AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.7.3 INDUCED POTENTIAL, TRANSFORMERS AND THE NATIONAL GRID

SCORE	PERCENTAGE
/254	%

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Q1.

(a) P-waves are longitudinal and
S-waves are transverse

1

(b) 0.4

1

(c) wave speed = frequency × wavelength

allow $v = f\lambda$

1

(d) 7200 = 0.4 × wavelength

1

$$\text{wavelength} = \frac{7200}{0.4}$$

1

wavelength = 18 000 (m)

allow up to full marks for ecf using their answer to part ***(b)***

a method shown as
7200 × 2.5 = 18 000
scores ***0*** *marks*

1

an answer 18 000 scores ***3*** *marks*

(e) because S-waves cannot travel through a liquid

1

and S-waves do not travel through the (outer) core

allow some (seismic) waves cannot travel through a liquid and do not go through the core for ***1*** *mark*

1

(f) magnetic field around the coil changes
or
the magnetic field (lines) cut by the coil

allow the generator effect

1

(g) because the magnet changes direction

1

(h) stationary

1

(i) any **two** from:

- stronger magnetic field

allow stronger magnet
allow heavier magnet

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bigger magnet is insufficient

- more turns on the coil
  bigger coil is insufficient
  *do **not** accept more coils of wire*

- turns pushed closer together

- spring with a lower spring constant
  allow less stiff spring
  allow weaker spring
  *do **not** accept add an iron core*

2

[13]

Q2.

(a) any **one** from:

- too few turns / coils on the secondary
  allow number of turns / coils on the primary was increased

- p.d. across the primary was reduced
  ignore human error

1

(b) the p.d. (across the secondary) goes above 2V
allow p.d. across secondary is higher than p.d. across primary after 20 turns

1

(c) it increases (until the nails reach a constant temperature)

1

(d) $\frac{640}{4} = \frac{V_p}{1.75}$

1

$V_p = \frac{640 \times 1.75}{4}$

1

$V_p = 280$ (V)

1

$280 \times I_p = 336$
allow their calculated
$V_p \times I_p = 336$

1

$I_p = 1.2$ (A)
allow an answer that is consistent with their calculated value of V_p

1

or

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$336 = I_s \times 1.75$ (1)

$$I_s = \frac{336}{1.75} \quad (1)$$

$I_s = 192$ (A) (1)

$$I_p = 192 \times \frac{4}{640} \quad (1)$$

allow

$$I_p = \text{their calculated } I_s \times \frac{4}{640}$$

$I_p = 1.2$ (A) (1)

allow an answer that is consistent with their calculated value of I_s

*an answer of 1.2 (A) scores **5** marks*

[8]

Q3.

(a) It is easily magnetised.

1

(b) p.d. across the secondary coil is smaller (than p.d. across the primary coil)

1

(c) ratio $\frac{V_p}{V_s} = \frac{6}{12}$

accept any other correct ratio taken from the graph

1

$\frac{6}{12} = \frac{50}{N_p}$

use of the correct turns ratio and substitution or correct transformation and substitution

1

$N_p = 100$

*allow 100 with no working shown for **3** marks*

1

[5]

Q4.

(a) a magnetic field

accept electromagnetic field

heat is insufficient

1

that is alternating / changing

1

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(b) 20

*allow **1** mark for correct substitution, ie*

$$\frac{230}{11.5}$$

provided no subsequent step

2

(c) (most) transformers are not 100% efficient

allow energy / power is lost to the surroundings

allow energy / power is lost as heat / sound

power is lost is insufficient

1

(d) (i) 0.01 (V)

1

because there is a change in p.d. each time (the number of turns changes)

allow because all the results (to 2 decimal places) are different

accept if results were to 1 decimal place, there might not be a difference

1

(ii) student 2 moved the coil more slowly (than student 1)

accept student 2 moved the coil at a different speed to student 1

do not accept student 2 moved the coil faster (than student 1)

1

(iii) both sets of results show the same pattern

accept trend for pattern

results are similar is insufficient

results follow a pattern is insufficient

1

(iv) (electromagnetic) induction

accept it is induced

do not accept electric / magnetic induction

1

(e) any **one** from:

