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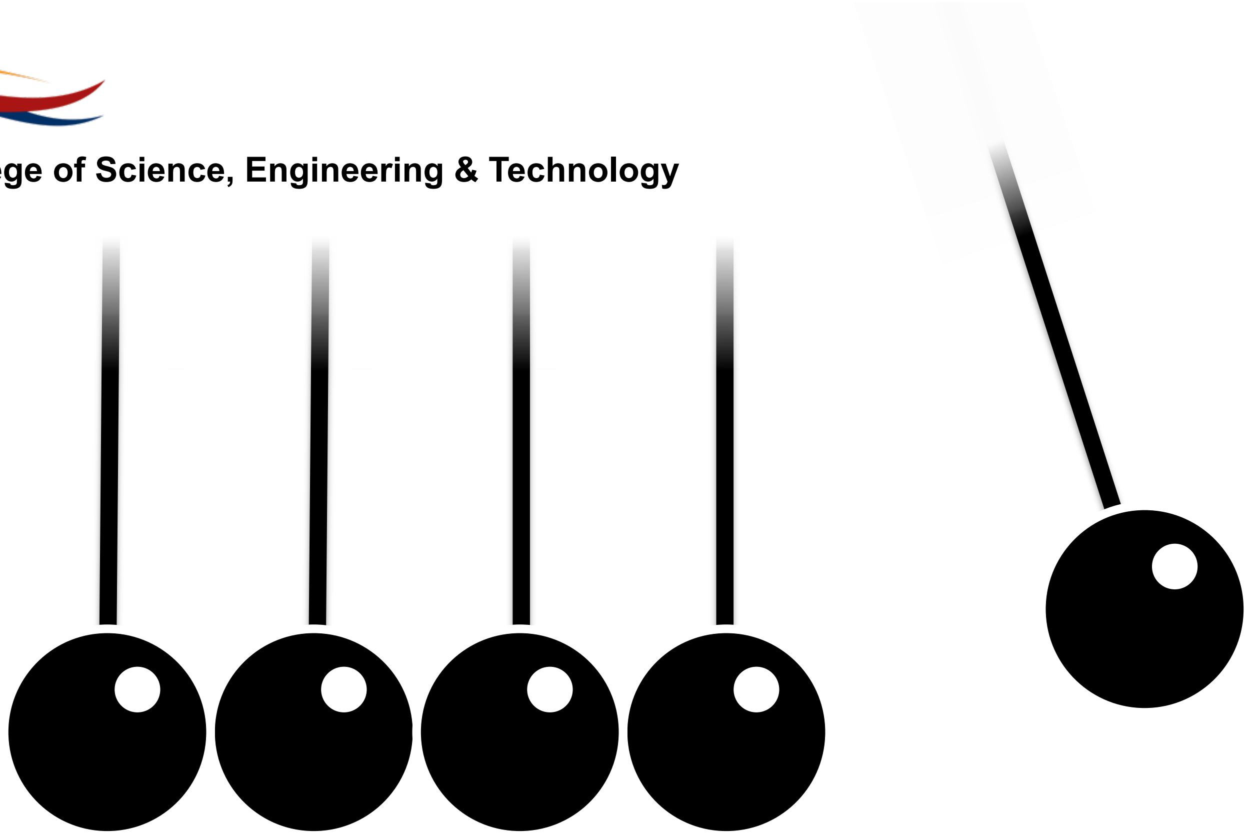

Grade 10 Physics

QUESTIONS

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Pulses and Waves

1.1. A vibrating bar completes 5 cycles every 4 seconds. Attached to the bar is a tensioned string, through which the vibrations are transferred in the form of waves.

1.1.1. What will the frequency of the wave produced be?

1.1.2. What speed will the wave travel at if the wavelength of the wave is 10m?

1.2. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**

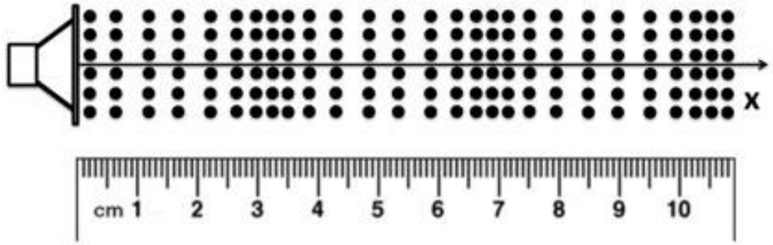
A wave traveling through the ocean moves 200m in ten minutes.

1.2.1. What is the speed of this wave?

1.2.2. Calculate the time it will take for one cycle of the wave to pass by if the wavelength of the wave is 15m.

1.3. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**

Consider the diagram showing position of some air particles to the right of a loudspeaker.

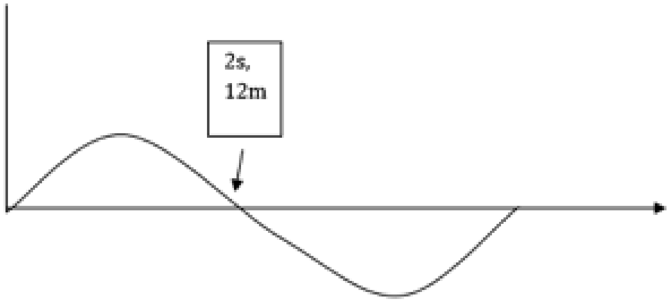


1.3.1. Use the scale (provided above) to measure the wavelength.

1.3.2. Calculate the speed of sound if the frequency of the speaker is 8800 Hz.

1.4. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**

Study the waveform shown below and answer the following questions:



1.4.1. What is the wavelength of this wave ?

1.4.2. What is the frequency of the wave ?

1.4.3. Calculate the velocity of the wave.

1.5. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**

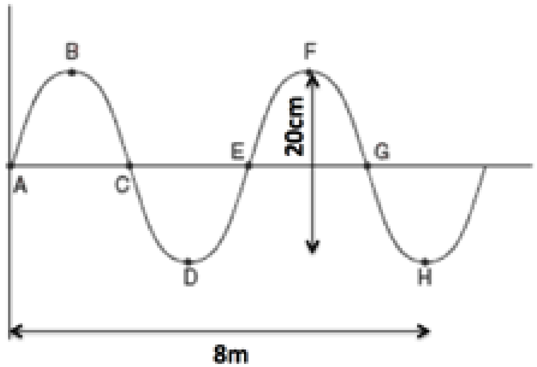
An earthquake under the sea causes waves in the sea. An observer on a ship counts 10 crests passing by in an hour. The distance from the top of one crest to the top of the next crest is 100m.

1.5.1. Calculate the frequency of the water waves.

1.5.2. Calculate the velocity of the water waves

1.6. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**

Study the wave pattern. It takes 0.3s to complete the pattern from A to H.



1.6.1. Define the term amplitude.

1.6.2. Explain the difference between period and frequency

1.6.3. Name any two points that are in phase.

1.6.4. Determine the wavelength of the wave.

1.6.5. What is the amplitude of the wave?

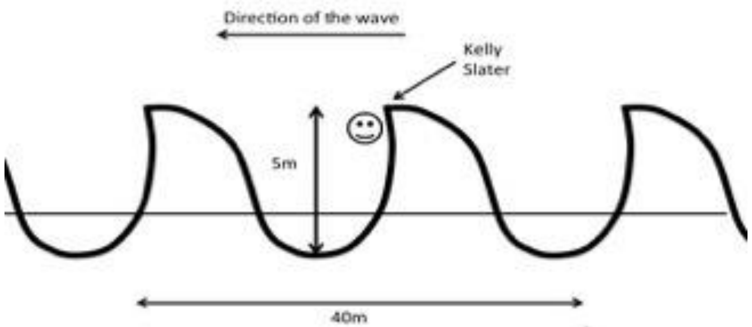
1.6.6. What is the period of the wave?

1.6.7. Calculate the frequency of the wave.

1.6.8. Calculate the speed of the wave.

1.6.9. Determine how long it will take the wave to travel a distance of 20m.

1.7. Kelly Slater is a professional surfer. He is currently preparing for the Billabong Pro Surf competition.

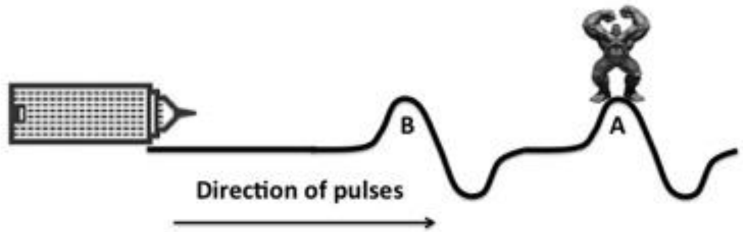


From studying the waves, Kelly's coach determined that 1 wave will come past Kelly every 10 seconds.

1.7.1. Determine the frequency of the waves.
1.7.2. Calculate how fast the waves are traveling.
1.7.3. How many waves will Kelly ride if he is training for **an hour** and only "catches" every **10th wave**?
1.7.4. Consult the diagram and, by taking the direction of the waves into consideration, will Kelly "catch" the wave he is on? Explain your answer.
1.7.5. After doing all the calculations, Kelly's coach wants to share all the answers with him but unfortunately Kelly is too far from the beach.
1.7.5.1. Will Kelly's coach need to increase his voice's amplitude or frequency in order for Kelly to hear him? Explain why.
1.7.5.2. If the coach shouts 3 times in 10 seconds, determine the frequency of his shouting
1.7.5.3. Sound travels at $340 ms^{-1}$ at sea level. Determine the wavelength of the coach's voice if the frequency is 256 Hz.
1.7.5.4. It takes Kelly 0.6 seconds to react to his coach's voice. How far is Kelly away from his coach?
1.7.6. Even though the sun is an excellent source of energy, the energy it provides can be very harmful to humans.
1.7.6.1. Ultraviolet rays with a frequency of 1×10^{14} Hz are released by the sun over Jeffrey's Bay area. Calculate the amount of energy the ultraviolet photons have.
1.7.6.2. Explain by referring to the answers in 7.3.1 why Kelly Slater should rather wear a wetsuit while taking part in the competition.

1.8. In the movie The Avengers 2: Age of Ultron, the group of superheroes known as the Avengers need to fight as a team to defeat the mechanical army of the evil Ultron.
1.8.1. During the fight, Captain America protects himself with his shield from a punch thrown by one of mechanical soldiers. The soldier's punch lands perpendicularly onto his shield and causes the shield to vibrate.
1.8.1.1. Captain American notices that the vibrations on the shield follow a wavelike pattern. What type of wave is he observing?
1.8.1.2. Draw a diagram of a wave representing how the molecules would move due to the vibration. Indicate on your diagram an amplitude, a wavelength, two particles in phase and label these characteristics.
1.8.1.3. The shield blocks two punches simultaneously. Midway between the punches, Captain America observes a bigger vibration on his shield. Which wave characteristic causes this phenomena to occur?
1.8.1.4. Captain America sees the bigger vibrations 4 times every 10 seconds. What is the frequency of the vibrations on his shield?
1.8.1.5. Calculate the speed of the vibrations if the distance between each bigger vibration is 5mm.

1.8.2. The mechanical army of Ultron causes a lot of damage to the city. A section of a building falls onto the street in which the Hulk is standing. The impact of the building falling onto the street creates multiple shock pulses. The diagram below is a representation of the situation.



1.8.2.1. Will the Hulk's next movement be up, down, left or right.
1.8.2.1.1. from where he is currently positioned? (pulse A)
1.8.2.1.2. when pulse B reaches him?
1.8.2.2. The Hulk uses his supernatural strength to make a sonic clap that destroys the fallen building.
1.8.2.2.1. What type of wave pattern will the sonic clap cause amongst the particles surrounding the Hulk?

1.8.2.2.2. By referring to the wave pattern mentioned in your previous answer, explain why the clap destroyed the building.

1.8.3. The sonic clap was so powerful that it disrupted Ultron's flying abilities, which caused him to crash. The Hulk screams loudly as Ultron comes crashing down. Thor is fighting his own battle against many soldiers 400m away from where the Hulk is, but doesn't stop when he hears the Hulk's scream.

1.8.3.1. Was it due to high frequency or a high amplitude that Thor could hear the Hulk's scream from so far away? Explain your answer.

1.8.3.2. If sound travels at 330ms^{-1}, how long did it take the Hulk's scream to reach Thor?

1.8.3.3. When Thor hits a soldier with his hammer, it makes a sound when it vibrates. Explain why it makes a deeper sound compared to the sound of Captain America's shield (Refer to shapes and surface area).

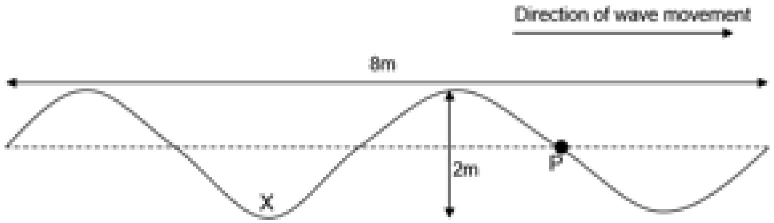
1.8.3.4. Is sound a transverse or longitudinal wave?

1.8.4. Ultron crashes near Ironman. Ironman fires a repulsor ray from his palm at Ultron, but Ultron ducks and the shot misses. Ultron fires a laser beam back at Ironman that hits him in the chest.

1.8.4.1. Calculate the amount of energy a photon of the laser beam has if it has a frequency
of 10^{18} Hz.

1.8.4.2. Ironman's suit is made from an alloy that can withstand 6,63 x 10^{-10} J of energy. Will he survive the laser beam shot from Ultron?

1.9. Study the wave below and answer the questions that follow.



1.9.1. What is a wave like this called, where the direction in which the medium is displaced is perpendicular to the direction in which the wave propagates?

1.9.2. How many complete waves are shown above?

1.9.3. Calculate the wavelength of the wave.

1.9.4. In which direction is point P moving?

1.9.5. What is the part of the wave at X called?

1.9.6. What is the amplitude of this wave?

1.9.7. Suppose these waves move a distance of 500 m in 25 seconds. Calculate the speed of the wave.

1.9.8. Calculate the frequency of this wave.

1.10. In 2011, a mega tsunami struck the coast of Japan. The water moved inland as far as 10km, destroying homes, infrastructure and nuclear power plants. The waves from the earthquake also reached Chile (17 000km away), and even broke icebergs off the Sulzberger Ice Shelf in Antarctica. The earthquake produced a low-frequency rumble called infrasound, which traveled into space and was detected by the Goce satellite.

