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OCR GCSE Physics B

Twenty First Century Science J259

CHAPTER P2

Sustainable Energy

Foundation Tier

Systematic lesson notebook

Teaching and worked examples, lesson practice, a chapter assessment, complete indicative answers and a knowledge organiser.

Read the explanation, try the practice independently, then use the answers to improve your reasoning and calculations.

Name _____ Class _____

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How to use this notebook

Follow the lesson sequence. Each assessed lesson includes an explanation, a worked example and practice. Keep your working and units visible. Check the numbered lesson answers after attempting the questions; equivalent correct scientific wording can receive credit.

Specification reference: Cambridge OCR J259, Version 5.0, July 2026. References identify the intended outcomes; this independent notebook does not replace the official specification.

Foundation and Higher

Foundation contains shared assessable outcomes. Higher-only lessons are identified as awareness pages, without marked Foundation practice. In mixed lessons the shared material remains assessed and the Higher-only boundary is stated explicitly.

Separate Physics content belongs to J259 at both tiers unless the specification explicitly marks an outcome as Higher-only.

Working and marking

Use the maximum mark shown for each question. The answer sections are indicative classroom guidance, not official OCR mark schemes. Credit valid alternatives and avoid awarding the same idea twice. This assessment is diagnostic; no GCSE grade boundary is implied.

Numerical tariffs, example data and model situations are classroom examples, not current prices or real safety estimates.

Lesson map

Lesson	Focus	References
1	Energy transfers by electric current	P2.1.1
2	Power ratings, time and energy use	P2.1.2
3	Energy transferred: E = Pt, kWh and cost	P2.1.3
4	Conservation of energy and dissipation	P2.1.4-5
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9	a.c., d.c. and UK mains	P2.2.4
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Use lesson numbers to locate the matching practice and answers. Pagination differs between editions because the assessed scope differs.

Lesson map continued

Lesson	Focus	References
11	Live, neutral and earth wires	P2.2.6
12	Energy-use patterns, sustainability and decisions	P2.2.7

Use lesson numbers to locate the matching practice and answers. Pagination differs between editions because the assessed scope differs.

Lesson 1 Energy transfers by electric current

P2.1.1 | Foundation

describe how energy in chemical stores in batteries, or in fuels at power stations, is transferred by an electric current to domestic devices.

Energy can be stored chemically in a battery or fuel. In a power station, energy from a fuel is transferred through a sequence of processes before an electric current transfers energy through the grid.

Electricity is a transfer pathway, not an energy store. A motor transfers energy mechanically to moving parts; a heater transfers energy to thermal stores.

A precise answer names both the starting store and the destination or effect. Avoid saying that electricity is 'used up'.

Worked example

A battery drives a motor that lifts a load. Chemical store of battery → electrical transfer → mechanical work by motor → gravitational potential store of load–Earth system. Include heating of the motor and surroundings in a complete account.

Lesson 1 practice

Energy transfers by electric current

Answer independently. Show a clear method, substitutions and units for calculations.

1. State one energy store in a battery. [1]

2. Describe the energy transfer when a battery powers a motor. [3]

3. Explain why electricity is not itself an energy store. [2]

4. A heater warms water. Describe the transfer from supply to water. [3]

5. Correct: 'electrical energy is stored in the cable'. [2]

Practice total 11 marks

Self check Write one correction you made and why it matters.

Lesson 2 Power ratings, time and energy use

P2.1.2 | Foundation

explain the relationship between appliance power rating, time in use and changes in stored energy.

Power is the rate of energy transfer. A 2000 W device transfers 2000 J each second.

For the same operating time, a higher-power appliance transfers more energy. For the same energy transfer, a lower-power appliance must operate for longer.

Power does not tell you total energy use unless time is also known.

Worked example

A 750 W appliance runs for 40 s. E = Pt = 750 × 40 = 30,000 J. The same transfer at 1500 W takes 30,000/1500 = 20 s.

Lesson 2 practice

Power ratings, time and energy use

Answer independently. Show a clear method, substitutions and units for calculations.

