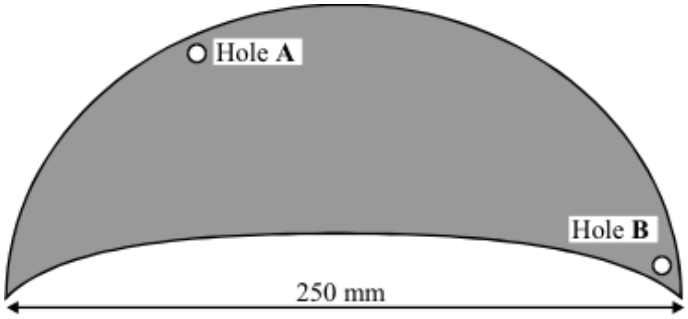
Q1. (a) Every object has a *centre of mass*. What is meant by the *centre of mass*?

.....

.....

(1)

(b) The drawing shows a thin sheet of plastic. The sheet is 250 mm wide. Two holes, each with a radius of 2 mm, have been drilled through the sheet.



Describe how you could use:

- a clamp and stand
- a steel rod 100 mm long and with a radius of I mm
- a weight on a thin piece of string (= a plumb line)
- a ruler
- a pen which will write on the plastic sheet

to find the centre of mass of the plastic sheet.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

.....

.....

.....

.....

.....

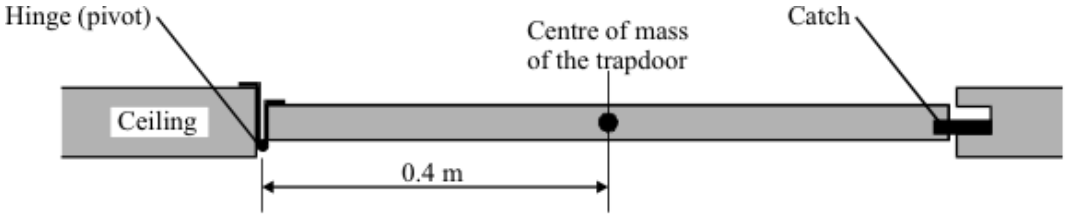
.....

.....

.....

(5)

(c) There is a trapdoor in the ceiling of a house.
The trapdoor weighs 44 N.
The drawing shows a side view of the trapdoor.



(i) Complete the **three** spaces to give the equation which is used to calculate the turning effect of a force.

..... = ... × perpendicular between .....
line of action and pivot

(1)

(ii) Calculate the turning effect, about the hinge, due to the weight of the trapdoor.

Show clearly how you work out your final answer and give the unit.

.....

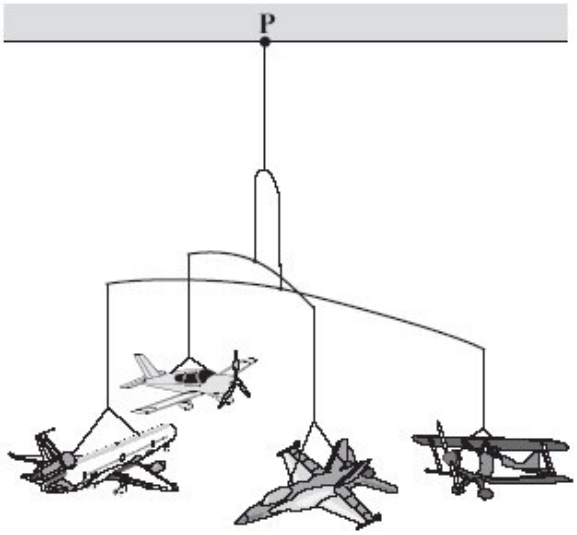
.....

Turning effect = ...

(3)
(Total 10 marks)

Q2. (a) The diagram shows a child's mobile. The mobile hangs from point **P** on the ceiling of the child's bedroom.

(i) Mark the position of the centre of mass of the mobile by drawing a letter **X** on the diagram. Do this so that the centre of the **X** marks the centre of mass of the mobile.



(1)

(ii) Explain why you have chosen this position for your letter **X**.

.....

