

Q1. (a) **Figure 1** shows a sheet of card.

Figure 1



Describe how to find the centre of mass of this sheet of card.

You may draw diagrams as part of your answer.

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(5)

(b) **Figure 2** shows a person in his wheelchair.

Figure 2



AndreyPopov/iStock/Thinkstock

(i) Tipping the wheelchair at a large angle may cause it to become unstable and to topple over.

Explain why.

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(2)

(ii) Some disabled athletes use a wheelchair in sports.

State **two** ways of changing the design of the wheelchair in **Figure 2** so that it is more stable when used by a disabled athlete.

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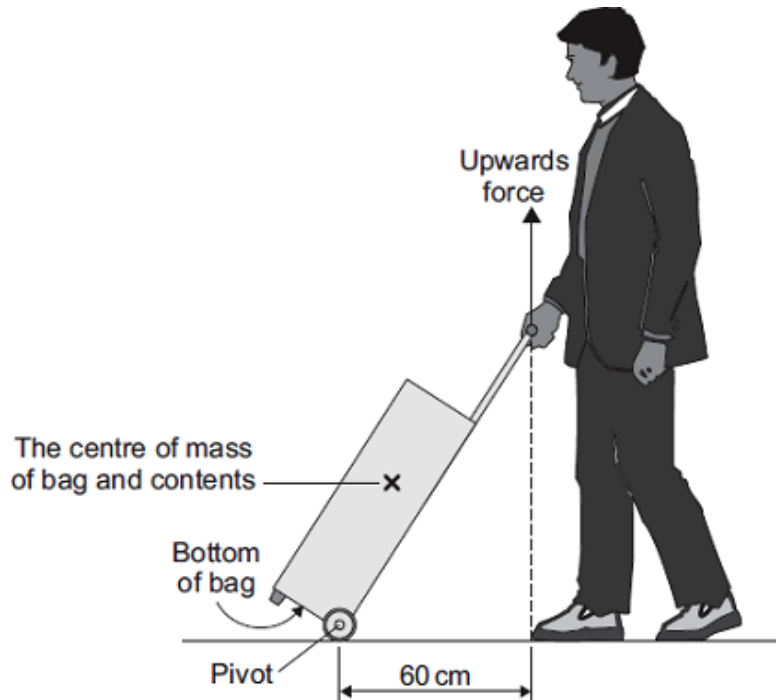
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(2)

(Total 9 marks)

Q2. The diagram shows a man standing in an airport queue with his wheeled bag.



- (a) The man applies an upward force to the handle of his bag to stop the bag from falling. The moment of this force about the pivot is 36 Nm.

Calculate the upward force the man applies to the handle of his bag.

Use the correct equation from the Physics Equations Sheet.

.....

Force = N

(2)

- (b) When the man lets go of the bag handle, the bag falls and hits the floor.

Explain why.

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(2)

- (c) During his holiday the man visits the Foucault Pendulum in Paris, France. The pendulum makes 10 complete swings every 160 seconds.

Calculate the frequency of the pendulum and give the unit.

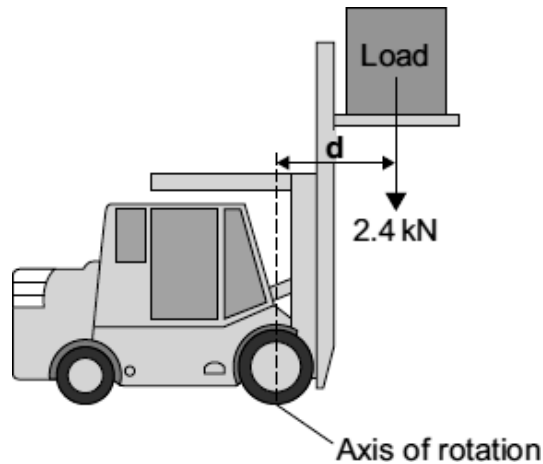
Use the correct equation from the Physics Equations Sheet.

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Frequency =

(3)
 (Total 7 marks)

- Q3.** The diagram shows a fork-lift truck with a load of 2.4 kN. The clockwise moment caused by this load is 2880 Nm.