1. What does a rating of 1200 W mean? [2]

2. Two heaters run for the same time: 500 W and 2.0 kW. Which transfers more energy? [2]

3. Explain why power alone does not determine total energy use. [2]

4. A 100 W lamp runs four times as long as a 400 W lamp. Compare their energy use. [2]

5. State the SI unit of power. [1]

Practice total 9 marks

Self check Write one correction you made and why it matters.

Lesson 3 Energy transferred E = Pt, kWh and cost

P2.1.3 | Foundation

apply energy transferred = power × time in joules or kilowatt-hours.

Use E = Pt. Pair units correctly: W × s gives J; kW × h gives kWh.

For domestic energy, convert watts to kilowatts and minutes to hours before calculating kWh.

Cost = energy in kWh × tariff. Write units beside each converted value before substituting to avoid mixing scales.

Worked example

A 1.2 kW heater runs for 45 minutes. Time = 45/60 = 0.75 h; E = 1.2 × 0.75 = 0.90 kWh. At an invented tariff of 30 p/kWh, cost = 0.90 × 30 = 27 p.

Lesson 3 practice

Energy transferred: E = Pt, kWh and cost

Answer independently. Show a clear method, substitutions and units for calculations.

1. A 1.8 kW heater runs for 2.0 h. Calculate energy in kWh. [2]

2. A 900 W microwave runs for 300 s. Calculate energy in J. [3]

3. Electricity costs 28 p/kWh. Find the cost of 3.0 kWh. [2]

4. Convert 750 W to kW. [1]

5. Explain why 1500 W × 2 h is not 3000 kWh. [2]

Practice total 10 marks

Self check Write one correction you made and why it matters.

Lesson 4 Conservation of energy and dissipation

P2.1.4-5 | Foundation

describe energy transfers in systems and explain that dissipated energy is stored in less useful ways.

In a closed system, total energy does not change. Energy is transferred between stores, but is not created or destroyed.

Dissipated energy spreads into thermal stores of the surroundings and becomes less useful for the intended purpose.

Use the phrase 'less useful' rather than 'lost' unless you explain that total energy is still conserved.

Worked example

A motor receives 800 J and lifts a load by 600 J of gravitational potential energy. The remaining 200 J is transferred to other stores, mainly by heating. 800 = 600 + 200 J: no energy has disappeared.

Lesson 4 practice

Conservation of energy and dissipation

Answer independently. Show a clear method, substitutions and units for calculations.

1. State the law of conservation of energy. [2]

2. Explain what happens to 'wasted' energy in a motor. [2]

3. A device receives 500 J and transfers 350 J usefully. How much is dissipated? [1]

4. Why is 'energy disappears' incorrect? [2]

5. Give one useful and one dissipated transfer in a lamp. [2]

Practice total 9 marks

Self check Write one correction you made and why it matters.

Lesson 5 Reducing unwanted transfer and building insulation

P2.1.6-7 | Foundation

explain ways of reducing unwanted energy transfer and describe effects of wall thickness and thermal conductivity on cooling.

Lubrication reduces unwanted transfer caused by friction. Thermal insulation reduces energy transfer by heating to the surroundings.

Thicker walls or insulation generally reduce the rate of cooling. Materials with lower thermal conductivity transfer energy more slowly.

For an insulation investigation, control water volume, starting temperature, container, exposed area and timing. Change only the insulation variable.

Worked example

Compare two insulating sleeves with the same thickness. Use identical containers and equal masses of water at the same starting temperature. Record temperature at equal time intervals in the same surroundings, repeat, and compare cooling curves over the same temperature range.

Lesson 5 practice

Reducing unwanted transfer and building insulation

Answer independently. Show a clear method, substitutions and units for calculations.

1. Give one way to reduce unwanted energy transfer in a machine. [1]

2. Explain why thicker insulation reduces cooling rate. [3]

3. State two control variables in a cooling experiment. [2]

4. Why should starting temperature be controlled? [2]

5. Suggest one limitation and matching improvement. [2]

Practice total 10 marks

Self check Write one correction you made and why it matters.

