

Investigative Skills

Name: _____

Class: _____

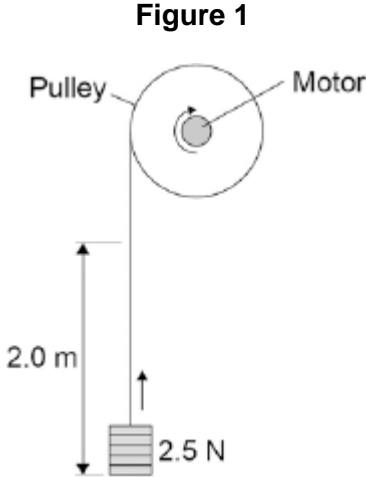
Date: _____

Time: **46 minutes**

Marks: **45 marks**

Comments:

Q1.A student investigated the efficiency of a motor using the equipment in **Figure 1**.



He used the motor to lift a weight of 2.5 N a height of 2.0 m.

He measured the speed at which the weight was lifted and calculated the efficiency of the energy transfer.

He repeated the experiment to gain two sets of data.

(a) Give **one** variable that the student controlled in his investigation.

.....

(1)

(b) Give **two** reasons for taking repeat readings in an investigation.

1

.....

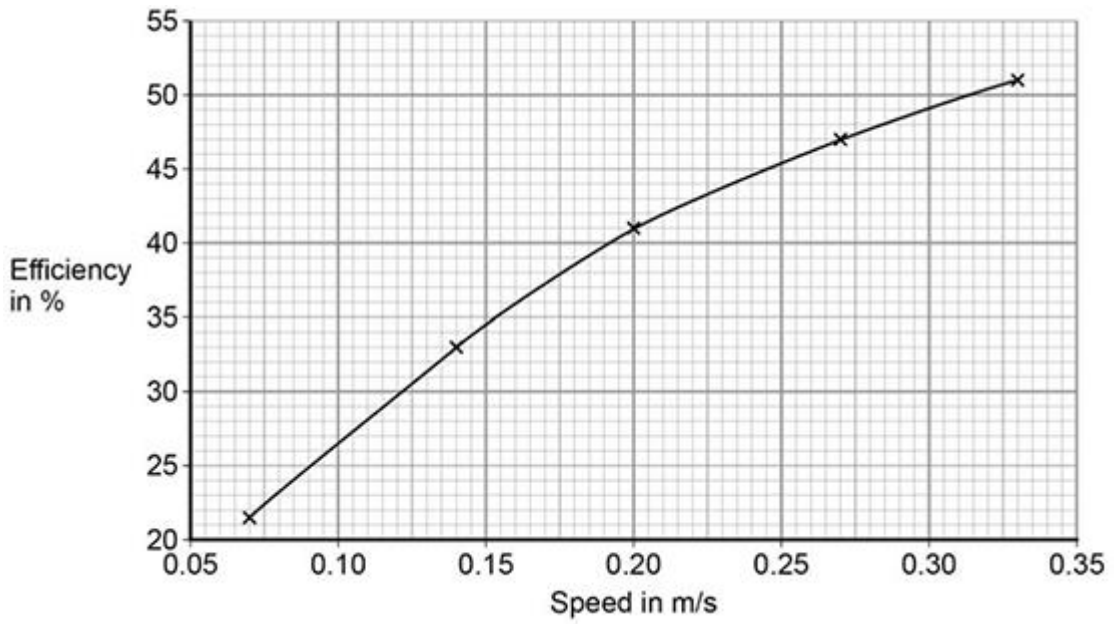
2

.....

(2)

(c) **Figure 2** shows a graph of the student's results.

Figure 2



Give **two** conclusions that could be made from the data in **Figure 2**.

.....

.....

.....

.....

(2)

(d) Give the main way that the motor is likely to waste energy.

.....

.....

(1)

(e) When the total power input to the motor was 5 W the motor could not lift the 2.5 N weight.

State the efficiency of the motor.