1.10.1. Determine the speed of the wave if it reached Chile 21 hours after it was formed.

1.10.2. The wavelength of a tsunami can reach up to 100km. Determine;

1.10.2.1. The frequency of the wave.

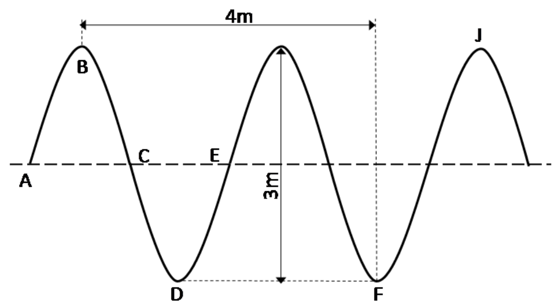
1.10.2.2. The time between each wave.

1.10.3. As the wave travelled towards Chile, it lost some energy along the way. Which variable will change due to a loss of energy in the wave?

1.10.4. Explain what is mean by "infrasound".

1.10.5. If the tsunami was formed 72 km for the coastline, determine how much time people had to get to safety.

1.11. The diagram below represents a water wave moving from left to right. The time between two consecutive crests is 0,4s.



1.11.1. What type of wave is a water wave?

1.11.2. Write down the amplitude of the wave.

1.11.3. Identify any 2 points in phase.

1.11.4. Determine the wavelength of the wave.

1.11.5. Calculate the wave frequency.

1.11.6. Calculate:

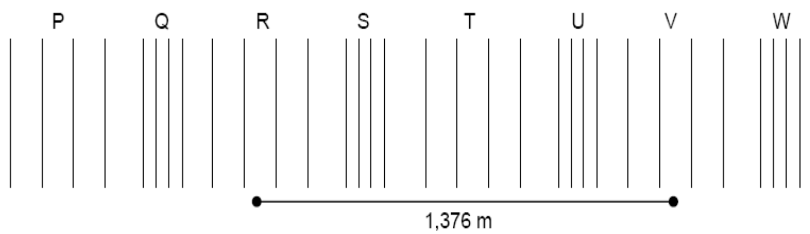
1.11.6.1. The time taken for FOUR crests to move past a certain point in the path of the wave
1.11.6.2. The speed of the wave

Sound and EM Spectrum

2.1. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
94.7 is a radio station that broadcasts using radio waves of frequency 94.7 MHz. Answer the following questions:
2.1.1. How many times a second does an electron in the radio broadcasting antennae move up and down the antennas?
2.1.2. What is the wavelength of the radio signals sent out by this radio station?
2.1.3. Draw a sketch showing how the Electric field and the Magnetic field propagate from the antennas.

2.2. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Light travels at 300 000 000 ms^{-1} in a vacuum.
2.2.1. How fast do radio waves travel?
2.2.2. Calculate the wavelength of microwaves of frequency 3×10^{10} Hz.
2.2.3. Calculate the wavelength of ultraviolet radiation of frequency 10^{15} Hz.
2.2.4. Calculate the wavelength of the 80 MHz waves used for broadcasting on VHF?
2.2.5. What is the frequency of the 1 500 m radio waves used on the Long Wave Band?

2.3. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
The following pattern of a sound wave associated with human speech at 60 dB, has a frequency of 500 Hz:

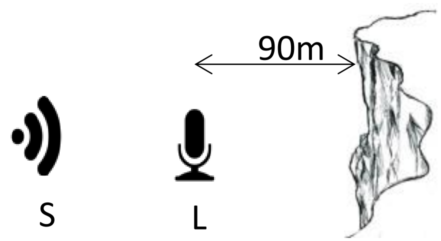


2.3.1. Draw the corresponding particle position versus time graph of the wave shown above. Indicate ALL the corresponding points on the graph.
2.3.2. Write down the letters of TWO consecutive points on the wave, which are in phase.
2.3.3. Calculate the period of this wave.
2.3.4. Calculate the speed of this wave.

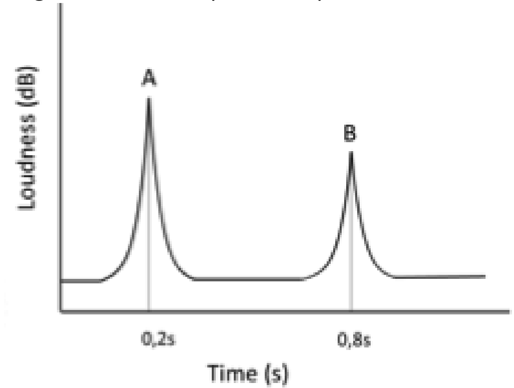
2.4. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Answer the following:
2.4.1. Draw a fully labelled diagram showing 2 cycles of a sound wave with a frequency of 45Hz. All characteristics of the wave must be indicated.
2.4.2. Sound travels at a speed of 340ms^{-1} in air. How far will this sound wave travel during 2 cycles?

2.5. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Answer the following:
2.5.1. A stationary bat emits a squeak. It takes 0,018s for the echo to return to the bat. The speed of sound in air is 345 ms^{-1}. Calculate how far the bat is from the obstacle.
2.5.2. Sound waves are disturbed by objects that are comparable to, or larger than, their wavelength. The maximum frequency that bats can emit is $1,2 \times 10^5$ Hz. Calculate the diameter (in mm) of the smallest object that a bat can detect.

2.6. A group of learners want to experimentally determine the speed of sound in air. They set up a sound source (S) and a listening device (L) at various distances from each other. In one instance, the listening device is set 90m from a large, rocky cliff face as shown.



They send out a loud beep, and simultaneously start the listening device. The listening device produced a graph as shown below, where point A represents the original sound and point B represents the echo.



2.6.1. Write an aim for this investigation.
2.6.2. Identify the following variables:
    2.6.2.1. Independent
    2.6.2.2. Dependent
2.6.3. Determine the speed of sound in air.
2.6.4. Calculate how far the source (S) was positioned from the listening device (L).
2.6.5. Explain why B is not as loud as A.
2.6.6. How will the speed of sound change if the following changes are made? Write only “**INCREASE”, “DECREASE” or “STAY THE SAME”.**
    2.6.6.1. Decreased frequency:
    2.6.6.2. Increased loudness of source:
    2.6.6.3. Increased air temperature:
    2.6.6.4. Decreased altitude:
2.6.7. Explain your answer for Question 2.6.6.3 and Question 2.6.6.4 above.

2.7. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Thato stays in a village in KwaZulu-Natal. On a very cloudy day, he wants to determine the direction in which a thunderstorm is moving. He measures the time between seeing the lightning flash and hearing the sound. Below is a table of his results. The time taken for the light to reach him is negligibly small because the speed of light is so large.

Lightning no.	Time between sound and flash (s)
1	3,25
2	2,84
3	2,08
4	2,39
5	1,64

2.7.1. Determine how far away from Thato the first lightning strike took place, if the speed of sound in air is $340 m.s^{-1}$.
2.7.2. Determine the distance between the 2nd and 3rd strike.
2.7.3. Show by calculation why the time taken for the light from the lightning strike is negligibly small.
2.7.4. Is the storm moving towards Thato or away from him? Provide a reason for your answer.

The light from a lightning strike and the light from the sun are both part of the electromagnetic spectrum. The light from the sun is formed from the energy released when nucleur reactions take place on the surface of the sun.
2.7.5. Explain why we can see the light from the sun, but cannot hear the sound of the explosions from the sun.
2.7.6. The sun is 149,6 million km from the earth, determine how long it takes for the image of the sun to reach the earth.

Alpha Centauri is the nearest star to earth, and is 4,3 light-years away. That means that the image we see of Alpha Centauri was produces 4,3 years ago!
2.7.7. Calculate the distance between Alpha Centauri and earth in km.

2.8. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Bathymetry is the study of underwater depth of lake or ocean floors by using echo location. A fathometer is used to measure the depth by transmitting sound waves into the water and measuring the time taken for the reflection to return. The sound used has a frequency of 24kHz, and a wave speed of $1490 m\cdot s^{-1}$ in water.
2.8.1. Define the term *frequency*.

2.8.2. Calculate the wavelength of the sound used.
2.8.3. Would a diver in the water under the boat be able to hear the sound? Provide a reason for your answer.

While mapping a part of the ocean, the fathometer registers a signal 0,28s after sending it out. If the speed of sound in water is $1490 m.s^{-1}$,
2.8.4. Calculate the depth at that point.
2.8.5. If the measurement is only accurate to 1 wavelength, determine the percentage certainty of this depth measurement.

Lake Victoria, the largest lake in Africa, has an average depth of 40m.
2.8.6. Calculate the percentage accuracy of a measurement at this depth using a 24kHz fathometer.
2.8.7. How can the percentage accuracy be improved? Provide a reason for your answer.
2.8.8. Which property of waves allow them to be used in bathymetry.

2.9. 5FM broadcasts on a frequency of 98,0MHz.
2.9.1. State which type of electromagnetic wave is used for 5FM to broadcast.
2.9.2. Calculate the wavelength of the broadcast.
2.9.3. Determine how long it would take the signal to travel 9km.

Another radio station, RSG, broadcasts along a spectrum from 100MHz to 104MHz.
2.9.4. Calculate the energy of a quantum of an RSG wave if broadcast at 103,5MHz.
2.9.5. Explain how this electromagnetic wave would be created and propagated through the air.

2.10. Ultraviolet radiation can be used to kill bacteria, and is also responsible for sunburn.
2.10.1. What is the relationship between the energy transferred by a quantum of EM radiation and its penetrating ability?
2.10.2. For an ultraviolet wave of 10^{16}Hz, calculate:
2.10.2.1. Wavelength
2.10.2.2. Energy of a photon of UV

Infrared radiation is also part of the electromagnetic spectrum and is observable as heat.

2.10.3. With reference to applicable wave properties, explain why it is possible to become sunburnt on a cloudy day even when you don't feel hot.
2.10.4. Determine the period of infrared oscillations with a frequency of 10^{12}Hz.
2.10.5. Except for producing heat, provide one technological use of infrared radiation.

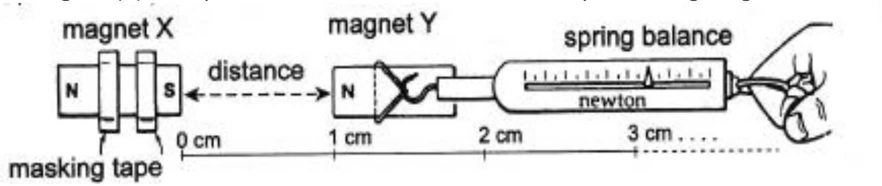
Between ultraviolet and infrared is the visible spectrum which makes up all observable light.3 samples of visible light have the following properties:

Light 1- frequency of $5,56 \times 10^{14}$ Hz
Light 2- wavelength of 605nm
Light 3- period of $1,37 \times 10^{-15}$ seconds

These lights have the colours orange, green and violet.
2.10.6. Determine the colour of the 3 light samples.

Magnetism

3.1. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Steven wants to investigate the relationship between the force of attraction and the distance between two identical bar magnets. A bar magnet (X) is fixed onto a lab bench with masking tape and equal distances of 1cm each are measured from its S-pole up to a distance of 9cm. A spring balance is fastened to another identical bar magnet (Y), and placed on the bench with its north pole facing magnet X.



Steven pulls the spring balance so that magnet Y is a distance of 1cm from magnet X. He takes a reading on the scale to acquire the magnitude of the force of attraction (in N) between two magnets. He continues taking readings off the scale for the forces of attraction between the magnets at increments of 1cm until the magnets are 9cm from each other.
3.1.1. Write an investigative question for this experiment.
3.1.2. Write a hypothesis for the investigation, stating the relationship between distance and the magnetic field.
3.1.3. Write down the following:
3.1.3.1. Independent variable
3.1.3.2. Dependant variable
3.1.3.3. Controlled variables

The following table gives the readings that Steven got off the spring balance at the marked distances.

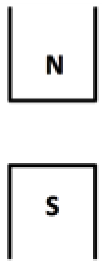
Distance between X and Y (cm)	1	2	3	4	5	6	7	8	9
Force of attraction (N)	4.5	2.3	1.6	1.2	0.9	0.8	0.7	0.6	0.5

3.1.4. Use the values in the table above to plot a graph of force (in N) versus distance (in cm) between magnets X and Y.
3.1.5. What conclusion can be made from the shape of the graph?
3.1.6. What will the force of attraction between magnets X and Y be if they are 1.5cm from each other?
3.1.7. At what distance between magnet X and Y will the force of attraction between them be 1,25N?
3.1.8. Sketch the magnetic field patterns that exist between magnet X and Y.

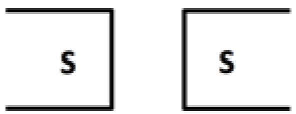
Magnet X is now turned around

3.1.9. What will the nature of the force between the magnets be?
3.1.10. Sketch the magnetic field patterns that will now exist between the magnets

3.2. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Copy and complete the diagrams by drawing in the magnetic field lines for each diagram:
3.2.1.

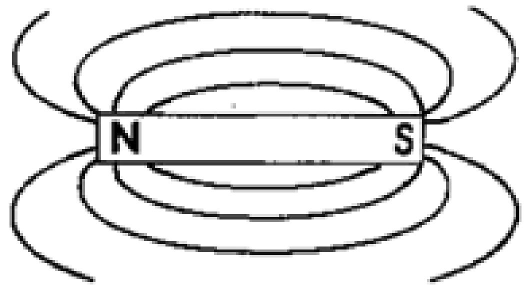


3.2.2.



3.2.3. State three properties of magnetic field lines.
3.2.4. Briefly explain how the polar auroras are formed.
3.2.5. Why can auroras only be seen near the earth's magnetic poles?
3.2.6. Briefly describe what magnetic domains are and explain the difference between unmagnetised and magnetised materials.

3.3. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
3.3.1. The diagram below shows magnetic field lines around a magnet. The direction



is not shown. Redraw the diagram below and fill in the direction of the field lines.

3.3.2. On the diagram below, two north ends are pointed towards each other. Draw the pattern of iron fillings you would see if you placed iron filings between the two magnets

3.3.3. What force is experienced by the north poles?
3.3.4. Describe a magnetic field.
3.3.5. Explain the difference between hard iron and soft iron.
3.3.6. Describe how you can magnetise a piece of iron, using electricity.

