Physics paper two

Stretch and challenge booklet

Exam command words

Command words are the words and phrases used in exams that tell students how they should answer a question.

The following command words are taken from Ofqual's official list of command words and their meanings that are relevant to this subject.

Calculate	Use numbers in the question to work these out.	**Draw**	Produce, or add a diagram.
Choose	Select from a range of alternatives.	**Estimate**	Give an approximate value.
Compare	Describe similarities/differences.	**Use**	The answer must include the information in the question.
Define	Specify the meaning of something.	**Work out**	Students should use numbers in the question.
Describe	Recall facts, events or process in an accurate way.	**Write**	Short answer, no explanation or description.
Design	Set out how something will be done.	**Evaluate**	Students should use the information provided as well as their own knowledge and consider evidence for or against.
Determine	Use the data provided to work out your answer.	**Explain**	Students should make something clear, or state reasons for something happening.
Give	Short answer only.	**Identify**	Name or characterise.
Label	Add words to complete a diagram, picture or graph	**Justify**	Use evidence from the information supplied to support your answer.
Measure	Find an item of data for a given quantity.	**Name**	Single word or phrase.
Plot	Mark on a graph.	**Plan**	Write a method.
Predict	Give a plausible outcome.	**Show**	Provide structured evidence to reach a conclusion.
Suggest	Apply your own knowledge.	**Sketch**	Draw approximately.

Scientific key words

These are keywords often used in questions. You need to be able to recognise and use them in your answers.

Hypothesis	A scientific statement that explains certain facts or observations	**Anomaly**	A result that does not fit the pattern
Prediction	This describes what you think will happen in an experiment	**Accuracy**	How close the reading is to the true value
Independent variable	This is the variable that is changed during an investigation. There should only be one of these.	**True value**	This is the real value of a measurement in an experiment
Dependent variable	This is the variable that changes as a result of a change in the independent variable	**Precision**	This is determined by the scale on the measuring apparatus e.g. a ruler marked mm is more precise than one in cm
Control variable	Variables that remain constant, to make sure that an investigation is valid	**Resolution**	The smallest change that can be read from a measuring device for example a ruler measured in mm or cm
Fair test	This is where only the independent variable is changed and the others controlled	**Calibration**	When we make sure that the measuring apparatus is making correct readings e.g. the temperature of melting ice is 0 degrees Celsius
Valid	The results and conclusions will be this if the variables are correctly controlled	**Measurement error**	The difference between the real value and the measured value
Categoric variable	A variable that can be described by a label or category such as colour or surface	**Random error**	This error causes measurements to be spread around the true value – can be reduced by taking repeats and calculating a mean
Continuous variable	A variable which can have any numerical value	**Zero error**	When a piece of measuring equipment should be reading zero but it doesn't
Interval	This is the difference between the values of your independent variable	**Systematic error**	This is an error that is always the same for each repeat – usually because of an error in the equipment used
Range	The maximum and minimum values of the independent or dependent variables e.g. 'from 10cm to 50cm'	**Uncertainty**	When the results obtained are not as accurate as they could be due to the procedure carried out
Data	Information or measurements that you collect	**Repeatable**	If the same person can get the same reading using the same equipment and method
Datum	One piece of information	**Reproducible**	If another person can get the same result (trend/specific results) using the same method and equipment or with different method or equipment.

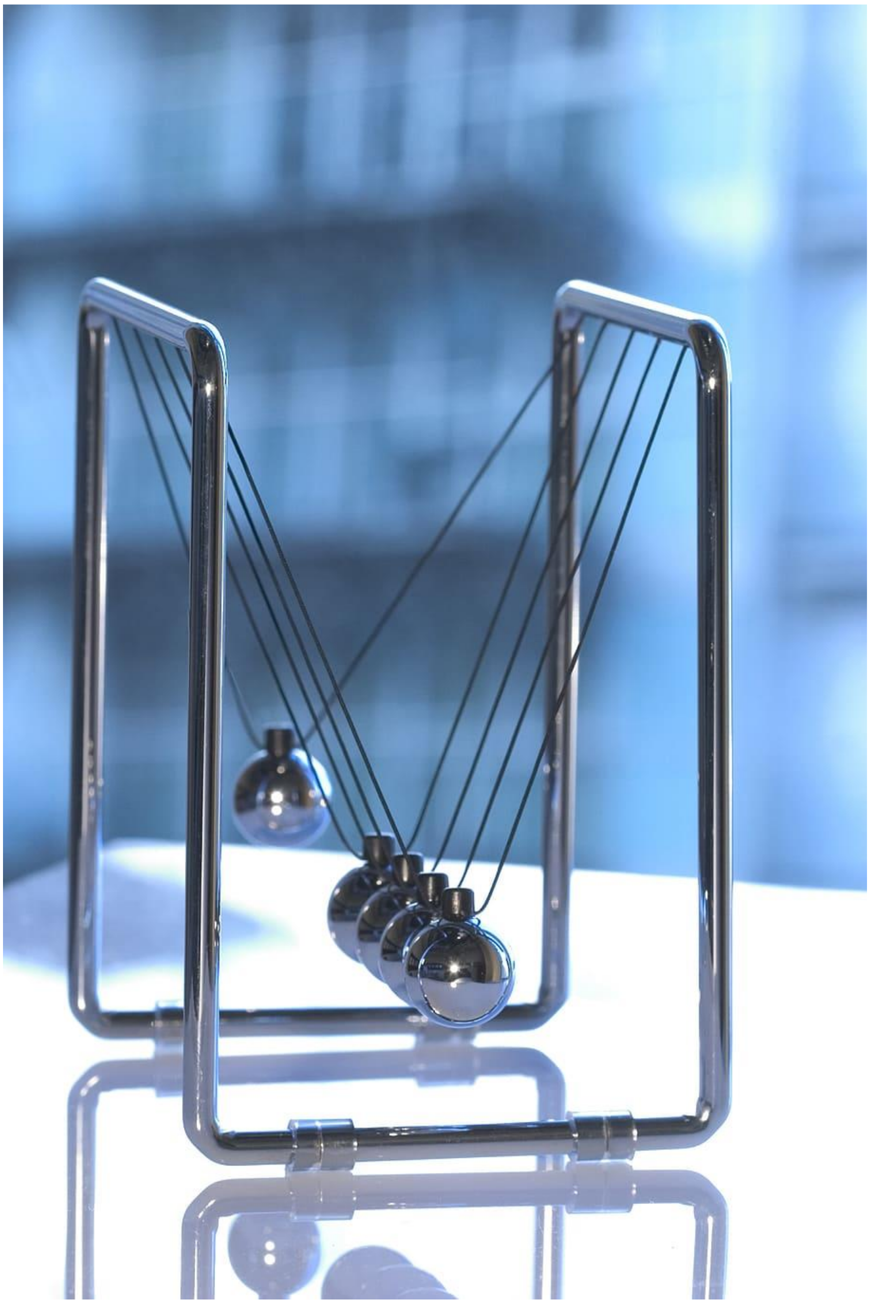
Physics paper 2 Revision Checklist – Trilogy

