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8.1 Energy Sources

Hard

PHYSICS

IB HL

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8.1 Energy Sources

Question Paper

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

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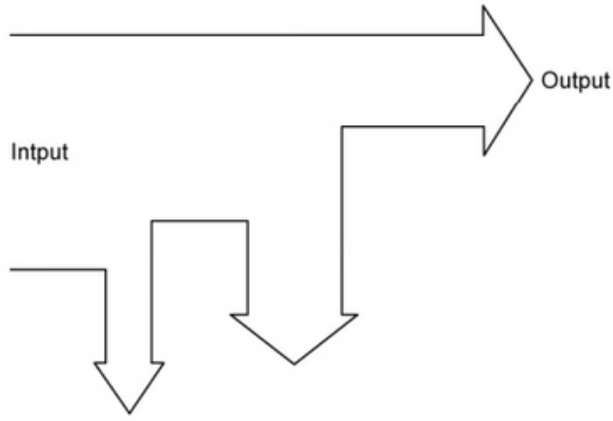
Time allowed: 20

Score: /10

Percentage: /100

Question 1

What is the efficiency of a system whose Sankey diagram is shown below?



The Sankey diagram is drawn to scale.

A. 10%

B. 20%

C. 30%

D. 40%

[1 mark]

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Question 2

A coal-fired power station with an efficiency ε burns fuel that has an energy density D and a specific energy S. The rate at which the mass of the fuel is consumed is M.

What is the power output of the power station?

A. $\frac{D \times M}{\varepsilon}$

B. $\frac{M \times S}{\varepsilon}$

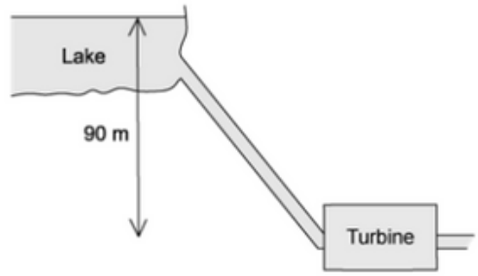
C. $\varepsilon \times M \times S$

D. $\varepsilon \times D \times M$

[1 mark]

Question 3

Water flows from a lake into a turbine that is a vertical distance of 90 m below the lake, as shown.



The mass flow rate of the water is 3000 kg min^{-1}. The turbine has an efficiency of 60%. Acceleration due to free fall is 10 m s^{-2}.

What is the output power of the turbine?

A. 1.62 kW

B. 27 kW

C. 45 kW

D. 2700 kW

[1 mark]

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Question 4

Which adaptation to a wind turbine produces the largest increase in its maximum possible theoretical power output?

A. Increasing the radius of the blades by a factor of two

B. Increasing the blade area by a factor of two

C. Increasing the density of the incident air by a factor of two

D. Increasing the speed of the incident air by a factor of two

[1 mark]

Question 5

Burning 1 kg of coal produces less energy than burning 1 litre of gasoline. The density of gasoline is 1 g cm^{-3}.

Which option is correct?

A. Specific energy of coal is greater than the specific energy of gasoline

B. Energy density of coal is greater than the energy density of gasoline

C. Energy density for gasoline is greater than the energy density for coal

D. Specific energy for gasoline is greater than the specific energy for coal

[1 mark]

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Question 6

In a nuclear reactor, a chain reaction is produced and controlled. Uranium-235 is the isotope used in many nuclear reactors.

Which of the following statements is incorrect?

A. The fission causes 2 or 3 neutrons to be released every second.

B. This causes further uranium nuclei to fission.

C. This releases further neutrons that can be absorbed again, leading to a chain reaction.

D. These neutrons can be absorbed by other nuclei.

[1 mark]

Question 7

A wind turbine of blade length r m has wind of a speed v m s^{-1} and air density ρ incident on its blades.

Which expression shows the power obtained by the wind turbine every second?

A. $\frac{1}{2} r\pi\rho^2 v^2$

B. $\frac{1}{2} \rho\pi r^2\ v^3$

C. $\frac{1}{2} \rho r^2 v^3$

D. $\frac{1}{2} \rho\pi v^2\ r^3$

[1 mark]

Question 8

The following nuclear fusion reaction is taking place in a nuclear reactor:

$$^{2}_{1}\mathrm{H} + ^{3}_{1}\mathrm{H} \rightarrow ^{4}_{2}\mathrm{He} + ^{1}_{0}\mathrm{n} + \text{energy}$$

The following data is available:

- The mass defect ≈ 0.02 u
- Atomic mass unit, u ≈ 2.0×10^{-27} kg
- Number of seconds in a year = 3×10^{7}

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What is an estimate of the number of such fusion reactions required to keep an average household, which uses approximately 24 000 kWh of electrical energy per year, running for a year?

A. 2×10^{15}

B. 1×10^{19}

C. 3×10^{21}

D. 2×10^{26}

[1 mark]

Question 9

Burning 1000 kg of coal can yield 3×10^{10} J of energy. When a thermal neutron is absorbed by a uranium-235 nucleus it produces fission products as well as three neutrons.

$$^{1}_{0}\text{n} + {}^{235}_{92}\text{U} \rightarrow {}^{98}_{40}\text{Zr} + {}^{135}_{52}\text{Te} + 3{}^{1}_{0}\text{n} + \text{energy}$$

The following data is available:

- Mass defect ≈ 0.2 u
- Mass of ${}^{235}_{92}\text{U} \approx 4 \times 10^{-25}$ kg
- Atomic mass unit, u $\approx 2.0 \times 10^{-27}$ kg

What is an estimate of the mass of coal needed to give the same amount of energy as 1 kg of Uranium-235?

A. 3×10^{4} kg

B. 2.6×10^{6} kg

C. 4.7×10^{8} kg

D. 7.7×10^{13} kg

[1 mark]

Question 10

A solar panel has a surface area of 2.5 m^2 and an efficiency of 25 %. The average intensity of sunlight received per day is 8 kWh m^{-2} for an average of 10 hours per day.

The average electricity consumption per factory is 100 kWh per day on an industrial estate of five factories where each factory is in operation for 20 hours each day.

How many solar panels are needed to power the industrial estate for one day?

A. 5

B. 10

C. 25

D. 50

[1 mark]

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