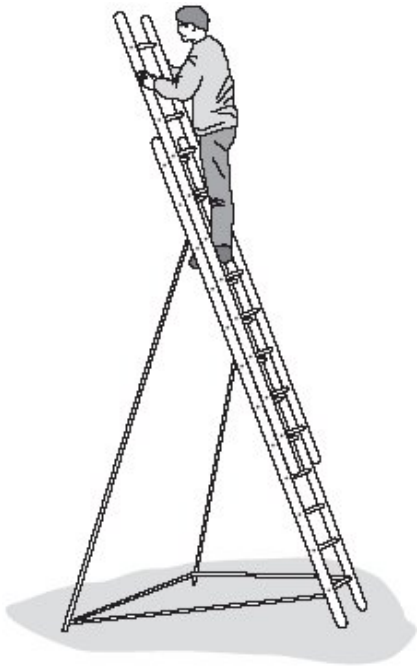
.....

.....

.....

(2)

(b) The diagram shows a device which helps to prevent a ladder from falling over.



Use the term *centre of mass* to explain why the ladder, in the situation shown, is unlikely to topple over.
You may add to the diagram to illustrate your explanation.

.....

.....

.....

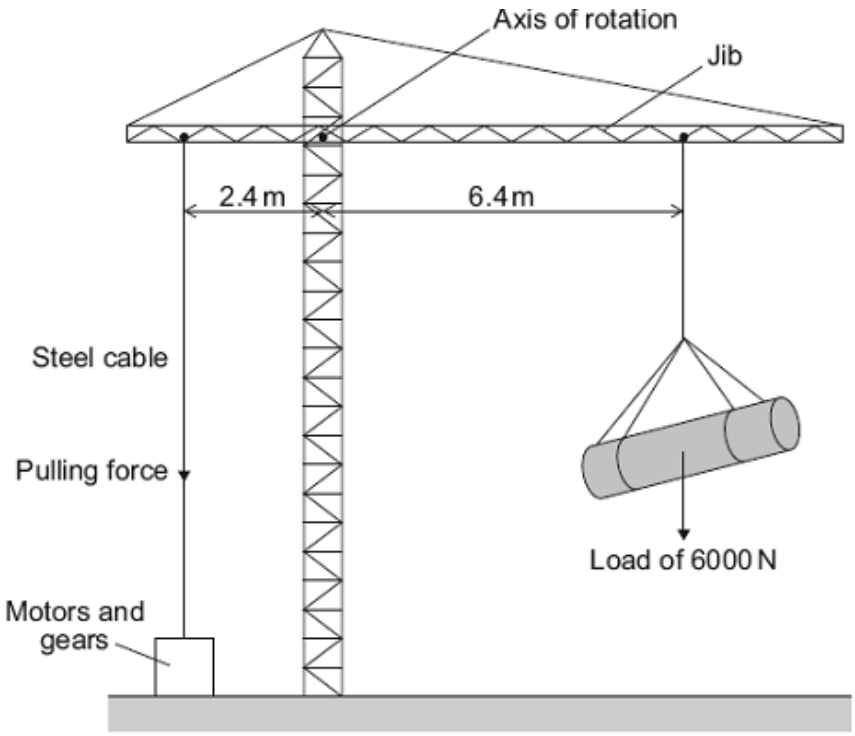
.....

.....

.....

(3)
(Total 6 marks)

Q3. The diagram shows a design for a crane. The crane is controlled by a computer.



The purpose of the motors and gears is to change the pulling force in the steel cable.
This is done so that the jib stays horizontal whatever the size of the load or the position of the load.

Use the equation in the box to answer questions (a) and (b).

moment = force	x	perpendicular distance from the line of action of the force to the axis of rotation

(a) Calculate the moment caused by the load in the position shown in the diagram.

Show clearly how you work out your answer and give the unit.

.....

.....

Moment = ...

(3)

(b) Calculate the pulling force that is needed in the steel cable to keep the jib horizontal.

Show clearly how you work out your answer.

.....

.....