Forces		
Name contact and non-contact forces and describe their interaction		
Define scalar and vector quantities and give examples of each		
Calculate resultant forces		
Define weight and use w=mxg to calculate any one of those values		
Define ‘centre of mass’		
Draw free body diagrams to scale including **resolving forces at different angles**		
Know the equation to calculate work done and apply this to find work done, force or distance		
Describe the relationship between joules and newton-metres and convert between them		
Give examples of forces involved in stretching or compression and explain the difference between elastic deformation and inelastic deformation		
Describe the features of a graph of force applied versus the extension of a spring		
Know Hooke’s Law (f = ke) and apply it in stretching or compression scenarios		
Calculate work done during stretching or compressing using $e= ½ k x e^2$		
Motion		
Interpret distance-time graphs to calculate velocity and total distance moved		
Explain the difference between distance and displacement		
Know typical values for speed for walking, running, cycling and sensible values for car, train and airplane speeds		
Describe the difference between velocity and speed and calculate them using s=d/t		
Describe circular motion in terms of speed and direction		
Interpret distance time graphs to find speed, **including drawing a tangent if the object is accelerating**		
Describe what is meant by acceleration		
Calculate the acceleration or deceleration of an object using a=v-u/t, using negative values to represent deceleration		
Use uniform acceleration equation to calculate acceleration, velocity or distance		
Know that acceleration under gravity is $9.8 m/s^2$		
Interpret velocity-time graphs to calculate acceleration, velocity **and total distance/displacement**		
Describe the change in forces that occur during free fall of an object through a fluid		
Define terminal velocity		

Apply Newton’s first law to predict the effect of balanced and unbalanced forces on stationary and moving objects		
Explain what is meant by ‘inertia’ and find inertial mass using f=ma		
Use Newton’s second law (f=ma) to calculate force, mass or acceleration		
Apply Newton’s third law to equilibrium situations – ie describe how forces exerted by two objects interacting are equal and opposite		
Define the terms stopping distance, thinking distance and braking distance and know how speed affects overall stopping distance		
Explain how reaction time can affect thinking distance and how this can be measured		
Describe physical factors that can affect braking distance – condition of tyres, road etc		
Explain why large decelerations are dangerous **and estimate values forces involved in deceleration of road vehicles**		
Describe what is meant by momentum and calculate values from an equation		
Explain what is meant by ‘conservation of momentum’ and apply this in calculations		
Waves		
Describe the origin and properties of longitudinal and transverse waves and give examples		
Calculate frequency of waves using frequency = number of waves/time and use Hz as the unit		
Use the wave equation to calculate wave speed, frequency or wavelength including using standard form		
Describe properties of all EM waves		
Name the 7 EM waves and describe their uses and dangers		
Link uses of EM waves to their properties		
Describe three things that can happen to waves when they meet an object		
Explain what happens to waves as they travel into more or less dense materials		
Label a diagram to show refraction of light, including the normal and angles of incidence and refraction		
Describe ways of measuring wave speed– e.g ripple tank, waves on a string		
Describe how to measure the speed of sound and know it’s approximate value in air		
Explain how radio waves are generated by oscillating charges in the transmitter and how this generates a current in the receiver		
Explain how microwaves can be used to communicate with satellites and how microwaves of a different wavelength can be used to cook food		
Explain how IR radiation emission and absorption is affected by surface and describe an investigation to measure this		
Explain some of the dangers of EM waves and how the radiation dose is measured		

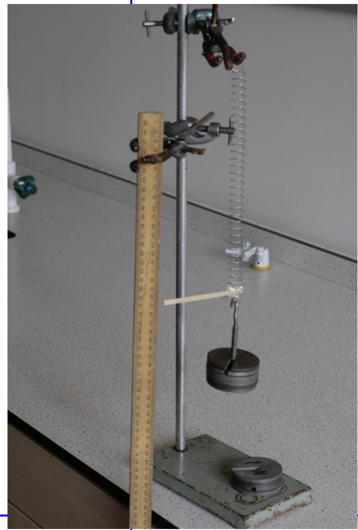
Magnetism & electromagnetism		
Describe the force between two poles of a magnet		
Describe the difference between permanent and induced magnets		
Explain how a current produces a magnetic field and how a solenoid can increase the strength		
Explain how the interaction of a magnetic field induce by a current and a magnetic field between a horseshoe magnet can produce movement of the wire		
Explain the motor effect and use Flemings left hand rule to predict direction of movement		
Describe factors that can affect the size of the force acting on a wire and use F=BIl to calculate it		
Explain how an electric motor can produce a turning effect		

Required practical activities



Organise the method used to measure force and extension of spring:

- Adjust the ruler so that it is vertical. The zero on the scale needs to be at the same height as the top of the spring.
- Attach the ruler to the bottom clamp with the zero on the scale at the top of the ruler.
- Take a reading on the ruler – this is the length of the unstretched spring.
- Add further weights. Measure the length of the spring each time.
- Hang the spring from the top clamp.
- Attach the splint securely to the bottom of the spring. Make sure that the splint is horizontal and that it rests against the scale of the ruler.
- Carefully hook the base of the weight stack onto the bottom of the spring. This weighs 1.0 newton (1.0 N).



Risk Assessment:

Suggest what the risks are in this experiment. Describe what you should do to minimise the risks.

1.

2.

3.

