Exam Papers Practice

# 8.1 Energy Sources

## Mark Schemes

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| Course | DP IB Physics |
| Section | 8. Energy Production |
| Topic | 8.1 Energy Sources |
| Difficulty | Medium |



To be used by all students preparing for DP IB Physics HL
Students of other boards may also find this useful

1

The correct answer is **D** because:

- The equations for specific energy and energy density are;
  - Specific energy, $E_S = \frac{E}{m}$ where $E$ is the energy of the substance and $m$ is its mass
  - Energy density, $E_D = \frac{E}{V}$ where $E$ is the energy of the substance and $V$ is its volume
- We can write $E_S \times x = E_D$ and determine the factor $x$ algebraically:
  - $\frac{E}{m} \times x = \frac{E}{V}$
  - $x = \frac{E}{V} \times \frac{m}{E} = \frac{m}{V}$
  - Therefore, the correct answer is **D**

With a question like this where you are looking for an algebraic relationship, always start by writing what you know already then looking for a pattern. Often you will just have to 'play' with the options by trying them out.



2

The correct answer is **B** because:

- To calculate density, use the equation;
  - Density, $\rho = \frac{E_D}{E_S} = \frac{3.5 \times 10^{10}}{4.5 \times 10^7}$
  - $\frac{3.5}{4.5}$ gives a ratio of $\frac{7}{9}$ which approximates to 0.78
  - $\frac{10^{10}}{10^7}$ gives $10^{(10-7)} = 10^3$
  - Therefore, $\rho \approx 0.78 \times 10^3 = 780$ kg m$^{-3}$
- This is closest in magnitude to option **B**

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| **A** is incorrect as | specific energy was divided by energy density rather than the other way around |
| **C** is incorrect as | this is the value for energy density |
| **D** is incorrect as | energy density was multiplied by specific energy density rather than divided |

3

The correct answer is **C** because:

- The width of each arrow on the Sankey diagram represents the number of energy units
- Counting squares shows that:
    - Input electrical energy = 13 units
    - Thermal energy = 9 units
    - Light energy = 1 unit
    - Sound energy = 3 units
- From the data booklet:
    - Efficiency = $\frac{useful\ energy\ out}{total\ energy\ in}$
- The useful energy out while watching a film includes both light and sound
    - Useful energy out = 1 + 3 = 4 units
    - Efficiency = $\frac{4}{13}$ which we can see is about one third, making option **C** the only possible answer

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| **A** is incorrect as | the answer has not been multiplied by 100, leaving it as a ratio rather than a percentage |
| **B** is incorrect as | only the output energy of light was included in the calculation, sound was ignored |
| **D** is incorrect as | the output thermal energy was used in the calculation, but this is the wasted energy |

4

The correct answer is **B** because:

- Primary sources are unconverted or original fuels, found naturally, which can be mined, harvested, extracted or directly harnessed
- Secondary sources of energy have already been converted
  - These examples are all found, or occur, naturally, so they are all primary sources
  - An example of this is biofuels

Be very careful when categorising hydroelectric dams as primary or secondary. Water which is already elevated, such as in a naturally formed lake, would count as a primary source of energy when it is allowed to flow downhill through turbines. However, if the upper reservoir in a hydroelectric system has to be refilled by pumping, then that process makes the energy a secondary source.

5

The correct answer is **A** because:

- Geothermal energy is a renewable resource used to directly heat homes
- Natural gas is a non-renewable fossil fuel used to directly heat homes



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| **B** is incorrect as | nuclear fuel is in the 'renewable' column, this is a common mistake! Nuclear fuel is classed as non-renewable fuel because it is made from naturally occurring material which can run out |
| **C** is incorrect as | neither fuel has a major direct use in fuelling transport |
| **D** is incorrect as | neither fuel has a major direct use in heating homes. The electricity generated by nuclear power stations goes into the National Grid, but this is an indirect use |

6

The correct answer is **C** because:

- The kinetic energy of the air molecules, $E_K = \frac{1}{2}mv^2$
  - If all the kinetic energy was transferred, so that the final kinetic energy of the air molecules $E_K = 0$, then the final velocity $v^2$ would also have to equal 0
  - In other words, the air molecules would stop moving and create a blockage or wall of air, which can't happen

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| **A** is incorrect as | wind energy is often described as being 'unreliable' but that isn't relevant here. In fact, wind farms are major investments and are only built in areas with predictable and reliable wind |
| **B** is incorrect as | the blades of turbines are very large and have a lot of angular momentum when in motion. Any density and temperature changes of the surrounding air would have no discernible effect |
| **D** is incorrect as | the blades are partially kept in motion by their own angular momentum, but that isn't relevant to the question, which is about conservation of energy |



7

The correct answer is **B** because:

- Kirchhoff's Circuit Laws tells us $\Sigma V = 0$ in a loop:
  - In each branch total potential difference = 4 × 12 = 48 V.
  - All potential differences in parallel are the same (option **A** or **B** must be correct)

- Kirchhoff's Circuit Laws tell us that $\Sigma I = 0$ at a junction
  - Current = 2.5 A in each branch
  - There are five branches, therefore the total current = 5 × 2.5 = 12.5 A
  - **B** is correct

8

The correct answer is **C** because:

- Pumped storage systems hold water behind a dam, which can be released as and when energy is needed
- The electricity generation is very quick compared to power stations which require heating and burning fuels, or setting up nuclear reactions
- Pumped storage is a key method of boosting energy supply at times of peak demand