- more economical / cheaper for the consumer

  allow more convenient

- easier/cheaper to replace if broken/lost

  allow in case one gets lost

- since fewer transformers need to be made less resources are used

  allow fewer plug sockets are needed

  allow fewer transformers are needed

  environmentally friendly is insufficient

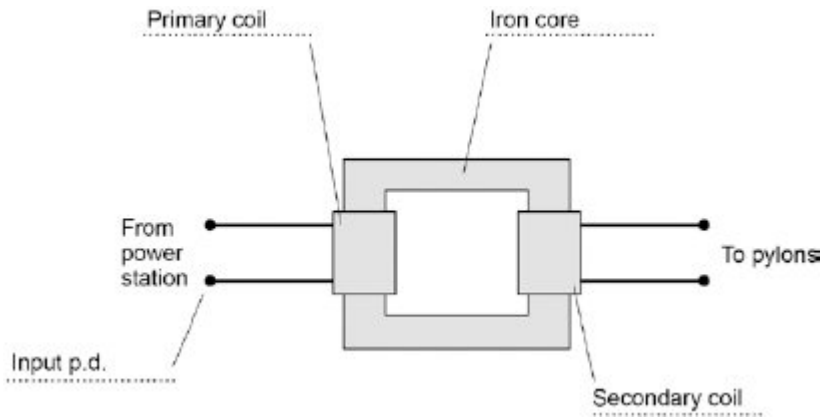
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1

[11]

Q5.

(a) (i)



1
1
1
1

(ii) 16 000

allow 1 mark for correct substitution
ie 400 ÷ 25 = n ÷ 1000

2

(iii) p.d. increased (by transformer at power station)

do not accept energy increased

1

so current decreases

1

this reduces energy / power loss (in cables)

allow heat for energy
allow increases the efficiency
*do **not** accept no energy losses*

1

(b) smaller / lighter

1

uses little power / energy

1

when left switched on with no load applied

dependent on second marking point

1

[12]

Q6.

(a) (i) Iron

1

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(ii) 50

ignore references to current

reason only scores if 50 chosen

1

there are more turns on the secondary coil (than the primary coil)

accept it is a step-up transformer

not more coils

1

(b) (i) 200

1

(ii) any **one** from:

- Lighter
- smaller
- use very little power / current (when switched on with no load / phone attached).

accept more efficient

do not accept uses no power / current

a disadvantage of a traditional transformer is insufficient on its own

1

[5]

Q7.

(a) an alternating current through the primary coil (in the charging base)

it must be clear which coil is being referred to

1

causes a changing / alternating magnetic field in / around the (iron) bar

1

which induces an (alternating) p.d. across the secondary coil (in the toothbrush)

accept induces an (alternating) current in the secondary coil

1

(b) 18

*allow **1** mark for correct substitution, ie*

$$\frac{230}{7.2} = \frac{575}{n_s}$$

2

[5]

Q8.

(a) (i) generator

1

(ii) alternating current

1

(iii) voltmeter / CRO / oscilloscope / cathode ray oscilloscope

1

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(b) (i) time

1

(ii) peaks and troughs in opposite directions

1

amplitude remains constant

dependent on first marking point

1

(c) any **two** from:

- increase speed of coil
- strengthen magnetic field
- increase area of coil

*do **not** accept larger*

2

[8]

Q9.

(a) *attempt to draw four cells in series*

1

correct circuit symbols

circuit symbol should show a long line and a short line, correctly joined together

example of correct circuit symbol:



1

(b) (i) 6 (V)

*allow **1** mark for correct substitution, ie*

*V = 3 × 2 scores **1** mark*

provided no subsequent step

2

(ii) 12 (V)

ecf from part (b)(i)

18 – 6

or

*18 – their part (b)(i) scores **1** mark*

2

(iii) 9 (Ω)

ecf from part (b)(ii) correctly calculated

3 + their part (b)(ii) / 2

or

*18 / 2 scores **1** mark*

provided no subsequent step

2

(c) (i) need a.c.

1

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battery is d.c.

1

(ii) 3 (A)

*allow **1** mark for correct substitution, ie*
*18 × 2 = 12 × I_s scores **1** mark*

2

[12]

Q10.

