4. Electricity and magnetism

4.5 Electromagnetic effects

Paper 3 and 4

Answer Key

Paper 3

Q1.

(c)	40	**A3**
	(N_s) = (12 ÷ 228) × 760 OR 228 / 12 = 760 / N_s	(C2)
	N_s / N_p = V_s / V_p	(C1)

Q2.

Question	Answer	Marks
(a)	any **two** from: • increase (battery) voltage OR larger current in coil • increase strength of magnet(ic) field OR strong(er) magnet • increase number of turns (in coil)	**B2**
(b)	440 (turns)	**A3**
	(N_S =) 800 × 120 / 220	(C2)
	V_P / V_S = N_P / N_S	(C1)

Q3.

Question	Answer	Marks
(a)(i)	(soft) iron	**B1**
(a)(ii)	8 (cells)	**A2**
	(number of cells =) 12 ÷ 1.5 **OR** battery e.m.f ÷ e.m.f. of 1 cell	(C1)
(b)(i)	(plotting) compass	**B1**
(b)(ii)	north **OR** N (pole)	**B1**
(c)	(V =) 9.6 (V)	**A3**
	(V =) 8(.0) × 1.2	(C2)
	R = V ÷ I in any form **OR** (V =) I × R	(C1)

Q4.

(b)(i)	(secondary coil voltage V_s =) 16 (V)	**A3**
	230 / V_s = 720 / 50 **OR** (V_s =) {230 × 50} ÷ 720	(C2)
	(V_p / V_s) = (N_p / N_s) in any form	(C1)
(b)(ii)	(P =) 320 (W)	**A3**
	(P =) 1.4 × 230	(C2)
	(P =) I × V	(C1)

Q5.

Question	Answer	Mark
(a)	fault: insulation damaged owtte	**B1**
	hazard: electrocution **OR** electric shock	**B1**
(b)(i)	earth (wire)	**B1**
(b)(ii)	(switch is connected in) live (wire)	**M1**
	(so appliance is) disconnected from main / supply **OR** disconnected from high voltage (when switch is open / off)	**A1**

Q6.

Question	Answer	Marks
(a)	(plotting) compass OR iron filings	**B1**
	detail of method	**B1**
	idea of using a (plotting) compass to give direction of magnetic field	**B1**
(b)	any **four** from: current in coil P (changing) magnetic field around / in coil P (magnetic field) links with / cuts coil Q an induced emf (across) coil Q OR voltage / current produced / generated in coil Q (induced emf) causes pointer on (sensitive) voltmeter to move when current steady no changing magnetic field OR no field (lines) cutting coil Q pointer then returns to zero	**B4**

Q7.

Question	Answer	Marks
(a)(i)	any **two** from: • magnetic field • cuts / links with coil / conductor / wire • e.m.f. / voltage / p.d. induced (in coil)	**B2**
(a)(ii)	any **two** from: • increase strength of the magnet(ic field) • increase speed of the magnet • increase (the number of) turns on coil	**B2**
(b)	(V_s =) 7.5 (V)	**A3**
	V_s / 180 = 200 / 4800 **OR** (V_s =) (200 × 180) ÷ 4800	(C2)
	V_s / V_p = N_s / N_p	(C1)

Q8.

Question	Answer	Marks
(a)	(switch is in) the live wire	**B1**
	(so when switch is off, desktop is) disconnected from supply / mains(voltage) **OR** high voltage	**B1**
	(so) no current (in computer / circuit) **OR** no risk of electrocution	**B1**
(b)(i)	step-down (transformer)	**B1**
(b)(ii)	any **four** from: • (soft) iron core • two coils of copper wire • primary coil **AND** secondary coil • transformer equation stated • turns ratio of 20 : 1 **OR** 240 : 12 owtte **OR** use of transformer equation	**B4**

Q9.

(b)	110 (V)	**A3**
	V_s / 230 = 150 / 314 **OR** V_s = (150 / 314) × 230 **OR** V_s = 230 / 2.093 **OR** 150/314 = ? / 230	C2
	V_s / V_p = N_s / N_p	C1
(c)(i)	(soft) iron	**B1**
(c)(ii)	copper	**B1**
(c)(iii)	fewer turns on output / secondary (than on input coil)	**B1**

Q10.