Efficiency = %

(1)

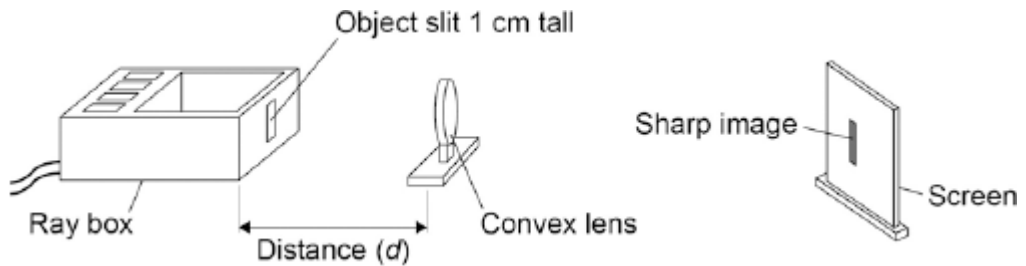
(Total 7 marks)

Q2.A student investigated how the magnification produced by a convex lens varies with the

distance (d) between the object and the lens.

The student used the apparatus shown in **Figure 1**.

Figure 1



- (a) The student measured the magnification produced by the lens by measuring the image height in centimetres.

Explain why the image height in centimetres was the same as the magnification.

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.....

.....

(2)

- (b) The data recorded by the student is given in **Table 1**.

Table 1

Distance between the object and the lens in cm	Magnification
25	4.0
30	2.0
40	1.0
50	0.7
60	0.5

It would be difficult to obtain accurate magnification values for distances greater than 60 cm.

Suggest **one** change that could be made so that accurate magnification values could be obtained for distances greater than 60 cm.

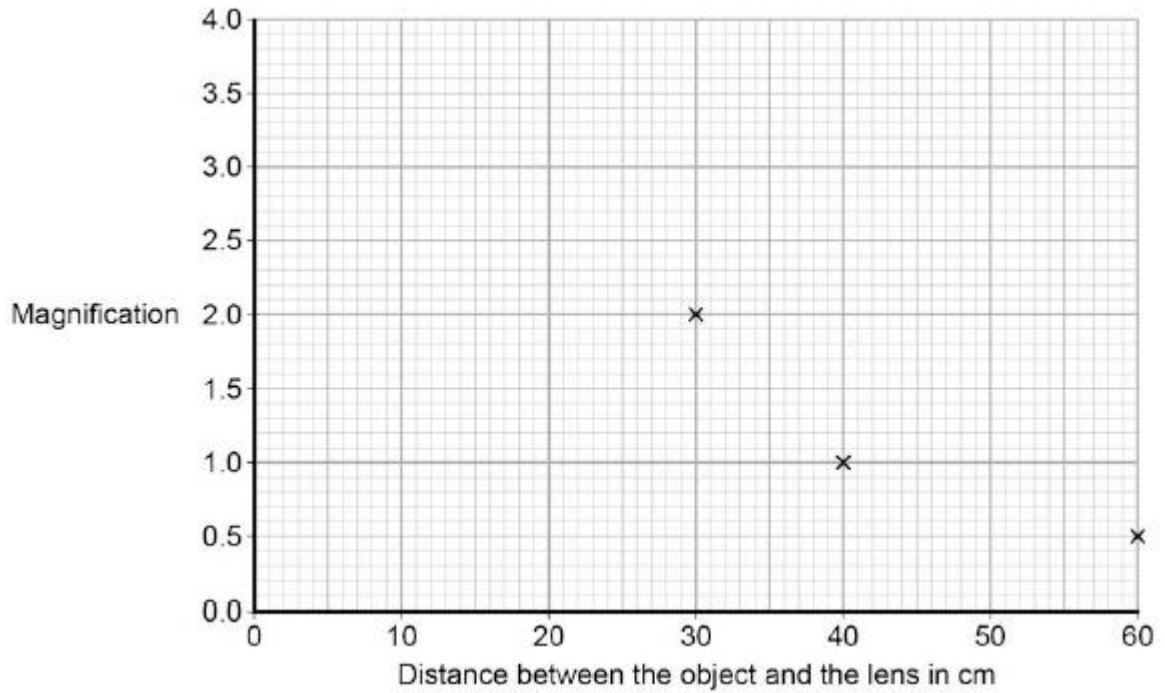
.....

