GCSE Topic 7 AQA Physics: Magnetism and Electromagnetism Mark Scheme

Q1. Ben plays with a bar magnet and a paperclip [3]

(a) Paperclip is an **induced magnet** (1)

(b) It becomes magnetic **only when near a magnet** (1)
The magnetism **disappears when the magnet is removed** (1)

Alternative for (a): "temporary magnet" is acceptable

Q2. Tom places two bar magnets close together [2]

(a) **They repel** (1)
(b) **They attract** (1)

Q3. Harry sprinkles iron filings around a bar magnet [2]

(a) **Iron filings show the magnetic field lines** (1)
Lines run from north to south pole (1)

Alternative for (a): filings show the shape of the magnetic field

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Q4. Jack uses a plotting compass near a magnet [3]

(a) **The needle shows the direction of the magnetic field** (1)

(b) **The compass needle moves because it is a small magnet** (1)
It aligns with the magnetic field of the bar magnet (1)

Q5. Ethan is revising permanent and induced magnets [2]

(a) **Permanent magnet produces its own magnetic field all the time** (1)
(b) **Induced magnet is magnetised only when in a magnetic field** (1)

Alternative for (b): "temporary magnet"

Q6. Oliver builds an electromagnet [3]

(a) **The nail becomes magnetic because the current in the wire creates a magnetic field** (1)
  The magnetic field magnetises the iron nail (1)

 (b) **Increase the current / add more turns of wire / use a stronger iron core** (1)

Q7. Sam uses Fleming's left-hand rule [4]

(a) **Used to predict the direction of force on a current-carrying wire in a magnetic field** (1)

 (b) **Thumb = motion / force** (1)
  First finger = magnetic field (1)
  Second finger = current (1)

Alternative labels for fingers (first/second finger) acceptable as long as direction is correct

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Q8. Daniel moves a wire through a magnetic field [2]

(a) **An induced current / potential difference is produced** (1)
 (b) **Increasing the speed of movement or strength of the magnetic field increases the effect** (1)

Alternative for (b): increase the number of turns in the coil

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Q9. Jacob is studying the motor effect [3]

(a) **Force depends on the current in the wire** (1)

B) **Force depends on the strength of the magnetic field** (1)
  Reversing the current reverses the direction of the force (1)

Alternative for (a): force depends on the length of wire in the field

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Q10. Noah looks at electric motors [3]

(a) Used in electric fans / electric cars / washing machines (1)

(b) The coil keeps turning because of the split-ring commutator (1)
This reverses the current every half turn to maintain rotation (1)

Alternative for (a): drills, mixers, conveyor belts

Q11. Alex looks at magnetic fields around a wire [3]

(a) The field is circular around the wire (1)

(b) Field strength is stronger closer to the wire (1)
Field strength decreases with distance from the wire (1)

Q12. Luke investigates solenoids [3]

(a) Field inside solenoid is strong and uniform (1)
Field resembles that of a bar magnet (1)

(b) Increase number of coils / increase current / use stronger iron core (1)

Alternative for (b): increase solenoid length

Q13. William looks at transformers [3]

(a) Transformer changes the potential difference (1)

(b) Must use a.c. because changing magnetic field is required (1)
Direct current does not produce a changing magnetic field (1)

Q14. Charlie studies the National Grid [4]

(a) Step-up transformers increase voltage (1)
This reduces current and energy loss over long distances (1)

(b) Step-down transformers decrease voltage before homes (1)
This makes electricity safe for domestic use (1)

Q15. James looks at induced potential difference [3]

(a) **Electromagnetic induction = producing a potential difference by changing magnetic field** (1)

(b) **Move a magnet in and out of a coil** (1)
Or move the coil in a magnetic field / rotate coil in a magnetic field (1)

Q16. Ben investigates magnetic fields [4]

(a) Draw magnetic field lines from **north to south pole** (1)
Include arrows showing direction of field lines (1)

(b) **Field is stronger near the poles** (1)
Field strength decreases with distance from magnet (1)

Q17. Compass near current-carrying wire [3]

(a) **Current produces a magnetic field around the wire** (1)
Compass needle aligns with this magnetic field (1)