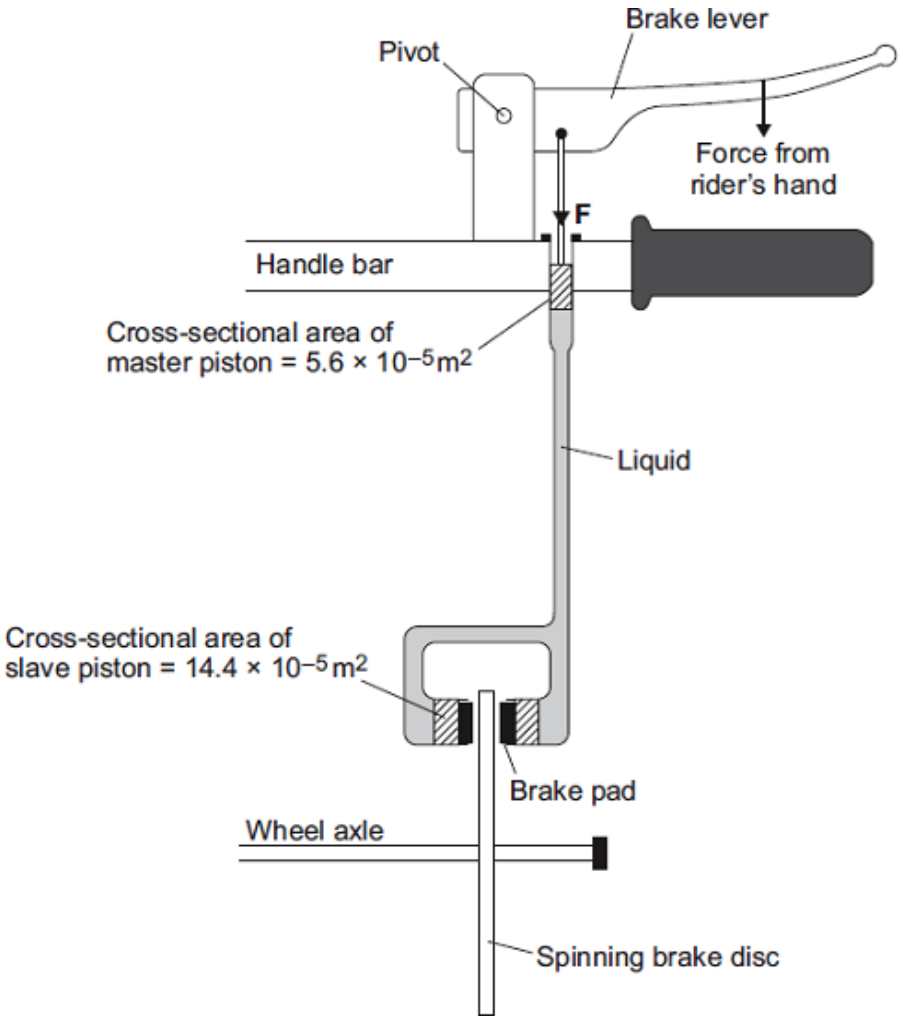
Pulling force = ... N

(2)

(Total 5 marks)

Q4. Mountain bike riders use brakes to slow down.

Some mountain bikes have hydraulic brakes.



(a) What property of a liquid enables a hydraulic brake system to work?

.....

(1)

(b) When the rider's hand pulls on the brake lever, the master piston applies a pressure of 1.5×10^6 pascals to the liquid.

Using information from the diagram, calculate the force **F** exerted on the liquid by the master piston.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Force **F** = ... N

(2)

(c) The pressure in the liquid applies a force to move each slave piston.

How does the size of this force compare to the force **F** applied by the master piston?

.....

.....

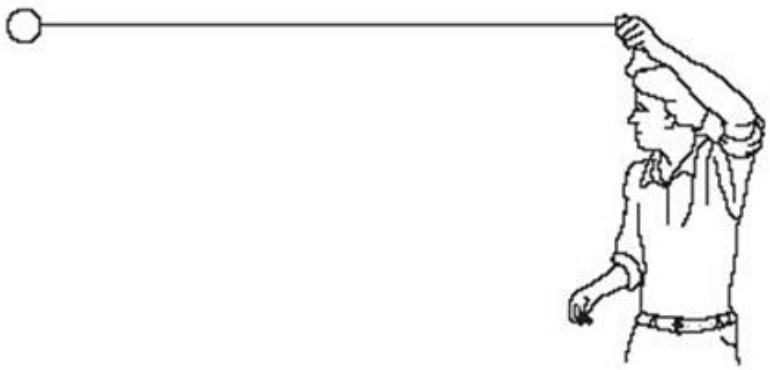
Give a reason for your answer.

.....