Lesson 6 Efficiency calculations

P2.1.8 | Foundation

calculate energy efficiency for any energy transfer; Higher also describes ways to increase efficiency.

Efficiency = useful energy transferred / total energy transferred. Give as a decimal or multiply by 100 for a percentage.

The useful and dissipated outputs together equal the input if all relevant transfers are included.

Foundation assesses the calculation. The specification marks 'describe ways to increase efficiency' as Higher-only.

Worked example

A device receives 240 J and transfers 180 J usefully. Efficiency = 180/240 = 0.75 = 75%. The other 60 J is dissipated. Always divide useful output by total input, not by wasted energy.

Lesson 6 practice

Efficiency calculations

Answer independently. Show a clear method, substitutions and units for calculations.

1. A device receives 500 J and transfers 350 J usefully. Calculate efficiency. [2]

2. A lamp is 20% efficient and receives 600 J. Calculate useful energy. [3]

3. State the maximum possible efficiency. [1]

4. Explain why an efficiency of 1.2 is impossible. [2]

5. A device transfers 80 J usefully from a 100 J input. Calculate its percentage efficiency. [1]

Practice total 9 marks

Self check Write one correction you made and why it matters.

Lesson 7 Sankey diagrams

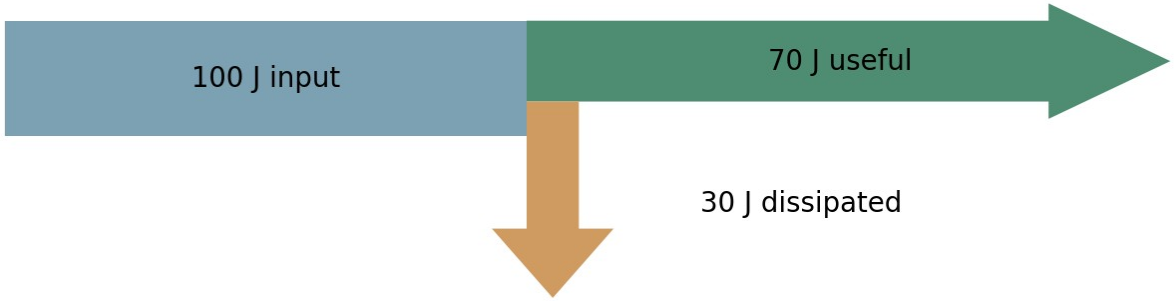
P2.1.9 | Foundation

interpret and construct Sankey diagrams to show that energy is conserved.

A Sankey diagram uses arrow width to represent the amount of energy transferred.

The input arrow equals the sum of useful and dissipated output arrows.

Label arrows with both the type of transfer and, where given, numerical energy values.



Worked example

For a 100 J input with 65 J useful output, dissipation = 35 J. Draw input width 20 mm, useful width 13 mm and waste width 7 mm. Widths, not just arrow lengths, represent energy.

Lesson 7 practice

Sankey diagrams

Answer independently. Show a clear method, substitutions and units for calculations.

1. A 100 J input gives 70 J useful output. Find dissipated energy. [1]

2. What does arrow width represent in a Sankey diagram? [1]

3. Describe arrow widths for an 80% efficient device. [2]

4. Why must output arrows add to the input? [2]

5. Draw labels for a 200 J input with 150 J useful output. [2]

Practice total 8 marks

Self check Write one correction you made and why it matters.

Lesson 8 Energy resources and electricity generation

P2.2.1-3 | Foundation

describe main energy resources, distinguish renewable/non-renewable, and compare how they generate electricity.

Main resources: fossil fuels, nuclear fuel, biofuel, wind, hydroelectricity, tides and the Sun.

Renewable resources are replenished on a human timescale; non-renewable resources are finite.

Many power stations heat water so steam turns a turbine connected to a generator. Wind, hydro and tidal systems can drive turbines directly. Solar photovoltaic panels generate electricity without a turbine.