(b) **Deflection increases if current is increased** (1)

Q18. Electromagnet with iron nail [4]

(a) **Current produces magnetic field around the coil** (1)
This magnetises the iron nail (1)

(b) **Increase number of coils** (1)
Increase current (1)
Alternative for (b): use a stronger iron core

Q19. Motor effect [3]

(a) $F = B \times I \times L$ (1)

(b) F = 0.5 × 4 × 0.2 = **0.4 N** (1)
 Include correct unit N (newtons) (1)

Q20. Fleming's left-hand rule [5]

(a) **Thumb = force / motion** (1)
 First finger = field (1)
 Second finger = current (1)

 (b) **Rule predicts direction of force on wire** (1)
 Can be used to determine motion of coil in motor (1)

Q21. D.C. motor [3]

(a) **Split-ring commutator reverses current every half turn** (1)

 (b) **This keeps torque in same rotational direction** (1)
 Prevents the coil from stopping or reversing each half turn (1)

Q22. Electromagnetic induction [3]

(a) **A potential difference / current is induced** (1)

 (b) **Increasing speed of wire movement increases p.d.** (1)
 Increasing magnetic field strength increases p.d. (1)

Q23. Magnet and coil [4]

(a) **Induced current increases if magnet moves quickly** (1)

 (b) **No current is produced if magnet is stationary** (1)

 (c) **Because a changing magnetic field is required to induce current** (1)
 No change in flux = no induced current (1)

Q24. Transformers [3]

(a) **$V_\square$ / $V_\square$ = $N_\square$ / $N_\square$** (1)

(b) $V_\square$ = 12 × (200 / 50) = **48 V** (1)
Include correct unit V (volts) (1)

Q25. Alternating current [4]

(a) **D.C. gives constant current → no changing magnetic field** (1)
Transformers require changing magnetic field to induce voltage (1)

(b) **Alternating current in primary coil produces alternating magnetic field in core** (1)
This induces alternating p.d. in secondary coil (1)

Q26. National Grid [4]

(a) **Step-up transformers increase voltage** (1)
This reduces current and energy loss over long distances (1)

(b) **Step-down transformers reduce voltage for safe domestic use** (1)
Prevents dangerous high voltage entering homes (1)

Q27. Motor effect [3]

(a) **No force if current is parallel to field** (1)

(b) **Force depends on angle between current and field** (1)
Zero force when angle = 0° / 180° (1)

Q28. Loudspeakers [4]

(a) **Current in coil interacts with permanent magnet** (1)
Motor effect moves coil back and forth (1)
Movement vibrates speaker cone producing sound (1)

(b) **Pitch depends on frequency of the alternating current** (1)

Q29. Relays [3]

(a) **Electromagnet attracts switch when current flows** (1)
  This completes the second circuit (1)

 (b) **Used to control high voltage circuits with low voltage** (1)

Q30. Generators [3]

(a) **D.C. generator produces direct current; a.c. generator produces alternating current** (1)

 (b) **Rotating coil in magnetic field induces current** (1)
  Change in magnetic flux direction produces alternating current (1)

Q31. Transformer calculation [3]

(a) V_s = 230 × (100 / 2000) = **11.5 V** (1)
  Correct substitution into equation (1)
  Include unit V (1)

Q32. Transformer efficiency [3]

(a) **Soft iron core increases efficiency by directing magnetic field** (1)
  Reduces energy loss due to magnetisation (1)

 (b) **Energy wasted as heat / sound** (1)

Q33. Transformer current calculation [3]

(a) Using $P_s = P_p \rightarrow V_p \times I_p = V_s \times I_s$ (1)
  I_s = (230 × 0.2) / 46 = **1 A** (1)
  Include unit A (amperes) (1)

Q34. Induced current [2]

(a) **Reverse direction of magnet movement** (1)
 (b) **Reverse direction of coil movement** (1)

Q35. Earth's magnetic field [3]

(a) **Compass needle aligns along magnetic field lines** (1)
  North-seeking end points to geographic north (1)

 (b) **Evidence: magnetic rocks / pole reversals recorded in lava** (1)

Q36. Design of powerful electromagnet [3]