Question	Answer	Marks
(a)	alternating (current)	**B1**
(b)	step-up	**B1**
(c)	(soft) iron	**B1**
(d)	40 (V)	**A3**
	(V_S =) 800 / 200 × 10	(C2)
	$V_P / V_S = N_P / N_S$ in any form	(C1)
(e)	zero	**B1**

Q11.

Question	Answer	Marks
(b)	1920 (V)	**A3**
	Vs / 240 = 560/70 OR Vs = (560/70) × 240 OR Vs = 240 × 8 OR 560/70 = ? / 240	**(C2)**
	Vs/Vp = Ns/Np in any form	**(C1)**

Q12.

Question	Answer	Marks
(a)	circles drawn	**B1**
	concentric (by eye) with wire	**B1**
	arrow drawn clockwise on/near field (line)	**B1**
(b)(i)	any **two** from: increase current (in wire) increase strength of magnets or magnetic field move poles closer together	**B2**
(b)(ii)	reverse the (direction of the) current (in the wire)	**B1**
	reverse the magnetic field	**B1**

Q13.

Question	Answer	Marks
(a)(i)	connect (both ends of) wire to galvanometer	B1
	move wire relative to magnet owtte	B1
(a)(ii)	any **two** from: increase strength of magnet(ic field) OR strong(er) magnet turn wire into a coil owtte increase the speed (of relative motion)	B2
(b)(i)	arrow drawn from N to S on Fig. 10.1	B1
(b)(ii)	any **two** from: increase (battery) voltage OR larger current in coil increase strength of magnet(ic) field OR strong(er) magnet increase number of turns in coil	B2
(b)(iii)	reverse polarity of battery owtte OR reverse magnet(ic field) owtte	B1

Q14.

Question	Answer	Marks
(a)	strong(er) magnet	B1
	move (magnet) more quickly / faster movement	B1
	more turns / coils (per unit length)	B1
(b)(i)	(soft) iron	B1
(b)(ii)	$V_p / V_s = N_p / N_s$ in any form	C1
	$(V_s =) 240 \times 50 / 1000$	C1
	12 (V)	A1

Q15.

Question	Answer	Marks
(a)	top box ticked (alternating)	B1
(b)	any **two** from: increase strength of magnet/magnetic field increase speed of magnet increase number of turns (of wire in coil)	B2

Q16.

Question	Answer	Marks
(a)(i)	in any order:	
	increase current (in coil)	B1
	increase strength of magnet(s) or magnetic field(s)	B1
	increase the number of turns on the coil	B1
(a)(ii)	(direction of the) current (in the coil) is reversed	B1
(b)	$(V_p/V_s) = (N_p/N_s)$ in any form	C1
	$234 \div 18 = 2470 \div N_s$ OR $N_s = 2470 \div (234 \div 18)$ OR $2470 \div 13$	C1
	(turns on secondary/output coil N_s =) 190	A1

Q17.

Question	Answer	Marks
(a)	$V_p \div V_s = N_p \div N_s$	C1
	$230 \div V_s = 300 \div 30$	C1
	23 (V)	A1
(b)	(soft) iron	B1
(c)	Any **two** from: less energy or power wasted OR less heating(of wires) OR more efficient lower current (in transmission wires) can use thinner (transmission) wires / cables fewer power stations needed (so) lower cost for cable and supporting pylons transmit (energy over) longer distances (without drop in power)	B2

Q18.

Question	Answer	Marks
(a)	any **two** from: increase current increase magnetic field strength field more turns on coil	B2
(b)	$(V_p / V_s) = (N_p / N_s)$ in any form	C1
	$N_s = (12 \div 240) \times 900$	C1
	45	A1

Q19.

Question	Answer	Marks
(a)	relative movement (between conductor and magnetic field) And any **two** from: connect conductor/coil to (sensitive) meter use of magnet/magnetic field	**B1**
	deflection on meter (indicates emf) OR voltage generated OR current in conductor	**B2**
(b)(i)	(soft-) iron	**B1**
(b)(ii)	more turns on output coil (than input coil) ora	**B1**
(b)(iii)	Vs / Vp = Ns / Np in any form	**C1**
	Vs / 12 = 300 / 20 OR Vs = (300 / 20) × 12 OR Vs = 15 × 12 OR 12 / 20 = ? / 300	**C1**
	180 (V)	**A1**

Q20.

Question	Answer	Marks
(a)	(diagram) A	**B1**
(b)(i)	connect coil to (centre zero) meter	**B1**
	move magnet in OR / AND out of coil	**B1**
	(observe) deflection on meter	**B1**
(b)(ii)	**any two from:** use stronger magnet move magnet faster more turns on coil OR use more than 100 turns	**B2**
(c)	(generator produces) alternating current OR direction of current keeps changing	**B1**

Q21.