Worked example

A town compares wind and gas. Wind has no fuel combustion during operation but variable output; gas can provide controllable output but burns finite fuel and emits CO_2. A useful comparison uses the same delivered energy and considers storage or backup.

Lesson 8 practice

Energy resources and electricity generation

Answer independently. Show a clear method, substitutions and units for calculations.

1. Classify coal, nuclear, wind and biofuel as renewable/non-renewable. [4]

2. Describe the thermal power-station sequence. [4]

3. State one advantage and one disadvantage of wind. [2]

4. Why is solar described as renewable? [1]

5. Compare hydro and fossil generation using two factors. [4]

Practice total 15 marks

Self check Write one correction you made and why it matters.

Lesson 9 a.c., d.c. and UK mains

P2.2.4 | Foundation

recall UK mains as a.c. at 50 Hz and about 230 V, and explain the difference between direct and alternating voltage.

UK domestic mains is alternating voltage, about 230 V at 50 Hz.

In d.c., the polarity does not reverse. In a.c., the potential difference changes direction repeatedly.

A 50 Hz supply completes 50 cycles each second.

Worked example

A 50 Hz supply completes 50 cycles in 1 s. Period T = 1/f = 1/50 = 0.020 s. The nominal 230 V value is an effective mains value, not the peak height of a voltage-time sine wave.

Lesson 9 practice

a.c., d.c. and UK mains

Answer independently. Show a clear method, substitutions and units for calculations.

1. State UK mains voltage and frequency. [2]

2. Explain one difference between a.c. and d.c. [2]

3. How many cycles occur in 2 s at 50 Hz? [1]

4. Name one common d.c. source. [1]

5. Explain what 50 Hz means. [2]

Practice total 8 marks

Self check Write one correction you made and why it matters.

Lesson 10 The National Grid and transformers

P2.2.5 | Foundation

recall the use of transformers to transfer power at high voltage and then reduce voltage for local/domestic use.

The National Grid transfers electrical power from power stations to consumers.

Transformers increase voltage before long-distance transmission and decrease it again before local/domestic use.

High-voltage transmission reduces energy losses in cables. Detailed transformer equations belong mainly to later P3 learning, not this P2.2 outcome.

Worked example

A grid line delivers fixed power. Increasing its voltage by a factor of 10 reduces current by a factor of 10. Since cable heating power is I^2R, with unchanged cable resistance it becomes 1/100 of the original.

Lesson 10 practice

The National Grid and transformers

Answer independently. Show a clear method, substitutions and units for calculations.

1. Where is a step-up transformer used? [1]

2. Where is a step-down transformer used? [1]

3. Why is electricity transmitted at high voltage? [3]

4. Correct: 'transformers create extra electrical energy'. [2]

5. Order: homes, power station, step-down, step-up, high-voltage grid. [2]

Practice total 9 marks

Self check Write one correction you made and why it matters.

Lesson 11 Live, neutral and earth wires

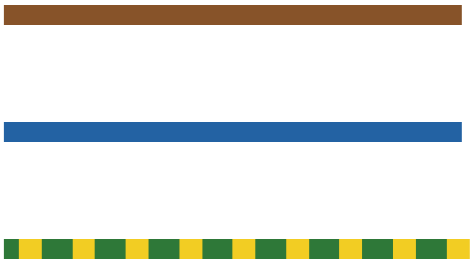
P2.2.6 | Foundation

recall wire functions and potential differences, and explain mains hazards.

Live wire: high alternating potential relative to Earth. Neutral wire: close to Earth potential and completes the circuit. Earth wire: protective connection to the metal case.

A live wire can remain dangerous even with a switch open because the supply side of the live wire remains at high potential.

A connection between live and an earthed object can produce a large current and serious shock/heating hazard.



Live
Brown • alternates at high p.d.

Neutral
Blue • near Earth potential

Protective earth
Green and yellow • fault path

Worked example

If live touches a correctly earthed metal case, fault current can flow through the protective earth conductor. A suitable fuse or circuit breaker disconnects the live supply. The earth wire and protective device work together; the earth wire normally carries no operating current.