3.4. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
3.4.1. Briefly mention two methods that can be used to destroy a magnet.
3.4.2. " A compass is used to determine the polarity of a magnet."
Explain why a magnet will only attract a compass when it is relatively close to its north or south pole end
3.4.3. Explain two advantages of the use of magnets in society

3.5. "An un-magnetized ferromagnetic substance consists of magnetic domains"

3.5.1. Give an example of a ferromagnetic substance.

3.5.2. What is a magnetic domain?

3.5.3. What happens to these domains when a strong magnet is brought close to it

3.5.4. What is the difference between a hard ferromagnetic substance and a soft ferromagnetic substance? Give an example of each.

3.5.5. Below is a diagram representing three wooden toy trains. They each have a north and a south pole.

Pole B attracts pole P

Pole Q attracts pole X

Would the following poles attract or repel each other if they were brought close together?

3.5.5.1. Pole B and pole X
3.5.5.2. Pole A and pole Q
3.5.5.3. Pole B and pole Y

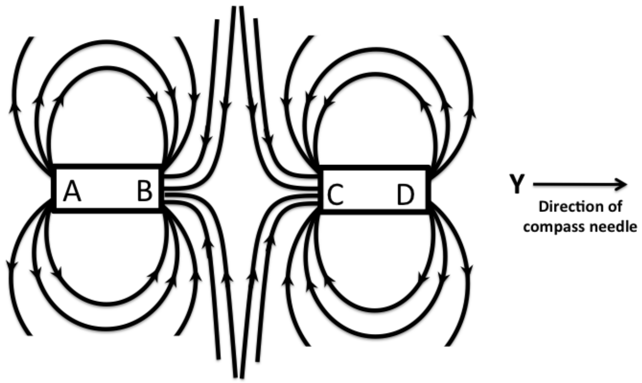
3.6.

3.6.1. Name an example of a hard ferromagnetic and a soft ferromagnetic substance.
3.6.2. Explain the difference in magnetic field lines of two magnets with different strengths.
3.6.3. Why does a permanent magnet lose its magnetism above the Curie temperature?
3.6.4. Give examples of every day uses of magnets.

3.7.

3.7.1. Define the term magnetic field.
3.7.2. What general term is used to describe materials that have magnetic properties?

The diagram below shows the magnetic field pattern of two identical bar magnets with ends AB and CD.



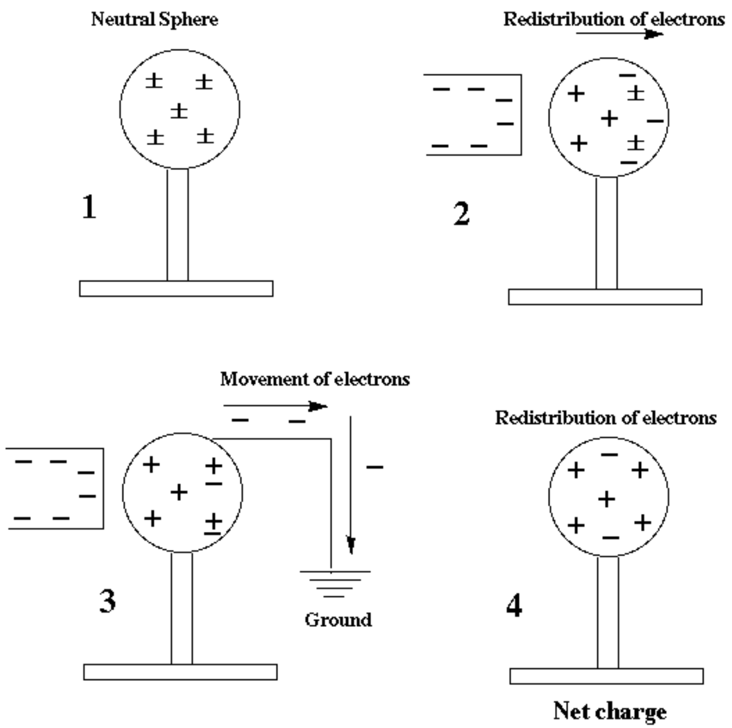
3.7.3. What important information about the polarities of B and C is obtained from the diagram?
3.7.4. A small piece of magnetic material is placed in the middle of the arrangement. Will the material move? Write down only YES or NO.

A small compass is placed at point Y. The north pole of the compass points AWAY from D.

3.7.5. Do the field lines inside the magnet CD point from C to D, or from D to C? Give a reason for your answer.
3.7.6. Give a reason why the Earth's magnetic field is so important to our existence.

Electrostatics

4.1. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Kevin and Sarah perform an investigation on the nature of electrostatic charge on a metal sphere in the following way:



1. They place a neutral sphere on an insulated stand.
2. They bring a negatively charged rod close to the sphere.
3. The sphere is earthed.
4. The pathway to earth is removed and the negatively charged rod is removed.

ANSWER THE FOLLOWING QUESTIONS:

4.1.1. Why does the sphere in Figure 1 have to be placed on an insulated stand?
4.1.2. In Figure 2 a negatively charged rod is brought close to the sphere which polarises the sphere. Identify where the positive and negative sides will be?
4.1.3. Name the polarisation method used in Figure 2, and explain how it forms a charge on the sphere.
4.1.4. In Figure 3 the connection on the other side of the sphere is earthed. Explain the movement of the charges on the sphere.

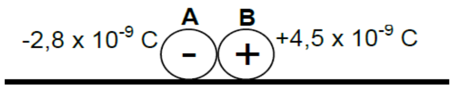
In Figure 4 the earth connection is removed once again:

4.1.5. What will the nature of the charge on the sphere be now? Give a reason for your answer.

They rub a glass rod with a wool cloth, giving the rod a positive charge:

4.1.6. Will the rod be attracted or repelled by the sphere?
4.1.7. Name the polarisation method used to charge the glass rod.
4.1.8. State whether the following statement is true or false, and give a reason for your answer:
The rod is positively charged because the wool cloth has transferred protons to the rod.

4.2. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Two identical metal spheres, A and B, on an insulated surface carry charges of -2,8 x 10^{-9} C and +4,5 x 10^{-9} C respectively. The spheres are brought in contact with each other.



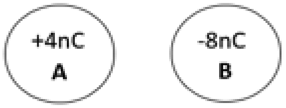
4.2.1. Determine the amount of electrons that were transferred to A to acquire an initial charge of -2,8nC.
4.2.2. Name the law/principle applicable to the calculation in 2.1.
4.2.3. It is observed that the spheres move apart after contact. Briefly explain this observation.
4.2.4. Calculate the charge on B after the spheres have been in contact.
4.2.5. Name the law/principle applicable to the calculation in 2.4.

The two spheres are separated and sphere B is suspended from a light, inelastic string:

4.2.6. Explain what will happen if a negatively charged rod is brought close to sphere B
4.2.7. State whether the following statement is true or false, and give a reason for your answer: A sphere caries a charge of 2,8x10-19C.

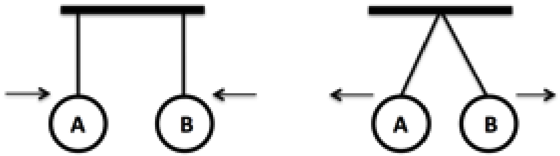
4.3. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
4.3.1. State the principle of the conservation of charge

4.3.2. Two identical spheres with charges as indicated in the diagram are brought closer together so that they touch. Then they are separated again.



4.3.2.1. What would the charge on each be after separation?
4.3.2.2. In which direction did the electrons move: A to B or B to A?
4.3.2.3. Will the spheres attract or repel each other after touching? Give a reason for your answer.
4.3.2.4. Charge B then comes into contact with a neutral sphere. What is the new charge on B after this contact?
4.3.2.5. How many electrons were transferred to the neutral sphere?

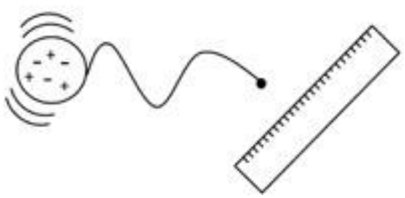
4.3.3. A is a negatively charged balloon. It attracts balloon B when brought closer to B. Balloon A and B touch each other and then move apart under mutual forces of repulsion.



State whether the following statements are true (T) or false (F) concerning balloon B before it touches A.
4.3.3.1. B may be positively charged
4.3.3.2. B may be negatively charged
4.3.3.3. B may be neutral

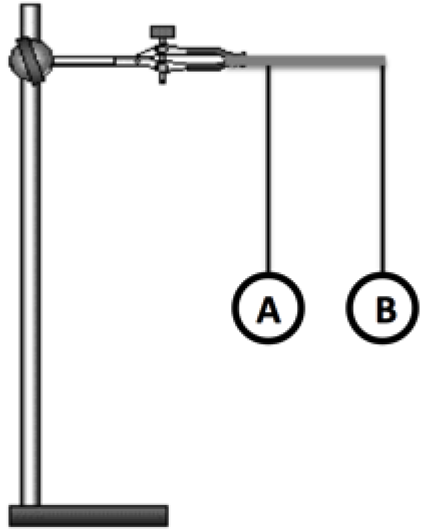
4.3.4. What type of charge on B when the balloons move apart? Give a reason for your answer.

4.3.5. Stephani and Alice would like to do an experiment to investigate what happens when a charged object like a ruler is brought close to a neutral object. They have a small neutral ball attached to a piece of string and a Perspex ruler. Alice brings along a silk cloth.



Alice rubs the Perspex ruler with the silk cloth to give it a negative charge
4.3.5.1. Explain the difference between a charged object and a neutral object
4.3.5.2. Were electrons added to or removed from the Perspex ruler during this process
4.3.5.3. Will the balloon be attracted to or repelled by the ruler?

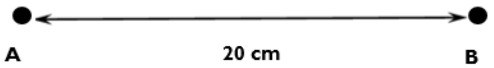
4.4. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Two small charged spheres, A and B, hanging from a retort stand are placed 10 cm apart. The charge on A is +10nC and the charge on B is -6nC.



4.4.1. Draw the electric field pattern between the two charged spheres
4.4.2. Name the force between the two charged spheres.
4.4.3. How did sphere B gain its charge?
4.4.4. The charged spheres are brought into contact with each other and then separated. Calculate the charge on each sphere after separation.
4.4.5. Which sphere lost electrons?
4.4.6. Calculate the amount of charge transferred.
4.4.7. How many electrons were transferred?

4.5. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Two small charged spheres, A and B, are placed 20 cm apart. The charge on A is

+15nC and the charge on B is +6nC.



4.5.1. Draw the electric field pattern between the two charged spheres.
4.5.2. What kind of force would be experience between charges A and B?
4.5.3. How did sphere A gain a positive charge?
4.5.4. State the principle of conservation of charge
4.5.5. The charged spheres are brought into contact with each other and then separated. Calculate the charge on each sphere after separation.
4.5.6. Calculate the amount of charge transferred between A and B.

4.6. Cheslin Kolbe enjoys experimenting with static electricity in his free time. He decides to investigate the relationship between the time that a PVC rod is rubbed with a cloth and the magnitude of the charge that the rod obtains as a result.

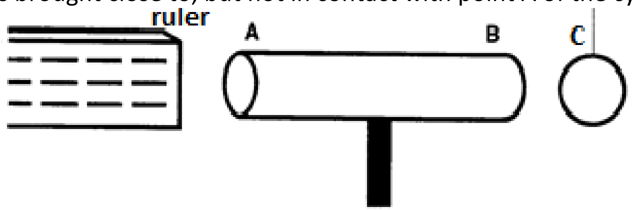
4.6.1. Provide a hypothesis for Cheslin's experiment.
4.6.2. Identify the independent variable for this experiment
4.6.3. Identify the dependent variable for this experiment.

Cheslin starts with a neutral rod and obtains the following results:

Time rubbed (s)	Charge on rod after rubbing (C)
1	0,4
2	0,6
3	0,7
4	0,75
5	0,75

4.6.4. Plot a graph of Cheslin's results on your folio sheets. A heading for the graph does not have to be provided but both axes have to be labelled and the points have to be clearly shown. An accurate graph according to scale is not necessary.
4.6.5. After Cheslin charged the rod, he uses it to lift a small piece of neutral paper. Explain how it is possible for a negative PVC rod to attract a neutral piece of paper.

4.7. A neutral metal cylinder is suspended on an insulated stand. A neutral polystyrene sphere is suspended very close to one end of the cylinder. A negatively charged ruler is brought close to, but not in contact with point A of the cylinder.



4.7.1. What will the charge be at point A and B respectively?
4.7.2. State what will happen between the neutral polystyrene sphere and the cylinder.

The cylinder is removed and brought towards the polystyrene ball.
4.7.3. Describe the type of force that exists between the ruler and the sphere.

4.8. A learner in a Physical Sciences class rubs his hair with a plastic rod. The rod becomes negatively charged. The learner now opens a tap so that a thin stream of water runs out of it. When the rod is brought close to the water without touching it, it is observed that the water bends toward the rod.
4.8.1. State the principle of conservation of charge in words.
4.8.2. Give a reason why the stream of water bends towards the rod.

During the rubbing process 10^{14} electrons are transferred to the rod
4.8.3. Calculate the net charge now carried by the rod.

The rod makes contact with a conductive surface and looses 1/10th of its charge.
4.8.4. Calculate the new charge on the rod.
4.8.5. Determine the number of electrons that were transferred

4.9. Two charged spheres, one with a charge of 15mC and another with an unknown charge, are brought into contact and obtained a charge of 6mC.
4.9.1. Determine the original charge of the unknown sphere.

One of the 6mC spheres is suspended from a string. Next to it, a neutral sphere is suspended at a distance of 5mm apart.
4.9.2. Determine the amount of electrons transferred to the 15 mC sphere to obtained a charge of 6mC.
4.9.3. State whether the following statement is true or false. Explain your answer.

The neutral sphere is considered neutral because there are no electrons on the sphere.

