Mark schemes

Q1.

(a) top of each paper clip labelled N / north

both parts required

and

bottom of each paper clip labelled S / south

1

(b) so the paper clips have the same weight / mass

1

which allows the results for different numbers of turns to be compared (fairly)

allow <u>fair test</u>
allow the control variable (is the weight / mass of a paper clip)
allow to obtain valid results
ignore accurate results

1

(c) as the number of turns increases so does the number of paper clips (held)

allow positive correlation

1

in a linear pattern

*directly proportional scores **2** marks*
*allow a correct description of directly proportional for **2** marks*

1

(d) some of the paper clips were already magnetised

1

(e) discount the result of 18

ignore repeat experiment / measurements

1

as the three new results are similar (and not close to 18)

1

and use 15 (the mean of the new results)

allow find the mean of the remaining results (16,14 and 15)

if no other marks have been awarded: calculate the mean (of all four results) (1)

round down to 15 (1) − this mark only scores if the mean of 15.75 has been calculated

1

(f) keep number of turns constant

allow a specific number of turns

1

(use the variable resistor to) change the current (several times)

change the p.d. is insufficient

1

(for each current value) count how many paper clips the electromagnet will hold

1

[12]

Q2.

(a) at least three circles drawn

1

clockwise arrows on circles

*allow **1** mark for one or two circles with clockwise arrows*

1

(b) 4×10^{-6}

1

(c) the sides of the coil (parallel to the magnet) experience a force (in opposite directions)

allow the current creates a magnetic field
ignore Fleming's Left Hand Rule

1

the forces cause moments that act in the same (clockwise / anticlockwise) direction
or
the moments cause the coil to rotate (clockwise / anticlockwise)

allow the magnetic fields interact to create a pair of forces (acting in opposite directions)
or
allow the magnetic fields interact causing the coil to rotate

1

(each half-revolution) the two halves of the (rotating) commutator swap from one (carbon) brush to the other

1

(each half-revolution) the commutator reverses the current (in the coil)
or
keeping the forces in the same direction (keeping the coil rotating)

allow keeps the current in the same direction relative to the (permanent) magnetic field

1

[7]

Q3.

(a) the magnets are not touching

1

but (each) experiences a force

allow but there is a force of attraction between them

1

(b) place a (plotting) compass near the (north / south) pole of

the magnet and mark the direction that the compass points

1

move the (plotting) compass around the bar magnet (to the other pole) marking at (regular) intervals the direction the compass points

1

join the points up and add an arrow pointing from the north pole to the south pole

1

(c) (closing switch S) causes a current in the coil

allow switches on the electromagnet

1

a magnetic field is created

1

a force of attraction acts on the ball bearing

1

so the ball bearing accelerates (towards the iron rod)

1

[9]

Q4.

(a) move a (magnetic / plotting) compass around the wire

1

the changing direction of the compass needle shows a magnetic field has been produced

OR

sprinkle iron filings onto the card (1)

tapping the card will move the filings to show the magnetic field (pattern) (1)

1

(b) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that explain how the ignition circuit works.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content

- closing the (ignition) switch causes a current to pass through the electromagnet
- the iron core (of the electromagnet) becomes magnetised
- the electromagnet / iron core attracts the (short side of the) iron arm
- the iron arm pushes the (starter motor) contacts (inside the electromagnetic switch) together

- the starter motor circuit is complete
- a current flows through the starter motor (which then turns)

4

[6]

Q5.

(a) move a (magnetic / plotting) compass around the wire

1

the changing direction of the compass needle shows a magnetic field has been produced

OR

sprinkle iron filings onto the card (1)

tapping the card will move the filings to show the magnetic field (pattern) (1)

1

(b) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that explain how the ignition circuit works.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content

Indicative content

- closing the (ignition) switch causes a current to pass through the electromagnet
- the iron core (of the electromagnet) becomes magnetised
- the electromagnet / iron core attracts the (short side of the) iron arm
- the iron arm pushes the contacts (inside the electromagnetic switch) together
- the starter motor circuit is complete
- a current flows through the starter motor (which then turns)

4

[6]

Q6.

(a) motor effect

1

(b) increase the strength of the magnet

or

increase the current

1

(c) $4.8 \times 10^{-4} = F \times 8 \times 10^{-2}$

1

$F = 6 \times 10^{-3}$ (N)

1

$6 \times 10^{-3} = B \times 1.5 \times 5 \times 10^{-2}$

1

$B = \frac{6 \times 10^{-3}}{7.5 \times 10^{-2}}$

1

$B = 8 \times 10^{-2}$ or 0.08

1

*allow 8×10^{-2} **or** 0.08 with no working shown for **5** marks*
*a correct method with correct calculation using an incorrect value of F gains **3** marks*

Tesla

accept T

1

do not accept t

[8]

Q8.