What can you do to minimise errors in this experiment. For each part of the experiment suggest how it has been minimised:

- Adjust the ruler so that it is vertical.
- Attach the ruler to the bottom clamp with the zero on the scale
- Hang the spring from the top clamp
- Make sure that the splint is horizontal

What are the variables in this experiment:

Independent:

Dependent:

Control (describe how you might keep these from affecting your experiment):

Plan

Without turning over (!) write a step by step plan for measuring the extension of a spring when weights are put on.

Measuring the Extension against force

Force on Spring (N)	Extension (cm)
1N	8 cm
2N	12 cm
3N	16 cm
4N	17 cm
5N	17 cm

As the force increases, the extension ……………..

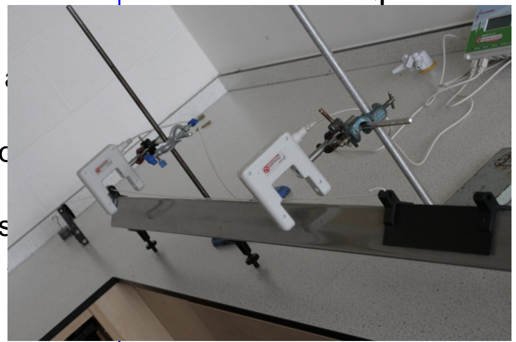
Until it reaches it's ……… of proportionality at …………….cm

<u>Complete the sketch graph</u>

Acceleration

Organise the method used to obtain results on acceleration:

- Connect the light gates to the interface and computer. Start the software for timing, telling the computer the length of card.
- Place the air track on a bench and attach it to the vacuum cleaner, set on 'blow'.
- Tie a length of string to the glider. Pass the string over the pulley and attach the weight stack to the other end of the string.
- Make sure the string is horizontal and is in line with the air track.
- Clamp the two light gates horizontally. Position them above the a so that the card passes through them as the glider moves.
- Switch on the vacuum cleaner. The glider should accelerate thro light gates as the weight falls to the ground.
- Place a glider with a piece of card attached on the air track and s on the vacuum cleaner. The glider should lift up off the air track free to move.



Risk Assessment:

Suggest what the risks are in this experiment. Describe what you should do to minimise the risks.

Variables

In the experiment, suggest what the following are:

Independent Variable:

Dependent Variable:

Two Control Variables (include how they are to be controlled)

1.

2.

Acceleration

Formula **Acceleration = change in velocity/time**

Complete the following calculations:

1. A mass accelerates from rest to 4 m/s in 8 seconds. What is the acceleration?
2. A mass accelerates from 2m/s to 8 m/s in 2 seconds. What is the acceleration?
3. A mass decelerates from 100 m/s to 50 m/s in 10 seconds. What is the deceleration?

Plan

Without turning over (!) write a step by step plan for measuring the acceleration of an object.

Looking for Correlations

Force (N)	Acceleration (m/s/s)
0.2 N	0.8 m/s/s
0.4 N	1.6 m/s/s
0.6 N	2.4 m/s/s
0.8 N	3.2 m/s/s
1 N	4.0 m/s/s

As the force increases…

Is the graph proportional?

What does this mean?

<u>Complete the sketch graph</u>

Radiation and Absorption

Organise the method used to measure Radiation and Absorption:

- Use the detector to measure the amount of infrared radiated from each surface.
- Draw a bar chart to show the amount of infrared radiated against the type of surface.
- Fill the cube with very hot water and replace the lid of the cube.
- Make sure that before a reading is taken the detector is the same distance from each surface.
- Place the Leslie cube on to a heat proof mat.

Precision

How might precision be affected and why by:

Changing an infra-red detector to:

A Digital Thermometer will …………………… because……………….. ………………………………………………………………………………………

An Analogue Thermometer will ………….. because……………….. ………………………………………………………………………………………

An Analogue Thermometer painted black will ……………………….…. because………………………..………………………………………………..

Complete the table of the properties of different types of surface

Surface	Good Emmiter?	Good Absorber?	Uses
Black (Shiny)			
Black (Matt)			
White			
Silver			

Risk Assessment

Suggest what the risks are in this experiment. Describe what you should do to minimise the risks.

1.

2.

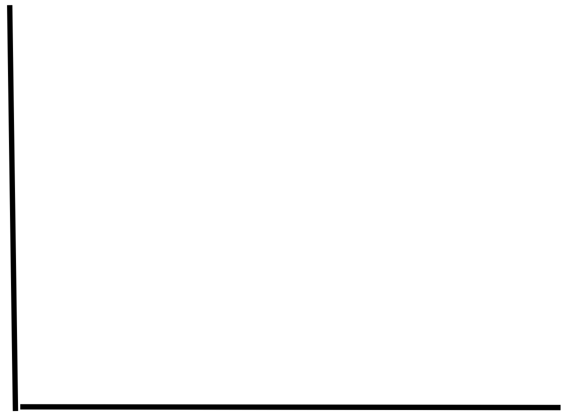
Plan

Without turning over (!) write a step by step plan for measuring radiation and absorption

Measuring the Radiation Emitted

Surface	Radiation Emitted
Matt Black	80
Shiny Black	72
White	35
Silver	12

<u>Complete the bar chart</u>



Waves

Organise the method used to prepare a microscope slide:

- Switch on the vibration generator. The elasticated cord should start to vibrate.
- Calculate the speed of the wave using the equation: wave speed = frequency x wavelength.
- Adjust the tension in the string or move the wooden bridge to adjust the length of the string, until a clear wave pattern is seen.
- Attach the signal generator to the vibration generator.
- The **frequency** is the frequency of the power supply.
- The waves should look like they are stationary.
- Use a metre ruler to measure across as many half wavelengths as possible (a half wavelength is one loop).
- Then divide the total length by the number of half waves. Multiplying this number by two will give the **wavelength**.
- Attach one end of a piece of elasticated cord to the signal generator and some masses on a pully to the other.

