Motor Effect

Trilogy

Name: _____

Class: _____

Date: _____

Time: **105 minutes**

Marks: **102 marks**

Comments:

Mark schemes

1 (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]

2 (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]

3 (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]

4 (a) velocity is a vector (so has both magnitude and direction)

1

direction is changing (and so velocity is changing)

1

if velocity is changing, there is an acceleration

1

(b) as radius increases, force required decreases

allow converse statements for all marking points

1

as speed increases, force required increases

1

at greater speeds, change in force for same change in speed is greater

allow force proportional to square of speed

1

(c) a conductor carrying a current in magnetic field has a force exerted on it (by the motor effect)

1

(so) force on opposite sides in opposite directions (so the coil turns)

allow current in opposite directions

1

as coil turns, commutator reverses direction of current relative to coil (so rotation can continue)

allow current / force directions in terms of arrows on the diagram
(force directions do not have to be correct from Fleming's LHR to illustrate the point)

1

[9]

5 (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]

6 (a) thumb, index finger and third finger are held mutually at right angles

1

index finger shows the direction of the magnetic field from North to South, third finger shows the direction of the current from positive to negative terminal

1

the thumb then shows the direction of the force acting on the copper rod

1

so the copper rod will move upwards

1

(b) any **one** from:

use a stronger magnet

increase the magnetic flux density

increase the length of the copper rod in the magnetic field

coil the copper rod

1

(c) $W = 9.8 \times 4 \times 10^{-4} = 3.92 \times 10^{-3}$

1

conversion of the length 7cm to 0.07m

1

$3.92 \times 10^{-3} = B \times 1.12 \times 0.07$

1

$B = 3.92 \times 10^{-3} / 0.0784$

1

$B = 0.05$ (T)

1

allow 0.05 (T) without working shown for the ***5*** *calculation marks*

[10]

7 (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]

8 (a) the current creates a magnetic field in the wire

1

which interacts with the magnetic field from the permanent magnet

1

Flemming's left hand rule says the force on the wire is upwards

1

so the force on the permanent magnets is downwards

1

(b) x-axis labelled current **and**
y-axis labelled (magnetic) force

ignore units on labels

1

straight line through the origin

1

(c) $W = mg = 1.2 \times 10^{-3} \times 9.8$

1

$W = 0.01176$

1

$0.01176 = B \times 0.80 \times 4.8 \times 10^{-2}$

1

$$B = \frac{1.2 \times 10^{-3} \times 9.8}{0.8 \times 4.8 \times 10^{-2}}$$

1

$B = 0.31$

*an answer of 0.031 scores **3** marks*
*an answer of 0.31 scores **5** marks*

1

[11]

9 (a) place thumb and first two fingers (of left hand) at right angles to each other

1

first / index finger indicates (direction of) magnetic field

allow forefinger for first/index finger
*do **not** accept electric field*

1

second / middle finger indicates (direction of) current

1

thumb (then) shows (direction of) force

allow motion / thrust

1

*a clearly labelled diagram can score up to **4** marks*

(b) there is a downwards force on the magnets

1

(because when there is a current in the wire) there is a magnetic field around the wire

1

which interacts with the magnetic field of the (permanent) magnets

1

(c) 0.00214 = B × 0.32 × 0.048

this mark may be awarded if F is incorrectly / not converted

1

$$B = \frac{0.00214}{0.32 \times 0.048}$$

this mark may be awarded if F is incorrectly / not converted

1

0.1393 (T)

*an answer that rounds to 0.14 (T) scores **3** marks*

1

0.14 (T)

allow answer consistent with their incorrectly / not converted F to 2 significant figures
allow an answer from an incorrect calculation to 2 significant figures

1

*an answer of 0.14 (T) scores **4** marks*

*an answer of 140 scores **3** marks*

[11]

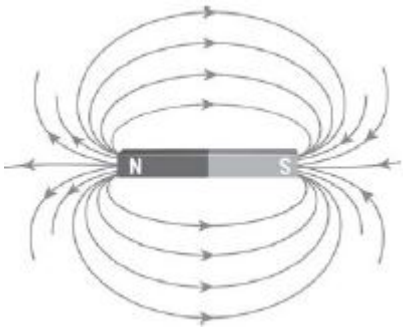
10 (a) continuous field lines that start and finish on the poles

1

direction of arrow from North to South

1

the diagram:



*scores **2** marks*

(b) **Level 2:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- place the magnet on a piece of paper
- draw around the magnet
- mark north and south poles
- place the compass by a pole of the magnet
- make a dot at the tip of the compass needle
- move the compass tail to the new dot
- make a dot at the tip
- repeat until the compass reaches the other pole of the magnet
- draw a line through the dots
- add arrow to show direction of field line (from north to south)
- repeat for different starting positions at the poles

(c) compass needle is a (small bar) magnet

1

(so) the compass / needle and bar magnet exert a force on each other

1

or

(so) the compass / needle is attracted / repelled by the bar magnet

(d) cobalt

1

(e) (magnetic north / south) poles are changing position

allow reference to compass needle changing direction (over time)

1

direction of magnetic field has reversed

allow magnetic patterns in rocks (at constructive plate boundaries)

allow changing migration patterns of birds / animals

1

(f) (molten) iron moving

1

in (Earth's outer) core

1

[13]

11 (a) Fe_2O_3 + 3 CO → 2Fe + 3 CO_2

correct formulae of reactants

1

correct formulae of products

1

correct balancing

1

(b) iron loses oxygen – reduction

1

carbon gains oxygen – oxidation

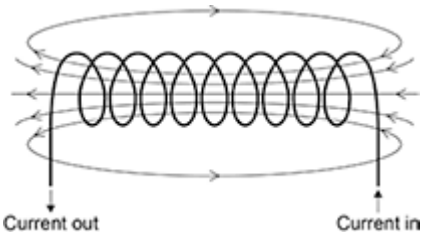
1

(c) any **four** from:

- resources for manufacture are limited
- recycling reduces the use of resources
- reduces energy consumption in extraction / manufacture
- reduces waste from processing and extraction
- reduces environmental impact of extraction

4

(d)



field lines going through and around coil

1

correct directional arrows

1

(e) any **two** from:

***1** mark for suggestion, **1** mark for correctly linked explanation*

- use many coils **or** tight coils **or** long wire (1)
- to give a strong magnetic field for lifting heavy objects (1)

explanation must be correctly linked to the suggestion to gain the mark

or

- add an iron core
- to increase field circuit for lifting

or

- include a switch in circuit
- so can drop / pick up cars

max. 4

[15]