.....

(1)

(c) The graph in **Figure 2** is incomplete.

Figure 2



Complete the graph in **Figure 2** by plotting the missing data and then drawing a line of best fit.

(2)

(d) How many times bigger is the image when the object is 35 cm from the lens compared to when the object is 55 cm from the lens?

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

(2)

(e) During the investigation the student also measured the distance between the lens and the image.

Table 2 gives both of the distances measured and the magnification.

Table 2

Distance between the lens and the image in cm	Distance between the lens and the object in cm	Magnification
100	25	4.0
60	30	2.0
40	40	1.0
33	50	0.7
30	60	0.5

Consider the data in **Table 2**.

Give a second way that the student could have determined the magnification of the object.

Justify your answer with a calculation.

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.....

.....

.....

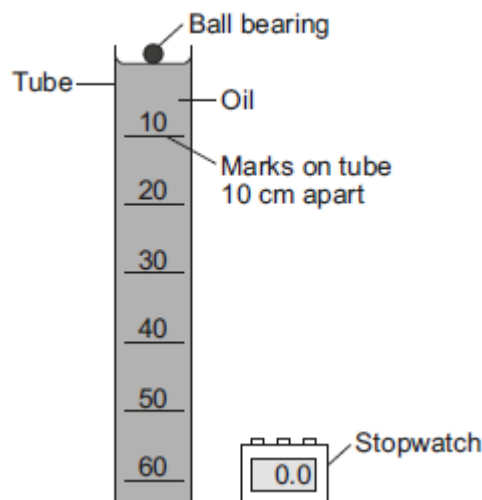
.....

(2)
(Total 9 marks)

Q3.A student investigated how the speed of a ball bearing changes as the ball bearing falls through a tube of oil.

Figure 1 shows the equipment the student used.

Figure 1



The student measured the time taken for the ball bearing to fall different distances. Each distance was measured from the top of the oil.

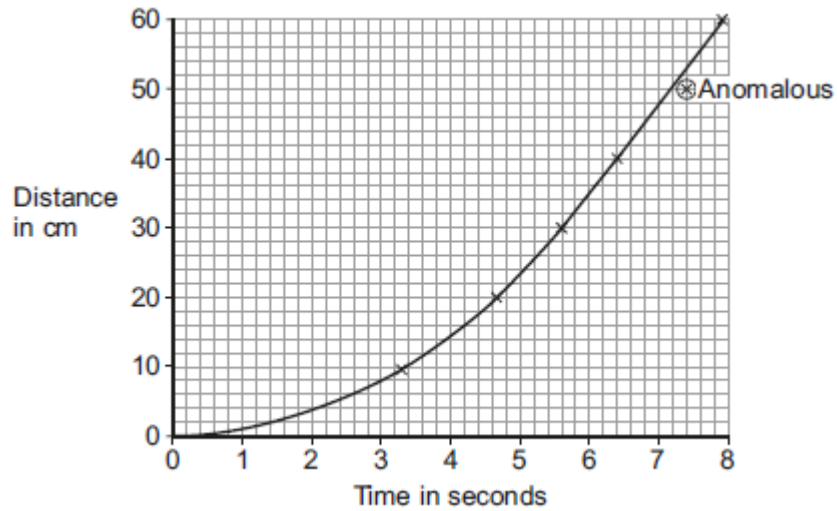
(a) What is likely to have been the main source of error in this investigation?

.....
.....

(1)

(b) **Figure 2** shows the student's results plotted as a graph.

Figure 2



(i) The student has identified one of the results as being anomalous.