.....

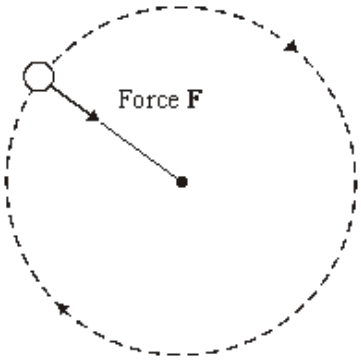
(2)
(Total 5 marks)

Q5. (a) A student has fastened a ball to a piece of string and is swinging it round in a horizontal circle.



(i) The diagram below shows an overhead view of the movement of the ball.

Add an arrow, from the centre of the ball, to show the direction in which the ball would move if the string broke at this instant.



(1)

(ii) Complete the table to show how force **F** changes if the student changes what he is doing. In each case, all the other factors stay the same.

If the student	Force F needs to
uses a ball with a greater mass	.....
swings the ball at a greater speed	.....
swings the ball with a shorter piece of string	.....

(3)

(b) The Moon orbits the Earth in a circular path. Use words from the box to complete the **three** spaces in the sentence.

direction	**resistance**	**speed**	**velocity**

You may use each word once, more than once or not at all.

The Moon's ..... is constant but its ..... changes

because its ..... changes.

(2)

(c) When any object moves in a circular, or nearly circular, path a force must act towards the centre of the circle.

(i) What word is used to describe this force?

.....

(1)

(ii) The Moon orbits the Earth. What provides the force towards the Earth?

.....

(1)

(iii) In an atom, name the particles which are moving in circular paths around the nucleus.

.....

(1)

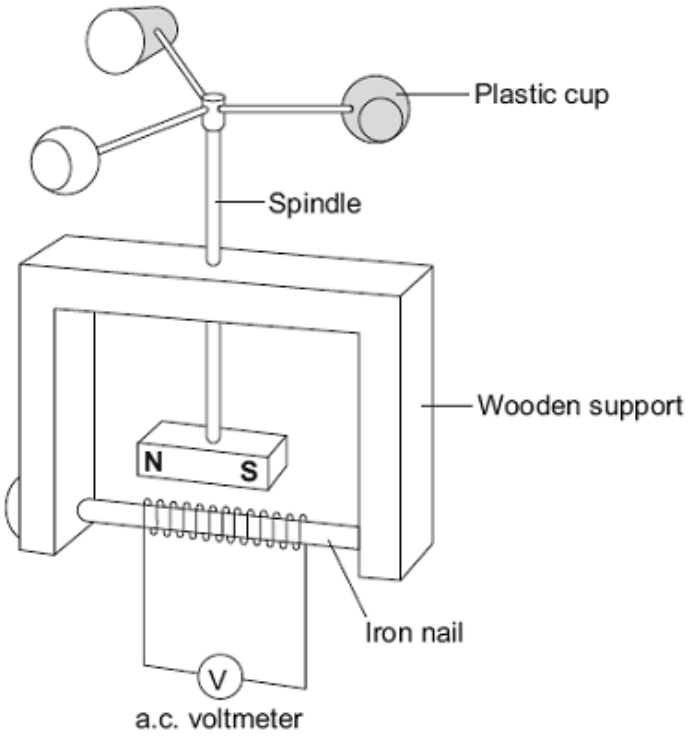
(iv) In the case of an atom, what word describes the forces which keep these particles moving in circular paths around the nucleus?

.....

(1)

(Total 10 marks)

Q6. The diagram shows a student's design for a simple wind speed gauge.



(a) Explain why the wind causes the a.c. voltmeter to give a reading. The explanation has been started for you.

The wind causes the plastic cups to turn. .....

.....

.....

.....

.....

.....

.....

(3)

(b) The gauge is not sensitive enough to measure light winds.

Suggest **one** way that the design can be modified to make the gauge more sensitive.

.....

.....

(1)
(Total 4 marks)

Q7. (a) Name a material that could be used to make the outside case of the plug.

.....

Give a reason for your choice.