(a) field

correct order only

1

current

1

force

accept motion
accept thrust

1

(b) (i) arrow pointing vertically downwards

1

(ii) increase current / p.d.

accept voltage for p.d.

1

increase strength of magnetic field

accept move poles closer together

1

(iii) reverse (poles of) magnets

1

reverse battery / current

1

(c) (i) 1.5 or 150%

efficiency = 120 / 80 (× 100)
*gains **1** mark*
an answer of 1.5 % or 150

*gains **1** mark*

2

(ii) efficiency greater than 100%
or
output is greater than input
or
output should be 40 (W)

1

(iii) recorded time much shorter than actual time
accept timer started too late
accept timer stopped too soon

1

[12]

Q9.

(a) motor

1

(b) increase the strength of the magnetic field
accept use a stronger magnet
use a larger / bigger magnet is insufficient
*do **not** accept move magnets closer*

1

increase the (size of the) current
accept use a current greater than 2 (A)
accept increase the p.d. / voltage (of the power supply)
increase the power supply is insufficient

1

(c) any **one** from:
- (reverse the) direction of the current
accept swap the wires at the power supply connections
swap the wires around is insufficient
- (change the) direction of the magnetic field
accept turn the magnet around
*do **not** accept use an a.c. supply*

1

(d) The wire is parallel to the direction of the magnetic field.

1

[5]

Q10.

(a) (i) (closing the switch makes) a current (through the wire)

1

(the current flowing) creates a magnetic field (around the wire)

1

this field interacts with the permanent magnetic field
accept links / crosses attracts / repels is insufficient

1

(ii) arrow drawn showing upwards force on XY

judge vertical by eye the arrow must be on or close to the wire XY

1

(iii) motor

accept catapult

1

(b) (i) the wire moves up and down
or
the wire vibrates

back and forth or side to side is insufficient for vibrate

1

(ii) the force (continually) changes direction (from upwards to downwards, on the wire)

accept the direction of the magnetic field (of the wire) changes

1

[7]

Q11.

(a) hydraulic (system)

1

(b) 15.40×10^2
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]

Q12.

(a) north (pole)

accept N

north (pole)

both needed for mark

1

(b) reverses

accept changes direction

1

(c) (i) first finger:
(direction of) (magnetic) field

1

second finger:
(direction of) (conventional) current

1

(ii) into (plane of the) paper

1

(iii) less current in wire

accept less current / voltage / more resistance / thinner wire

1

weaker field

allow weaker magnets / magnets further apart
*do **not** accept smaller magnets*

1

rotation of magnets (so) field is no longer perpendicular to wire

1

(d) (i) reverse one of the magnets
*do **not** accept there are no numbers on the scale*

1

(ii) systematic or zero error
accept all current values will be too big
accept it does not return to zero
accept it does not start at zero

1

[10]

Q13.

(a) (i) 9000
*an answer of 9 k(N) gains **1** mark*

1

(ii) increase
accept other comparative terms, eg give a bigger
affect / change is insufficient

1

(iii) smaller
accept other comparative terms, eg less

1

(b) Q N M
all three in correct boxes
*one statement in correct box gains **1** mark*

2

(c) any **two** from:

- increase the current / p.d. (supplied to the coil)
*accept reduce the resistance of the coil **or** increase cross sectional area of wire*
*accept more cells / batteries **or** turn up the power supply*
increase power is insufficient
- increase number of turns (on the coil)
- increase the area (of the coil)
accept increase the width of the coil
increase width / size is insufficient
- increase the (strength of the permanent) magnetic field
accept move the magnets closer to the coil
accept use stronger magnets

*do **not** accept use larger magnets*

2

(d) an economic

1

[8]

Q14.

(a) (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

(b) (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

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

accept decrease resistance

accept voltage for p.d.

accept increase strength of magnetic field / electromagnet

1

(d) 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

[10]

Q15.

(a) a force

1

(b) any **two** from:

- more powerful magnet

  *do **not** allow 'bigger magnet'*

- reduce the gap (between magnet and coil)

- increase the area of the coil

- more powerful cell

  *do **not** allow 'bigger cell'*

  accept battery for cell

  accept add a cell

  accept increase current / potential difference

- more turns (on the coil)

  allow 'more coils on the coil'

  *do **not** allow 'bigger coil'*

2

(c) reverse the (polarity) of the cell

allow 'turn the cell the other way round'

accept battery for cell

1

reverse the (polarity) of the magnet

allow 'turn the magnet the other way up'

1

[5]

Q16.

(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 × 8 = 2 × 0.02 **or** F × 8 = 0.04*

3

[8]

Q17.