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| **A** is incorrect as | only areas where water can be trapped and stored high up are suitable |
| **B** is incorrect as | the water is pumped back to the upper reservoir after use using electricity from the National Grid, which cannot be guaranteed to be carbon neutral. In addition dam building uses large amounts of concrete, the manufacture of which produces large amounts of $CO_2$ |
| **D** is incorrect as | the energy used to pump the water would not be wasted, as it is part of the supply to the Grid |

9

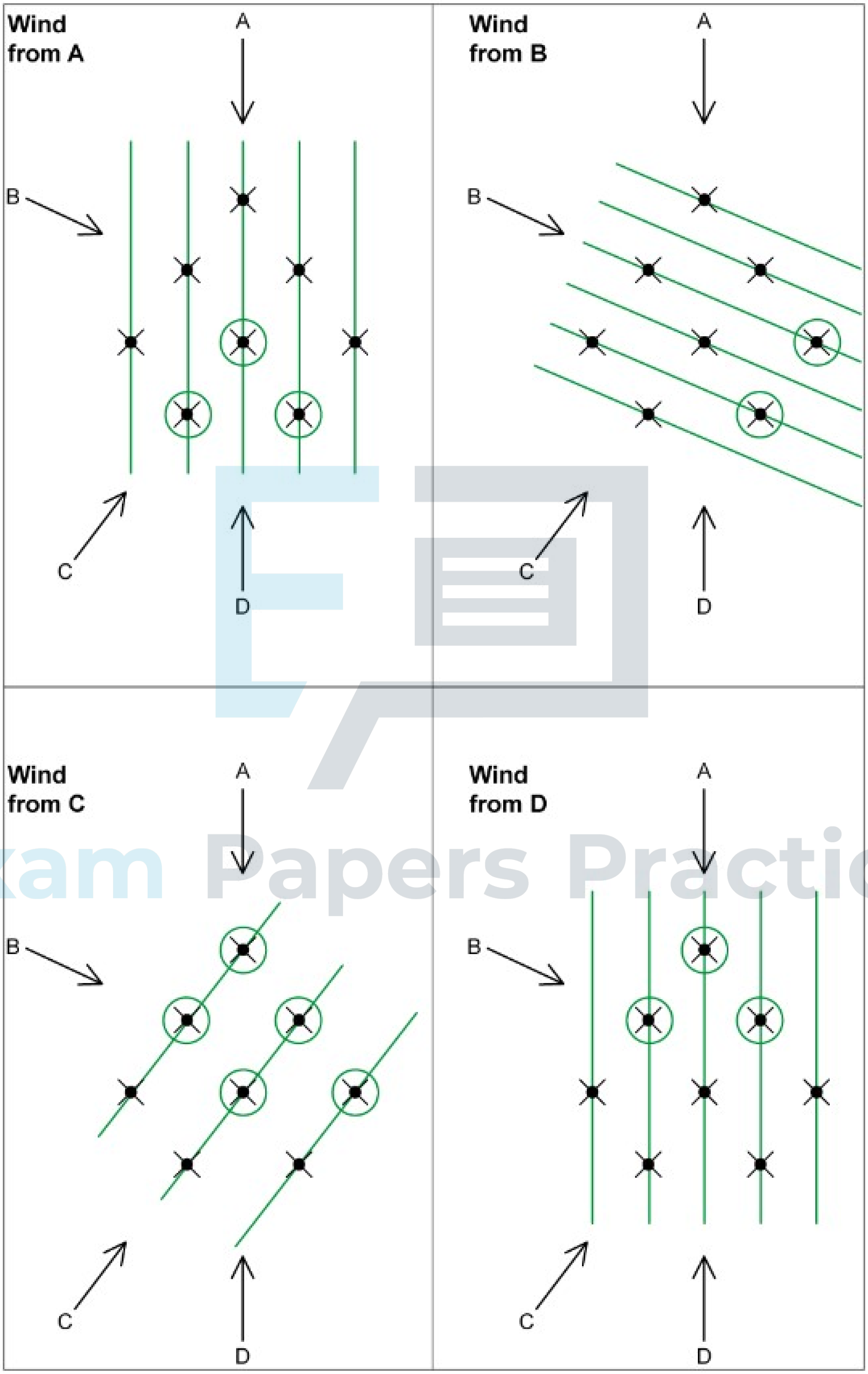
The correct answer is **D** because:

- From the data booklet, power $P = \frac{1}{2}\rho A v^3$
- Remove the constants and we can see that;
  - $P \propto v^3$
  - $\sqrt[3]{P} \propto v$
- The power becomes $\frac{1}{2}P$, therefore:
  - $\sqrt[3]{P} \rightarrow \sqrt[3]{\frac{P}{2}} = \frac{1}{\sqrt[3]{2}} \times \sqrt[3]{P}$
  - Therefore, the new wind speed = $\frac{v}{\sqrt[3]{2}}$

10

The correct answer is **B** because:

- Wind turbines create a 'wind shadow' downwind of the blades, where the strength of the wind has been reduced
- This affects any turbine sited directly behind them with respect to wind direction
- To solve this question, consider how many turbines are in a wind shadow in each situation


Wind from A
Wind from B
Wind from C
Wind from D
A
B
C
D

- The least number is in option **B**

At first glance this is a challenging question. For a problem like this there is no better way to find the solution than getting out a ruler and sketching on the paper. Once the lines of wind direction and the turbines in the **wind shadow** are circled, the solution is obvious.