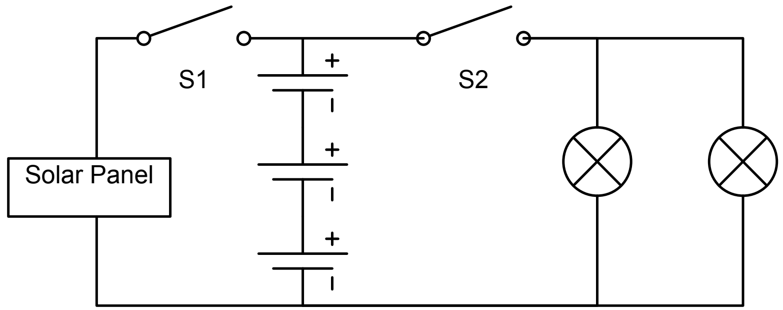
4.9.4. The spheres are brought into contact and then separated. Determine:
4.9.4.1. The charge on each sphere
4.9.4.2. The number of electrons transferred.

4.10. A glass rod is charged positively by rubbing it with a cloth. The rod is held near a neutral graphite coated, insulated sphere.
4.10.1. Explain how the glass obtained a positive charge.
4.10.2. What is the charge on the cloth?
4.10.3. With reference to the charged particles, explain why the sphere is neutral.
4.10.4. Draw a diagram showing the neutral sphere before the rod was introduced.
4.10.5. Draw a diagram and explain what will happen when the rod is brought close to, but not in contact with, the sphere.
4.10.6. Name the polarization method described above.
4.10.7. Does the number of charges change when the sphere is polarized using this method? Give a reason for your answer.
4.10.8. State two ways that can be used to increase the electrostatic force between the glass rod and the sphere.

The graphite coated sphere is replaced with a neutral wooden sphere.
4.10.9. Does the same polarization occur? Give a reason for your answer.

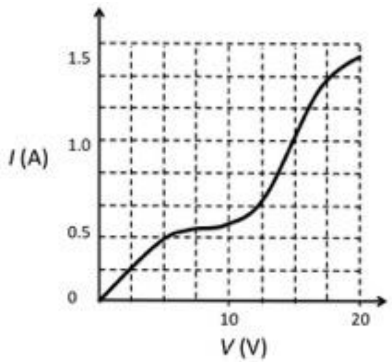
Electric Circuits

5.1. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
In 2014, schools were asked to support the drive to collect plastic which was recycled to make Rethaka Light Bags. The bags have a solar panel on the outside. During the day, while a student walks to school and back home, the solar panel recharges a battery pack. Six hours of direct sun onto the solar panel provides the battery with a total charge of 576 C. The battery consists of three 1,2 V cells connected in series. When the battery pack is connected to the light jar at night, the battery uses the stored energy to provide current to the lights in the circuit so that the student can study. The circuit is shown below.



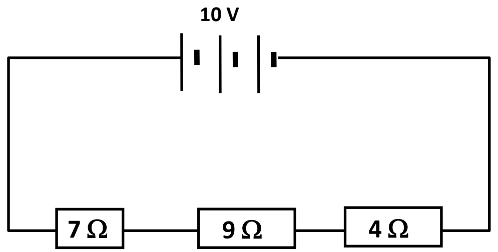
5.1.1. Define the term 'current'.
5.1.2. Calculate the average current provided by the solar panel during the charge cycle.
5.1.3. Give the position of switches 1 and 2 during the charge cycle.
5.1.4. How much energy is stored in the battery when it is fully charged?
5.1.5. Energy changes from into various forms in the Rethaka Light Bag. Draw a flow diagram to show these changes.
5.1.6. Give the position of switches 1 and 2 during the discharge cycle.
5.1.7. How long will the lights last if they each draw a current of 0,03 A?
5.1.8. Calculate the resistance of one light bulb.
5.1.9. Calculate the resistance of the parallel combination of bulbs.
5.1.10. Give two reasons why the lights are not connected in series.
5.1.11. Give two advantages of the bag.
5.1.12. Give two disadvantages of the bag.
5.1.13. Light bulbs are **non-ohmic** devices. Explain what this means. (You may draw a graph to illustrate your answer.)

5.2. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Conductors: A strange electrical device has the *I*–*V* characteristic shown below:



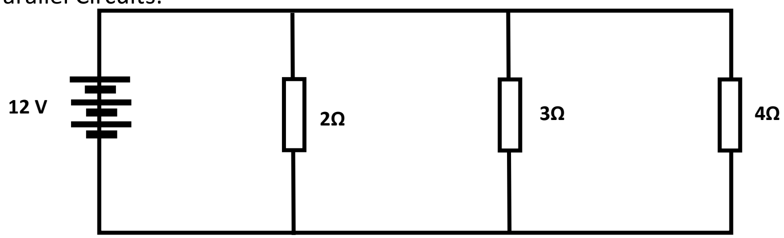
5.2.1. Is it an Ohmic or non-Ohmic device? Explain.
5.2.2. What current is drawn when a voltage of 10 V is applied to it?
5.2.3. What voltage would be required to double the current drawn at 10 V?
5.2.4. What is the resistance of the device at 10 V; at 20 V?

5.3. Series Circuit:



5.3.1. Explain why this a series circuit.
5.3.2. Calculate the following:
5.3.2.1. Total resistance
5.3.2.2. Total current
5.3.2.3. V across 7Ω
5.3.2.4. V across 9Ω
5.3.2.5. V across 4Ω

5.4. Parallel Circuits:

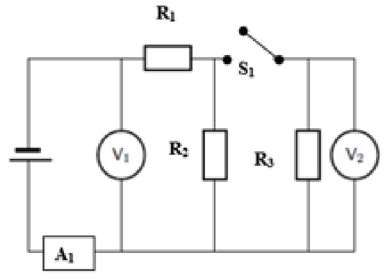


Calculate the following:
5.4.1. Total resistance
5.4.2. Total current
5.4.3. V across 2Ω
5.4.4. V across 3Ω
5.4.5. V across 4Ω
5.4.6. I through 2Ω
5.4.7. I through 3Ω
5.4.8. I through 4Ω

5.5. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
A circuit is constructed out of the following elements:
- Two 1.5V cells in parallel
- A 1.5Ω resistor
- A 2 Ω resistor

5.5.1. Draw the circuit diagram of this circuit.
5.5.2. Calculate the voltage of the battery.
5.5.3. Calculate the total resistance of the circuit.
5.5.4. Calculate the total current.
5.5.5. Calculate the current through the 1.5 Ω resistor.

5.6. In the circuit below the V_1 reads 12V when the switch is open. R_1 is 6Ω and R_2 is 4Ω. Internal resistance is negligible.

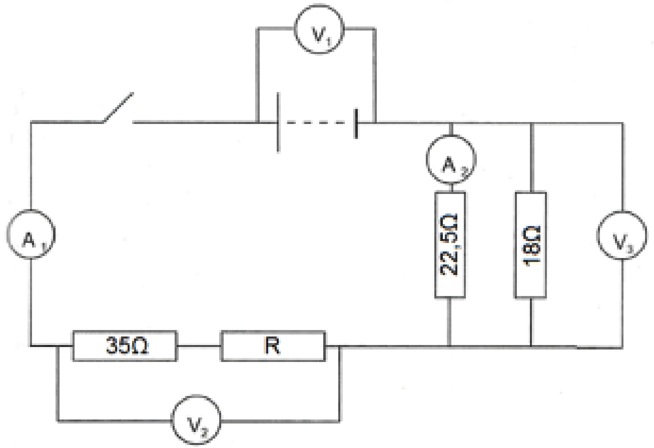


5.6.1. Define current.
5.6.2. What voltage does the cell provide in the above circuit?
5.6.3. Determine the reading on A_1.

S_1 is now closed and A_1 in the circuit reads 1,5 A.
5.6.4. Calculate the total resistance in the circuit.
5.6.5. Calculate the resistance of R_3.
5.6.6. Explain how the ammeter reading changes when S_1 is closed.
5.6.7. What is the reading on V_2?

5.7. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
In the accompanying circuit diagram, the battery, ammeters, and connecting wires have negligible resistances.

5.7.1. Which meter/s (if any) will show a reading while the switch is open?
5.7.2. Determine the effective resistance of the parallel resistors.



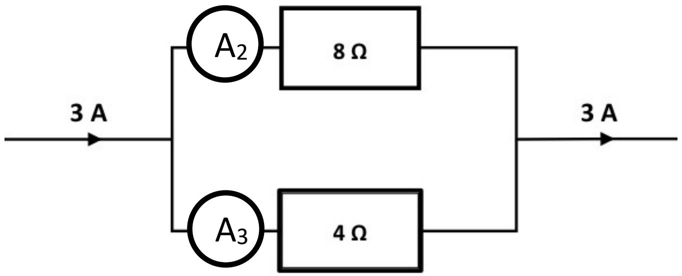
The switch is now closed:
The readings on V_1 is now 120V and A_1 is 1,5A.

5.7.3. What is the reading on voltmeter V_3?
5.7.4. What is the reading on voltmeter V_2?
5.7.5. Determine the readings of ammeter A_2.
5.7.6. Determine the resistance of resistor R.

The 18Ω resistor is then removed:

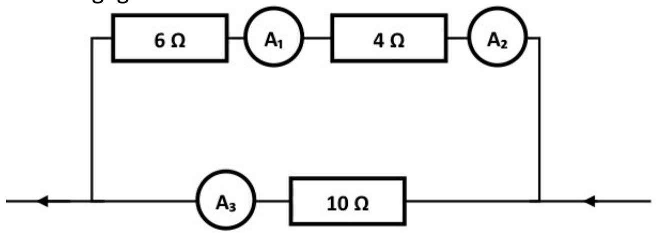
5.7.7. Calculate the effective resistance of the circuit.
5.7.8. Without calculation, state whether the current of the circuit will increase, decrease or stay the same? Provide a reason for your answer.

5.8. Below is a section of a circuit through which it is found that 3A of current flows.



5.8.1. Calculate the total effective resistance of the circuit.
5.8.2. Determine the potential difference across each conductor.
5.8.3. Calculate the amount of current through each of the ammeters A_2 and A_3.
5.8.4. Explain why the current at the start and the end of the circuit will remain the same.
5.8.5. Explain, with reason, how the readings on A_2 would change if:
5.8.5.1. The potential difference across the resistor is increased.
5.8.5.2. The 4Ω resistor is removed.
5.8.5.3. The 8Ω resistor heats up.
5.8.5.4. The 4Ω resistor is replaced with a 16Ω resistor.

5.9. In the accompanying circuit diagram, the battery, ammeters, and connecting wires have negligible resistances.

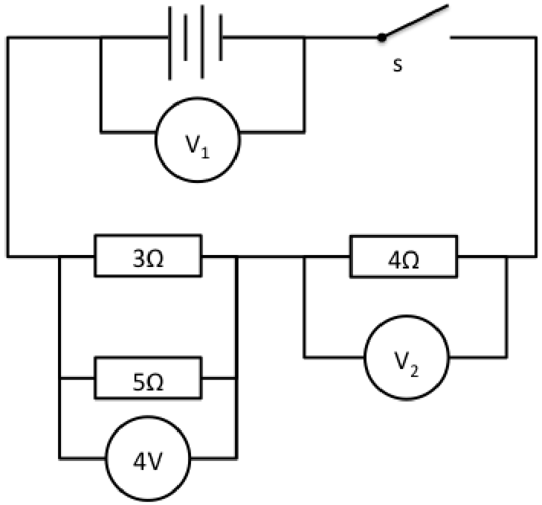


5.9.1. Define current.
5.9.2. Compare the readings on A_1, A_2 and A_3.
5.9.3. Determine the total current in the circuit if the reading on A_1 is 1,5A.
5.9.4. Assuming that the components shown are the only resistors in the circuit, determine the total potential difference across the circuit.
5.9.5. Define potential difference.
5.9.6. Determine the amount of total amount of electrical work done in the circuit over a time of 2 minutes.

The resistors are replaced with light bulbs. The light bulbs are left on until the batteries “run flat”.

5.9.7. Explain why the batteries “run flat” with reference to the energy transformations that take place.

5.10. In the circuit below, potential difference V_1 across the battery and potential difference V_2 across the 4Ω resistor are unknown.



5.10.1. Define the term potential difference

5.10.2. Calculate the:

5.10.2.1. Effective resistance of the parallel component of the circuit

5.10.2.2. Reading on voltmeter V_1

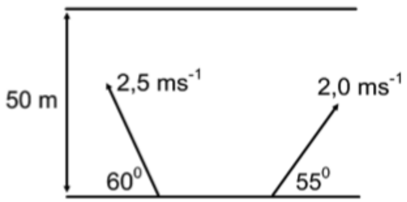
5.10.2.3. Reading on voltmeter V_2

5.10.2.4. Amount of charge that moves past the closed switch in 4 minutes.

Vectors and Scalars

6.1. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**

Two swimmers, David and Sean, are racing across a still river. Sean swims with a speed of 2,5 ms^{-1} at an angle of 60° to the bank and David swims with a speed of 2,0 ms^{-1} at an angle of 55° to the bank as shown below:



6.1.1. Calculate the northward components of the velocities for both swimmers.

6.1.2. The distance across the river is 50m as shown. By calculating the time each swimmer would take, show which one reaches the other side first.

6.1.3. If the river has a current of $1ms^{-1}$ to the right while they were crossing, explain fully how this would affect the resultant velocities of both boys if they swam at the angles shown

6.2. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**

In a game of softball the pitcher can throw the ball at speeds of 80 kmh^{-1}. The catcher is a distance of 13m from the pitcher.

6.2.1. Convert $80kmh^{-1}$ to ms^{-1}.

6.2.2. Explain what is wrong with the following statement:

"If the batter swings and misses the ball, the displacement of the ball from the time it leaves the

pitcher's hand it is 13m."

The wind suddenly picks up and blows with a speed of $12ms^{-1}$ to the east. The batter is directly north of the pitcher.

6.2.3. Show by means of a labelled sketch diagram in which direction the pitcher needs to throw the ball in order to still get directly to the catcher.

6.2.4. Calculate the direction of the velocity the pitcher would need to throw the ball at in order for it to get directly to the catcher.

6.2.5. Calculate the resultant velocity of the ball.

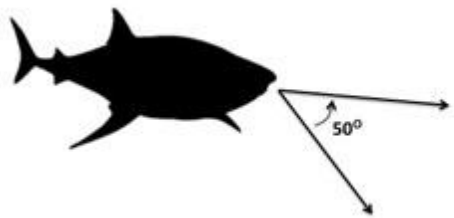
6.2.6. Convert this resultant velocity to kmh^{-1}.