(a) *there is a* magnetic field *(around the magnet)*

1

(this magnetic field) changes / moves

1

and cuts through coil

accept links with coil

1

so a p.d. *induced* across coil

1

the coil forms *a* complete circuit

1

so a current (*is* induced)

1

(b) ammeter reading does not change

must be in this order
accept ammeter has a small reading / shows a current

1

zero

1

greater than before

accept a large(r) reading

1

same as originally but in the opposite direction

accept a small reading in the opposite direction

1

(c) 0.30

*allow **1** mark for correct substitution, ie 0.05 = Q / 6*

2

C / coulomb

allow A s

1

[13]

Q11.

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(a) (i) live

1

(ii) react faster

1

(iii) live and neutral

1

(b) (i) ammeter

1

to measure current

accept to measure amps

1

plus any **one** from:

- *variable resistor* (1)
  to vary current (1)
  accept variable power supply
  accept change or control

- *switch* (1)
  to stop apparatus getting hot / protect battery
  or
  to reset equipment (1)

- fuse (1)
  to break circuit if current is too big (1)

2

(ii) any **two** from:

- use smaller mass(es)
- move mass closer to pivot
- reduce gap between coil and rocker
- more turns (on coil)*coil / loop*
- iron core in coil

  accept use smaller weight(s)

2

[9]

Q12.

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant / correct content.

Level 1 (1–2 marks)
Either there is an attempt at a description of the construction of a transformer

or

a correct statement of the effect of one type of transformer on the input p.d.

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Level 2 (3–4 marks)
There is a description of the construction of a transformer
and
a correct statement of the effect of one type of transformer on the input p.d.

Level 3 (5–6 marks)
There is a clear description of the construction of a transformer
and
there is a correct description of how transformers affect the input p.d.

details of construction:

extra information

a (laminated) core

core is made from a magnetic material / iron

2 coils

the coils are made from an electrical conductor / copper

the coils are covered in plastic / insulation

the coils are (usually) on opposite sides

step-up transformer has more turns on secondary coil than (its) primary (or vice versa)

step-down transformer has fewer turns on secondary coil than (its) primary (or vice versa)

effect on input p.d. :

step-up transformer, the output p.d. is greater (than the input p.d.)

accept voltage for p.d.

step-down transformer, the output p.d. is lower (than the input p.d.)

6

[6]

Q13.

(a) step-down

1

(b) (i) 1.6

correct order only

1

12.8

1

(ii) values of p.d. are smaller than 230 V

1

(c) (i) a.c. is constantly changing direction

accept a.c. flows in two / both directions

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accept a.c. changes direction(s)
a.c. travels in different directions is insufficient

1

d.c. flows in one direction only

1

(ii) an alternating current / p.d. in the primary creates a changing / alternating magnetic field

1

(magnetic field) in the (iron) core
current in the core negates this mark
accept voltage for p.d.

1

(and so) an alternating p.d.

1

(p.d.) is induced across secondary coil

1

[10]

Q14.

(a) iron
correct positions only

1

primary

1

secondary

1

(b) (it) decreases the p.d.
accept it would increase current
accept voltage for p.d.
the voltage goes from 230(V) to 20(V) is insufficient
*do **not** accept decreases current / energy / power*
*do **not** accept decreases p.d. / voltage and current*

1

(c) an environmental

1

[5]

Q15.

(a) (the alternating current creates) a changing / alternating magnetic field

1

(magnetic field) in the (iron) core
accept that links with the secondary coil
current in the core negates this mark

1

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(causing a) potential difference (to be) induced in / across secondary coil

accept voltage for p.d.

1

(b) (i) 20

*allow **1** mark for correct substitution, ie* $\frac{230}{V_s} = \frac{575}{50}$

or $\frac{V_s}{230} = \frac{50}{575}$

2

(ii) 0.3

or

correct calculation using $230 \times I_p$ = their (b)(i) × 3.45

*allow **1** mark for correct substitution, ie*

$230 \times I_p = 20 \times 3.45$

allow ecf from (b)(i) for 20

OR

substitution into this equation $\frac{I_p}{I_s} = \frac{N_s}{N_p}$

2

(c) any **one** from:

- fewer (waste) batteries have to be sent to / buried in land-fill
- the soil is polluted less by batteries in land-fill
- fewer (waste) batteries have to be recycled
- fewer batteries have to be made
- less raw materials are used in making batteries
- customers have to replace their batteries less often

  longer lifetime is insufficient
- customers have to buy fewer (replacement) batteries

  it costs less is insufficient

1

[8]

Q16.