- (a) Use the equation in the box to calculate the distance **d**.

$\text{moment} = \text{force} \times \text{perpendicular distance from the line of action of the force to the axis of rotation}$
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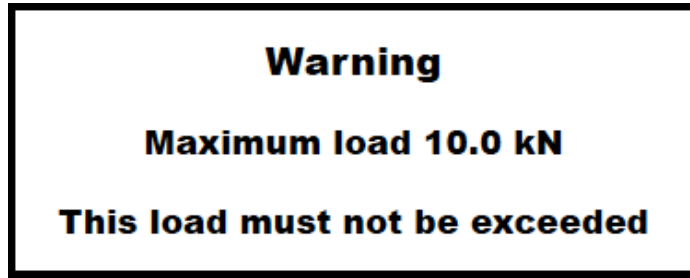
Show clearly how you work out the answer and give the unit.

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Distance **d** =

(3)

(b) This warning notice is in the driver's cab.



Explain in terms of moments why the maximum load must not be exceeded.

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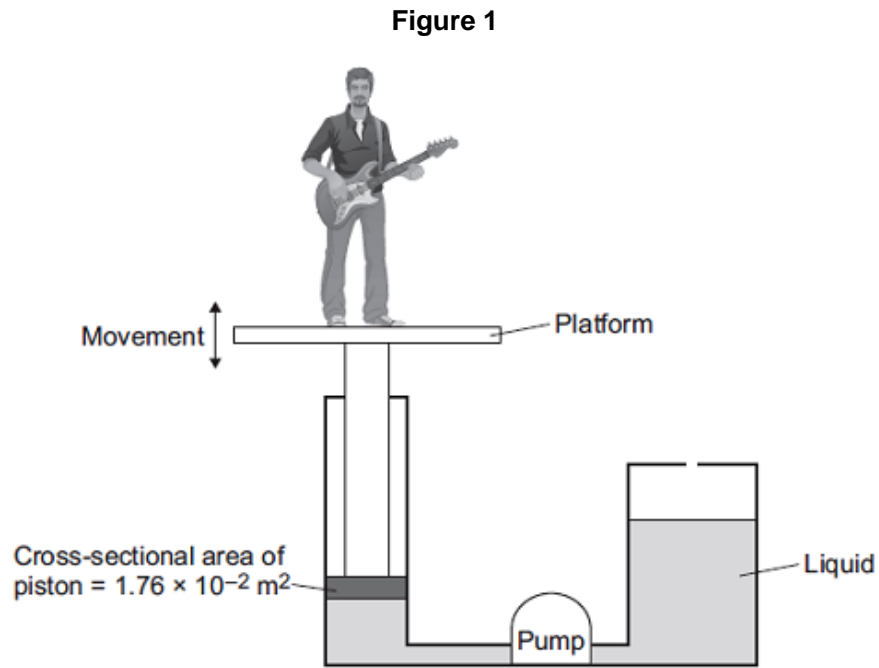
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(2)
(Total 5 marks)

Q4. Musicians sometimes perform on a moving platform.

Figure 1 shows the parts of the lifting machine used to move the platform up and down.



(a) What type of system uses a liquid to transmit a force?

.....

(1)

(b) The pump creates a pressure in the liquid of $8.75 \times 10^4 \text{ Pa}$ to move the platform upwards.

Calculate the force that the liquid applies to the piston.

Use the correct equation from the Physics Equations Sheet.

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Force = N

(2)

(c) The liquid usually used in the machine is made by processing oil from underground wells. A new development is to use plant oil as the liquid.

Extracting plant oil requires less energy than extracting oil from underground wells.

Suggest an environmental advantage of using plant oil.

