

Mark schemes

1

- (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]

2

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4

[6]

3

(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

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

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

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

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]

4

- (a) an electromagnet can be switched off

accept a permanent magnet cannot be switched off

or

an electromagnet is stronger

accept control the strength

1

- (b) 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 apply a 'best-fit' approach to the marking.

Level 3 (5 – 6 marks):

there is a description of how the electromagnet is made

and

there is a description of how the strength of the electromagnet can be varied

and

there is a description of how the strength of the electromagnet can be tested

Level 2 (3 – 4 marks):

there is a description of how the electromagnet is made

and either

there is a description of how the strength of the electromagnet can be varied

or

there is a description of how the electromagnet can be tested

Level 1 (1 – 2 marks):

there is a basic description of how to make an electromagnet

or

there is a basic description of how the strength of the electromagnet can be varied

or

there is a basic description of how the electromagnet can be tested

Level 0 (0 marks):

No relevant / correct content

examples of the points made in the response

Details of how to make an electromagnet

- wrap the wire around the nail
- connect the wire to the power supply (with connecting leads and croc clips)
- switch on the power supply

accept a current should be sent along the wire

Details of how to vary the strength of the electromagnet

- change the number of turns (on the coil)
- change the current (through the coil)
- change the separation of the turns

allow change the potential difference (across the coil)

accept wrap the coil more tightly

Details of how to test the electromagnet

- suspend paperclips from the electromagnet
- the more paperclips suspended, the stronger the electromagnet is
- clamp the electromagnet at different distances from the paperclip(s)
- the further the distance from which paperclips can be attracted the stronger the electromagnet is
- test before and after making alterations to change the strength
- compare the results from before and after making alterations
- use de-magnetised paper clips

accept count the number of paperclips

*with different current **or** p.d. **or** no. of turns*

***or** core and see if the number changes/increases*

6

[7]

5

(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. 1
accept voltage for p.d.
- increase strength of magnetic field 1
accept move poles closer together
- (iii) reverse (poles of) magnets 1
- reverse battery / current 1
- (c) (i) 1.5 or 150% 2
efficiency = $120 / 80 (\times 100)$
gains 1 mark
an answer of 1.5 % or 150
gains 1 mark
- (ii) efficiency greater than 100% 1
or
output is greater than input
or
output should be 40 (W)
- (iii) recorded time much shorter than actual time 1
accept timer started too late
accept timer stopped too soon

[12]

- 6** (a) motor 1
- (b) increase the strength of the magnetic field 1
accept use a stronger magnet
use a larger / bigger magnet is insufficient
*do **not** accept move magnets closer*
- increase the (size of the) current 1
accept use a current greater than 2 (A)
accept increase the p.d. / voltage (of the power supply)
increase the power supply is insufficient

- (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]

7

- (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]

8

- (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]

9

- (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]

10

- (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]

11

- (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]

12

(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]

13

(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]

14

(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]

15

- (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

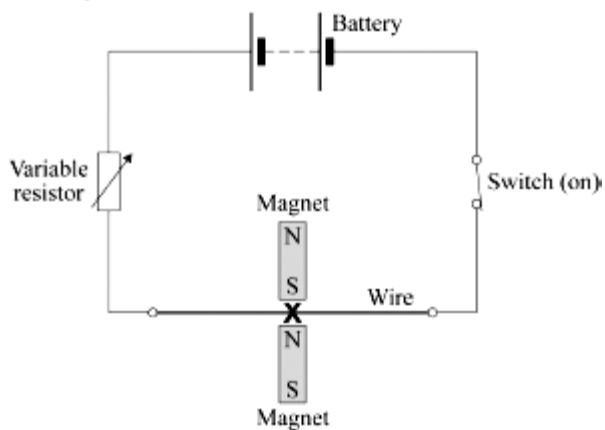
- (ii) ethical
allow political (instability)
allow economic (migration)

1

[6]

16

- (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]

17

(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]

18

(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]

19

- (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]

20

(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]

21

(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]

22

(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]