6.3. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**

Luke and Anakin go fishing and both hook the same shark. Luke pulls on his line with a force of 500 N

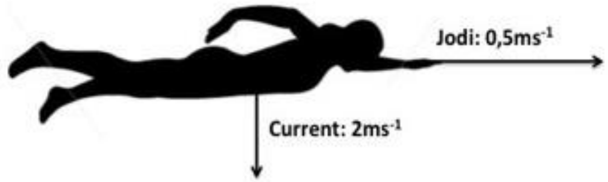
to the right and Anakin pulls on his line with a force of 400 N at an angle of 50° from the first, as

shown in the diagram below.



6.3.1. Define a vector.
6.3.2. Determine the resultant force on the shark by construction.

Jody hears there is a shark in the water and frantically tries to get away by swimming with a velocity of 0,5 ms^{-1} as shown below in the diagram. There is unfortunately also a current of 2 ms^{-1} which is flowing as shown in the diagram below:

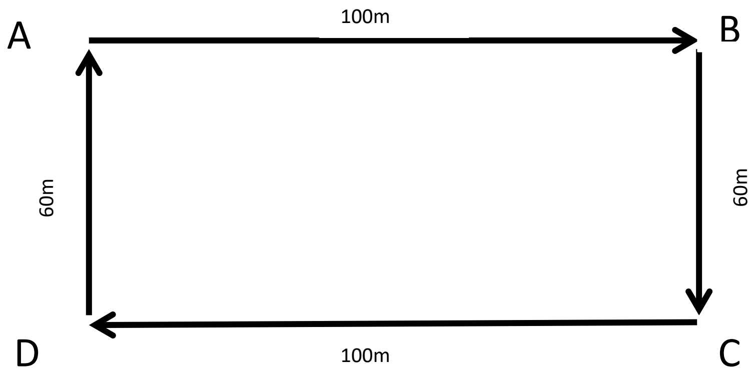


6.3.3. Calculate Jody's resultant velocity.
6.3.4. If Jody swims for 3 minutes to get away, what distance from the shark does he end up?

6.4. Three little hungry rats find a delicious steak in the alley-way behind a restaurant and simultaneously sink their little rat teeth into it. Lord Paxton pulls on the steak with a force of 5N on a bearing of 90° and Lulu pulls on the steak with a force of 4N on a bearing of 180°.
6.4.1. Draw a labelled force diagram showing the forces that Lulu and Paxton are applying to the steak
6.4.2. Calculate the magnitude of the resultant force that Paxton and Lulu are applying to the steak
The third rat, Anastasia, pulls in such a way that the steak does not move.
6.4.3. With what force should Anastasia pull on the steak?

6.4.4. Calculate the angle which she should be pulling at in order to keep the steak balanced.

6.5. Usain Bolt is training for the 2015 World championships by running along a rectangular field as shown in the figure below. He runs 100m from point A to B in 10 seconds, then 60m to point C. His total time from point A to C is 18s. He rests for 5s after reaching point C and then sprints another 100m along the width of the field to point D in 11s. He walks the last 60m from D to A at a speed of 1,5m·s^{-1}.



6.5.1. Determine his total displacement when he reaches:
6.5.1.1. Point D
6.5.1.2. The end of his run
6.5.1.3. Point C
6.5.2. Determine his total distance covered when he reaches:
6.5.2.1. Point B
6.5.2.2. Point C
6.5.2.3. Point D
6.5.3. Determine his average speed for the following sections:
6.5.3.1. A to C
6.5.3.2. B to D
6.5.4. Calculate his average velocity between point A and D.
6.5.5. Calculate the time taken to return from point D to point A.

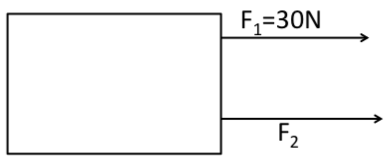
6.6. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Roland Schoeman, a South African swimmer, improved his world record for a 100 m event in Sweden on 18 January 2005 when he completed it in 52,51 s. He swam in a pool that has a length of 50
6.6.1. What was the total distance Roland Schoeman swam in the 52,51 s?
6.6.2. What was Roland Schoeman's total displacement in the 52,51 s?
6.6.3. Calculate Roland's average speed for the race.
6.6.4. Explain the difference between speed and velocity.
6.6.5. Roland exerted 50N of force to swim to the first 50 m and the water offers 10N of water resistance.
6.6.5.1. Draw a vector diagram showing all the horizontal forces acting on him.
6.6.5.2. Calculate the resultant force on Roland for the first 50 m.

6.7. A bus travels east at $13 m.s^{-1}$ relative to the ground.
6.7.1. Determine the velocity of the bus in $km.h^{-1}$.
6.7.2. ow long will it take the bus to reach its next stop which is 900m away?

A passenger in the bus is walking towards the back of the bus at $1 m.s^{-1}$while the bus is moving.
6.7.3. What is the velocity of the passenger relative to the ground during this time?

A car travelling east at $17 m.s^{-1}$overtakes the bus.
6.7.4. Sketch a velocity-time graph for the car and the bus on the same axis. Label each graph accordingly.
6.7.5. Use the graph to determine the difference in distance covered by the car and the bus after 20s.
6.7.6. If the speed limit is $60 km.h^{-1}$, determine if the vehicle is exceeding the speed limit. Show all relevant calculations.

6.8. Two forces act on an object as shown in the diagram below. The resultant of the two forces is 50N.



6.8.1. Define the term *resultant vector*.
6.8.2. Determine the magnitude of F_2.
6.8.3. How will the resultant force change if the angle between the two forces is increased from 0˚ to 60˚.Write only **INCREASE, DECREASE** or **REMAIN THE SAME**.
6.8.4. Sketch a force diagram showing a configuration of the forces to produce the **minimum** resultant force.
6.8.5. Determine the magnitude of minimum possible resultant between F_1 and F_2.

6.9. A boat's engine produces an applied force of 750N it move westwards on the ocean. While moving forward, a drag force of 200N acts on the boat in the opposite direction, slowing down the boat.
6.9.1. Define the term *vector*.
6.9.2. Calculate the resultant force acting on the boat.

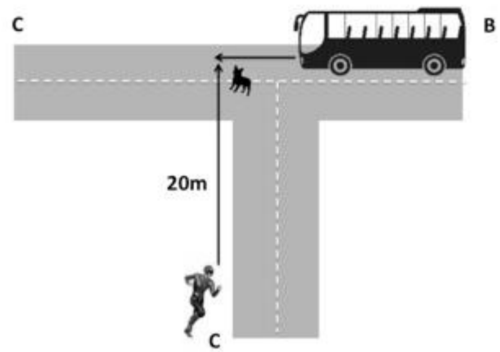
The boat travels 120 km westwards against the current in a time of 2 hours. The boat immediately turns around and travels back to the starting point in a time of 1,5 hours, this time with the current.

6.9.3. Write down the total displacement for the entire journey.
6.9.4. Calculate the average speed of the boat for the entire journey in $km{\cdot}h^{-1}$.
6.9.5. Calculate the magnitude of the actual velocity of the boat, in $km{\cdot}h^{-1}$. (The velocity of the boat relative to the water).

6.10. A cruise ship moves from South Africa to Madagascar. Although the cruise ship has the ability to travel at $40 km{\cdot}h^{-1}$, it is found that it is moving at a resultant velocity of only $32 km{\cdot}h^{-1}$ because it is moving directly into an ocean current.
6.10.1. Determine the speed of the ship in $m{\cdot}s^{-1}$.
6.10.2. How far will the ship be able to travel in 10 minutes?
6.10.3. Calculate the speed of the ocean current.
6.10.4. Determine how fast the ship will move if it moves with the current instead of against it.

Motion in 1 Dimension

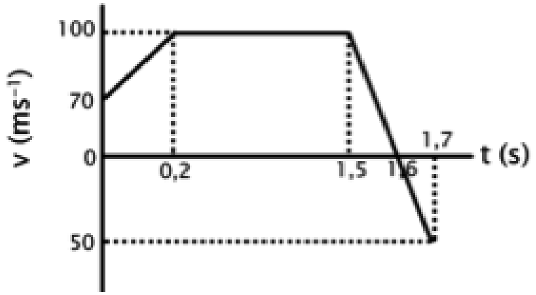
7.1. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
A dog escapes from its leash 20m north of where Barry, 'The Flash' Allen, is standing. The dog runs across a busy intersection, where a bus is approaching from the west but its brakes had failed. and at the same time the brakes fail on a bus headed west.



The dog is a distance of 20m ahead of Barry. If he accelerates from rest and reaches a velocity of $90 ms^{-1}$ in a time of 0,3 s some distance before reaching the dog, calculate:
7.1.1. his acceleration in 0,3s.

7.1.2. the distance he covered in 0,3s.
7.1.3. If he travels the remainder of the distance to the dog at 90 ms^{-1}, calculate the time it will take him to reach the dog from his current position

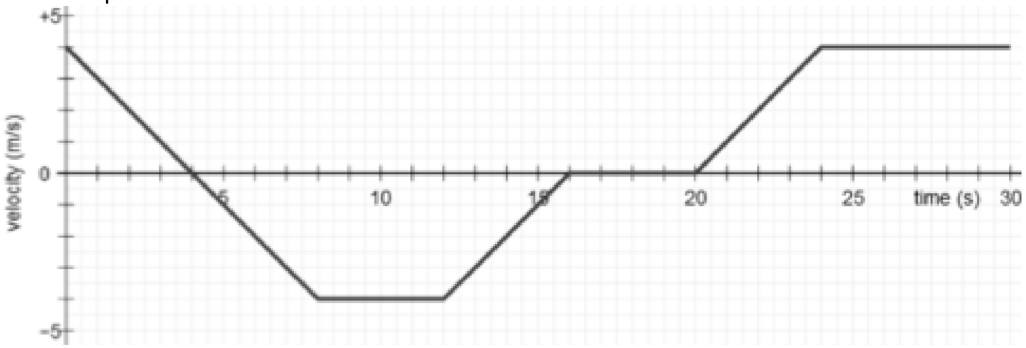
7.2. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Consider the following velocity-time graph for the motion of Barry Allen, known to superhero fans as 'the Flash' as he chases after a runaway bus headed west:



7.2.1. Describe Barry's motion for the 1,7s shown.
7.2.2. Calculate Barry's acceleration during the first 0,2s.
7.2.3. What was the total distance he covered in 1,6s.
7.2.4. What was Barry's displacement after 1,7s.
7.2.5. Assuming that the bus was travelling west at a speed of 25ms^{-1}, what was Barry's speed relative to the bus:
7.2.5.1. after he passed it at 1,3s?
7.2.5.2. as he ran towards it at 1,7s?
7.2.6. What is the definition of a vector?
7.2.7. Explain using your answer in 2.6 why Barry's distance and his displacement are different after 1,7s

7.3. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
7.3.1. A Jet takes off by accelerating at 6,25ms^{-2} from rest along the 0,2km long deck of an aircraft carrier.
Show that it leaves the end of the runway with a velocity of 50 ms^{-1}
7.3.2. Sketch both a velocity-time graph and an acceleration time graph for the motion of the jet. Axes
must be labelled but specific values do not need to be included.
7.3.3. How long does it take to take off from when it starts accelerating to when it leaves the end of the
runway?
7.3.4. If a can of paint had been accidently left on the runway 20m from the edge, calculate the
aircraft's acceleration in order to reach the required velocity to take off safely and avoid hitting the paint.

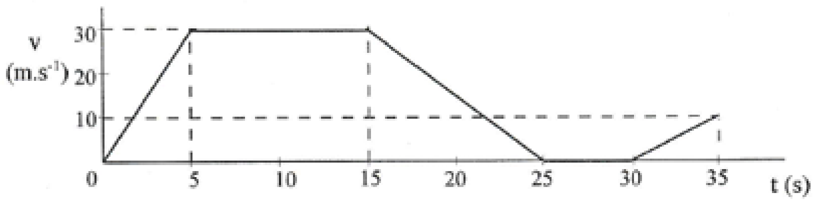
7.4. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
Consider the velocity-time graph shown below for the movement of an object over a period of 30s headed North.



7.4.1. Calculate the acceleration of the object between 0 and 8s.
7.4.2. Calculate the displacement of the object after 19s.
7.4.3. During which time interval(s) did the object experience zero acceleration?
7.4.4. Draw the acceleration time graph for the motion of the object from 0-19s.
7.4.5. At which time(s) did the object change direction?

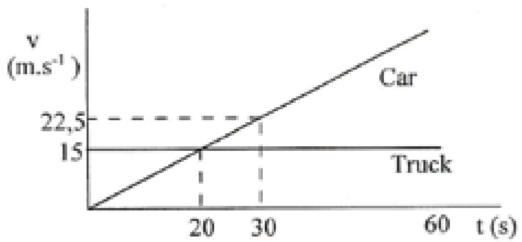
7.5. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
A car approaching a yield sign at 20ms^{-1} slows uniformly from 20ms^{-1} to 4ms^{-1} over a 4 second period. Calculate:
7.5.1. the acceleration of the car during those 4 seconds
7.5.2. the distance covered by the car over the 4 second period.
7.5.3. how much further, if slowing down by the same rate, he would travel to actually
bring the car to a standstill.
7.5.4. The car was travelling at 20ms^{-1} in a 60 kmh^{-1} zone. Determine if the driver was speeding or not.

7.6. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
The velocity-time graph below represents the motion of a vehicle.



7.6.1. Describe the motion of the vehicle through the 5 different movements represented by the above graph.
7.6.2. Determine the acceleration of the vehicle in the first 5 s.
7.6.3. What is the velocity of the vehicle between t=5s and t=15s?
7.6.4. Find the acceleration of the vehicle between 15 and 25 s.
7.6.5. Determine the distance covered by the vehicle in the first 15s.

7.7. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
A car stops at a traffic light. When the light turns green, the car pulls off and accelerates uniformly. At the moment when the car starts to move, a truck passes it at a constant speed of $15 ms^{-1}$. The graph below represents the speeds of the two vehicles for the first 60 s. Use the graph to answer the following questions.



7.7.1. At what time will the car and the truck have the same speed?
7.7.2. What is the distance between the car and the truck after the first 30s.
7.7.3. Calculate the acceleration of the car.

7.8. A racing car starts from rest and accelerates uniformly along a straight horizontal road
at $5,3 ms^{-2}$ for 8 seconds, after which it continues with a constant velocity for a further 9 seconds.