Question	Answer	Marks
(a)	step-down (transformer)	**B1**
(b)	(soft) iron	**B1**
	forms a temporary magnet	**B1**
(c)(i)	$V_p/V_s = N_p/N_s$ **OR** ratio used	**C1**
	240 × (125 ÷ 5000)	**C1**
	(PQ =) 6 (V)	**A1**
(c)(ii)	(PR =) 12 (V) / double the value in **(c)(i)** (PQ)	**B1**
	twice as many turns between P and R (as P and Q)	**B1**

Q22.

Question	Answer	Marks
(a)	(Vp / Vs) = (Np / Ns) in any form	C1
	230 / Vs = 1710 / 90 or Vs = (230 × 90) / 1710 OR Vs = 230 / 19	C1
	12 (V)	A1
(b)	In a step-down transformer there are fewer turns on secondary / output coil (than on primary / input coil) In a step-up transformer there are more turns on secondary / output coil (than on primary / input coil)	B2
(c)	less energy / power wasted (in cables) / more efficient (transmission)	B1
	And any one from: (because) smaller current (in transmission cables) (and so) smaller heating effect (in transmission cables) (and so) thinner cables can be used (which are cheaper)	B1

Q23.

Question	Answer	Marks
(a)(i)	(Q is the) secondary/output (coil)	1
(a)(ii)	1. (soft–) iron	1
	2. core	1
(a)(iii)	magnetic field **OR** e.m.f. **OR** magnet	1
	changing **OR** alternating	1
(a)(iv)	EITHER more …**AND** step-down **OR** fewer …**AND** step-up	1
(b)	any **two** from: smaller current (in wires) smaller drop in p.d./voltage (across cables) smaller heating effect less energy wasted/more efficient thinner cables can be used fewer pylons neededl (electricity) can be transmitted over long(er) distances	2

Paper 4

Q24.

Question	Answer	Marks
(a)	(soft) iron	**B1**
(b)(i)	(at least) one complete field line between the poles of the bar (either above or below the bar)	**B1**
	no crossing **AND** attempt at correct shape **AND** at least six lines from / to poles	**B1**
	at least **one** arrowhead towards S pole	**B1**
(b)(ii)	current (in the coil) decreases	**B1**
	(current decreases so magnetic field) strength decreases	**B1**
	(field strength decreases so) fewer field lines (in same area) **OR** (field strength decreases so) field lines further apart	**B1**
(c)	*Any two from:* 1 (changing resistance causes) changing current (through solenoid) 2 (changing current causes) changing magnetic field (around solenoid) 3 (square) coil cuts (changing) magnetic field **OR** coil in changing magnetic field	**B2**
	e.m.f. induced (between terminals)	**B1**

Q25.

Question	Answer	Marks
(a)	*any **two** from:* 1 (magnitude is) constantly changing owtte 2 (magnetic field is) stronger closer to the coil of wire ORA 3 (the magnetic field is) perpendicular to the a.c. current (producing it) 4 (the magnetic field) changes direction owtte	**B2**
(b)(i)	*any **one** from:* • secondary coil is in changing / varying magnetic field • secondary coil is in the magnetic field of primary coil	**B1**
	voltage is induced (in the secondary coil)	**B1**
(b)(ii)	*any **one** from:* • There is no iron core (to strengthen field) • transformer usually has an iron core to connect the two coils • some energy transferred to thermal energy (in phone / surroundings)	**B1**
(c)(i)	6000 s	**A2**
	$E = VIt$ **OR** (t =) E / IV **OR** $4.5 \times 10^4 / [12 \times 0.63]$	C1
(c)(ii)	(Q =) 38 C	**A2**
	$I = Q / t$ **OR** (Q=) It **OR** 0.63×60	C1

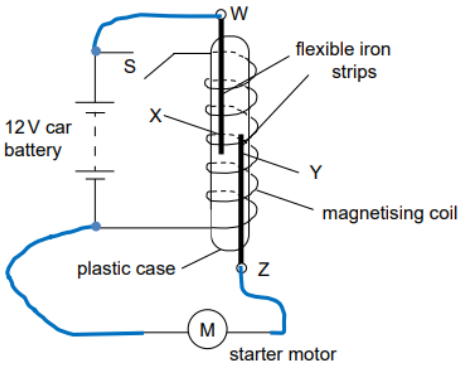
Q26.