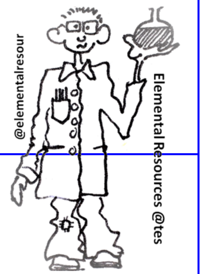
Precision and Accuracy

Describe and Explain how these changes would affect Precision and Accuracy:

Measuring the wavelength in mm
Affect:……………………………………………………………….
Explanation: …………………………………………………….
……………………………………………………………………………

Repeating the wavelength measurements , removing anomalous results and doing a mean average.
Affect:……………………………………………………………….
Explanation: …………………………………………………….
……………………………………………………………………………

One of your own suggestions:
……………………………………………………………………………
……………………………………………………………………………



Speed Of Waves

Formula
Speed = Frequency x Wavelength

Rearrange this formula to find:

Frequency =

Wavelength =

Units of **Speed** are……………..
Units of **Frequency** are……………..
Units of **Wavelength** are……………..

Help?
100cm = 1m

cm → m ÷100
m → cm x1000

1 cm = 100m

Calculations

Use the equations opposite to calculate the following:

1. If the frequency of the wave is 100Hz and the wavelength is 0.25m, what is the speed of the waves?
2. If the frequency of the wave is 250Hz and the wavelength is 0.2m, what is the speed of the waves?
3. If the frequency of the wave is 300Hz and the wavelength is 10 cm, what is the speed of the waves? (Remember to convert to m)
4. If the frequency of the wave is 1000Hz and the wavelength is 2cm, what is the speed of the waves? (Remember to convert to m)

Plan

Without turning over (!) write a step by step plan for measuring the speed of a waves.

Variables:

State what the variables are:

Independent:

Dependent:

Control Variables:

1……………………………

How would you control this variable so it did not affect the results?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

2……………………………

How would you control this variable so it did not affect the results?

…………………………………………………………………………………………………

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How would changing the mass affect the tension in the elastic?

…………………………………………………………………………………………………

How would it affect the speed of the wave? Why?

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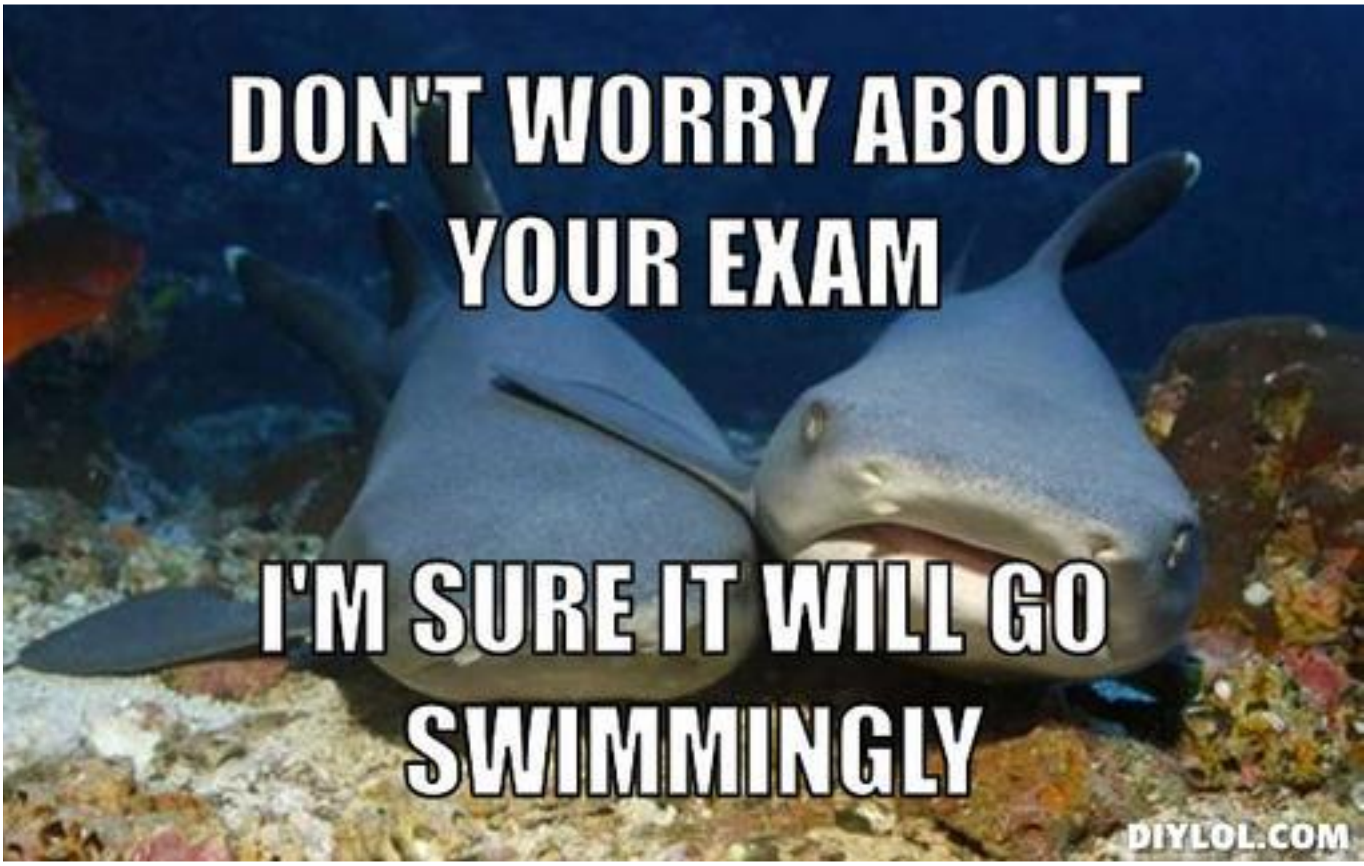
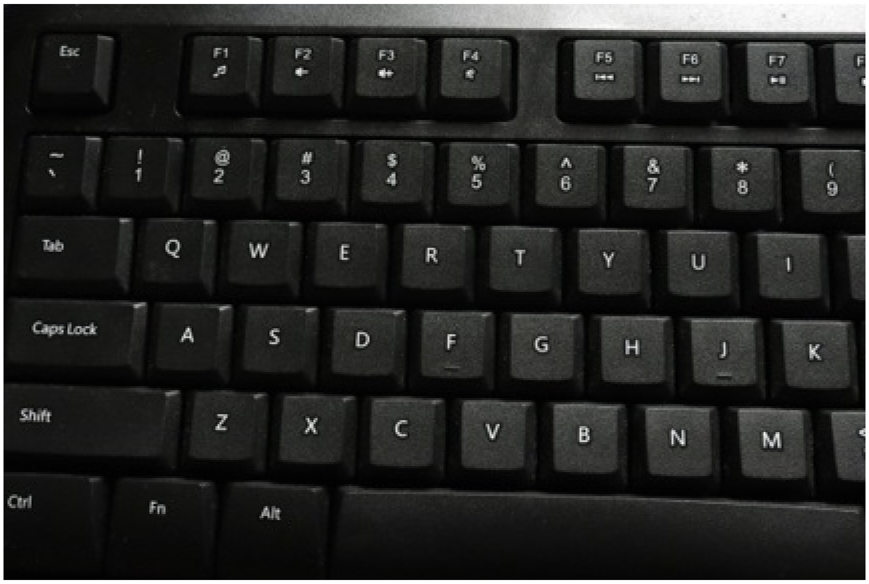
Exam questions



1. The photograph below shows a computer keyboard.

There is a spring under each key.