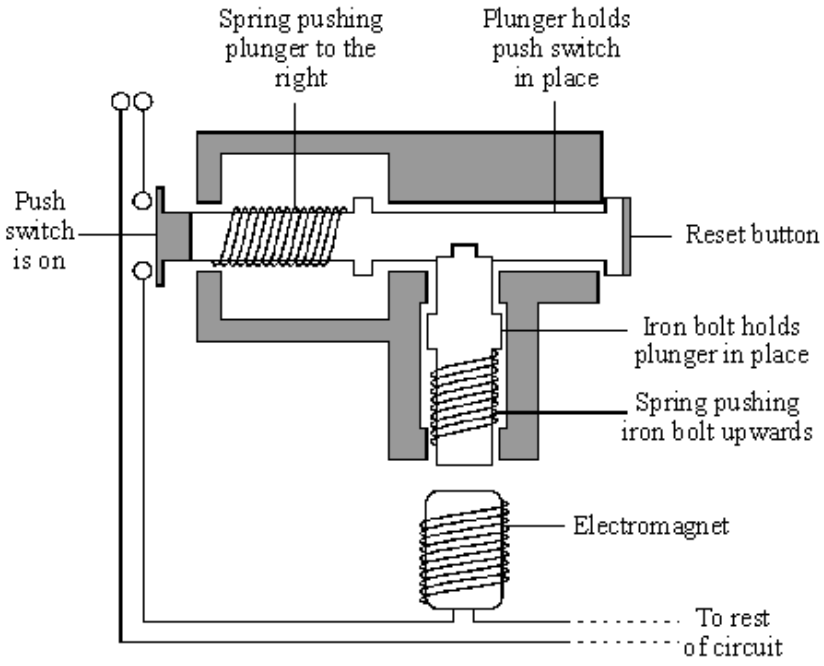
.....

.....

(2)

(b) *To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

Some electrical circuits are protected by a circuit breaker. These switch the circuit off if a fault causes a larger than normal current to flow. The diagram shows one type of circuit breaker. A normal current (15 A) is flowing.



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Explain what happens when a current larger than 15A flows. The answer has been started for you.

When the current goes above 15 A, the electromagnet becomes stronger and

.....

.....

.....

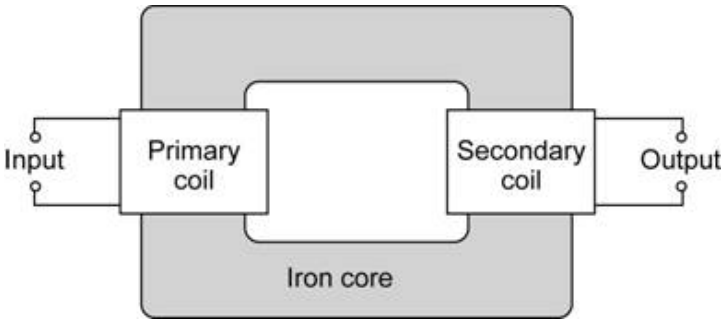
.....

.....

.....

(3)
(Total 5 marks)

Q8. The diagram shows the basic structure of a transformer.



(a) Explain how a transformer works.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5)

(b) A transformer is used to change the 230 volt mains electricity supply to the 12 volts needed to operate a low voltage halogen lamp. The current through the halogen lamp is 4 amps.

Calculate the current drawn by the transformer from the mains electricity supply.

Assume that the transformer is 100 % efficient.

Write down the equation you use, and then show clearly how you work out your answer.

.....

.....

.....

.....

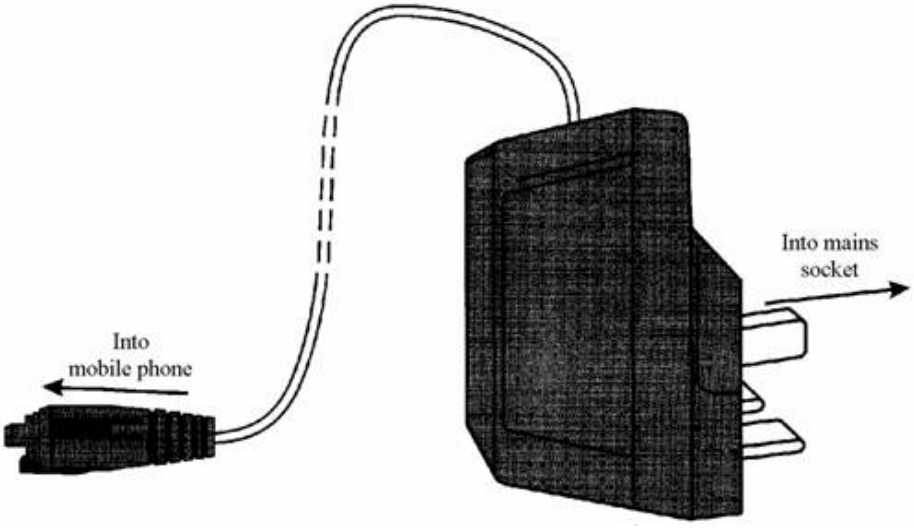
.....