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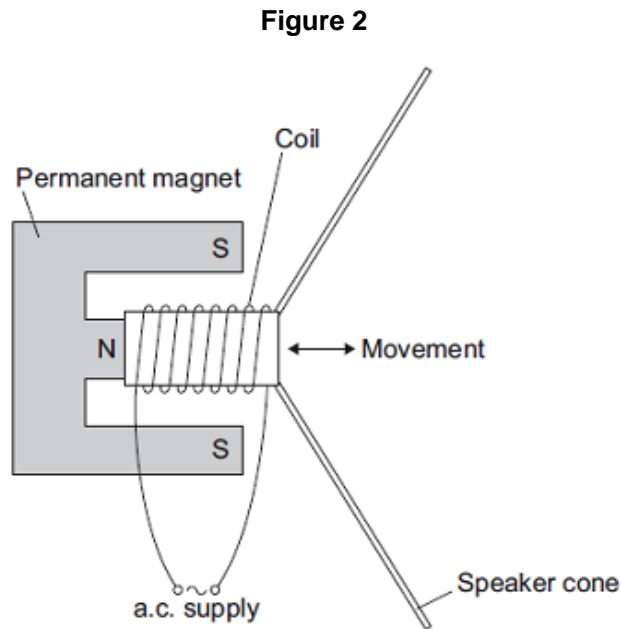
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(1)

(d) Musicians often use loudspeakers.

Figure 2 shows how a loudspeaker is constructed.



The loudspeaker cone vibrates when an alternating current flows through the coil.

Explain why.

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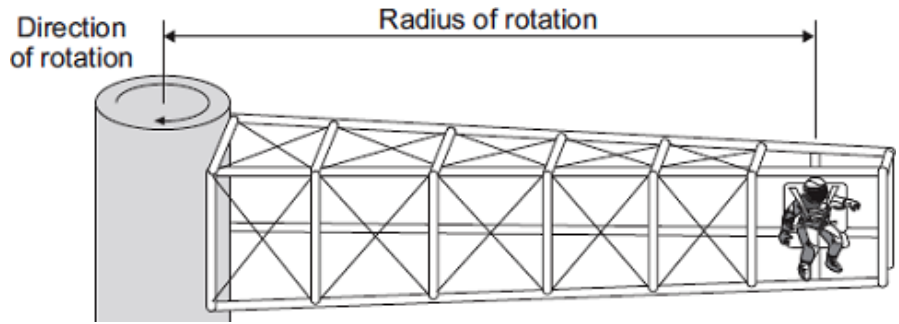
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(4)
(Total 8 marks)

Q5. The diagram shows a 'G-machine'. The G-machine is used in astronaut training.



The G-machine moves the astronaut in a horizontal circle.

(a) When the G-machine is rotating at constant speed, the astronaut is accelerating.

State the name and direction of the force causing the astronaut to accelerate.

Name of force

Direction of force

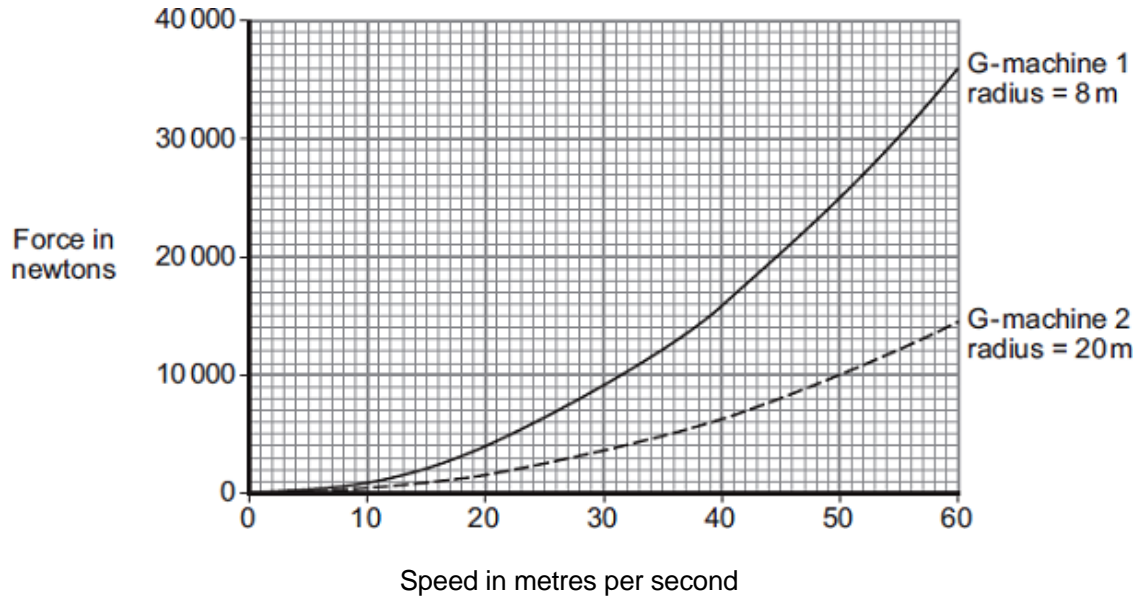
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(2)