7.8.1. What is meant by the term 'average acceleration'?
7.8.2. Calculate the magnitude of the maximum velocity of the car after accelerating for 8 seconds.
7.8.3. Draw the velocity versus time graph of the car's motion for the entire journey.
7.8.4. Determine the cars displacement for the 9 s when it is not accelerating.
7.8.5. Differentiate between the terms 'distance' and 'displacement'.

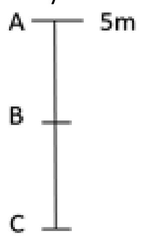
7.9. A cyclist pedalling east on a mountain pass keeps pedalling with a constant force over a distance of 1000m. The gradient of the road changes, resulting in a change in acceleration of the cyclist. During the first 260m, he moves downhill and accelerates at $0,4 m.s^{-2}$ from rest. He then travels at a constant velocity for 600m along a horizontal section, before cycling uphill to the end. During the uphill section, the magnitude of his acceleration is constant. He comes to rest at the 1000m mark.

7.9.1. Determine:
7.9.1.1. The time taken to cover the downhill section
7.9.1.2. The velocity of the cyclist at the bottom of the hill
7.9.1.3. The time taken to travel across the horizontal section
7.9.1.4. The acceleration during the uphill section
7.9.1.5. The time taken to complete the uphill section.
7.9.2. Plot an acceleration-time graph of his movement through the pass. Include all known values on your graph.
7.9.3. Use the graph to determine:
7.9.3.1. Average velocity of the uphill section
7.9.3.2. Average velocity of the downhill section

7.10. A motorcycle is travelling at a constant speed of $75 km.h^{-1}$ in a $60 km.h^{-1}$ zone. A policeman starts his car from rest just as the motorcycle passes him. The police car accelerates at $2,5 m{\cdot}s^{-2}$ until it reaches a maximum velocity of $30 m.s^{-1}$. The policeman then continues driving at this constant velocity.
7.10.1. Define the term *acceleration*.
7.10.2. Convert $75 km.h^{-1}$ to metres per second.
7.10.3. Calculate the time it takes the police car to reach its maximum velocity.
7.10.4. Calculate which vehicle (the motorcycle or the police car) is ahead at the time calculated in QUESTION 2.10.3.
7.10.5. Calculate how far the police car has to travel before it catches up with the motorcycle.
7.10.6. Write down the total time taken by the police car to catch up with the motorcycle.

Energy

8.1. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
A metal ball with a mass of 3kg is dropped from point A, 5m above the ground. Take C as your reference point.

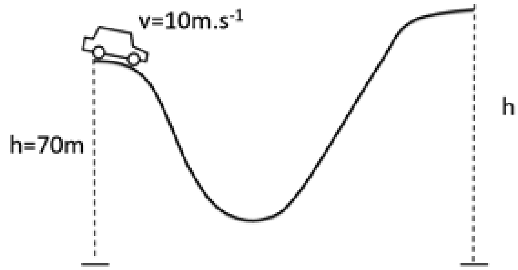


8.1.1. Calculate the mechanical energy at point A
8.1.2. What is the gravitation potential energy at point C?
8.1.3. What is the kinetic energy at C?
8.1.4. If the gravitational potential energy at B is 100J, what is the kinetic energy?
8.1.5. Calculate the velocity of the object at B.

8.2. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
A box of mass 50kg falls from a table with a height of 10m and hits the floor with a velocity of $14ms^{-1}$.
8.2.1. Calculate the gravitational potential energy of the box when it was on the table
8.2.2. Calculate the kinetic energy of the box when it strikes the ground
8.2.3. Was mechanical energy conserved? Provide a brief explanation why.

8.3. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
A truck of mass 180kg is parked at the top of a hill, 80 m high. The truck driver releases the break and the truck free-wheels down the hill.
8.3.1. What is the maximum velocity that the truck can achieve at the bottom of the hill?
8.3.2. In reality will the truck achieve this velocity? Why/why not?

8.4. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
A woman is driving home from work. Her car (total mass 200kg) runs out of petrol just as it reaches the top of a hill that is 70 m high. She is driving at a constant speed of $10ms^{-1}$ when it reaches the top. It coasts down the hill, without friction, coming to rest at a height of *h* at the top of the next hill as shown in the diagram below.

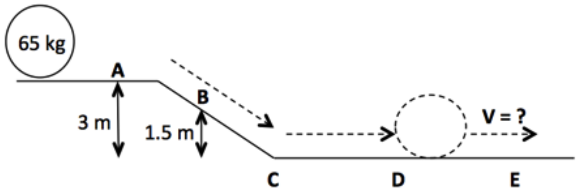


8.4.1. Calculate the total mechanical energy of the car at the top of the first hill.

Choose the correct word in brackets. Write only the word in each case.
8.4.2. The potential energy of the car at the bottom of the hill will be at a (MINIMUM/MAXIMUM) value.
8.4.3. The kinetic energy of the car at the top of the second hill where it comes to rest will be at a (MINIMUM/MAXIMUM) value.
8.4.4. If mechanical energy is conserved, calculate the height at which the car comes to rest at the top of the second hill.

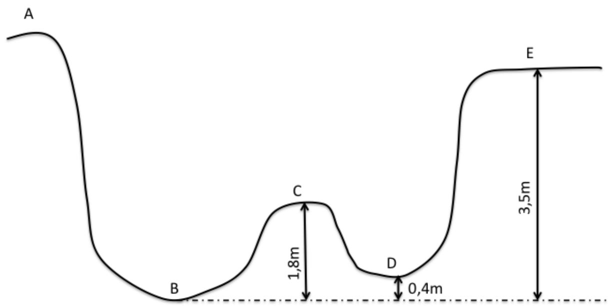
8.5. A worked memo is available for this question at **http://tinyurl.com/ScienceClinicYoutube**
A fireman slides down an 8m pole at the firehouse. The mass of the fireman is 90kg.
8.5.1. State the Law of Conservation of Mechanical Energy.
8.5.2. Calculate the potential energy of the fireman at the top of the pole.
8.5.3. Use the law you stated above to calculate the velocity with which the fireman would land if there was no friction.
8.5.4. In reality, the fireman would not land with such a high velocity. Give ONE reason why the fireman's velocity will be less than calculated above.

8.6. A skier 65 kg is standing at the top of a hill (as indicated in the diagram below), ready to descend. The skier has 1911 J of energy with respect to the lowest point (point C) on the track just before she starts to move. The friction is negligible between A and D.



8.6.1. What type of energy does the skier have at the top of the hill?
8.6.2. How much kinetic energy does the skier have at point B?
8.6.3. Calculate the skier's velocity at point B.
8.6.4. How much potential energy does the skier have at point C?
8.6.5. State the Law of Conservation of Mechanical Energy.
8.6.6. Suppose the skier moves over a rough patch of soil at point D and loses 196J of her kinetic energy. How much energy will the skier have at point E?
8.6.7. Calculate the velocity of the skier at point E?

8.7.



A themepark wants to install a new kiddies rollercoaster with some variation in track height as shown above. The coaster is designed to finish on the last part of the track with a velocity of $2 m.s^{-1}$ when fully loaded and has a mass of 1500kg. Ignore the effects of friction

8.7.1. State the principle of *conservation of mechanical energy*.
8.7.2. Determine the total mechanical energy of the coaster if fully loaded.
8.7.3. Determine the magnitude of the maximum velocity that the coaster will reach.
8.7.4. Calculate the velocity of the coaster at the top of C.
8.7.5. How will the velocity at B compare to the velocity at D. Write only **GREATER THAN**, **LESS THAN**, **EQUAL TO**.

Along the length of the track, 17 000J of energy is lost due to air resistance.

8.7.6. Determine the height at which the coaster should start at A to achieve the intended final velocity.

8.8. Timmy shoots a marble of mass 50g vertically upwards with his slingshot. It moves 30m upwards, at which point it starts falling down again. Assume the energy losses due to air resistance are negligible.
8.8.1. Determine the potential energy of the marble at the top of its movement.
8.8.2. Determine the velocity with which the marble leaves the slingshot.
8.8.3. Determine the velocity of the marble halfway along its downward movement.
8.8.4. Use equations of motion to prove the magnitude of the acceleration is $9{,}8 m.s^{-2}$.

8.9. A 2kg object is thrown downwards from a height of 10m with a velocity of $1{,}8 m.s^{-1}$ Assume the energy losses due to air resistance are negligible.
8.9.1. Determine the potential and kinetic energy of the object immediately after it is thrown.
8.9.2. Calculate the kinetic energy of the object when it hits the ground.
8.9.3. Calculate the velocity of the object when it hits the ground

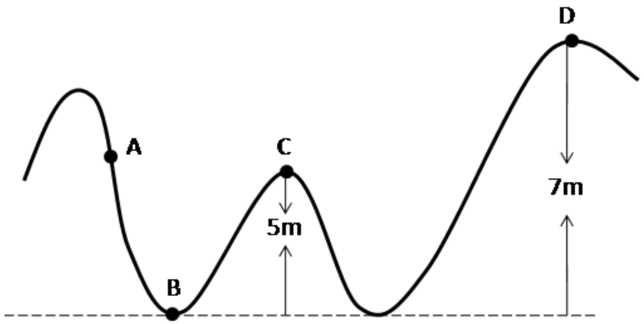
If the object was thrown upwards instead,

8.9.4. Determine the maximum height that it would reach.

8.10. An 800g pendulum is swung from a height of 13cm with a downward velocity of $3 m.s^{-1}$
8.10.1. Determine the potential energy of the pendulum at the top of its movement.
8.10.2. Calculate the maximum velocity that the pendulum will reach.
8.10.3. Determine the maximum height of the swinging pendulum.

An object of 300g is placed in the path of the pendulum at the bottom of its swing. The pendulum makes contact with the object, and continues to swing up to a height of 11cm. Determine:
8.10.4. The amount of energy transferred to the object.
8.10.5. The magnitude of the velocity with which the object moves off after contact
Assume the energy losses due to air resistance are negligible. , if no dissipative forces were experience.

8.11. A steel ball of mass 3 kg is rolling over a frictionless surface, as shown below. When the ball reaches point A it has mechanical energy of 200 J. (The sketch is NOT drawn to scale.)



6.10.5. Write down the kinetic energy of the steel ball at point B

6.10.6. Calculate the speed of the steel ball at the instant it reaches point C

6.10.7. Determine whether the mechanical energy acquired by the ball at point A will be enough to carry the ball over point D. Show ALL calculations.

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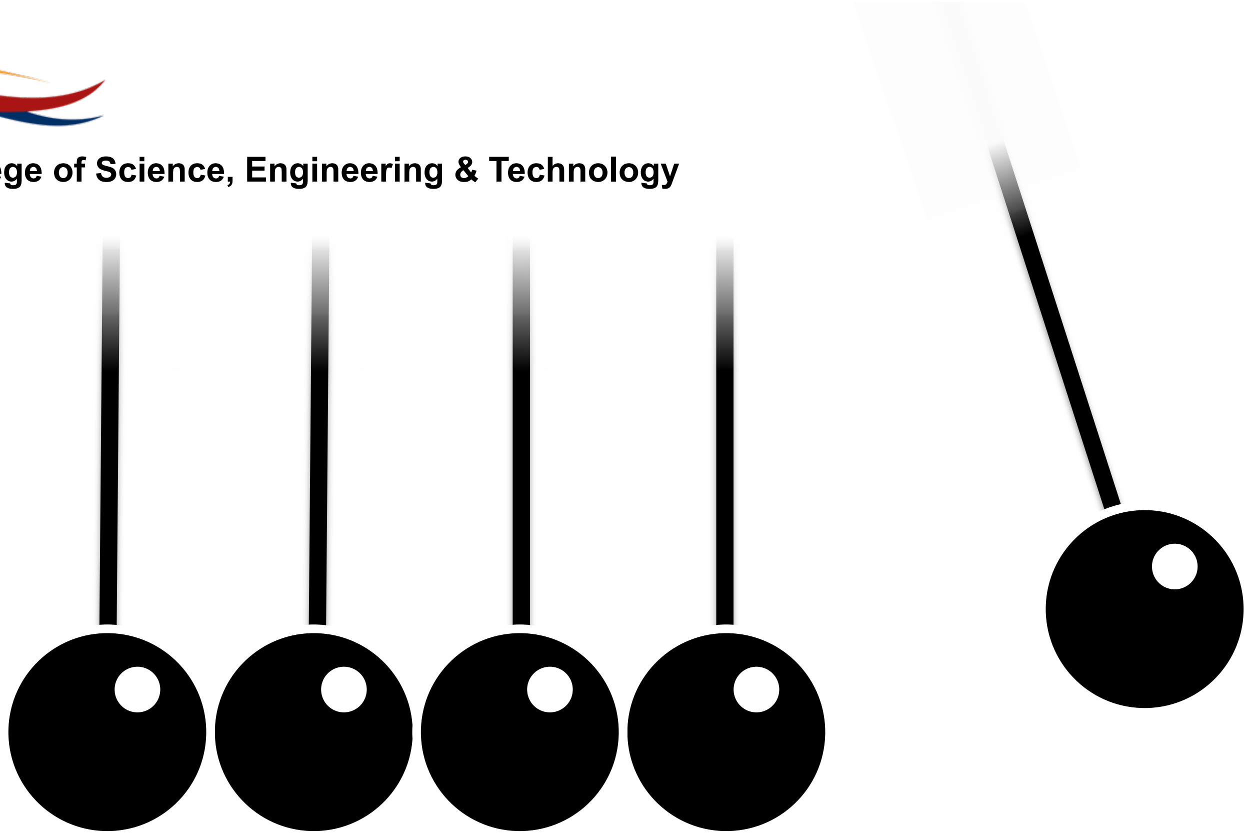

Grade 10 Physics

MEMORANDUM

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Pulses and Waves

1.1.
- 1.1.1. Frequency = 1,25 Hz
- 1.1.2. speed = f x λ = 1,25 x 10 = 12,5 ms^{-1}

1.2.
- 1.2.1. v = d / t = 200 / (10 x 60) = 0,33ms^{-1}
- 1.2.2. f = v / λ = 0,33 / 15 = 0,022 Hz.
  T = 1 / f = 45s

1.3.
- 1.3.1. λ = 6,3 – 2,6 = 3,7 cm = 0,037m.
- 1.3.2. v = f x λ = 8800 x 0,037 = 325,6 ms^{-1}.