(a) 400 000

*allow **1** mark for correct substitution ie*

$\frac{25000}{?} = \frac{800}{12800}$

or

$\frac{25}{?} = \frac{800}{12800}$

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2

(b) (i) any **one** from:

*do **not** accept any response in terms of heat insulation, safety or electric shock*

- (so that there is) no short circuit
- (so that the) current goes around the coil

*do **not** accept electricity for current*

- (so that the) current does not enter the core

1

(ii) (easily) magnetised (and demagnetised)

accept '(it's) magnetic'
*do **not** accept 'because it's a conductor'*

1

(iii) alternating current in the primary (coil)

1

produces a changing magnetic field (in the core)

1

this induces an (alternating) potential difference across the secondary (coil)

1

(c) any **two** from:

- if the (local) power station breaks down / fails / demand / load exceeds supply
- electricity / power can be switched from elsewhere in the system / from other power station(s)
- electricity can be generated in places remote from customers
- (in total) fewer power stations are needed
- power available in rural / remote areas
- National Grid allows for (better) control of supply and demand

2

[9]

Q17.

(a) which causes the magnet to turn / spin / rotate

1

(magnetic) field / lines of force / flux rotate(s) / move(s) / through / in / cut(s) the coil

*do **not** credit the idea that movement 'creates' the magnetic field*

1

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potential difference / p.d. / voltage induced across the coil

*do **not** credit just 'current induced'*

1

(b) any **one** from:

- more powerful / stronger / lighter magnet

  *do **not** credit 'a bigger magnet'*
- larger / more / bigger / lighter cups / with a bigger surface area
- longer arms
- lubricate the spindle
- add more turns to the coil

1

[4]

Q18.

(a) aluminium cannot be magnetised

accept aluminium is not magnetic
"it" refers to aluminium
*do **not** accept aluminium is not easily magnetised*
reference to conduction and aluminium negates mark
iron can be magnetised is insufficient

1

(b) (i) 10 to 50

either order

1

(ii) (data is) anomalous

*accept does **not** fit the pattern*
it is an error is insufficient

1

(iii) 21

accept 22
*do **not** accept any fraction of a turn ie 20.1*

1

secondary p.d. (just) larger than primary p.d.

accept output (just) larger than input/2V

or

there must be more turns on the secondary coil than primary coil

*do **not** accept coil for turns*

1

(c) to reduce/step-down the (input) p.d./voltage

mains p.d. is too high is insufficient
step-down transformer is insufficient

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*answers in terms of changing/ stepping-up current **or** fuse blowing **or** not working with 230 volts are insufficient*
any mention of step-up negates mark
*stepping down both voltage/p.d. **and** current negates mark*

1

[6]

Q19.

(a) (i) step-up

both parts required

more turns on the secondary / output (coil)

*do **not** accept coils for turns*
'secondary output is greater than primary input' is insufficient

1

(ii) (easily) magnetised (and demagnetised)

accept (it's) magnetic
it's a conductor negates answer

1

(b) 60

*allow **1** mark for correct substitution, ie* $\frac{230}{15} = \frac{720}{N_s}$

2

[4]

Q20.

(a) iron

accept any unambiguous correct indication

1

(b) (i) step-down (transformer)

*do **not** accept down step or a description*

1

(ii) less than

accept any unambiguous correct indication

1

(c) (i) 2000

1

(ii) There is no pattern.

1

[5]

Q21.

(a) 10

*allow **1** mark for correct substitution ie* $\frac{230}{V_s} = \frac{4600}{200}$

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2

(b) any **one** from:

- to prevent short circuiting
- to ensure that the current flows / goes round the coil
- to prevent the current entering the core

*do **not** accept electrocution*
*do **not** accept electricity for current*
answers including heat / energy loss negate mark

1

(c) (i) (soft) iron

*do **not** accept 'steel'*

1

(ii) can be magnetised

because it is magnetic

answers including it's a conductor negate mark

1

[5]

Q22.