Use the correct answer from the box to complete the sentence.

after	as	before
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The anomalous result was caused by the stopwatch being started
..... the ball bearing was released.

(1)

(ii) What can you conclude from the graph about the speed of the ball bearing during the first four seconds?

.....
.....

(1)

(iii) The graph shows that the ball bearing reached its terminal velocity.

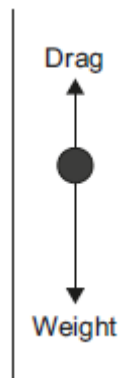
Describe how the graph would be used to calculate the terminal velocity of the ball bearing.

.....
.....

(1)

(iv) The directions of the two forces acting on the ball bearing as it falls through the oil are shown in **Figure 3**.

Figure 3



Explain, in terms of the forces shown in **Figure 3**, why the ball bearing reaches its terminal velocity.

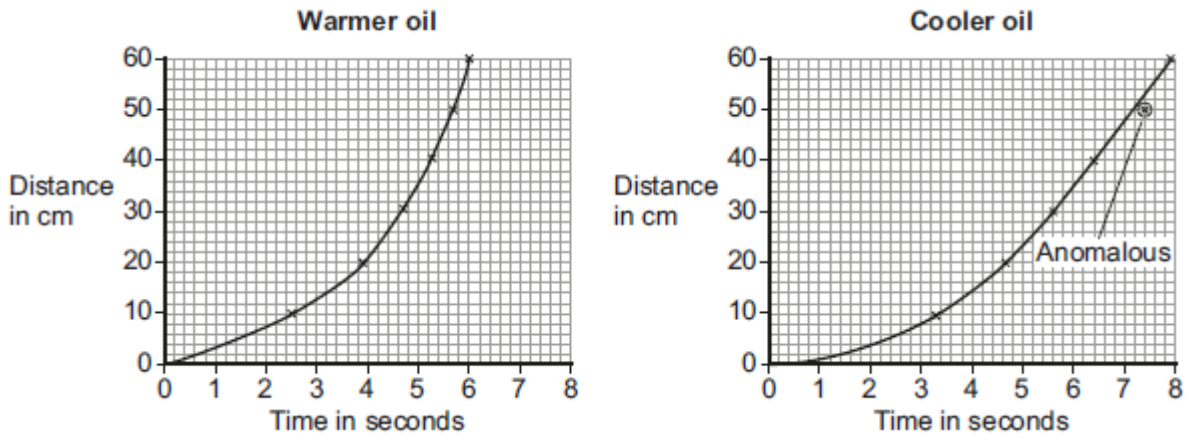
.....
.....
.....
.....

(2)

(c) The student repeated the investigation using warmer oil.

Figure 4 shows the set of results using the warmer oil **and** the set of results using the cooler oil.

Figure 4



Compare the two graphs in **Figure 4**.

Use the correct answer from the box to complete the sentence.

less than	equal to	greater than
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After falling 40 cm, the drag force on the ball bearing in the warmer oil is the drag force on the ball bearing in the cooler oil.

Explain the reason for your answer.

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.....

.....

.....

(3)
(Total 9 marks)

Q4. If a fault develops in an electrical circuit, the current may become too great. The circuit needs to be protected by being disconnected.

A fuse or a circuit breaker may be used to protect the circuit.
One type of circuit breaker is a Residual Current Circuit Breaker (RCCB).

(a) (i) Use the correct answer from the box to complete the sentence.

earth	live	neutral
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A fuse is connected in the wire.

(1)

(ii) Use the correct answer from the box to complete the sentence.

are bigger	are cheaper	react faster
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RCCBs are sometimes preferred to fuses because they

(1)

(iii) RCCBs operate by detecting a difference in the current between two wires.