Lesson 11 practice

Live, neutral and earth wires

Answer independently. Show a clear method, substitutions and units for calculations.

1. State the function of the earth wire. [2]

2. Which wire is at high potential relative to Earth? [1]

3. Why can live remain dangerous with a switch open? [2]

4. Why is live-to-earth contact dangerous? [2]

5. State the approximate potential difference live-neutral. [1]

Practice total 8 marks

Self check Write one correction you made and why it matters.

Lesson 12 Energy-use patterns, sustainability and decisions

P2.2.7 | Foundation

explain patterns and trends in energy-resource use in domestic, workplace and national contexts.

Energy-use patterns can change with technology, price, policy, population and demand.

A good trend statement identifies direction and supports it with data. Avoid simply quoting two values without explaining the pattern.

Energy decisions consider reliability, cost, environmental effects, resource availability, public acceptance and future demand. Different groups may reasonably choose differently.

Worked example

Renewable share rises from 20% to 30%. That is a 10 percentage-point increase, or a 50% relative increase in share. If total electricity output changes, these percentages alone do not determine the change in renewable kWh.

Lesson 12 practice

Energy-use patterns, sustainability and decisions

Answer independently. Show a clear method, substitutions and units for calculations.

1. A renewable share rises from 25% to 45%. State the trend. [1]

2. Give two factors besides cost that affect an energy decision. [2]

3. Why might two countries choose different energy mixes? [3]

4. Fossil use falls while renewables rise. Give one supported conclusion. [2]

5. State one extra piece of information needed before choosing a power source. [1]

Practice total 9 marks

Self check Write one correction you made and why it matters.

End of chapter assessment

Foundation | Total 48 marks across all assessment parts

Answer every question. Use additional paper for diagrams or longer explanations when needed.

1. Describe how energy in a battery is transferred to a motor. [3]

2. A 1.5 kW heater runs for 2.5 h. Calculate energy in kWh. [2]

3. Electricity costs 30 p/kWh. Calculate the cost of Question 2. [2]

4. Explain conservation of energy and dissipation in an electric lamp. [3]

5. Describe a fair investigation of insulation and cooling. [5]

End of chapter assessment continued

Foundation | Total 48 marks across all assessment parts

Answer every question. Use additional paper for diagrams or longer explanations when needed.

6. A device receives 800 J and transfers 560 J usefully. Calculate efficiency. [2]

7. Interpret a Sankey diagram with 100 J input and 70 J useful output. [2]

8. Classify coal, nuclear, wind, solar and biofuel as renewable or non-renewable. [5]

9. Compare fossil-fuel and wind generation using two factors. [4]

10. State UK mains voltage/frequency and explain a.c. versus d.c. [4]

End of chapter assessment continued

Foundation | Total 48 marks across all assessment parts

Answer every question. Use additional paper for diagrams or longer explanations when needed.

11. Explain the purpose of step-up and step-down transformers in the National Grid. [4]

12. Explain the functions of live, neutral and earth wires and one live-wire hazard. [5]

13. A renewable share rises from 30% to 48% while fossil share falls from 50% to 34%. Describe the trend. [3]

14. Give one scientific and one social/economic factor that can affect an energy decision. [2]

15. Explain one reason a renewable resource can still have environmental impacts. [2]

Lesson practice answers

Indicative answers. Credit equivalent correct wording, up to the maximum in the question.