(b)(i)	0.19 A	**A3**
	$I_p V_p = I_s V_s$ **OR** (I_p =) $I_s V_s / V_p$ **OR** (I_p =) 45 / 240 **OR** $I_p V_p$ = 45 **OR** power in primary = power in secondary	C1
	(I_p=) 45 / 240	C1
(b)(ii)	labelled diagram showing: • (soft) iron core • copper (coils) • primary and secondary (coils) labelled **AND** fewer coils on secondary than on primary	**B3**

Q27.

Question	Answer	Marks
(a)	any **four** from: • alternating current in (primary coil) • (current in primary generates) changing magnetic field • iron core concentrates (magnetic) field **OR** iron core transfers (magnetic) field (to secondary coil) • secondary coil is in alternating / changing (magnetic) field **OR** secondary coil cuts (magnetic) field • e.m.f. induced (in secondary coil)	**B4**
(b)(i)	(number of turns =) 3000	**A2**
	$N_p / N_s = V_p / V_s$ **OR** (N_p =) $N_s V_p / V_s$ **OR** (N_p =) 450 × 220 000 / 33 000	C1
(b)(ii)	(current =) 350 A	**A3**
	$P = IV$ **OR** (I =) P / V **OR** (I =) 7.7×10^7 / 220 000	C1
	(I =) 3.5×10^N	C1

Q28.

Question	Answer	Marks
(a)		**B3**
	X and Y / they become magnetised **or** they / strips have poles	B1
	strips in the centre have opposite (magnetic) poles **or** X and Y attract	B1
	X and Y touch / close switch / activate relay / complete circuit	B1
(b)(i)	150 A	**A2**
	$I = P / V$ in any form **or** 1.8 / 12 **or** 1800 / 12 **or** 1800 / 12 **or** 0.15	C1
(b)(ii)		**B2**
	small(er) resistance mentioned	B1
	less thermal energy produced **or** wires do not melt **or** large current mentioned	B1
(c)		**B2**
	flexible strips in series with motor	B1
	power supply in series with motor	B1
	expected answer: 	

Q29.

Question	Answer	Marks
(a)(i)	magnetic field mentioned	**B1**
	coil / wire cuts (magnetic) field **OR** changing (magnetic) field (through coil)	**B1**
	e.m.f. / voltage induced **OR** produced by electromagnetic induction	**B1**
(a)(ii)	(plane of coil) horizontal **OR** in position shown in diagram coil cutting magnetic field the fastest	**B1** **B1**

Q30.

Question	Answer	Marks
(a)	place magnet in coil	B1
	EITHER	
	(gradually) withdraw magnet…	B1
	…with ac (in coil) switched on	B1
	OR	
	reduce current…	(B1)
	…to zero	(B1)
(b)(i)	keeps coil rotating (in the same direction) o.w.t.t.e.	B1
	by changing direction of current (in the coil)	B1
	every half cycle/180 degrees	B1
(b)(ii)	(coil rotates) faster	B1

Q31.

Question	Answer	Marks
(a)	(soft) iron	B1
(b)(i)	Alternating / changing magnetic field in primary (coil)	B1
	Alternating / changing (magnetic) field in core (and in secondary coil) OR (magnetic) field lines / flux link secondary	B1
	e.m.f / voltage induced (in secondary coil)	B1
(b)(ii)	$V_P / V_S = N_P / N_S$ in any form OR $(V_P =) V_S \times N_P / N_S$ OR $78 \times 560 / 910$	C1
	48 V	A1
(c)	Lower current	B1
	(Power loss from cables =) I^2R so lower current means less power loss OR less heat loss	B1

Q32.

Question	Answer	Marks
(a)	To produce an alternating/changing magnetic field	1
	so that current/voltage is induced (continuously) in the secondary coil **OR** secondary circuit	1
(b)(i)	$N_s \div N_p = V_s \div V_p$ in any form **OR** $(N_s =) N_p \times V_s \div V_p$ **OR** $8000 \times 6 \div 240$	1
	200	1
(b)(ii)	$I_pV_p = I_sV_s$ in any form **OR** $(I_p =) I_s \times V_s \div V_p$ **OR** $2.0 \times 6 \div 240$	1
	0.050 A	1
(b)(iii)	(Number of lamps =) $2 \div 0.05 = 40$	1