength at a point. [1]

0 MARKS

~~The force of gravity at that point.~~

WRITE THIS · 1 MARK

- The gravitational force per unit mass on a small (point) test mass placed at that point. ✓

Why? Field strength is force PER UNIT MASS (N kg^{-1}).

33

D.1 Orbits

Astronauts on a space station in orbit feel weightless. Explain why. [2]

0 MARKS

~~There is no gravity in space.~~

WRITE THIS · 2 MARKS

- The astronauts and the station fall freely towards the Earth with the same acceleration (gravity provides the centripetal force). ✓
- So there is no normal (contact) force between the astronauts and the station, and this force is what we feel as weight. ✓

Why? Gravity is what keeps the station in orbit. Gravity there is still about 90% of its value at the surface.

34

D.1 Gravitational fields (HL)

Explain why gravitational potential is negative. [1]

0 MARKS

~~Because gravity pulls things down.~~

WRITE THIS · 1 MARK

- Zero potential is at infinity; gravity is attractive, so work must be done ON a mass to take it to infinity, so the potential everywhere else is below zero. ✓

Why? The sign comes from where zero is chosen: at infinity.

35

D.2 Electric fields

Define electric field strength at a point. [1]

0 MARKS

~~The area around a charge where it feels a force.~~

WRITE THIS · 1 MARK

- The electric force per unit charge on a small positive test charge placed at that point. ✓

Why? Say "per unit charge" and "positive test charge".

36

D.2 Electric fields

State the direction of an electric field line. [1]

0 MARKS

~~The direction in which electrons move.~~

WRITE THIS · 1 MARK

- The direction of the force on a positive test charge (away from positive charges). ✓

Why? Electrons move AGAINST the field lines.

37

D.3 Motion in fields

A proton moves at right angles to a uniform magnetic field. State and explain what happens to its speed. [2]

0 MARKS

~~It speeds up, because a force acts on it.~~

WRITE THIS · 2 MARKS

- The magnetic force is always perpendicular to the velocity. ✓
- So no work is done: the speed (and kinetic energy) stays constant; only the direction changes. ✓

Why? A force at 90° to the motion changes the direction, not the speed.

38

D.3 Motion in fields

An electron enters the uniform electric field between two parallel plates at right angles to the field. State and explain the shape of its path. [2]

0 MARKS

~~A circle, because the force is perpendicular to its velocity.~~

WRITE THIS · 2 MARKS

- A parabola. ✓
- The force (and acceleration) is constant and in one direction, while the velocity parallel to the plates stays constant (like a projectile). ✓

Why? Circles are for magnetic fields. In a uniform electric field the force does not change direction.

39

D.4 Induction (HL)

A magnet falls into a coil. Explain why an emf is induced in the coil. [2]

0 MARKS

~~Because the magnet moves.~~

WRITE THIS · 2 MARKS

- The magnetic flux linkage through the coil changes. ✓
- The induced emf equals the rate of change of flux linkage (Faraday's law). ✓

Why? Movement alone is not the reason. A magnet held still inside the coil induces nothing: the CHANGE in flux linkage is what counts.

40

D.4 Induction (HL)

State Lenz's law. [1]

0 MARKS

~~The induced current opposes the magnet.~~

WRITE THIS · 1 MARK

- The induced emf (current) is in a direction that opposes the CHANGE (in flux) that produces it. ✓

Why? It opposes the change, not the magnet or the field.

Theme E · Nuclear and quantum physics

41

E.1 Structure of the atom

In Rutherford's experiment a few alpha particles bounced back. State what this shows.

[1]

0 MARKS

~~That the atom is mostly empty space.~~

WRITE THIS · 1 MARK

- That there is a very small, dense, positively charged nucleus that contains most of the mass of the atom. ✓

Why? "Mostly empty space" comes from the alpha particles that went STRAIGHT THROUGH.

42

E.1 Structure of the atom

Explain why a gas emits a line spectrum, not a continuous one. [2]

0 MARKS

~~Because electrons give out light when they move around the nucleus.~~

WRITE THIS · 2 MARKS

- Electrons in atoms can only have discrete (certain) energy levels. ✓
- When an electron moves to a lower level it emits a photon of energy equal to the difference between the levels ($E = hf$), so only certain frequencies appear. ✓

Why? Discrete energy levels give discrete frequencies.

43

E.2 Quantum physics (HL)

Light of the same frequency but greater intensity falls on a metal. State and explain the effect on the maximum kinetic energy of the photoelectrons. [2]

0 MARKS

~~It increases, because there is more energy.~~

WRITE THIS · 2 MARKS

- There is no change. ✓
- Each photon still has energy hf . Greater intensity means more photons per second, so more electrons are emitted, not faster ones. ✓

Why? One photon gives its energy to one electron.

44

E.2 Quantum physics (HL)

No electrons are emitted from a metal, even with very bright light. Explain why. [2]

0 MARKS

~~The light is not bright enough.~~

WRITE THIS · 2 MARKS

- The frequency is below the threshold frequency: each photon's energy hf is less than the work function. ✓
- One photon is absorbed by one electron, so increasing the intensity does not help. ✓

Why? Change the FREQUENCY, not the brightness.

45

E.3 Radioactive decay

Define half-life. [1]

0 MARKS

~~Half the time it takes for the sample to decay.~~

WRITE THIS · 1 MARK

- The time taken for half of the radioactive nuclei (of an isotope) in a sample to decay, or for the activity to halve. ✓

Why? A sample never fully decays, so "half the total time" has no meaning.

46

E.3 Radioactive decay

State what is meant by radioactive decay being random. [1]

0 MARKS

~~We cannot know anything about it.~~

WRITE THIS · 1 MARK

- It is not possible to predict when a particular nucleus will decay (each nucleus has a constant probability of decaying per unit time). ✓

Why? Random is about ONE nucleus. For many nuclei the half-life is very predictable.

47

E.4 Fission

Explain why energy is released when a uranium-235 nucleus undergoes fission. [2]

0 MARKS

~~Energy is released because the bonds in the nucleus are broken.~~

WRITE THIS · 2 MARKS

- The product nuclei have a greater binding energy per nucleon than the uranium nucleus. ✓
- So the total mass decreases, and the mass lost Δm is released as energy ($E = \Delta mc^2$). ✓

Why? Breaking bonds NEEDS energy. The energy comes from the increase in binding energy.

48

E.4 Fission

State the role of the moderator in a nuclear reactor. [1]

0 MARKS

~~It absorbs neutrons to control the chain reaction.~~

WRITE THIS · 1 MARK

- It slows down the neutrons (by collisions) so that they are more likely to cause fission. ✓

Why? Absorbing neutrons is the job of the CONTROL RODS.

49

E.S Stars

State what prevents a white dwarf from collapsing under gravity. [1]

0 MARKS

~~Radiation pressure from fusion.~~

WRITE THIS · 1 MARK

- Electron degeneracy pressure: the electrons are squeezed so close that they resist being squeezed any more. ✓

Why? A white dwarf has no fusion, so there is no radiation pressure.

50

E.S Stars

Explain why a main sequence star is stable. [2]

0 MARKS

~~It is in hydrostatic equilibrium. (Or: it burns hydrogen.)~~

WRITE THIS · 2 MARKS

- Fusion in the core produces an outward radiation (and gas) pressure. ✓
- This balances the inward gravitational force, so the star does not collapse (or expand). ✓

Why? Link the outward pressure to FUSION and say it stops the collapse. Stars fuse; they do not "burn".

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