(a) The springs behave elastically when a force is applied.

What is meant by elastic behaviour?

Tick (✓) **one** box.

The spring will be compressed when the force is applied to it.	☐
The spring will become deformed when the force is applied to it.	☐
The spring will become longer when the force is removed.	☐
The spring will return to its original length when the force is removed.	☐

(1)

(b) Suggest **two** properties that should be the same for each spring.

1. ____

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2. ____

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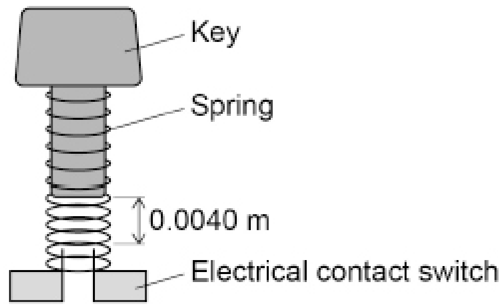
(2)

(c) **Figure 1** shows one of the keys and its spring.

Figure 1



The key must be pressed with a minimum force of 0.80 N before the key touches the switch.

Calculate the spring constant of the spring in **Figure 1**.

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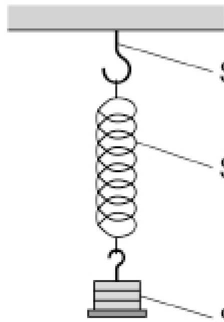
Spring constant = ________________ N/m

(3)

(d) **Figure 2** shows a spring that has been hung from a support.

The spring is stationary and has been stretched beyond its limit of proportionality.

Figure 2



Which **two** statements are true for the spring in **Figure 2**?

Tick (✓) **two** boxes.

The elastic potential energy of the spring is zero.	☐
The extension of the spring is directly proportional to the force applied.	☐
The upward force on the spring is equal to the downward force.	☐
The spring cannot be stretched any further.	☐
The spring is inelastically deformed.	☐

(2)
(Total 8 marks)

2. The speed limit on many roads in towns is 13.5 m/s

Outside schools this speed limit is often **reduced by** one-third.

(a) Calculate the reduced speed limit.

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Reduced speed limit = ________________ m/s

(2)

(b) A reduced speed limit may reduce air pollution.

Explain **one** other advantage of a reduced speed limit.

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(2)

(c) **Figure 1** shows a car being driven at a constant speed past a speed camera.

Figure 1

The camera recorded two images of the car 0.70 s apart.

The car travelled 14 m between the two images being taken.

The maximum deceleration of the car is 6.25 m/s^2

Calculate the minimum braking distance for the car at the speed it passed the speed camera.

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Minimum braking distance = ________________ m

(6)

(d) **Figure 2** shows a delivery van full of packages.

Figure 2

The driver delivers all the packages.

The empty van has a shorter stopping distance than the full van when driven at the same speed.

Explain why.

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(3)

(Total 13 marks)

3. The diagram shows some springs inside a mattress.

(a) Which proportionality is true when a force is applied to a spring?

Tick (✓) **one** box.

Example of an empty box table

Force ∝ energy stored	☐
Force ∝ extension	☐
Force ∝ length	☐
Force ∝ spring constant	☐

(1)

A mattress contains 1200 identical springs.

A person lies on the mattress and the springs compress.

The mean force on each spring in the mattress is 0.49 N

(b) Calculate the mass of the person.

gravitational field strength = 9.8 N/kg

Mass = ____________________ kg

(4)

(c) The mean compression of each spring is 3.5×10^{-3} m

Calculate the spring constant of each spring in the mattress.

Give the unit.

Spring constant = ____________________

Unit = ____________________

(4)

(d) For a given force, different springs compress by different amounts.

Explain what property of the springs would make the mattress soft.

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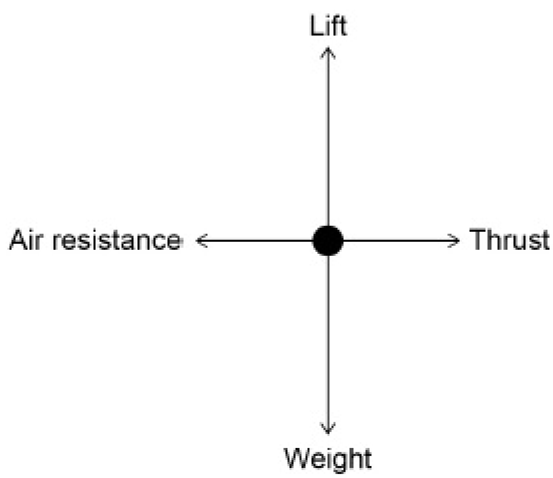
(2)
(Total 11 marks)

4. Below is a free body diagram for an aeroplane flying at a constant speed and at a constant height.

The speed of the aeroplane is much greater than the speed at which the aeroplane lands.



(a) Explain how the forces need to change so the aeroplane can land.

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(4)

(b) The aeroplane lands at a speed of 80 m/s

After landing, the aeroplane takes 28 s to decelerate to a speed of 10 m/s

The mean resultant force on the aeroplane as it decelerates is 750 000 N

Calculate the mass of the aeroplane.