(a) (i) an electric motor

1

(ii) force

1

(b) any **two** from:

- more powerful magnet

*do **not** allow 'bigger magnet'*

- reduce the gap (between magnet and coil)
- increase the area of the coil
- more powerful cell

  *do **not** allow 'bigger cell'*
  accept battery for cell
  accept add a cell
  accept increase current / potential difference
- more turns (on the coil)

  allow 'more coils on the coil'
  *do **not** allow 'bigger coil'*

2

(c) reverse the (polarity) of the cell

allow 'turn the cell the other way round'
accept battery for cell

1

reverse the (polarity) of the magnet

allow 'turn the magnet the other way up'

1

[6]

Q18.

(a) (i) an electrical conductor

1

(ii) increase current

accept increase p.d. / voltage

or

use stronger magnets

accept move magnets closer
*do **not** accept use larger magnets*

1

(iii) reverse the poles / ends (of the magnet)

either order

1

reverse the connections (to the power supply)

1

(b) (i) environmental

1

(ii) ethical

allow political (instability)
allow economic (migration)

1

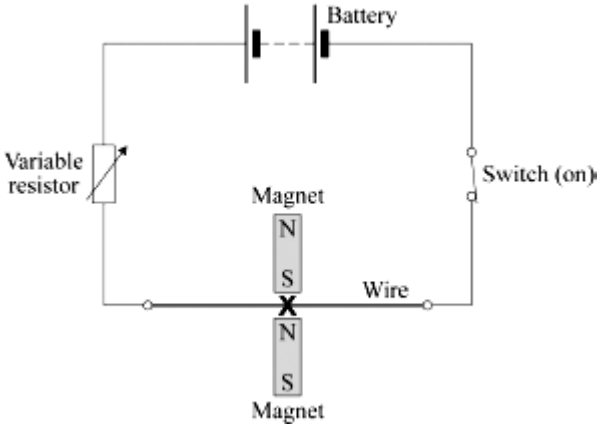
[6]

Q19.

(a) centre of the **X** midway between the poles

intention correct as judged by eye

example



1

(b) move the poles further apart

accept turn for move

accept ends / magnets for poles

accept use weaker magnets

*do **not** accept use smaller magnets*

1

(c) (i) add more cells (to the battery)

*do **not** accept 'use a bigger battery'*

accept increase the potential difference / voltage

accept increase the current

or

reduce the resistance (of the variable resistor)

*do **not** accept any changes to the magnets, to the wire or to their relative positions*

1

(ii) reverse (the polarity of) the battery

accept turn the battery / cells round

accept swap the connections to the battery

*do **not** accept any changes to the magnets, to the wire or to their relative positions*

1

[4]

Q20.

(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]

Q21.

(a) electric drill, electric fan, electric food mixer and electric screwdriver

all four ticked and no others (2)

***either** all four of these ticked and only one other (1)*

***or** any three of these ticked and none/one/two of the others (1)*

2

(b) (i) reverse (the direction of the) current (1)

***or** reverse the connections (to the battery)*

reverse (the direction of the) magnetic field (1)

***or** reverse the (magnetic) poles /ends*

*do **not** credit 'swap the magnets (around)'*

2

(ii) any **two** from:

- increase the strength of the magnet(s)/(magnetic) field

  *do **not** credit 'use a bigger magnet'*

- increase the current

  allow 'increase the voltage/p.d.'
  allow add cells/batteries
  allow increase the (electrical) energy
  allow increase the power supply
  allow 'decrease the resistance'
  allow 'increase charge'
  allow ' increase the electricity'

  *do **not** credit 'use a bigger battery'*

- reduce the gap (between coil/armature and poles/magnets)

  allow increase the (number of) coils

- increase the turns (on the coil/armature)

  *do **not** credit 'use a bigger coil'*

2

[6]

Q22.

(a) increase the current (1)

credit increase the p.d./voltage
credit reduce the resistance

credit have thicker wiring
credit add extra / more cells

1

increase the magnetic field (strength) (1)

credit 'have stronger magnet(s)
*do **not** credit 'bigger magnets' either order*

1

(b) **either** reverse polarity

or connect the battery the other way round

1

either reverse direction of the magnetic field

or put the magnet the other way round / reverse the magnet

*do **not** give any credit to a response in which both are done at the same time*

either order

1

(c) **either**

conductor parallel to the magnetic field

or lines of magnetic force and path of electricity do not cross

1

[5]

Q23.

(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]

Q24.

(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]

Q25.

(a) (i) it moves or experiences a force horizontally to the right

for 1 mark

1

(ii) A – moves in opposite direction or force reversed e.c.f.
B – faster movement or larger force
(**not** move further)

for 1 mark each

2

(b) turns clockwise
oscillates/reverses
comes to rest facing field/at 90° to field/vertically

for 1 mark each

3

(c) number of turns or linear number density of turns current core

for 1 mark each

3

[9]