(b) The force causing the astronaut to move in a circle is measured.

The graph shows how the speed of the astronaut affects the force causing the astronaut to move in a circle for two different G-machines.

The radius of rotation of the astronaut is different for each G-machine.



(i) State **three** conclusions that can be made from the graph.

- 1
-
- 2
-
- 3
-

(3)

(ii) The speed of rotation of G-machine 1 is increased from 20 m/s to 40 m/s.

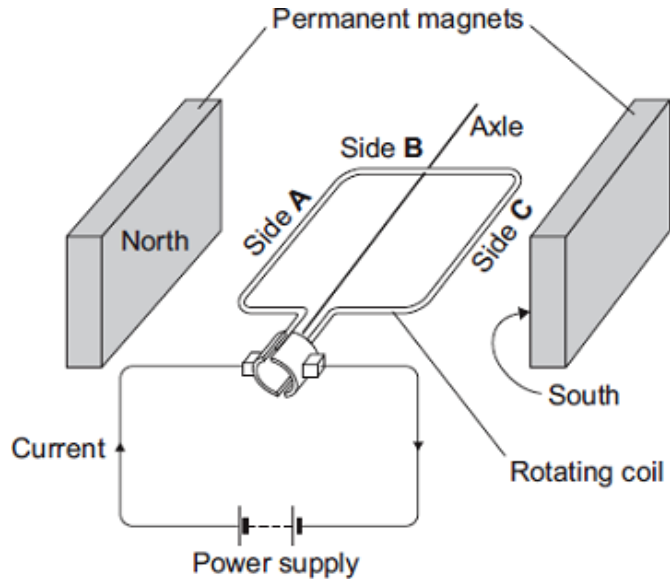
Determine the change in force on the astronaut.

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Change in force = N

(1)

- (c) Each G-machine is rotated by an electric motor. The diagram shows a simple electric motor.



- (i) A current flows through the coil of the motor.

Explain why side **A** of the coil experiences a force.

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(2)

- (ii) Draw arrows on the diagram to show the direction of the forces acting on side **A** of the coil and side **C** of the coil.

(1)

- (iii) When horizontal, side **B** experiences no force.

Give the reason why.

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(1)

- (d) While a G-machine is rotating, the operators want to increase its speed.

What can the operators do to make the G-machine rotate faster?

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(1)

(e) The exploration of space has cost a lot of money.

Do you think spending lots of money on space exploration has been a good thing?

Draw a ring around your answer.