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Mass = ____________________ kg

(5)

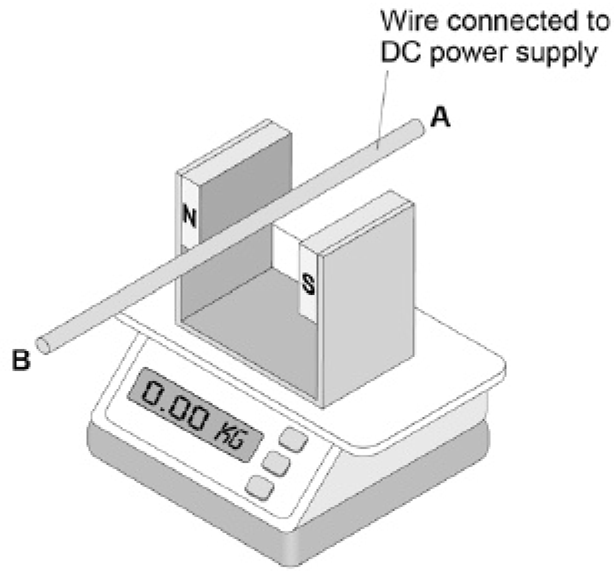
(Total 9 marks)

5. A student placed a permanent magnet on a top-pan balance.

He clamped a straight piece of wire so that it was suspended in the magnetic field.

Figure 1 shows the apparatus.

Figure 1



(a) When a current passed through the wire from **A** to **B**, the reading on the balance increased.

Explain why.

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(4)

(b) The student increased the current in the wire.

Sketch a graph on **Figure 2** to show the relationship between the current and magnetic force on the wire.

Label the axes, with the independent variable on the x-axis.

Figure 2

(2)

(c) The length of the wire in the magnetic field in **Figure 1** is 4.8×10^{-2} m

The current in the wire is 0.80 A

The reading on the balance is 1.2×10^{-3} kg

Gravitational field strength = 9.8 N/kg

Calculate the magnetic flux density of the permanent magnet.

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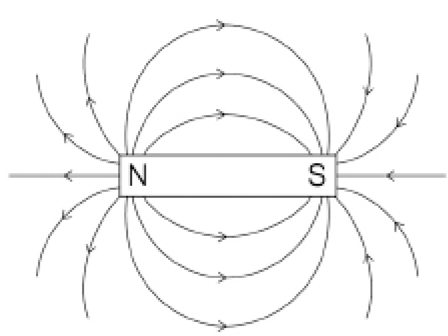
Magnetic flux density = ____________________ tesla

(5)

(Total 11 marks)

6. **Figure 1** shows the magnetic field pattern around a permanent magnet.

Figure 1



(a) Where is the magnetic field of the magnet the strongest?

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(1)

(b) How does **Figure 1** show that the strength of the magnetic field is not the same at all places?

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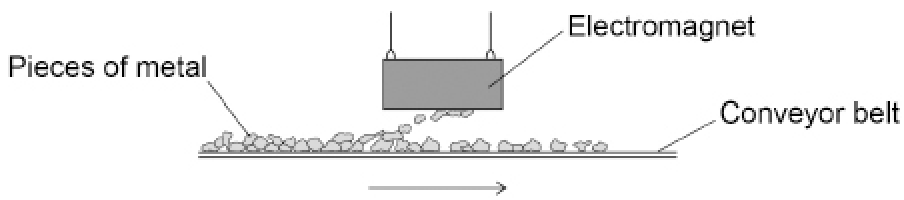
(1)

Figure 2 shows an electromagnet being used to separate iron and steel from non-magnetic metals.

Figure 2



(c) Explain **one** reason why an electromagnet is used instead of a permanent magnet.

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(2)

(d) Pieces of iron and steel are attracted to the electromagnet.

Name **two** other metals that would be attracted to the electromagnet.

1 ______________________________

2 ______________________________

(2)

(e) The design of the electromagnet **cannot** be changed.

Give **two** ways the force exerted by the electromagnet on a piece of iron or steel could be increased.

1 ____

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2 ____

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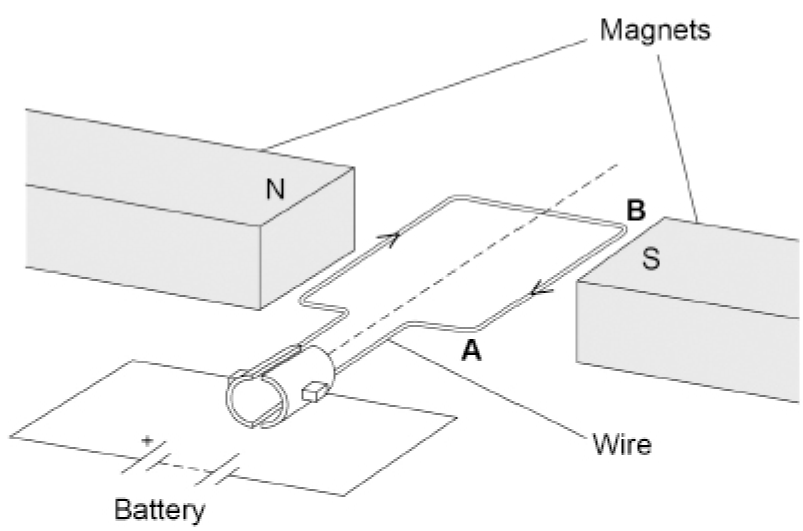
(2)

The conveyor belt that moves the pieces of metal is driven by an electric motor.

Figure 3 shows a simple electric motor.

Figure 3



(f) The length of the wire **AB** in the magnetic field is 120 mm.

There is a current of 4.0 A in the wire. The length of wire **AB** experiences a force of 0.36 N.

Calculate the magnetic flux density between the magnets.

Give the unit.

