

AC DC generators and output graphs

AQA GCSE Separate Physics 8463 | Higher tier only | Mainly Paper 2; AC/DC link to Paper 1

Suggested: 35–40 minutes +15–20 review | 28 parts | 48 marks

Specification points covered

- 4.7.3.1: induced p.d., factors affecting output, direction and opposing magnetic effects
- 4.7.3.2: alternators, dynamos and graphs of generated p.d. against time
- 4.2.3.1: direct and alternating potential difference
- 4.2.1.3: selected $V = IR$ calculations for a fixed test load

A harbour team tests a small turbine-driven generator for walkway marker lights. Two contact arrangements connect the same rotating coil to an external load. You will interpret the output and decide whether it meets the lighting driver's requirements.

Complete all sections after teaching. The whole worksheet is for Separate Physics Higher tier, not Combined Science or Foundation. The model has one electrical cycle per complete coil rotation. The magnet stays fixed. Use $V = IR$ when needed; show calculation working. No mains supply is used in the workshop tests.

1 Explaining the generator output

The test coil turns between magnetic poles. A fixed-resistance test load is connected across the external output. The mechanism is driven by the turbine, not by an electrical supply.

1(a) State the difference between alternating current and direct current in terms of direction. **[2 marks]**

1(b) Explain why rotating the coil can produce a p.d. and why a complete external circuit is needed to produce a load current. **[2 marks]**



2 Comparing the contact arrangements

Figure 1 shows simplified contact schematics. The coil and shaft are omitted. The two complete rings in A are drawn side by side for clarity. Each ring or half-ring rotates with its coil end; the brushes and external load remain stationary. Ignore the short contact gaps during switching.

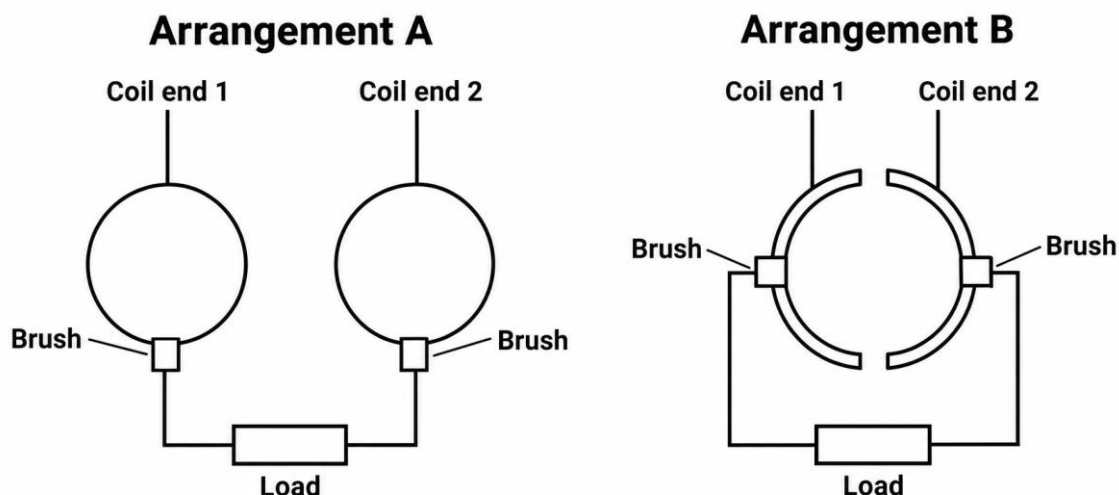


Figure 1

2(a) Name the rotating contact arrangement in A and the rotating contact arrangement in B. **[2 marks]**

2(b) State the function of the stationary brushes. **[1 mark]**

2(c) Why must the two halves of B be electrically insulated from each other? **[1 mark]**

2(d) The p.d. induced between the coil ends reverses every half-turn. Explain how B can still produce current in only one direction through the external load. **[2 marks]**

2(e) Why does A not compensate for the reversal of p.d. between the coil ends? **[1 mark]**



3 Reading the alternator trace

Arrangement A is tested at constant speed. Figure 2 shows p.d. across the external test load, using fixed lead connections. Positive p.d. gives current in one reference direction; negative p.d. gives the opposite direction. The load has constant resistance.