Use the correct answer from the box to complete the sentence.

earth and live	earth and neutral	live and neutral
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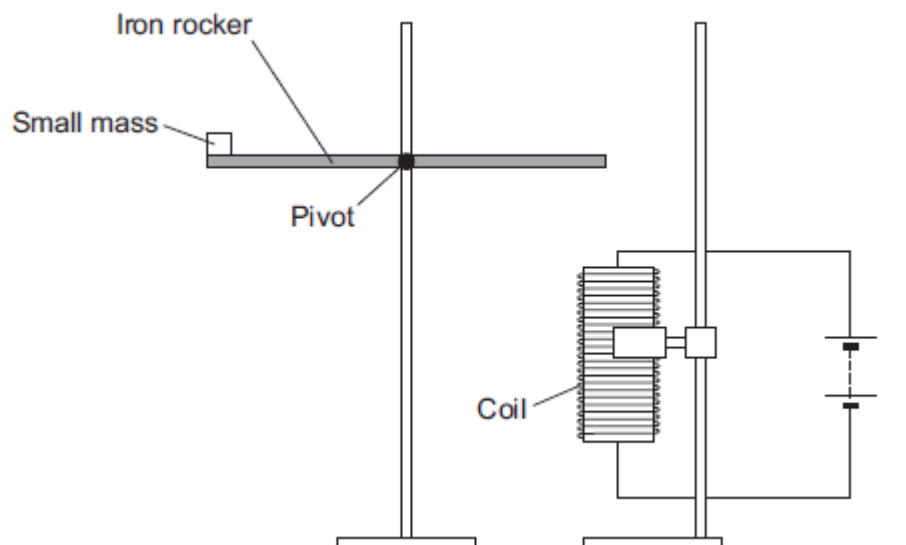
The two wires are the wires.

(1)

(b) An RCCB contains an iron rocker and a coil.

A student investigated how the force of attraction, between a coil and an iron rocker, varies with the current in the coil.

She supported a coil vertically and connected it in an electrical circuit, part of which is shown in the figure below .



She put a small mass on the end of the rocker and increased the current in the coil until the rocker balanced. She repeated the procedure for different masses.

Some of her results are shown in the table below.

Mass in grams	Current needed for the rocker to balance in amps
5	0.5
10	1.0
15	1.5
20	2.0

- (i) State **two** extra components that must have been included in the circuit in the figure above to allow the data in the above table to be collected.

Give reasons for your answers.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)

- (ii) A teacher said that the values of current were too high to be safe.

Suggest **two** changes that would allow lower values of current to be used in this investigation.

Change 1

.....

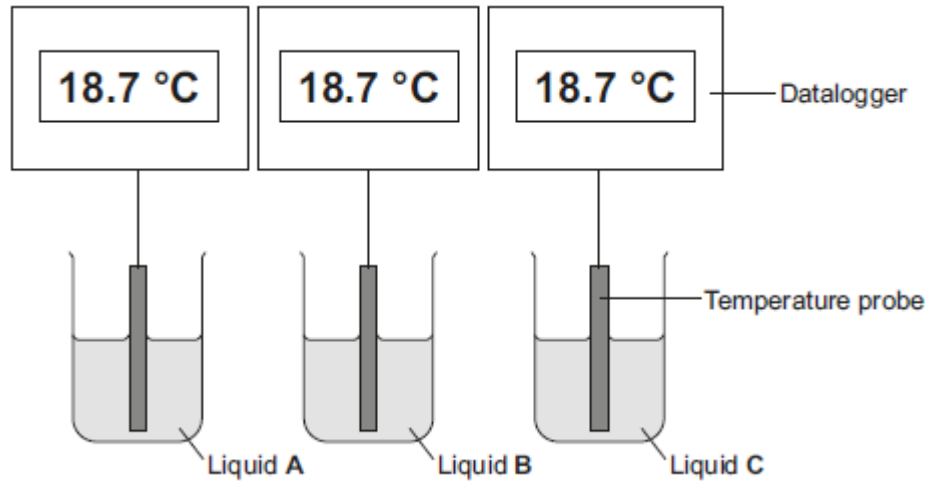
Change 2

.....

(2)
(Total 9 marks)

Q5.A A student investigated the cooling effect of evaporation. She used the equipment in **Figure 1** to measure how the temperature of three different liquids changed as the liquids evaporated.

