

# GCSE PHYSICS

Topic Paper: 7.2 & 7.3 The motor effect, induced potential, transformers,  
national grid (Higher tier physics)  
Part 1, 2 & 3 Mark Scheme

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## MARK SCHEME



**126 Marks**



**M1.** (a) output voltage less than (the) input voltage  
*or p.d. across output less than 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]

**M2.**

*each mark may be gained from a written description or from a caption on the diagram or from both together but do not credit if there is any contradiction between them*

one coil on each side

1

of insulated wire  
*or insulated coil*

1

number of turns on primary coil/coil 1/input coil greater than number of turns on the secondary coil/coil 2/output coil  
*this must be clear for example do not credit more coils do not credit bigger coil*

1

core of laminated iron  
*or core of (soft) iron*

1

[4]

**M3.** (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]

**M4.** (i) away from magnet

*arrow should be perpendicular to field lines and current as judged by eye*

1

(ii) current in wire creates magnetic field around wire

1

two fields interact **or** combine giving a resultant force (on the wire)

1

[3]

**M5.** (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**  $\frac{Vin}{Vout} = \frac{Nin}{Nout}$

1

- (ii)  $N_p = 4000$

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

2

- (d) (i) resistance of cable decreases

1

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

1

[11]



**M6.** (i)  $\frac{\text{voltage across primary}}{\text{voltage across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$

*accept input for primary  
accept output for secondary*

*accept  $\frac{V_p}{V_s} = \frac{N_p}{N_s}$  accept  $\frac{V_1}{V_2} = \frac{N_1}{N_2}$  or correct transposition*

1

(ii) 60

*allow 1 mark for correct transformation*

2

[3]

**M7.** (a) 10 500

*allow 1 mark for  $75 \times 32\ 200 \div 230$*

2

(b) any **three** from:

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

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]

**M8.** (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 =)  $\frac{\text{number of turns on secondary}}{\text{number of turns on primary}}$

*x p.d. across primary gains 1 mark*

2

- (c) any **two** from:

to reduce the voltage / p.d. (of the domestic supply)

*or to reduce to 230 V*

*allow 'to reduce to 240 V'*

*do not credit 'reduce current 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

*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]

**M9.** (a) an alternating input / current to primary (coil)

1

which produces an alternating magnetic field

*accept changing magnetic field for alternating magnetic field*

*if first mark point scores then 'alternating' not required here*

1

in the (iron) core

this magnetic field links with the secondary coil

1

which induces an (alternating) voltage / p.d. across the secondary (coil)

1

(b) 0.21

*accept 0.2 or any answer that rounds to 0.21*

*allow 1 mark for correct equation*

*ie power input = power output*

**or**

*allow 1 mark for substitution into correct equation*

*ie  $230 \times I_p = 12 \times 4$*

2

[7]



- M10.** (a) motor (effect) 1
- (b) (i) wire kicks further (forward)  
*accept moves for kicks*  
*accept moves more*  
*accept 'force (on the wire) increased'* 1
- (ii) wire kicks back(wards) / into (the space in) the (horseshoe) magnet  
*accept moves for kicks*  
*accept 'direction of force reversed'* 1
- [3]**
- 
- M11.** (a) (i) (laminated soft) iron  
*do **not** accept steel* 1
- (ii) produces a magnetic field  
*accept magnetic flux*  
 which is alternating / changing / varying  
 and which induces / produces an alternating / changing potential  
 difference across the secondary coil  
*accept current / voltage* 3
- (b) 3067 (V)  
*allow all 3 marks for 3060 to 3070 (V)*  

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

$$\frac{230}{V} = \frac{300}{4000} \text{ gains 1 mark}$$
 3
- [7]**
- 
- M12.** (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

(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) alternating / changing (magnetic) field in the (iron) core

1

induces (alternating) p.d. across the secondary (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]

**M13.**

(a) (i) current produces a magnetic field (around XY)

*accept current (in XY) is perpendicular to the (permanent) magnetic field*

1

(creating) a force (acting) on XY / wire / upwards

*reference to Fleming's left hand rule is insufficient*

1

(ii) motor (effect)

1

(iii) vibrate / move up and down

1



5 times a second

*only scores if first mark point scores*

*allow for 1 mark only an answer 'changes direction 5 times a second'*

1

(b) 0.005

*allow 1 mark for calculating moment of the weight as 0.04 (Ncm) and*

*allow 1 mark for correctly stating principle of moments*

**or**

*allow 2 marks for correct substitution*

*ie  $F \times 8 = 2 \times 0.02$  or  $F \times 8 = 0.04$*

3

[8]