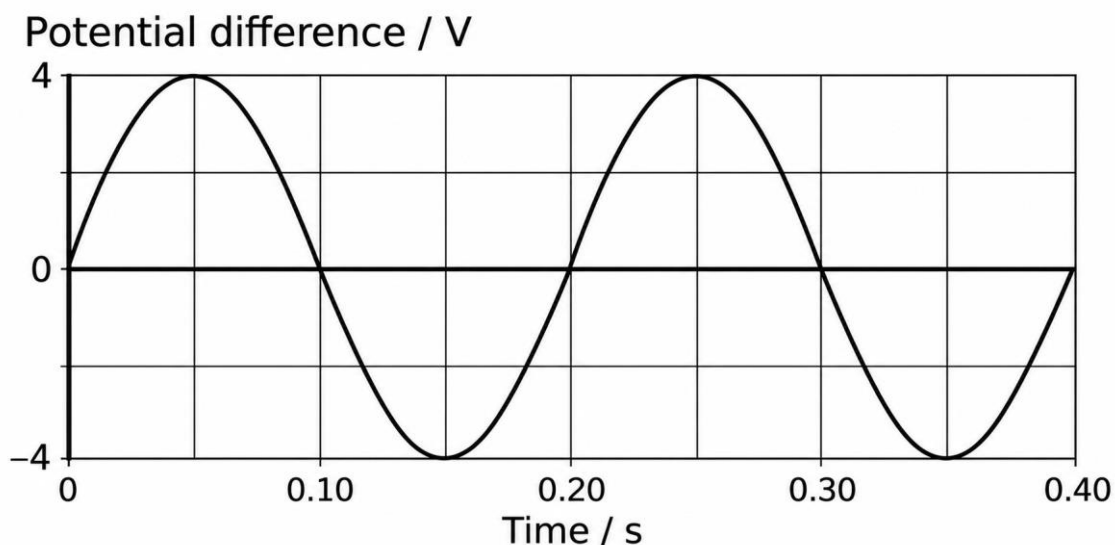


Figure 2

3(a) Read the p.d. at 0.05 s, including its sign. **[1 mark]**

3(b) Read the p.d. at 0.15 s, including its sign. **[1 mark]**

3(c) Compare the direction of load current at 0.05 s and 0.15 s. Use the signs on the graph. **[1 mark]**

3(d) Determine the time for one complete electrical cycle. **[1 mark]**

3(e) Calculate how many complete coil rotations occur in one minute at this speed. **[2 marks]**

3(f) A trainee says the coil must stop whenever the trace reaches zero. Explain why this is incorrect for the stated test. **[2 marks]**

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4 Predicting the dynamo trace

Now use Arrangement B at the same speed, with the same coil and magnet. Choose output leads so its first pulse is positive. Its peak p.d. is 4.0 V and it returns to zero at the same times as Figure 2. Ideal commutation reverses the connection to the coil every half-turn. Figure 3 is for the external load, not the coil ends.

4(a) Sketch the p.d. across the external load on Figure 3 for the two complete coil rotations from 0 to 0.40 s. **[2 marks]**