Lesson 1 Energy transfers by electric current

1. A chemical energy store. [maximum 1]

2. The battery's chemical store decreases. An electric current transfers energy to the motor. The motor does mechanical work, increasing the kinetic energy of moving parts (with some heating). [maximum 3]

3. Electricity describes a transfer pathway involving moving charge. Energy is stored in systems such as chemical or thermal stores, rather than in a store called electricity. [maximum 2]

4. An electric current transfers energy from the supply to the heater. Heating transfers it to the water. The water's internal energy increases and its temperature rises. [maximum 3]

5. The cable carries a current that transfers energy. It does not hold an electrical energy store for this purpose; cable heating can increase its internal energy. [maximum 2]

Lesson 2 Power ratings, time and energy use

1. It transfers energy at 1200 joules per second. [maximum 2]

2. The 2.0 kW heater transfers more: 2000/500 = 4 times as much for the same time. [maximum 2]

3. Energy = power × time. The duration is needed as well as the rate of transfer. [maximum 2]

4. They transfer equal energy: $100 \times 4t = 400 \times t$. [maximum 2]

5. The watt, W (1 W = 1 J/s). [maximum 1]

Lesson practice answers

Indicative answers. Credit equivalent correct wording, up to the maximum in the question.

Lesson 3 Energy transferred E = Pt, kWh and cost

1. E = Pt = 1.8 × 2.0 = 3.6 kWh. [maximum 2]

2. E = Pt = 900 × 300 = 270,000 J (2.7×10^5 J). [maximum 3]

3. Cost = 3.0 × 28 = 84 p (£0.84). [maximum 2]

4. 750 W = 0.750 kW. [maximum 1]

5. 1500 W = 1.5 kW, so 1.5 × 2 = 3.0 kWh. W × h gives Wh: 3000 Wh, not 3000 kWh. [maximum 2]

Lesson 4 Conservation of energy and dissipation

1. Energy cannot be created or destroyed. Total energy in a closed system remains constant as energy transfers between stores. [maximum 2]

2. It spreads into internal energy stores of the motor and surroundings, mainly by heating. It is less useful for the intended mechanical output. [maximum 2]

3. 500 − 350 = 150 J. [maximum 1]

4. Total energy is conserved. Energy described as lost has been transferred into other stores, usually spread through the surroundings. [maximum 2]

5. Useful: visible radiation. Dissipated: heating/infrared transfer to the surroundings. [maximum 2]

Lesson practice answers

Indicative answers. Credit equivalent correct wording, up to the maximum in the question.

Lesson 5 Reducing unwanted transfer and building insulation

1. Lubricate moving parts to reduce friction; also accept a relevant insulation measure. [maximum 1]

2. For the same material, area and temperature difference, greater thickness reduces the rate of conduction. Less energy leaves each second. Cooling is slower. [maximum 3]

3. Any two: water volume/mass, starting temperature, container, exposed area, room conditions, timing method. [maximum 2]

4. Temperature difference from the surroundings affects cooling rate. Different starting temperatures would confound the insulation comparison. [maximum 2]

5. Example: inconsistent water volumes change cooling behaviour; measure equal volumes using the same cylinder. Accept a specific limitation with a matching improvement. [maximum 2]

Lesson 6 Efficiency calculations

1. Efficiency = 350/500 = 0.70 = 70%. [maximum 2]

2. Useful energy = 0.20 × 600 = 120 J. [maximum 3]

3. 1, or 100%. [maximum 1]

4. 1.2 means 120% useful output, greater than the total input. This violates conservation of energy for a complete accounting. [maximum 2]

5. Efficiency = 80/100 × 100 = 80%. [maximum 1]

Lesson practice answers

Indicative answers. Credit equivalent correct wording, up to the maximum in the question.

Lesson 7 Sankey diagrams

1. 100 − 70 = 30 J. [maximum 1]

2. The amount of energy transferred (or power, if consistently labelled). [maximum 1]

3. Useful output is 80% of the input width; dissipated output is 20%. Their widths add to the input width. [maximum 2]

4. Energy is conserved, so all outgoing transfers together equal incoming transfer for the stated system. [maximum 2]

5. Input 200 J; useful output 150 J; dissipated output 50 J. Use widths in the ratio 4:3:1. [maximum 2]

Lesson 8 Energy resources and electricity generation

1. Non-renewable: coal and nuclear fuel. Renewable: wind and biofuel (if sustainably replenished). [maximum 4]

2. Fuel releases energy by heating water/steam; steam turns a turbine; turbine turns a generator; generator transfers energy electrically. [maximum 4]

3. Advantage: no fuel burned and low operational carbon emissions. Disadvantage: variable wind output; also accept a relevant visual, noise or habitat effect. [maximum 2]

4. Solar radiation is continuously supplied on human timescales and is not depleted by using it. [maximum 1]

5. Hydro uses replenished water flow and has low operational emissions; fossil fuel is finite and combustion emits CO_2. Both can be controllable, but hydro depends on stored water/site and can flood habitats. Credit two linked comparisons. [maximum 4]

Lesson practice answers

Indicative answers. Credit equivalent correct wording, up to the maximum in the question.