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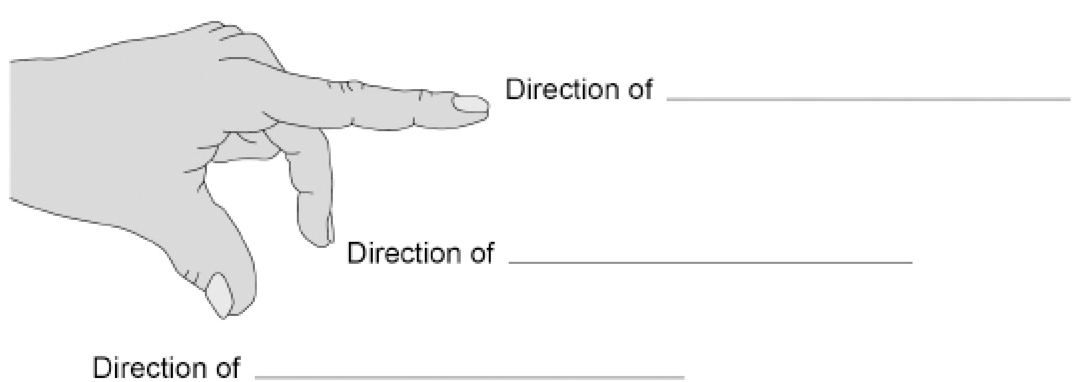
Magnetic flux density = ______________ Unit __________

(5)

(g) Fleming's left-hand rule can be used to determine the direction of the force on wire **AB**.

Complete the labels on **Figure 4** to show Fleming's left-hand rule.

Figure 4



(2)

(Total 15 marks)

7. A student made water waves in a ripple tank.

(a) Describe how the frequency and wavelength of the water waves in the ripple tank can be measured accurately.

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(4)

The student recorded values for the frequency and the wavelength of waves in the ripple tank.

Table 1 and **Table 2** show the results.

Table 1

Reading	**1**	**2**	**3**
Frequency in hertz	9.8	9.4	9.3

Table 2

Reading	**1**	**2**	**3**
Wavelength in cm	1.7	2.2	2.1

(b) Determine the mean wave speed.

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____

____

Mean wave speed = ________________ m/s

(4)

(c) What is the advantage of taking repeat readings and then calculating a mean?

____

____

(1)

(d) The speed of the wave is affected by the depth of the water in the ripple tank.

The deeper the water the faster the wave.

Explain how the depth of the water affects the wavelength of the wave if the frequency is constant.

____

____

____

____

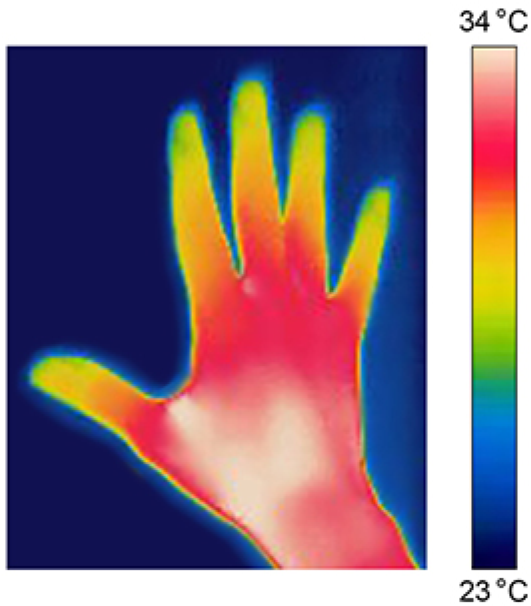
(2)

(Total 11 marks)

8. Different parts of the electromagnetic spectrum are used in medical imaging.

Figure 1 shows an Figure of a person's hand taken with an infrared camera.

Figure 1



(a) Explain why the infrared camera is able to show that parts of the hand are at different temperatures.

____

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____

____

(2)

(b) Infrared has a range of wavelengths from 700 nm to 1 mm.

Which part of the electromagnetic spectrum would have waves with a wavelength of 6.5×10^{-7} m?

Tick (✓) **one** box.

Infrared ☐

Microwaves ☐

Radio waves ☐

Visible light ☐

(1)

(c) **Figure 2** shows X-rays and gamma rays being used for medical imaging.

Figure 2

To use X-rays for medical imaging, a machine produces a very brief burst of X-rays.

To use gamma rays for medical imaging, a radioactive isotope is injected into the patient's blood. The isotope is circulated around the body in the blood. The isotope emits gamma rays.

Compare the potential risks to a patient of using X-rays and gamma rays for medical imaging.

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____

____

(4)

X-rays are produced by colliding high-energy electrons into a metal target.

The electrons have high energy because they are accelerated to high speeds.

Only a small proportion of the kinetic energy of an electron is converted into an X-ray when it collides with the metal target.

(d) An electron is accelerated through a distance of 15 mm.

The work done on the electron is 1.2×10^{-13} J.

Calculate the force on the electron.

___

___

___

___

___

Force = ________________ N

(3)

(e) The metal target is made from tungsten.

Tungsten has the highest melting point of any metal.

Explain why using tungsten as the metal target enables the X-ray machine to be more powerful.

___

___

___

___

___

___

(3)

(Total 13 marks)

Mark schemes

1. (a) the spring will return to its original length when the force is removed

1

(b) Any **two** from:

- spring constant
- (original) length
- diameter

2

(c) 0.80 = k × 0.0040

1

$k = \frac{0.80}{0.0040}$

1

k = 200 (N/m)

1

(d) the upward force on the spring is equal to the downward force

1

the spring is inelastically deformed

1

[8]

2. (a) $13.5 \times \frac{2}{3}$

1

9.0 (m/s)

allow 9 (m/s)

OR

$13.5 \times \frac{1}{3}$ = 4.5 (1)

13.5 - 4.5 = 9.0 (m/s) (1)

1

(b) reduced speed reduces stopping distance

allow reduces thinking / braking distance

1

means less chance of collision

OR

the car will have less kinetic energy (1)

so less likely to cause injury in the event of a collision (1)

1

(c) $14 = v \times 0.70$

1

$v = \frac{14}{0.70}$

1

$v = 20$ (m/s)

1

$0^2 – 20^2 = 2 \times (–6.25) \times s$

1

$s = \frac{20^2}{(2 \times 6.25)}$

ignore minus signs throughout

1

$s = 32$ (m)

1

(d) same maximum force applied by the brakes

1

because mass is less there is a greater deceleration

allow momentum for mass

1

braking distance is less

OR

reducing the mass reduced the kinetic energy of the van (at a given speed) (1)

less work needed to be done to bring the van to a stop (1)

(force from the brakes is the same) so braking distance is less (1)

1

[13]

3. (a) force $\propto$ extension

1

(b)

*an answer of 60 (kg) scores **4** marks*

F = 0.49 × 1 200
or
F = 588 (N)