(a) **Increase number of coils** (1)
  Increase current (1)
  Use stronger iron core (1)

Q37. Magnetic flux density [3]

(a) **Force per unit current per unit length on a wire perpendicular to the field** (1)

 (b) **Allows comparison of field strengths** (1)
  Useful for calculating force on a wire (1)

Q38. AC/DC graphs [2]

(a) **AC graph: sinusoidal wave crossing zero periodically** (1)
 (b) **DC graph: constant line above zero** (1)

Q39. Bicycle dynamo [4]

(a) **Rotating magnet induces current in stationary coil** (1)
  Electricity generated by change in magnetic flux (1)

(b) **Lamp flickers because current changes with rotation** (1)
 AC produced, brightness varies with current direction (1)

Q40. Electromagnetic induction [4]

(a) **Applications: electric generator / transformer / induction cooker / metal detectors** (1)
 Two applications needed for 2 marks (1)

 (b) **Induced current opposes the change producing it (Lenz's law)** (1)
 This resists motion / change in flux (1)

Q41. Transformer derivation [3]

(a) **Power input = power output** (1)
 V□ × I□ = V□ × I□ (1)
 V□ / V□ = N□ / N□ (1)

Q42. Eddy currents [4]

(a) **Loops of current induced in metal when magnetic flux changes** (1)
 Currents circulate in closed paths perpendicular to magnetic field (1)

 (b) **Use laminated core to reduce eddy currents** (1)
 Thin sheets of metal increase resistance, reducing current (1)

Q43. Flux linkage [3]

(a) **e.m.f. = −Δ(NΦ) / Δt** (1)

 (b) **Faster change in flux linkage increases rate of change** (1)
 Larger rate of change → larger induced e.m.f. (1)

Q44. Faraday's law calculation [3]

(a) e.m.f. = N × ΔΦ / Δt = 200 × 0.05 / 0.1 (1)
 e.m.f. = **100 V** (1)
 Include correct unit V (volts) (1)

Q45. Lenz's law [3]

(a) **Induced current opposes the change in magnetic flux that produced it** (1)

(b) **Energy is conserved because work must be done to overcome opposition** (1)
 Prevents creation of energy from nothing (1)

Q46. AC generators [4]

(a) **Slip rings maintain connection to rotating coil** (1)
 Allow current to alternate without twisting wires (1)

(b) **AC generator produces alternating current** (1)
 DC generator produces direct current (1)

Q47. Mains electricity [2]

(a) **50 Hz** (1)
(b) **230 V** (1)

Q48. Step-up / step-down transformers [4]

(a) **Output p.d. is proportional to ratio of turns** (1)
 More turns on secondary → higher voltage; fewer turns → lower voltage (1)

(b) V_s = 230 × (50 / 500) = **23 V** (1)
 Include unit V (volts) (1)

Q49. Power transmission [3]

(a) **P = I × V** (1)

(b) **Higher voltage allows lower current for same power** (1)
 Lower current reduces I²R energy loss in cables (1)

Q50. Energy losses calculation [3]

(a) P = I²R = 200² × 0.5 (1)
 P = **20,000 W** (1)
 Include correct unit W (watts) (1)

Q51. Flux density and force [3]

(a) **Unit of magnetic flux density is tesla (T)** (1)

(b) F = B × I × L = 0.4 × 5 × 0.3 (1)
 F = **0.6 N** (1)

Q52. Oscilloscopes [3]

(a) **Measure time period of one complete wave on the trace** (1)

 Frequency = 1 / period (1)
 (b) **Amplitude of trace proportional to p.d. of supply** (1)

Q53. Magnetic field strength [3]

(a) **F = B × I × L** (1)

 (b) **Wire must be perpendicular to magnetic field** (1)
  Current must be constant / steady (1)

Q54. Rotating coils [3]

(a) **Angle between coil and magnetic field changes continuously** (1)
  Flux linkage changes sinusoidally (1)
  Induced current varies sinusoidally with rotation (1)

Q55. Transformer efficiency [3]

(a) **Efficiency = (P□ / P□) × 100%** (1)

 (b) Efficiency = (180 / 200) × 100 = **90%** (1)
 Include % sign (1)