Lesson 9 a.c., d.c. and UK mains

1. Approximately 230 V and 50 Hz. [maximum 2]

2. a.c. reverses direction periodically; d.c. flows in one direction. [maximum 2]

3. 50 × 2 = 100 cycles. [maximum 1]

4. A cell or battery. [maximum 1]

5. 50 complete cycles of the alternating waveform each second. [maximum 2]

Lesson 10 The National Grid and transformers

1. At the power station before long-distance transmission. [maximum 1]

2. Near consumers to lower voltage for distribution/use. [maximum 1]

3. For the same power, higher voltage means lower current. Lower current reduces resistive heating in cables, reducing unwanted energy transfer. [maximum 3]

4. Transformers change voltage and current. They do not create energy; an ideal transformer has equal input and output power and a real transformer dissipates some. [maximum 2]

5. Power station → step-up transformer → high-voltage grid → step-down transformer → homes. [maximum 2]

Lesson practice answers

Indicative answers. Credit equivalent correct wording, up to the maximum in the question.

Lesson 11 Live, neutral and earth wires

1. It connects an exposed metal case to Earth. During a live-to-case fault it provides a low-resistance path so a fuse or circuit breaker disconnects the supply. [maximum 2]

2. Live. [maximum 1]

3. An open switch can stop the normal appliance current without removing the live wire's potential difference from Earth. Touching live while earthed can still complete a dangerous path. [maximum 2]

4. There is a large potential difference. A person bridging live to Earth can carry a dangerous current through their body. [maximum 2]

5. Approximately 230 V. [maximum 1]

Lesson 12 Energy-use patterns, sustainability and decisions

1. Renewable share increased by 20 percentage points. [maximum 1]

2. Any two: reliability, emissions, land/habitat effects, resource availability, public acceptance, energy security. [maximum 2]

3. Countries differ in local resources, demand, geography, existing infrastructure and priorities. These differences change the costs and suitability of each resource. [maximum 3]

4. The generation mix is shifting towards renewables and away from fossil fuels. Shares alone do not show the absolute energy generated. [maximum 2]

5. Examples: output/demand profile, lifetime cost, emissions, local resource availability or storage/backup need. [maximum 1]

Assessment answers

Indicative marking guidance. Award distinct valid points and correct method, up to the stated maximum.

1. The battery's chemical store decreases. An electric current transfers energy to the motor. The motor does mechanical work, increasing the kinetic energy of moving parts (with some heating). [maximum 3]

2. E = 1.5 × 2.5 = 3.75 kWh. [maximum 2]

3. Cost = 3.75 × 30 = 112.5 p = £1.125, rounded to £1.13 for payment. [maximum 2]

4. Energy is conserved (1). The lamp transfers some energy as useful visible radiation (1); other energy spreads into internal stores of the surroundings by heating/infrared and is less useful (1). [maximum 3]

5. Use identical containers and equal water masses (1); equal starting temperatures (1); vary insulation alone, controlling thickness/area as appropriate (1); record temperatures at fixed times and compare cooling curves (1); repeat safely and average valid readings (1). [maximum 5]

6. Efficiency = 560/800 = 0.70 = 70%. [maximum 2]

7. Useful fraction 70/100 = 70% (1); dissipated output 30 J, with output widths summing to input (1). [maximum 2]

Assessment answers continued

Indicative marking guidance. Award distinct valid points and correct method, up to the stated maximum.