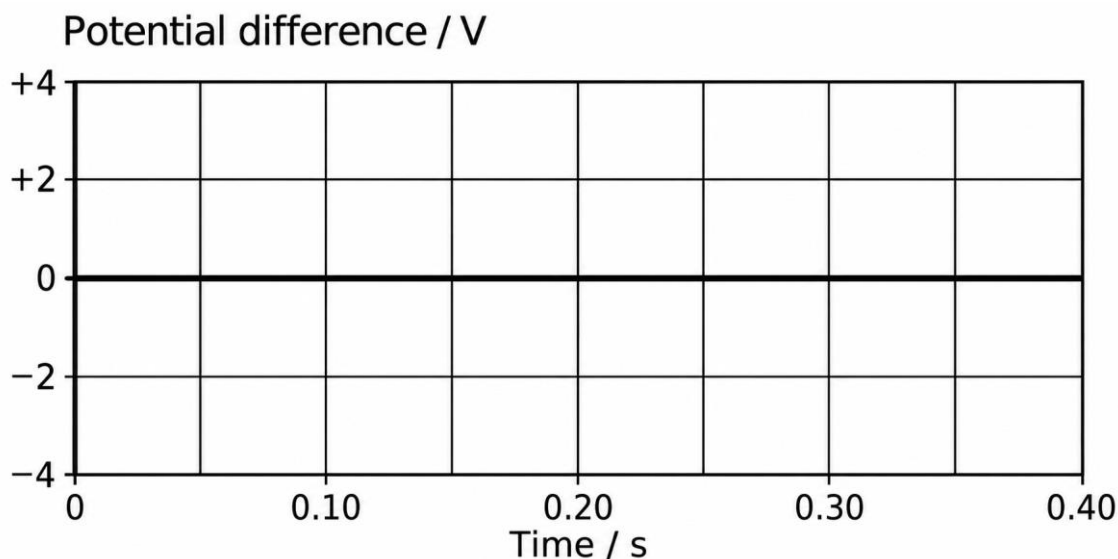


Figure 3

4(b) Explain why four positive pulses in this time do not mean four complete coil rotations. **[1 mark]**

4(c) Explain why this output is described as direct but not constant. **[2 marks]**

4(d) The test load is a constant $20\ \Omega$ resistor. Calculate its current at 0.05 s and at 0.10 s for your Figure 3 trace. **[2 marks]**

4(e) Only the two external load leads are swapped. Describe how the plotted dynamo p.d. changes and state whether it is still direct. **[2 marks]**



5 Testing changes to the generator

Each change below is a separate test from the original Figure 2 conditions. Keep the original coil, magnet and connections unless a change is explicitly stated.

5(a) Suggest two changes that could increase peak induced p.d. without turning the coil faster. **[2 marks]**

5(b) The coil now turns twice as fast. State the new cycle time and explain the expected change in peak p.d. Do not calculate a new peak value. **[2 marks]**

5(c) Describe a fair workshop test of how turning speed affects peak p.d. Include what to measure and what to keep unchanged. **[3 marks]**

5(d) With A, only the direction of rotation is reversed. Compare the p.d. at the same coil positions and decide whether the output becomes direct. **[2 marks]**

5(e) Both the magnet poles and the rotation direction are reversed. Predict the polarity at a given coil position compared with the original, and explain. **[2 marks]**

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6 Choosing an output for the walkway

Driver D operates only with a positive, unidirectional input. It tolerates pulses from 0 to 5.0 V; negative p.d. is not allowed. Driver S instead needs an almost steady 3.0 V supply. Neither driver contains smoothing or additional polarity-control equipment. The original generator peaks are 4.0 V.

6(a) For the original rotation direction and the chosen leads, which arrangement could supply Driver D directly? Justify your decision using its output trace. **[2 marks]**

6(b) Could the unsmoothed B output supply Driver S as specified? Use one feature of the trace to justify your answer. **[1 mark]**

6(c) The load circuit is opened, but the coil keeps rotating at the original speed. Is p.d. still induced across the coil ends? **[1 mark]**

6(d) Explain why opening the load circuit makes the generator easier to turn, even though its bearings are unchanged. **[3 marks]**

6(e) The team later lets the same turbine reverse its rotation when the tide changes. The magnet and Driver D leads remain unchanged. Is the original compatibility decision guaranteed to remain valid? Explain. **[2 marks]**

Review: state the measurement location, distinguish direction from magnitude, and support your decision with the trace.

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