Figure 1



- (a) The temperature and volume of each liquid was the same at the start of the investigation.

State **one** further control variable in this investigation.

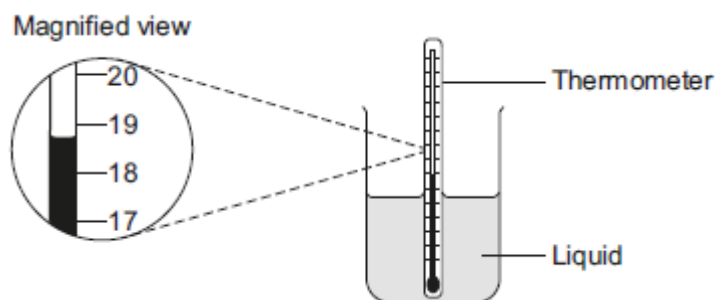
.....

.....

(1)

- (b) Give **two** advantages of using dataloggers and temperature probes compared to using the thermometer shown in **Figure 2**.

Figure 2



1.

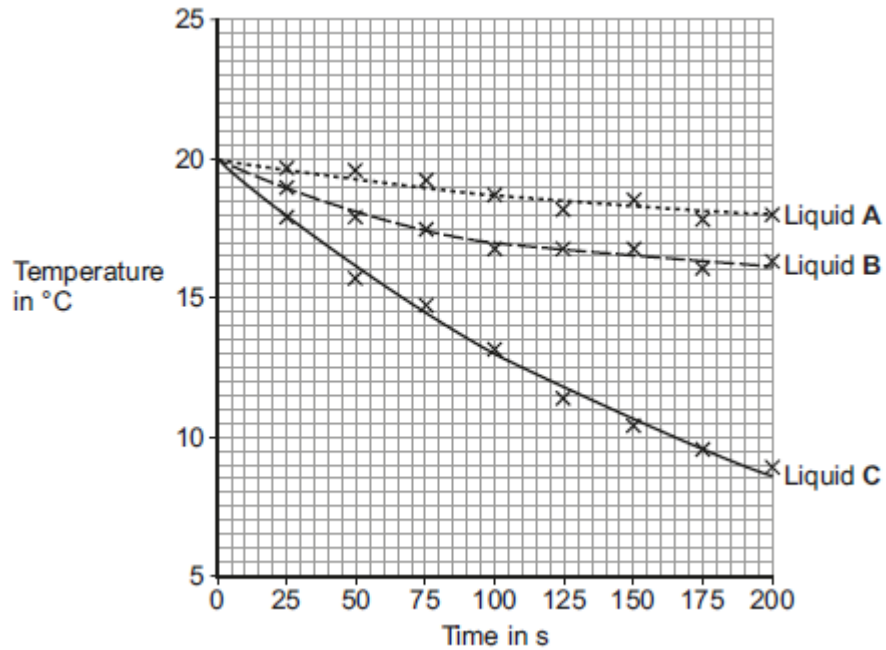
.....

2.

(2)

(c) The student's results are shown in **Figure 3**.

Figure 3



(i) Calculate the average rate of temperature decrease of liquid **C** between 0 and 100 seconds.

.....

Average rate of temperature decrease = °C / s

(2)

(ii) Give **one** conclusion that can be made about the rate of temperature decrease of **all three** liquids from the results in **Figure 3**.

.....

(1)

(iii) Which liquid had the lowest rate of evaporation? Give a reason for your answer.

Liquid

Reason

.....

(1)

- (iv) A second student did the same investigation but using a smaller volume of liquid than the first student.

All other variables were kept the same.

What effect would this have on the results of the second student's investigation?

.....

.....