1.4.
- 1.4.1. wavelength = 24m
- 1.4.2. T = 4s, frequency = 0,25s^{-1}
- 1.4.3. v = f x λ = .0,25 x 24 = 6 ms^{-1}

1.5.
- 1.5.1. T = 3600 / 10 = 360 s : frequency = 1 / T = 1 / 360 = 0.0027 Hz
- 1.5.2. velocity = f x λ = 0.0027 x 100 = 0,27 ms^{-1}

1.6.
- 1.6.1. The maximum displacement of a pulse or wave from its position of rest.
- 1.6.2. Period is the amount of time it takes to complete one wavelength , while frequency is the number of completed wavelengths is 1 second
- 1.6.3. A and E or B and F or C and G or D and H.
- 1.6.4. $\frac{8}{1,75} = 4,57m$
- 1.6.5. $\frac{20}{2} = 10cm$
- 1.6.6. $0.15s$
- 1.6.7. T=$\frac{1}{f}$
  0.15 =$\frac{1}{f}$
  f= 6.67Hz
- 1.6.8. v=fλ
  = (6.67)(4,57)
  =30,48ms^{-1}
- 1.6.9. v= $\frac{\Delta s}{\Delta t}$
  30,48=$\frac{20}{\Delta t}$
  Δt=0.66s

1.7.
- 1.7.1. $T = \frac{1}{f}$
  $f = \frac{1}{T}$
  $f = \frac{1}{10}$
  $f = 0.1\text{Hz}$
- 1.7.2. $\lambda = \frac{40}{2}$
  $\lambda = 20m$
  $\therefore v = f\lambda$
  $v = 0.1x20$
  $v = 2m.s^{-1}$
- 1.7.3. 60 min x 60s =3600s
  3600/10 = 360 waves because every 10 second there's 1 wave
  360/10 = 36 waves (every 10th wave)
- 1.7.4. No. The wave is moving to the left which means that he is moving upwards and will thus miss the wave.
- 1.7.5.
  - 1.7.5.1. Amplitude. To produce a louder noise, the energy in the medium must be greater, thus the amplitude must be greater. Frequency affects the pitch of the sound so there is no need to increase the frequency.
  - 1.7.5.2. $\frac{3}{10} = 0.3\ Hz$ (3 shouts in 10 sec)
  - 1.7.5.3. $v = f\lambda$
    $\lambda = \frac{v}{f}$
    $\lambda = \frac{340}{256}$
    $\lambda = 1.328m$
  - 1.7.5.4. $v = \frac{d}{t}$
    $d = vt$
    $d = 340 \times 0.6$
    $d = 204m$
- 1.7.6.

1.7.6.1. $E = hf$
$E = 6.63 \times 10^{-34} \times (1 \times 10^{14})$
$E = 6.63 \times 10^{-20}$J

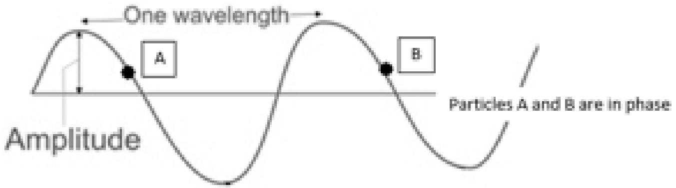
1.7.6.2. With an energy output that high, a lot of damage can be caused to Kelly's skin thus the wetsuit will help protect his skin from damage caused by the ultraviolet rays.

1.8.

1.8.1.

1.8.1.1. Transverse Wave

1.8.1.2.



1.8.1.3. Constructive interference

1.8.1.4. $f = \frac{vibrations}{time}$
$f = \frac{4}{10}$
$0.4Hz$

1.8.1.5. $5mm = 0.005m$
$v = f \times \lambda$
$v = 0.4 \times 0.005$
$v = 0.002m.s^{-1}$
OR
$v = \frac{x}{t}$
$v = \frac{0.005}{\frac{10}{4}}$
$v = 0.002m.s^{-1}$

1.8.2.

1.8.2.1.

1.8.2.1.1. Down

1.8.2.1.2. Up

1.8.2.2.

1.8.2.2.1. Longitudinal Wave

1.8.2.2.2. The particles surrounding the Hulk will be compressed due to the force that he exerts on the particles. The particles will be compressed in the same direction in which he is clapping. The force and energy that he is exerting on the particles is so large/powerful that it causes the structure of the building to collapse, because the particles and structural elements of the building will also vibrate.

1.8.3.

1.8.3.1. Amplitude. An increase in amplitude means that particles that are disturbed receives more energy. This means that the energy that the medium receives is more and thus travel further.

1.8.3.2. $t = \frac{s}{v}$
$t = \frac{400}{330}$
$t = 1.21s$

1.8.3.3. Captain America's shield has a round shape and bigger surface area which means that it vibrates at a higher frequency and thereby increases the pitch of the sound. Thor's hammer has a square shape and smaller surface area which means it vibrates at a lower frequency and thereby creates a lower pitch.

1.8.3.4. Longitudinal wave

1.8.4.

1.8.4.1. $E = hf$
$E = 6.63 \times 10^{-34} \times (1 \times 10^{18})$
$E = E = 6.63 \times 10^{-16}$J

1.8.4.2. Yes

1.9.

1.9.1. Transverse wave

1.9.2. Two

1.9.3. $\lambda = \frac{8}{2} = 4m$

1.9.4. Up

1.9.5. Trough

1.9.6. 1m

1.9.7. $speed = \frac{d}{t}$

$= \frac{500}{25}$

$= 20m.s^{-1}$

1.9.8. $v = f\lambda$

$20 = f \times 4$

$f = \frac{20}{4} = 5Hz$

1.10.

1.10.1. $v = \frac{D}{\Delta t}$

$v = \frac{17000000}{21 \times 60 \times 60}$

$v = 224,87m \cdot s^{-1}$

1.10.2.1. $v = f\lambda$

$224,87 = f(100000)$

$f = \frac{224,87}{100000}$

$\therefore f = 2,25mHz$

1.10.2.2. $T = \frac{1}{f}$

$T = \frac{1}{2,25 \times 10^{-3}}$

$T = 444,44s$

1.10.3. The amplitude will decrease

1.10.4. Sound that has a frequency lower than that of human hearing ability.

1.10.5. $v = \frac{D}{\Delta t}$

$224,87 = \frac{72000}{\Delta t}$

$\Delta t = \frac{72000}{224,87}$

$\Delta t = 320,18\ seconds$

$\approx 5\ minutes\ and\ 20\ seconds$

1.11.

1.11.1. A transverse wave

1.11.2. 1,5m

1.11.3. A+E **OR** D+F

1.11.4. 4/1,5= 2,67m

1.11.5. $f = \frac{1}{T}$

$f = \frac{1}{0,4}$

$f = 2,5Hz$

1.11.6.

1.11.6.1. $4\ crests = 3\ wavelengths$

$\therefore t = 3 \times 0,4$

$t = 1,2s$

1.11.6.2. $v = f\lambda$

$v = (2,5)(2,67)$

$v = 6,68m \cdot s^{-1}$

OR

$v = \frac{D}{t}$

$v = \frac{2,67}{0,4}$

$v = 6,68m \cdot s^{-1}$

Sound and EM Spectrum

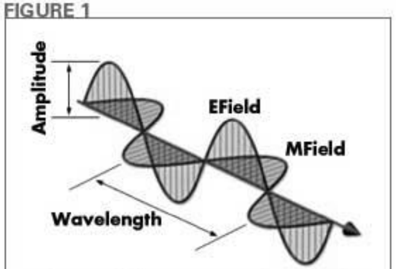
2.1.

2.1.1. 94,7 million times

2.1.2. λ = c /f = 3,1 m

2.1.3.

FIGURE 1



Waves of Electromagnetic Radiation

2.2. Light travels at 300 000 000 ms^{-1} in vacuum.

2.2.1. 300 000 000 ms^{-1}

2.2.2. λ = c / f = 3 x10^8/3 x 10^{10} = *10^{-2} m*

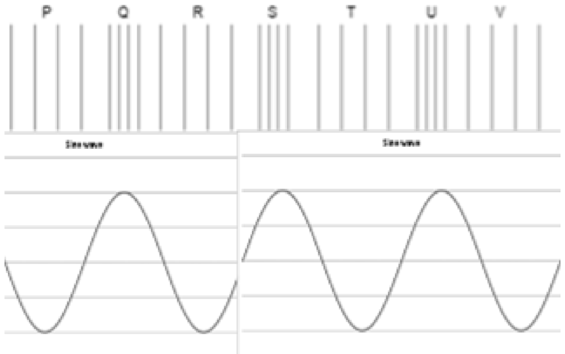
2.2.3. λ = c / f = 3 x10^8/3 x 10^{15} = *3 x 10^{-7} m*

2.2.4. λ = c / f = 3 x10^8 / 80 x 10^6 = *3,75 m*

2.2.5. $f = c / \lambda = 3 \times 10^8 / 1\,500 = 200 \times 10^5$ Hz = *200 kHz*

2.3.

2.3.1. Draw the corresponding particle position versus time graph of the wave shown above. Indicate ALL the corresponding points on the graph.



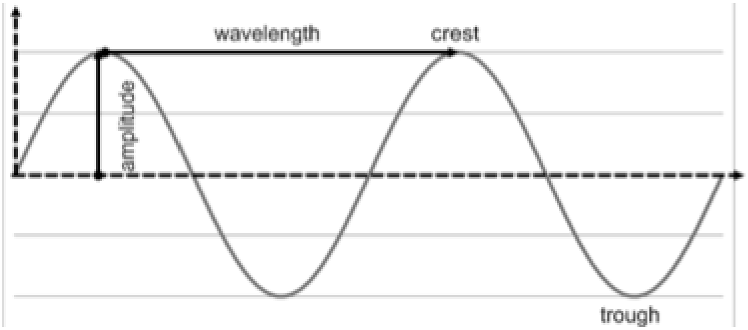
2.3.2. QS or RT or SU or TV are in phase.

2.3.3. $T = 1 / f = 1 / 500 = 0{,}002$s

2.3.4. $v = f \times \lambda = 500 \times (1{,}376 /2) = 344\text{ms}^{-1}$.

2.4.

2.4.1.



Remember: A sound wave is not a transverse wave – it has compressions and rarefactions. This diagram is used to represent the wave. Troughs are rarefactions where the pressure is minimum, and peaks on the graph are compressions, where the pressure is maximum.

2.4.2. $T = 1 / f = 1 / 45 = 0{,}022$s. $2T = 0{,}044$s
distance = speed x time = 340 x 0.044
= 15.11 m

2.5.

2.5.1. d = s x t = 345 x 0.018 = 6,21 m travelled to obstacle and back.
Distance from the obstacle = *3.11m*

2.5.2. $\lambda = v / f = 345 / 1.2 \times 10^5 = 0{,}00288$ m =*2.88 mm*

2.6.

2.6.1. The aim of the investigation is experimentally determine the speed of sound in the air.

2.6.2.

2.6.2.1. Distance that the sound is traveling

2.6.2.2. Time taken to hear the sound

2.6.3. $v = \frac{\Delta s}{\Delta t}$

$= \frac{180}{0.8-0.2}$

$= 300\text{ms}^{-1}$

2.6.4. $v = \frac{\Delta x}{\Delta t}$

$300 = \frac{s}{0.2}$

X= 60m

2.6.5. When the sound reflects off of the cliff, the sound waves lose some energy. The decreased energy decreases the amplitude and thus decreases the loudness.

2.6.6.

2.6.6.1. same

2.6.6.2. same

2.6.6.3. decrease

2.6.6.4. increase

2.6.7. An increase in temperature will result in more kinetic energy in the vibrations of the air particles, which results in a decrease in density of the medium. A decrease in altitude will result in more particles which are available for transmitting energy. The speed of sound through a medium is directly proportional to the density of the medium.

2.7.

2.7.1. $v = \frac{D}{\Delta t}$

$340 = \frac{D}{3,25}$

$D = (340)(3,25)$

$D = 1105m$

2.7.2. $v = \frac{D}{\Delta t}$

$340 = \frac{D}{(2,84-2,08)}$

$D = (340)(0,76)$

$D = 258,4m$

2.7.3. Time taken for the light to reach Thato:

$$c = \frac{D}{\Delta t}$$

$$3 \times 10^8 = \frac{1105}{\Delta t}$$

$$\Delta t = \frac{1105}{3 \times 10^8}$$

$$\Delta t = 3,69 \times 10^{-6} s$$

This time interval is so small that it will not affect his overall results.

2.7.4. Towards him. Time is directly proportional to distance. The time becomes smaller, meaning that the distance is decreasing.

2.7.5. The light from the sun is an electromagnetic wave, which does not need a medium to propagate through. Sound however relies on the compression and rarefactions of a medium. As space is a vacuum, there is no medium between the sun and the earth.

2.7.6. $c = \frac{D}{\Delta t}$

$3 \times 10^8 = \frac{149,6 \times 10^9}{\Delta t}$

$\Delta t = \frac{149,6 \times 10^9}{3 \times 10^8}$

$\Delta t = 498,67s$

$\Delta t \approx 8\, minutes$

2.7.7. 4,3 light years → seconds

$4,3 \times 365,25 \times 24 \times 60 \times 60$

$= 135697680s$

$$c = \frac{D}{\Delta t}$$

$$3 \times 10^8 = \frac{D}{135697680}$$

$$D = (3 \times 10^8)(135697680)$$

$$D = 4,07 \times 10^{16} m$$

$$= 4,07 \times 10^{13} km$$

2.8.

2.8.1. The number of waves that pass a point in 1 second.

2.8.2. $v = f\lambda$

$1490 = 24000\lambda$

$\lambda = \frac{1490}{24000}$

$\lambda = 0,062m$

2.8.3. No. The frequency of the sound is above the threshold of human hearing (20kHz)

2.8.4. $v = \frac{D}{\Delta t}$

$1490 = \frac{D}{0,28}$

$D = (1490)(0,28)$

$v = 417,2m$

$\therefore depth = \frac{417,2}{2}$

$= 208,6m$

2.8.5. $\%accuracy = \frac{208,6-0,062}{208,6} \times 100$

$= 99,97\%$

2.8.6. $\%accuracy = \frac{40-0,062}{40} \times 100$

$= 99,85\%$

2.8.7. Increase the frequency of sound used. By increasing the frequency of the sound, the wavelength is decreased, which allows for a smaller margin of error and a more accurate measurement.

2.8.8. Their ability to reflect

2.9.

