**Mark schemes**

Q1.

(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]

Q2.

(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]

Q3.

(a) motor effect

1

(b) increase the strength of the magnet

or

increase the current

1

(c) 4.8 × 10−4 = F × 8 × 10−2

1

F = 6 × 10−3 (N)

1

6 × 10−3 = B × 1.5 × 5 × 10−2

1

B =

1

B = 8 × 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]

Q4.

(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]

Q5.

(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]

Q6.

(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]

Q7.

(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]

Q8.

(a) hydraulic (system)

1

(b) 15.40 ×102

or

1540

allow 1 mark for correct substitution, ie

8.75 × 104 =

or

87 500 =

or

F = 8.75 × 104 × 1.76 ×10-2

or

F = 87 500 × 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]

Q9.

(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]

Q10.

(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]

Q11.

(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]

Q12.

(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]

Q13.

(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]

Q14.

(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 cellߣ

accept battery for cell

accept add a cell

accept increase current / potential difference

• more turns (on the coil)

allow ‘more coils on the coilߣ

do not allow ‘bigger coilߣ

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]

Q15.

(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]

Q16.

(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]

Q17.

(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]

Q18.

(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]

Q19.

(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]

Q20.

(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]

Q21.

(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]

Q22.

(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 90o 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]