Current = ... amps

(2)

(Total 7 marks)

Q9. (a) The drawing shows a small transformer used to recharge the battery in a 4.2 V mobile phone from a 230 V mains supply.



Explain how you know that this is a *step-down* transformer.

.....

.....

(1)

(b) A transformer consists of an insulated coil of wire, called the primary coil, on one side of a core. Another coil of insulated wire, called the secondary coil, is on the other side.

Give **two** features of the *core*.

1 .....

2 .....

(2)

(Total 3 marks)

M1. (a) point at which its mass (seems to) act **or** point at which gravity (seems to) act

accept ... its weight acts

accept correct statements if the intent is clear e.g.. .. if suspended, the centre of gravity will be directly under the point of suspension

e.g.... (if the object is symmetrical), the centre of gravity is on the ***or*** *an axis (of symmetry)*

do ***not*** *credit just 'it is a point'*

1

(b) *The answer to this question requires good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme*

maximum of ***4*** *marks if ideas not well expressed*

any **five** from:

clamp (steel) rod (horizontally)

no *marks if method quite unworkable*

hang plastic / sheet by rod through (one) hole

hang plumb line from rod

mark ends of plumb line on the sheet and
use the ruler to draw a straight line

repeat with other hole

centre of mass is where the lines cross

check by balancing at this point

maximum of ***3*** *marks if no 'repeat with other hole'*

5

(c) (i) (turning) effect **or** moment
force
distance

all three correct
accept weight
accept length

1

(ii) 17.6

allow 44 x 0.4 ***or*** *0.4 x 44 for* ***1*** *mark*

2

Nm **or** newton metre(s)

do ***not*** *accept N/m* ***or*** *N/cm*

1760 Ncm gains all ***3*** *marks*

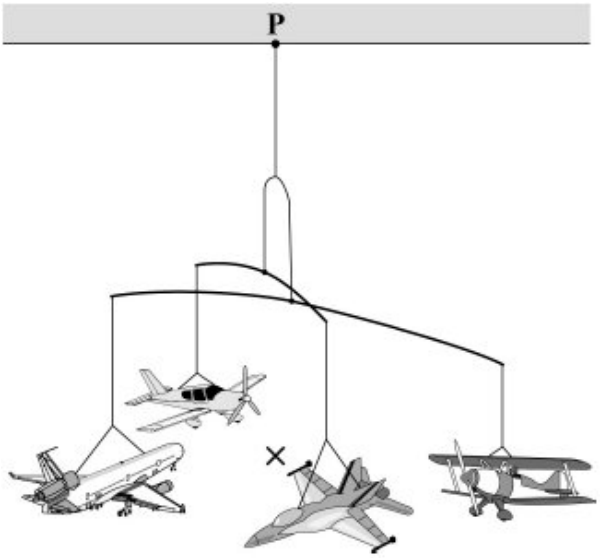
1

[10]

M2. (a) (i) centre of **X** directly below **P** and between the model aeroplanes

as judged by eye but between centre of propeller of top aeroplane and canopy of bottom aeroplane

example



1

(ii) the centre of mass is (vertically) below the point of suspension / P

1

the centre of mass is in the middle of the aeroplanes

accept the centre of mass is level with the aeroplanes

1

(b) centre of mass of the worker and the ladder (and device)

1

line of action of the weight is inside the base

accept the centre of mass is above / within / inside the base (of the ladder and device)

1

so there will not be a (resultant) moment

accept so he / it / the ladder will not topple even if he leans over

or it will (only) topple over if the line of action of the weight / the centre of mass is outside the base

*accept each point, either on the diagram or in the written explanation, but do **not** accept the point if there is any contradiction between them*

1

[6]