**M14.** (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]

**M15.** (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

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]

**M16.** (a) 400 000

*allow 1 mark for correct substitution ie*

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

**or**

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

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]

**M17.** (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

(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  $230 \times I_p = \text{their (b)(i)} \times 3.45$

*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) (switch mode transformers) use (very) little power / current / energy when switched on but no load is applied

*accept no for little*

*ignore it is more portable*

*do **not** accept electricity for power / current / energy*

**or**

it is more efficient

*accept does not get as hot **or** less heat produced*

1

- (d) 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

[9]

- M18.** (a) centripetal (force)

*allow tension (between astronaut and seatbelt)*

1

towards the centre (of the G-machine / circle)

*do **not** accept towards the centre of the Earth*

*allow inwards*

1

- (b) (i) the greater the speed (of a centrifuge), the greater the force

*answers must be comparative*

*accept velocity for speed*

*accept positive correlation between speed and force*

*speed and force are not proportional – treat as neutral*

1

the smaller the radius, the greater the force (at a given speed)

*allow (**G machine**) 1 has / produces a greater force (than*

***G machine 2**) at the same speed*

*must be comparative, eg a small radius produces a large force = 0*

*marks on own*

1



as the speed increases the rate of change in force increases

*accept force is proportional to the square of the speed*

**or**

*doubling speed, quadruples the force*

*accept any clearly correct conclusion*

1

(ii) 12000 (N)

**or**

12 k(N)

1

(c) (i) the current (in the coil) creates a magnetic field (around the coil)

*accept the coil is an electromagnet*

1

so the magnetic field of the coil interacts with the (permanent) magnetic field of the magnets (producing a force)

*accept the two magnetic fields interact (producing a force)*

*if no marks scored an answer in terms of current is perpendicular to the (permanent) magnetic field is worth max 1 mark*

1

(ii) vertically downwards arrow on side A

*one arrow insufficient*

**and**

vertically upwards arrow on side C

1

(iii) the current is parallel to the magnetic field

*allow the current and magnetic field are in the same direction*

*allow it / the wire is parallel to the magnetic field*

1

(d) increase the current / p.d. (of the coil)

*accept decrease resistance*

*accept voltage for p.d.*

*accept increase strength of magnetic field / electromagnet*

1



- (e) yes with suitable reason  
**or**  
 no with suitable reason

**eg**

**yes** – *it has increased our knowledge*

**yes** – *It has led to more (rapid) developments / discoveries (in technology / materials / transport) accept specific examples*

**no** – *the money would have been better spent elsewhere on such things as hospitals (must quote where, other things not enough)*

**no mark for just yes / no**

*reason must match yes / no*

1

[12]

- M19.** (a) hydraulic (system)

1

- (b)  $15.40 \times 10^2$   
**or**  
 1540

*allow 1 mark for correct substitution, ie*

$$8.75 \times 10^4 = \frac{F}{1.76 \times 10^{-2}}$$

**or**

$$87\,500 = \frac{F}{0.0176}$$

**or**

$$F = 8.75 \times 10^4 \times 1.76 \times 10^{-2}$$

**or**

$$F = 87\,500 \times 0.0176$$

2

- (c) any **one** environmental **advantage**:

*stating a converse statement is insufficient, or a disadvantage of the usual oil, ie the usual oil is non-renewable*

plant oil is renewable

using plant oil will conserve (limited) supplies **or** extend lifetime of the usual / crude oil.

plant oil releases less carbon dioxide (when it is being produced / processed)

plant oil will add less carbon dioxide to the atmosphere (when it is being produced / processed, than the usual oil)

plant oil removes carbon dioxide from **or** adds oxygen to the air when it is growing

*stating that plant oil is carbon neutral is insufficient*

1

- (d) (the current flowing through the coil) creates a magnetic field (around the coil)

1



(this magnetic field) interacts with the permanent magnetic field  
**or**  
current carrying conductor is in a (permanent) magnetic field  
*it must be clear which magnetic field is which*

1

this produces a (resultant) force (and coil / cone moves)

1

when the direction of the current changes, the direction of the force changes to the opposite direction

*accept for 2 marks the magnetic field of the coil interacts with the permanent magnetic field*

1

[8]