(a) 400 000

*allow **1** mark for correct substitution ie*

$$\frac{25000}{?} = \frac{800}{12800}$$

or

$$\frac{25}{?} = \frac{800}{12800}$$

2

volt(s) / V

*an answer 400 gains **2** marks*
*an answer 400 kilovolts / kV gains **3** marks*
*although the unit mark is independent to gain **3** marks it must be consistent with the numerical value*

1

(b) any **one** from:

*do **not** accept any response in terms of heat insulation, safety or electric shock*

- (so that there is) no short circuit
- (so that the) current goes round the coil

*do **not** accept electricity for current*

- (so that the) current does not enter the core

1

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(c) (the alternating p.d. in the primary causes) an (alternating) current in the primary

reference to the current in the core negates this mark

1

(causes an) <u>alternating / changing</u> (magnetic) field in the (iron) core

1

<u>induces</u> (alternating) p.d. across the <u>secondary</u> (coil)

accept in / through or similar for across

accept current for p.d.

accept output (coil) for secondary (coil)

*to gain **3** marks the sequence must be correct*

1

[7]

Q23.

(a) (i) (laminated soft) iron

*do **not** accept steel*

1

(ii) produces a <u>magnetic field</u>

accept <u>magnetic flux</u>

which is alternating / changing / varying

and which induces / produces an alternating / changing potential difference across the <u>secondary</u> coil

accept current / voltage

3

(b) 3067 (V)

*allow all **3** marks for 3060 to 3070 (V)*

$V = \frac{230 \times 4000}{300}$ *gains **2** marks*

$\frac{230}{V} = \frac{300}{4000}$ *gains **1** mark*

3

[7]

Q24.

(a) (i) iron

1

(ii) step-down (transformer)

1

(b) any **one** from:

- after the power station
- after the generator

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- before the power lines
- before the pylons

1

(c) each correct (1)

in its correct place

current

coil

field

core

ends

5

[8]

Q25.

(a) (it is) magnetic

or *will carry (an alternating) magnetic field*

or *magnetises and demagnetises (easily)*

reference to conduction negates the mark

1

(b) so the current / electricity does not flow through the iron / core

accept 'so the current / electricity / wires do not short (circuit)'

responses in terms of heat insulation negate the mark

ignore references to safety

1

(c) 5.75 or 5.8 or 6(.0)

*allow for **1** mark **either***

$$\frac{230}{p.d.} = \frac{20\,000}{500}$$

or

p.d. = 230 ÷ 40

2

V / volt(s)

1

[5]

Q26.

(a) (i) (quickly) becomes magnetized

or *(quickly) loses its magnetism*

or *'it's (a) magnetic (material)'*

any reference to conduction of electricity/heat nullifies the mark

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1

(ii) any **four** from:

- insulation prevents electricity/current flowing through the iron/core
  or *'insulation so electricity/current only flows in the wires/turns/coils'*
- <u>alternating</u> current/a.c. in the primary (coil)
- produces a <u>changing</u> magnetic field (in the iron/core)
- (and hence magnetic) field in the secondary (coil)
- induces/generates/produces an <u>alternating</u> potential difference/p.d./voltage across the secondary (coil)
- (and hence) <u>alternating</u> current/a.c. in the secondary (coil)

4

(b) 80 (turns)

or *credit (1) for any equation which <u>if correctly evaluated</u> would give 80 example*

example

$$\frac{230}{5.75} = \frac{3200}{number\ of\ turns}$$

2

[7]

Q27.

(a) (i) secondary(coil) / output (coil)

*do **not** accept just coil*

1

(ii) <u>core</u>

*do **not** accept for either mark it is made out of iron ore*

1

(laminated soft) <u>iron</u>

*allow **1** mark for 'it is made out of iron core'*

1

(iii) magnetic field

accept magnetism / magnetic force

1

(which is) changing / alternating

direction (of field) changes / strength (of field) varies

scoring second mark is dependent on first mark

1

(b) ...step-up .... step-down ...

both in the correct order

1

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(c) Do not build new houses ....

1

Build new power lines away ....

*deduct **1** mark for any other(s) to a minimum total of (0)*

1

[8]

Q28.