1

588 = m × 9.8

allow a correct substitution using an incorrectly calculated value of F

1

$m = \frac{588}{9.8}$

allow a correct rearrangement using an incorrectly calculated value of F

1

m = 60 (kg)

allow a correct calculation using an incorrectly calculated value of F

1

OR

0.49 = mean mass per spring × 9.8 (1)

$\text{mean mass per spring} = \frac{0.49}{9.8}$ (1)

mean mass per spring = 0.050 (1)

m = 0.050 × 1200 = 60 (kg) (1)

1

(c)

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

$0.49 = k \times 3.5 \times 10^{-3}$

1

$k = \frac{0.49}{3.5 \times 10^{-3}}$

1

140

1

N/m

1

(d) springs with a low spring constant

1

because they can compress by a larger amount (for a given force)

allow they can compress by the same amount for a smaller force

allow low stiffness

1

[11]

4. (a) thrust decreases

allow air resistance or drag increases

ignore air resistance decreases as speed decreases

1

so there is a resultant force in opposite direction

allow so air resistance or drag is greater than thrust

1

lift must decrease (because weight stays the same)

1

so there is a resultant downwards force

allow so weight is greater than lift

the last two marking points cannot be awarded if there is a reference to the weight increasing

1

(b)

*an answer of 300 000 (kg) scores **5** marks*

$$a = \frac{(10-80)}{28}$$

allow $a = \frac{(80-10)}{28}$

1

a = (−)2.5 (m/s^2)

a valid equation must have been used to calculate a to score subsequent marks

1

(−) 750 000 = m × (−)2.5

allow a correct substitution using their calculated value of a

1

$$m = \frac{(-)750\ 000}{(-)2.5}$$

allow a correct rearrangement using their calculated value of a

1

m = 300 000 (kg)

allow a correct calculation using their calculated value of a

1

[9]

5. (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]

6. (a) at the poles

1

(b) the distance between the field lines varies

1

(c) electromagnet is easy to demagnetise

allow electromagnet can be switched off

1

so easy to remove separated metal

*allow electromagnet is (generally) stronger than a permanent magnet for **1** mark if no other marks are awarded*

1

(d) cobalt

1

nickel

1

(e) increases the current in the coil of the electromagnet

allow increase potential difference across the coil

1

bring the electromagnet closer to the pieces of iron and steel

1

(f) L = 0.120 m

1

0.36 = B × 4.0 × 0.120

allow a correct substitution of an incorrectly / not converted value of L

1

$B = \frac{0.36}{(4.0 \times 0.120)}$

allow a correct rearrangement using an incorrectly / not converted value of L

1

B = 0.75

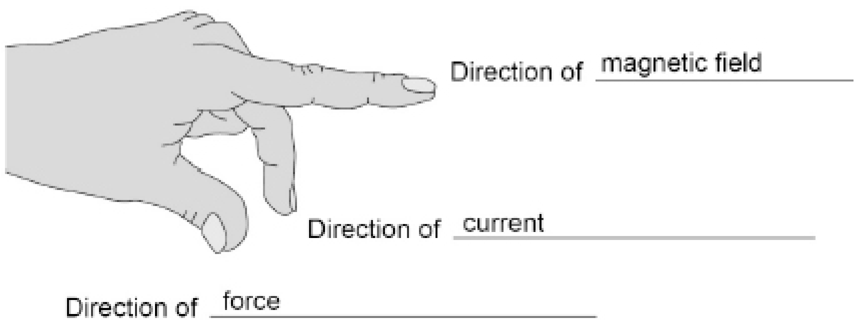
allow a correct calculation using an incorrectly / not converted value of L

1

T

1

(g)



allow **1** mark for 1 or 2 correct

2

[15]

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

3–4

Level 1: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.

1–2

No relevant content

0

Indicative content

Wavelength

- place a metre rule at the side of the screen perpendicular to the wave fronts
- use the metre rule to measure the length of the screen
- take a photograph of the shadow on the screen
- count the number of complete waves on the screen
- determine the wavelength by dividing the length of the by the number of complete waves

or

- place a metre rule at the side of the screen perpendicular to the wave fronts
- take a photograph of the shadow on the screen
- use the metre rule to measure the distance between two wave front

Frequency

- count the number of waves that pass a given point
- time how long it takes for the waves to pass that point using a stop clock
- frequency is number of waves divided by time taken

or

- put a stop clock on the screen
- use a digital video camera to record the waves passing a point
- replay in slow motion and count the number of waves passing a point in 1 second

There must be a description of both frequency and wavelength measurement to access level 2

(b) mean f = 9.5 Hz

1

mean λ = 0.020 m

1

v = 9.5 × 0.020

allow a correct substitution of an incorrect value of mean frequency and/or wavelength

1

v = 0.19 (m/s)

allow a correct calculation using an incorrect value of mean frequency and/or wavelength

1

or

v = 9.8 × 0.017
and
v = 9.4 × 0.022
and

v = 9.3 × 0.021 (2)

$$v = \frac{(1.67 + 2.07 + 1.95)}{3} \text{ (1)}$$

v = 0.19 (m/s) (1)

*allow a maximum of **2** marks if a single pair of values is used*

(c) reduces the effect of random errors

allow anomalous readings can be discarded before calculating a mean

1

(d) deeper water means longer wavelength

1

because

v increases and f is constant

allow for a fixed frequency period is constant

1

[11]

8. (a) different temperatures emit different intensities of infrared

1

which are represented (on the infrared camera) as different shades / colours

allow wavelength / frequency / amount for intensity throughout

1

(b) visible light

1

(c) both ionising radiation so some risk of cancer

1

the whole body is irradiated by gamma rays

1

when an X-ray is taken only part of the body is exposed

1

exposure time for gamma rays is longer

1

(d) $1.2 \times 10^{-13} = F \times 0.015$

1

$F = \frac{1.2 \times 10^{-13}}{0.015}$

allow a correct rearrangement using an incorrectly / not converted value of s

1

$F = 8.0 \times 10^{-12}$ N

allow 8×10^{-12} allow a correct calculation using an incorrectly / not converted value of s

1

(e) some of the energy of the electrons causes heating

1

(therefore) increasing the temperature

1

(so using tungsten) allows more electrons to be collided per second than using any other metal

allow (so using tungsten) enables more energy per second to be transferred than using any other metal

1

[13]