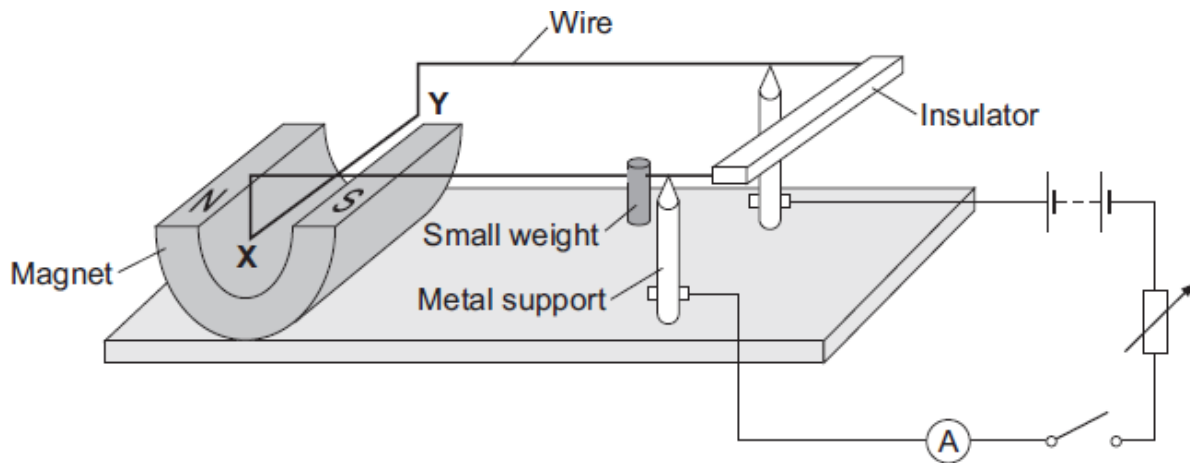
Yes No

Give a reason for your answer.

.....
.....

(1)
(Total 12 marks)

Q6. The diagram shows a device called a current balance.



(a) (i) When the switch is closed, the part of the wire labelled **XY** moves upwards.

Explain why.

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.....
.....
.....

(2)

(ii) What is the name of the effect that causes the wire **XY** to move?

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(1)

- (iii) An alternating current (a.c.) is a current which reverses direction. How many times the current reverses direction in one second depends on the frequency of the alternating supply.

Describe the effect on the wire **XY** if the battery is replaced by an a.c. supply having a frequency of 5 hertz.

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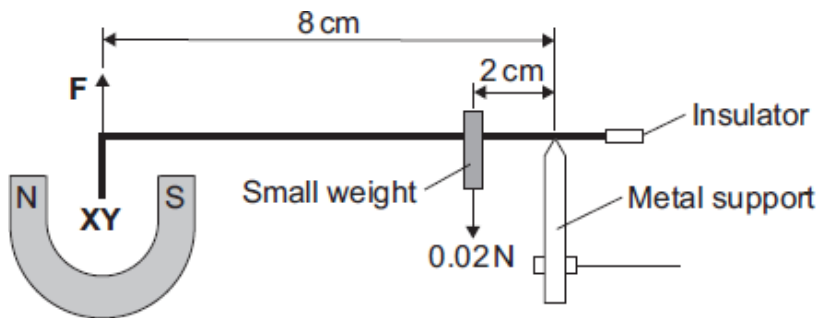
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(2)

- (b) The diagram shows how a small weight can be used to make the wire **XY** balance horizontally.



Side view

Use the data in the diagram and the equation in the box to calculate the force, **F**, acting on the wire **XY**.

$\text{moment} = \text{force} \times \text{perpendicular distance from the line of action of the force to the axis of rotation}$
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Show clearly how you work out your answer.

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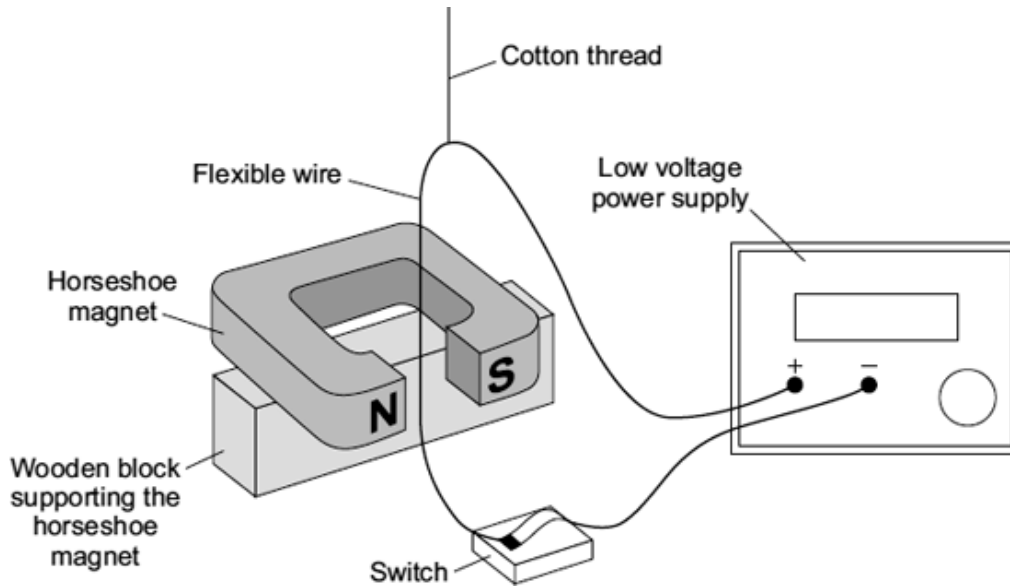
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Force = N