M3. (a) 38 400

*allow 6.4 × 6000 for **1** mark*

2

Nm **or** newton metres

*do **not** credit 'nm', 'mN' or 'metre newtons'*

1

(b) 16 000 (N) **or** 16 kN

*allow **1** mark for 38 400 ÷ 2.4*

*accept their (a) ÷ 2.4 correctly calculated for **2** marks*

*accept their (a) ÷ 2.4 for **1** mark*

2

[5]

M4. (a) (i) liquids are (virtually)

incompressible

1

(b) 84

*allow **1** mark for correct substitution, ie*

$1.5 \times 10^{6} = \frac{F}{5.6 \times 10^{-5}}$

numbers may not be written in standard form, ie

$1\,500\,000 = F \frac{F}{0.000\,056}$

*allow **1** mark for an answer 216*

2

(c) it (the force on the slave pistons) is greater / larger

accept force (at slave piston) = 216 (N)

1

the area (touching the liquid) of the slave piston is greater than the area of the master piston

accept it has a bigger area

just quoting numbers, eg the master piston is 5×10^{-5} and the slave piston is 14.4×10^{-5} is insufficient

1

[5]

M5. (a) (i) arrow from centre of the ball **and** at right angles to the string **and** in the correct direction

arrow should point to the student's belt
accept free-hand 'straight' line
*do **not** accept curved line*

1

(ii) increase

accept 'be stronger / bigger'

1

increase

accept 'be stronger / bigger'

1

increase

accept 'be stronger / bigger'

1

(b) speed
velocity
direction

*all **three** correct*
*any two correct for **1** mark*
*otherwise **0** marks*

2

(c) (i) centripetal

accept 'centripedal' and other minor misspellings
*do **not** accept anything which could be 'centrifugal'*

1

(ii) gravity

accept 'weight'
accept 'force of attraction due to mass(es) (of the Moon and the Earth)'

1

(iii) electron(s)

1

(iv) electrostatic

accept 'electrical'
*do **not** accept just 'centripetal'*

1

[10]

M6. (a) which causes the magnet to turn / spin / rotate

1

(magnetic) field / lines of force / flux rotate(s) / move(s) / through / in / cut(s) the coil

*do **not** credit the idea that movement 'creates' the magnetic field*

1

potential difference / p.d. / voltage induced across the coil

*do **not** credit just 'current induced'*

1

(b) any **one** from:

- more powerful / stronger / lighter magnet

  *do **not** credit 'a bigger magnet'*
- larger / more / bigger / lighter cups / with a bigger surface area
- longer arms
- lubricate the spindle
- add more turns to the coil

1

[4]

M7. (a) plastic or rubber

accept any named plastic
*do **not** accept wood*

1

it is a (good) insulator **or** it is a poor conductor

ignore mention of heat if in conjunction with electricity

1

(b) *The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.*

Maximum of 2 marks if ideas not well expressed.

pulls iron bolt down **or** attracts the iron bolt **or** moves bolt out of plunger

answers in terms of charges attracting
or repelling gain no credit

1

plunger pushed / moved to the right (by spring) **or** plunger released

1

push switch opens / goes to off / goes to right

accept circuit is broken
for maximum credit the points must follow a logical sequence
*3 correct points but incorrect sequence scores **2** marks only*
ignore reset action

1

[5]

M8. (a) an alternating input / current to primary (coil)

1

which produces an alternating magnetic field

accept changing magnetic field for alternating magnetic field

if first mark point scores then 'alternating' not required here

1

in the (iron) core

this magnetic field links with the secondary coil

1

which induces an (alternating) voltage / p.d. across the secondary (coil)

1

(b) 0.21

accept 0.2 or any answer that rounds to 0.21

*allow **1** mark for correct equation*
ie power input = power output

or

*allow **1** mark for substitution into correct equation*
ie $230 \times I_p = 12 \times 4$

2

[7]

M9. (a) output voltage less than (the) input voltage

*or p.d. across output less that p.d. across input **or** output is (only) 4.2 V*

(whereas) the input is 230V

or WTTE (words to that effect)

1

(b) any **two** from

(made of soft) iron

laminated

***or** designed to reduce eddy currents*

***or** made of thin slices with slices of insulating material between them*

core(s) joined to make a ring

2

[3]