(1)

- (d) Explain how the evaporation of a liquid causes the temperature of the remaining liquid to decrease.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(Total 11 marks)

M1.(a) weight (lifted)

or

height (lifted)

1

(b) any **two** from:

- calculate a mean
- spot anomalies
- reduce the effect of random errors

2

(c) as speed increases, the efficiency increases

1

(but) graph tends towards a constant value

or

appears to reach a limit

accept efficiency cannot be greater than 100%

1

(d) heating the surroundings

1

(e) 0 (%)

1

[7]

M2.(a) magnification = $\frac{\text{image height}}{\text{object height}}$

1

dividing by an object height of 1 cm gives the same (numerical) value

1

(b) accept anything practical that would work eg:

use a taller object

use a (travelling) microscope

attach a scale to the screen and use a magnifying glass

1

(c) both points plotted correctly

1

correct line of best fit drawn

a curve passing through all points (within $\frac{1}{2}$ square), judge by eye

1

(d) values of 1.4 and 0.6 extracted from the graph

1

2.33 times bigger

accept any number between 2.3 and 2.5 inclusive

1

(e) by dividing the distance between the lens and the image by the distance between the lens and the object

1

at least one correct calculation and comparison eg $100 \div 25 = 4$ which is the same as the measured magnification

1

[9]

M3.(a) starting / stopping the stopwatch

human error is insufficient
reaction time is insufficient

or

timing over the smaller distances

accept not timing accurately

do not accept references to measuring distance incorrectly

1

(b) (i) before

1

(ii) increasing

accept accelerating

it is not constant is insufficient

it is less than after four seconds is insufficient

it reaches a constant speed negates

1

(iii) calculate the gradient of the straight/steepest/constant section

accept gradient of any section after 5.5 seconds/30 cm

1

(iv) drag (force) increases (as the ball bearing gets faster)

accept frictional/upward force for drag

1

(until) drag (force) = weight

or

(until) resultant force is zero

accept upward force = downward force

accept till forces are balanced

1

(c) less than

1

ball bearing increases speed at a greater rate

accept it travels the same distance in less time

or

ball bearing has a greater acceleration

accept the ball bearing is going faster

or
terminal velocity has not been reached

1

so resultant force must be greater

or
as weight is the same (the drag must be less)

*accept warmer oil has a lower density/viscosity for 1 mark if
neither of the two reason marks score*

1

[9]

M4.(a) (i) live

1

(ii) react faster

1

(iii) live and neutral

1

(b) (i) ammeter

1

to measure current

accept to measure amps

1

plus any **one** from:

- variable resistor (1)
to vary current (1)
accept variable power supply
accept change or control
- switch (1)
to stop apparatus getting hot / protect battery
or
to reset equipment (1)
- fuse (1)
to break circuit if current is too big (1)

2

(ii) any **two** from:

- use smaller mass(es)
- move mass closer to pivot
- reduce gap between coil and rocker
- more turns (on coil) *coil / loop*
- iron core in coil
accept use smaller weight(s)

2

[9]

M5.(a) surface area

or

duration of experiment

accept shape of beaker

size of beaker is insufficient

1

(b) any **two** from:

- takes readings automatically
*ignore easier **or** takes readings for you*
- takes readings more frequently
- reduces / no instrument reading error
ignore human error
- higher resolution
allow better resolution
- don't need to remove probe to take reading
- more accurate

2

(c) (i) 0.07 (°C/s)

allow 1 mark for obtaining a temperature drop of 7 (°C)

allow 1 mark for an answer between 0.068 and 0.069 (°C/s)

2

(ii) rate of temperature change is greater at the start

accept rate of evaporation is greater at the start

or
rate of temperature change decreases
allow rate of evaporation decreases
allow temperature decreases faster at the start

1

(iii) A
reason only scores if A is chosen

lower temperature decrease (over 200 seconds)
accept lower gradient

1

(iv) no effect (as rate of evaporation is unchanged)
allow larger temperature change (per second as mass of liquid is lower)

1

(d) particles with more energy
accept particles with higher speeds

1

leave the (surface of the) liquid

1

(which) reduces the average (kinetic) energy (of the remaining particles)
allow reference to the total energy of the liquid reducing

1

[11]