(a) (i) step-down (transformer) because fewer turns on the output/secondary (coil)

no credit for just 'step-down transformer'

accept '…less turns…'
*do **not** credit '…fewer coils…'*

***or** 'the p.d. across the input / primary will be greater than the p.d. across the output / secondary'*

1

(ii) to prevent a short (circuit)(through the turns of wire or through the core

*do **not** credit references to safety **or** heat (insulation)*

1

(iii) (easily) magnetised (and demagnetised)

accept '(it's) magnetic'
*do **not** accept 'because it's a conductor'*

1

(b) 2250

correct substitution

eg $\frac{150}{p.d.across secondary} = \frac{500}{7500}$ *gains **1** mark*

***or** appropriate transformation*

eg (p.d. across secondary =) $\frac{number of turns on secondary}{number of turns on primary}$
*× p.d. across primary gains **1** mark*

2

(c) any **two** from:

- <u>to reduce the voltage</u> / p.d. (of the domestic supply)

  ***or** to reduce to 230 V*
  allow 'to reduce to 240 V'
  *do **not** credit 'reduce <u>current</u> to 230V'*

- higher voltage difficult to insulate

- higher voltage (would) result in (fatal) electric shock

  ***not** just 'less dangerous'*

- domestic appliances are not designed for (very) high voltage (input) / (are designed) for 230V

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*do **not** credit 'to increase efficiency' / 'to save energy' do **not** credit just 'it's safer'*

2

(d) any **two** (1) each

- if the (local) power station breaks down / fails / demand / load exceeds supply

1

or words to that effect

- electricity / power can be switched from elsewhere in the system / from other power station(s)

***or** words to that effect*

- electricity can be generated in places remote from customers

***or** words to that effect*

- (in total) fewer power stations are needed
- power available in rural / remote areas
- National Grid allows for (better) control of supply and demand

*do **not** credit just cheaper / more efficient / safer*

1

[9]

Q29.

(a) step-down (transformer)

1

(b) alternating current

accept minor misspellings but
*do **not** credit 'alternative current'*

1

(c) (i)(ii) magnet

attracts

upwards

correct order essential
accept 'up'

3

[5]

Q30.

(a) 10 500

*allow **1** mark for 75 × 32 200 ÷ 230*

2

(b) any **three** from:

- alternating current (a.c.) in the primary (coil)

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- produces a **changing** magnetic field / flux (in the core)
- which is made of (laminated soft) iron
- this induces

  must be idea of inducing something in the secondary coil
- an alternating potential difference across the secondary coil

  accept voltage for potential difference

3

[5]

Q31.

60

*allow **1** mark for correct transformation*

2

[2]

Q32.

(a) (i) **one** of the following:

- increase number of turns on the secondary coil
- decrease number of turns on the primary coil

1

(ii) constructed in (thin) layers

1

(b) (i) transformers only work with a c

1

(ii) used to increase **or** decrease **or** change voltage **or** current

reducing the energy **or** heat **or** power loss (along the cables)

1

or reduce to safe domestic level

must be consistent with first answer

1

(iii) (several metres of) air gives good electrical insulation (between cables and earth)
or reduce chance of earthing **or** sparks **or** arcing
or to avoid people touching it

1

(c) (i) $\frac{\text{voltage across primary}}{\text{voltage across secondary}} = \frac{\text{no of turns in primary}}{\text{no of turns in secondary}}$

accept $\frac{VP}{VS} = \frac{NP}{NS}$

or $\frac{Vin}{Vout} = \frac{Nin}{Nout}$

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1

(ii) Np = 4000

$$\frac{25(000)}{275(000)} = \frac{NP}{44000}$$ *for **1** mark*

2

(d) (i) resistance of cable decreases

1

(ii) convection (to the air)
or
conduction (to the air)
not radiation

1

[11]

Q33.

(a) (i) Iron

for 1 mark

1

(ii) V/240 = 2000/10 000
V = 48
V

for 1 mark each

3

(b) changing current in primary causes changing (magnetic) field in core links to secondary inducing voltage (emf) in secondary (**NOT** current) secondary voltage/current is alternating

for 1 mark each

4

(c) magnetic field not changing/no electromagnetic induction because direct current

for 1 mark each

2

[10]

Q34.

(i) iron

for 1 mark

1

(ii) 20

gains 2 marks

else working

gains 1 mark

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2

(iii) reverse input/output

for 1 mark

or increase secondary turns

1

[4]

Q35.

(a) output voltage less than (the) input voltage

*or p.d. across output less that p.d. across input **or** output is (only) 4.2 V (whereas) the input is 230V*
or WTTE (words to that effect)

1

(b) any **two** from

(made of soft) iron

laminated

***or** designed to reduce eddy currents*
***or** made of thin slices with slices of insulating material between them*

core(s) joined to make a ring

2

[3]

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