(3)
(Total 8 marks)

Q7. (a) A laboratory technician sets up a demonstration.



A flexible wire is suspended between the ends of a horseshoe magnet. The flexible wire hangs from a cotton thread. When the switch is closed, the wire kicks forward.

Identify the effect which is being demonstrated.

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(1)

(b) A teacher makes some changes to the set-up of the demonstration.

What effect, if any, will each of the following changes have?

(i) more powerful horseshoe magnet is used.

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.....

(1)

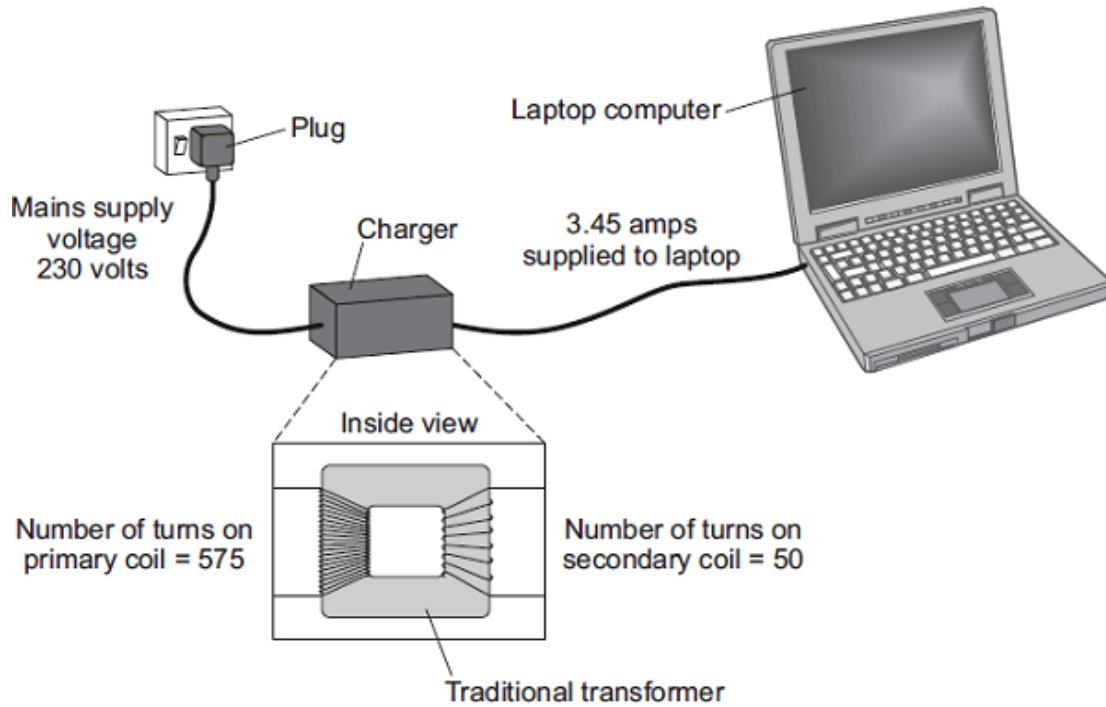
(ii) The connections to the power supply are reversed.

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(1)

(Total 3 marks)

Q8. Batteries inside laptop computers are charged using laptop chargers. The laptop charger contains a traditional transformer.



(a) The alternating current flowing through the primary coil of the transformer creates an alternating current in the secondary coil.

Explain how.

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(3)

- (b) (i) Use information from the diagram to calculate the potential difference the charger supplies to the laptop.