8. Non-renewable: coal, nuclear fuel. Renewable: wind, solar, biofuel when replenished sustainably (one mark each). [maximum 5]

9. Fossil generation burns finite fuel and emits CO_2, whereas wind has no fuel combustion during operation (2). Fossil output can be controlled to meet demand, whereas wind varies with weather and may need balancing/storage (2). [maximum 4]

10. 230 V (1); 50 Hz (1); a.c. reverses current direction periodically (1); d.c. is one-direction current (1). [maximum 4]

11. Step-up raises voltage before transmission (1), lowering current at the same power and reducing cable heating (1). Step-down lowers voltage near consumers (1), providing suitable domestic supply voltage (1). [maximum 4]

12. Live supplies the alternating high potential (1); neutral completes the normal circuit and is near Earth potential (1); earth connects an exposed case to Earth (1) so a fault can operate a fuse/breaker (1). Live can still be dangerous relative to Earth when an appliance switch is open (1). [maximum 5]

13. Renewable share rises by 18 percentage points (1); fossil share falls by 16 percentage points (1); the mix shifts towards renewables, but total generation is needed for absolute output (1). [maximum 3]

14. Scientific: emissions/output/reliability (1). Social/economic: cost, employment, fairness or public acceptance (1). [maximum 2]

Assessment answers continued

Indicative marking guidance. Award distinct valid points and correct method, up to the stated maximum.

15. Renewable means replenished, not impact-free (1). For example a hydro reservoir floods habitats, or turbine manufacture/installation affects materials and wildlife (1). [maximum 2]

Knowledge organiser

Lesson 1 Energy transfers by electric current

Energy can be stored chemically in a battery or fuel. In a power station, energy from a fuel is transferred through a sequence of processes before an electric current transfers energy through the grid.

Lesson 2 Power ratings, time and energy use

Power is the rate of energy transfer. A 2000 W device transfers 2000 J each second.

Lesson 3 Energy transferred E = Pt, kWh and cost

Use E = Pt. Pair units correctly: W × s gives J; kW × h gives kWh.

Lesson 4 Conservation of energy and dissipation

In a closed system, total energy does not change. Energy is transferred between stores, but is not created or destroyed.

Lesson 5 Reducing unwanted transfer and building insulation

Lubrication reduces unwanted transfer caused by friction. Thermal insulation reduces energy transfer by heating to the surroundings.

Lesson 6 Efficiency calculations

Efficiency = useful energy transferred / total energy transferred. Give as a decimal or multiply by 100 for a percentage.

Lesson 7 Sankey diagrams

A Sankey diagram uses arrow width to represent the amount of energy transferred.

Lesson 8 Energy resources and electricity generation

Main resources: fossil fuels, nuclear fuel, biofuel, wind, hydroelectricity, tides and the Sun.

Retrieval task Explain each idea without notes, then check it. For calculations, state the equation and SI units.

Knowledge organiser continued

Lesson 9 a.c., d.c. and UK mains

UK domestic mains is alternating voltage, about 230 V at 50 Hz.

Lesson 10 The National Grid and transformers

The National Grid transfers electrical power from power stations to consumers.

Lesson 11 Live, neutral and earth wires

Live wire: high alternating potential relative to Earth. Neutral wire: close to Earth potential and completes the circuit. Earth wire: protective connection to the metal case.

Lesson 12 Energy-use patterns, sustainability and decisions

Energy-use patterns can change with technology, price, policy, population and demand.

Retrieval task Explain each idea without notes, then check it. For calculations, state the equation and SI units.

Publication notes and references

Independent resource

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Specification

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https://www.ocr.org.uk/Images/234601-specification-accredited-gcse-twenty-first-century-science-suite-physics-b-j259.pdf

Edition and sources

Revised edition 2.0, 15 November 2026. Reconstructed from the supplied notebook with corrected questions, newly prepared indicative answers and worked examples, and newly drawn teaching diagrams. Diagrams are schematic and are not to scale unless numerical axes are supplied.

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Use supervised practical methods approved by the teaching centre. Written activities support, but do not replace, practical experience.