Use the correct equation from the Physics Equations Sheet.

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Potential difference = V

(2)

- (ii) Calculate the current in the primary coil of the transformer when the laptop is being charged.

Assume the transformer is 100% efficient.

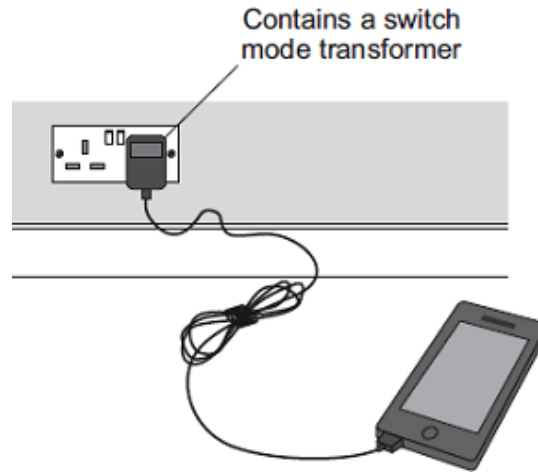
Use the correct equation from the Physics Equations Sheet.

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Current = A

(2)

- (c) Switch mode transformers can be used in mobile phone chargers.



Switch mode transformers and traditional transformers can both use the UK mains supply.

The switch mode transformer is smaller and lighter than the traditional transformer used in the laptop charger.

Give **one** other advantage of the switch mode transformer.

.....
.....

(1)

- (d) Laptop batteries and mobile phone batteries can only be recharged a limited number of times. After this, the batteries cannot store enough charge to be useful. Scientists are developing new batteries that can be recharged many more times than existing batteries.

Suggest **one** other advantage of developing these new batteries.

.....
.....
.....

(1)
(Total 9 marks)

- M1.** (a) suspend shape from a point / pivot / pin
can be shown on labelled diagram 1
- attach pendulum (bob) / plumb line to point of suspension 1
- draw (vertical) line on card where string rests 1
- suspend card from another point and draw (a second vertical) line on card where string rests 1
- where two lines cross = centre of mass
alternative method max 3 marks:
balance card on a point (1)
find point where card rests horizontally (1)
this point is the centre of mass (1) 1
- (b) (i) (the line of action of) the weight acts / lies outside the base
reference to centre of mass unqualified is insufficient 1
- there will be a resultant moment
references to stability insufficient 1
- (ii) move the wheels further apart
answers must be comparative to diagram
accept any method that would give a wider base
accept tilt the wheels
accept on own, make a wider base but not wider seat 1
- lower the seating position
accept any method that would lower the centre of mass, eg place heavy mass under the chair
accept on own make it have a lower centre of mass
make wheelchair heavier on its own is insufficient 1
- M2.** (a) 60
allow 1 mark for correct substitution (with d in metres), ie $36 = F \times 0.6$
an answer of 0.6 or 6 gains 1 mark 2
- [9]**

- (b) the line of action of the weight lies outside the base / bottom (of the bag)
accept line of action of the weight acts through the side
accept the weight (of the bag) acts outside the base / bottom
(of the bag)

1

a resultant / overall / unbalanced moment acts (on the bag)
accept the bag is not in equilibrium
 do **not** accept the bag is unbalanced

1

- (c) 0.0625

allow 1 mark for correct substitution, ie $16 = \frac{1}{f}$

an answer of 0.00625 gains 1 mark

2

hertz / Hz

do **not** accept HZ **or** hz

1

[7]

- M3.** (a) 1.2

allow 1 mark for conversion of 2.4 kN to 2400 N
or for correct transformation without conversion
ie $d = 2880 \div 2.4$

2

metre(s)/m

1

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

- as the load increases the (total) clockwise moment increases
- danger is that the fork lift truck / the load will topple / tip forward
- (this will happen) when the total clockwise moment is equal to (or greater than) the anticlockwise moment
accept moments will not be balanced
- (load above 10.0 kN) moves line of action (from C of M) outside base (area)

2

[5]

- M4.** (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]

- M5.** (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]

M6. (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]

M7. (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]

M8. (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]