2.9.1. Radio waves

2.9.2. $c = f\lambda$

$3 \times 10^8 = 98 \times 10^6 \lambda$

$\lambda = \frac{3\times10^8}{98\times10^6}$

$\lambda = 3{,}06m$

2.9.3. $c = \frac{D}{\Delta t}$

$3 \times 10^8 = \frac{9000}{\Delta t}$

$\Delta t = \frac{9000}{3\times10^8}$

$\Delta t = 73 \times 10^5 s$

2.9.4. $E = hf$

$E = (6{,}63 \times 10^{-34})(103{,}5 \times 10^6)$

$E = 6{,}86 \times 10^{-26} J$

2.9.5. Creation: To broadcast this electromagnetic wave, charges in the antenna of the station is oscillated at 103,5MHz. These moving charges will create an oscillating magnetic field around it, which in turn will create a perpendicularly directed electrical field.
Propagation: The wave then continues to propagate alternating electrical and magnetic fields at 90° to one another, allowing the wave to continue moving even without a medium

2.10.

2.10.1. Penetrating ability is directly proportional to energy

2.10.2.

2.10.2.1. $c = f\lambda$

$3 \times 10^8 = 1 \times 10^{16} \lambda$

$\lambda = \frac{3\times10^8}{1\times10^{16}}$

$\lambda = 3 \times 10^{-8} m$

2.10.2.2. $E = hf$

$E = (6{,}63 \times 10^{-34})(1 \times 10^{16})$

$E = 6{,}63 \times 10^{-18} J$

2.10.3. Infrared radiation is responsible for heat. Because it has a low frequency, it has lower energy and less penetrating ability. It cannot get through the clouds, and therefore your body does not warm up. Ultraviolet rays however have a higher frequency, as well as more penetrating ability due to increased energy. These rays are responsible for becoming sunburnt, and can still pass through the clouds.

2.10.4. $T = \frac{1}{f}$

$T = \frac{1}{1\times10^{12}}$

$T = 1 \times 10^{-12} s$

2.10.5. Used in remote controls OR motion sensors

2.10.6. The 3 lights can only be compared if they have the same variables. This can be frequency, wavelength or period, and only needs to be one of them.

	Frequency (Hz)	**Wavelength (nm)**	**Period (s)**
Light 1	**$5{,}56\text{x}10^{14}$**	539,57	$1{,}8\text{x}10^{-15}$
Light 2	$4{,}96\text{x}10^{14}$	**605**	$2{,}02\text{x}10^{-15}$
Light 3	$7{,}3\text{x}10^{14}$	410,96	**$1{,}37\text{x}10^{-15}$**

The light can then be arranged according to frequency or wavelength to compare to the colours.
Light 3- violet
Light 1- green
Light 2- orange

Magnetism

3.1.

3.1.1. What is the relationship between force of attraction and the distance between the poles of two magnets?

3.1.2. The force of attraction between the magnets is inversely proportional to the distance between their poles.

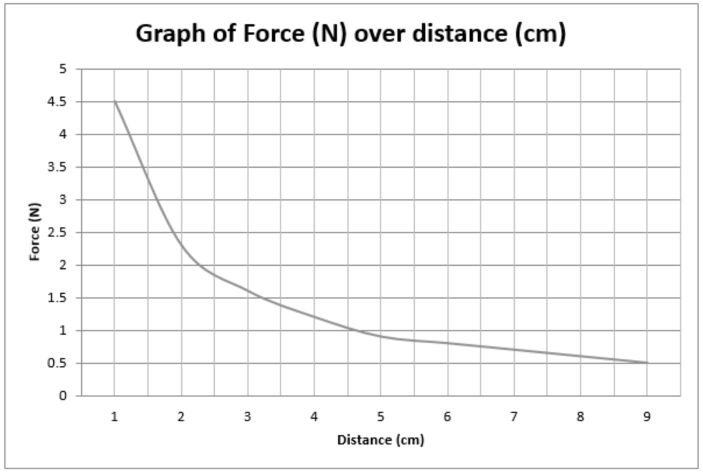
3.1.3.

3.1.3.1. Distance between poles

3.1.3.2. Force

3.1.3.3. Magnetic alignment
Strength of magnets

3.1.4. Heading, x-label, y-label, appropriate scale, Data points plotted:

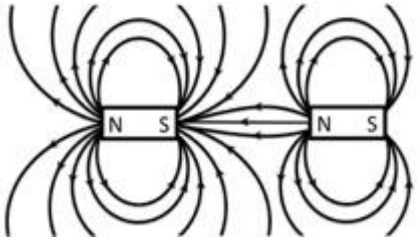


3.1.5. The force of attraction is inversely proportional to the distance between magnets.

3.1.6. ± 3.25N

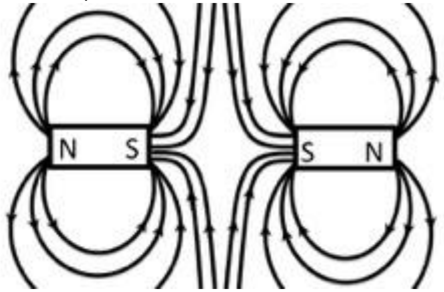
3.1.7. 4cm

3.1.8. Field pattern, arrow direction



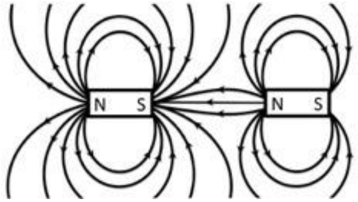
3.1.9. Repulsive

3.1.10. field pattern, arrow direction

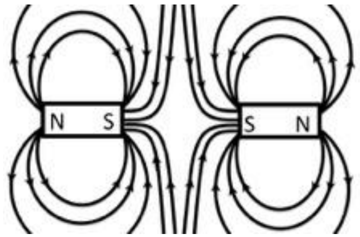


3.2.

3.2.1.



3.2.2.



3.2.3. They are 3 dimensional.
they never touch/cross.
they are directed from the north to south.
they are more concentrated where field strength is the highest.

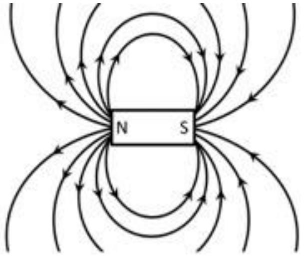
3.2.4. Charged particles from the sun get trapped in the magnetosphere and spiral down towards the magnetic poles of the earth where they collide with gas molecules in the atmosphere. The energised gas molecules emit light.

3.2.5. At the equator region, the magnetic field does not enter the earth and deflects solar radiation

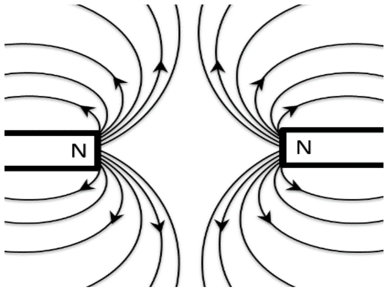
3.2.6. A magnetised material has magnetic domains that are all aligned in the same magnetic orientation. Unmagnetised materials either have no domains (not a ferromagnetic material) or the domains are not aligned and has no nett magnetic orientation.

3.3.

3.3.1.



3.3.2.



3.3.3. Repulsion

3.3.4. A region in space in which a magnet or ferromagnetic object experiences a magnetic force.

3.3.5. Hard iron =Ferromagnetic Material that retains its magnetism for longer periods of time
Soft iron= Ferromagnetic materials that loses its magnetism and the domains swing back to their original arrangement

3.3.6. Put the iron rod inside a solenoid. Pass a direct current (DC) through the coil for a period of time. Once all of the domains are lined up the iron will be magnetised.

3.4.

3.4.1. 1. Bash, drop or hammer the magnet. This gives energy to the domains and lets them re-orientate themselves into random directions again.
2. Heat it - this gives energy to the domains and lets them re-orientate themselves into random directions again.

3.4.2. The closer the object is to the end of the magnet, the greater the force it experiences, as it is a strong magnetic field at the end of the magnet.
If the force of attraction is strong the object will be attracted and move towards the magnet.

3.4.3. Magnets may be used to remove magnetic metal fragments from eyes. This may prevent infection and possible loss of an eye.
Magnets are used in compasses as navigation to prevent people from getting lost when navigating during flight or at sea. This can save lives and helps with rescue operations

3.5.

3.5.1. Iron, Nickel or Cobalt.

3.5.2. Clusters of atoms are arranged in units these are known as domains.

3.5.3. Domains are aligned with the external field.

3.5.4. Soft ferromagnetic substance – easily magnetised but loses magnetism easily, domains temporarily aligned: example are iron or iron-aluminium alloys.
Hard ferromagnetic substance – difficult to magnetise, keeps its magnetism to become a permanent magnet: examples are cobalt and steel.

3.5.5.

3.5.5.1. Attract

3.5.5.2. Attract

3.5.5.3. Repel

3.6.

3.6.1. hard – steel ; soft – iron

3.6.2. The closer the lines are drawn to each other (the more densely packed the line pattern) the stronger the field.

3.6.3. All ferromagnetic materials have a maximum temperature above which their magnetic properties disappear. As the domains receives the extra energy, it causes molecular vibration (kinetic energy) and so they move out of alignment.

3.6.4. 1. Use in the electrical bells
2. Used in the speakers
3. Used in old cathode ray TV screens
4. Used in the refrigerators to keep the door closed

3.7.
3.7.1. The space around a magnet in which other magnetic materials will experience a force.
3.7.2. Ferromagnetic material
3.7.3. B and C has the same polarity
3.7.4. No
3.7.5. C to D. If the north pole of the compass points away from D, then D is a north pole. Magnetic field lines always emerge from the north pole of a magnet, and are pointed from south to north inside the magnet.
3.7.6. The earth's magnetic field deflects the solar radiation away from earth.

Electrostatics

4.1.
4.1.1. To prevent any changes in charge taking place/It is necessary to isolate the system from the earth for steps 1,2,and 4.
4.1.2. The side closest to the rod will be positive and the end away from the rod negative. Induction the negative rod will repel the electrons, and electrons will move to the opposite side of the sphere. Protons will remain where they are, resulting in uneven distribution of charge.
4.1.3. By Induction. The negative rod will repel the electrons, and electrons will move to the opposite side of the sphere. Protons will remain where they are, resulting in uneven distribution of charge.
4.1.4. The electrons that are in concentration on the right hand side will move down the earth wire away from the sphere.
4.1.5. Positively charged. It has an electron deficit/excess of protons.
4.1.6. Repelled.
4.1.7. Friction.
4.1.8. False protons cannot be moved from one object to another, but the wool cloth took electrons from the rod.

4.2.
4.2.1. $Q = nq_e$
$-2.8 \times 10^{-9} = n(-1.6 \times 10^{-19})$
$n = 1.75 \times 10^{10}$ electrons
4.2.2. Principle of conservation of charge
4.2.3. During contact, the spheres shared electrons to receive an equal charge and these equal and like charges repel each other

4.2.4. $Q = \frac{Q1+Q2}{2}$
$Q = \dfrac{-2.8 \times 10^{-9} + 4.5 \times 10^{-9}}{2}$
$Q = 8.5 \times 10^{-10} C \text{ or } 0.85nC$
4.2.5. Law of conservation of charge.
4.2.6. The negatively charged rod will attract the positive sphere.
4.2.7. False, electrons can only be transferred in whole numbers/ the charge of an object has to be whole number multiples of $1.6\text{x}10^{-19}$C.

4.3.
4.3.1. Charge cannot be created or destroyed, it can only be transferred from one object to another.
4.3.2.

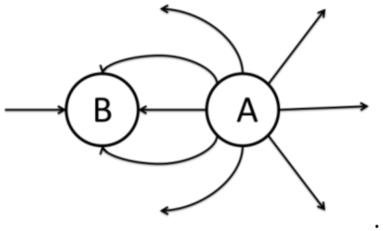
4.3.2.1. $Q = \frac{Q1+Q2}{2}$
$= \dfrac{4 \times 10^{-9} - 8 \times 10^{-9}}{2}$
$= -2 \times 10^{-9}$ C

4.3.2.2. B to A.
4.3.2.3. Repel – after touching they have the same charges and like charges repel.
4.3.2.4. $Q = \frac{Q1+Q2}{2}$
$= \frac{-2\times10^{-9}+0}{2}$
$= -1 \times 10^{-9} C$
4.3.2.5. $Q = nq_e$
$-1 \times 10^{-9} = n(-1.6 \times 10^{-19})$
$n = 6.25 \times 10^9$ electrons
4.3.3.
4.3.3.1. T
4.3.3.2. F
4.3.3.3. T
4.3.4. Same as A, they repel as they are like charges.
4.3.5.

4.3.5.1. A neutral object has equal number of protons and electrons. A charged object has either lost electrons (positive) or gained electrons (negative).
4.3.5.2. Added to.
4.3.5.3. The ball would be attracted to the ruler.

4.4.

4.4.1.

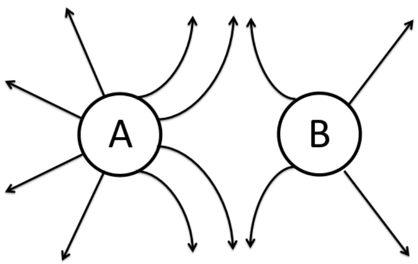


4.4.2. Electrostatic attraction.
4.4.3. Excess electrons.
4.4.4. $Q = \frac{Q1+Q2}{2}$
$= \frac{10\times10^{-9}+-6\times10^{-9}}{2}$
$= 2\times10^{-9}C$
4.4.5. Sphere B
4.4.6. 10nC-2nC = 8nC

4.4.7. $Q = nq_e$
$8\times10^{-9} = n(1.6\times10^{-19})$
$n = 5\times10^{10}$ electrons

4.5.

4.5.1.



4.5.2. Force of Repulsion
4.5.3. Loss of electrons
4.5.4. The net charge of an isolated system remains constant.
4.5.5. $Q = \frac{Q1+Q2}{2}$
$= \frac{15\times10^{-9}+6\times10^{-9}}{2}$
$= 10.5\times10^{-9}C$
4.5.6. 15nC - 10.5nC = 4.5nC

4.6.

4.6.1. The greater the time that the rod is rubbed with a cloth, the greater the charge that it will obtain.
4.6.2. Time (that the rod is rubbed)
4.6.3. Charge that is obtained
4.6.4. Both Variables included; any relationship between the variables stated
4.6.5. The molecules in the piece of paper becomes polarised (due to the presence of the charged rod).

4.7.

4.7.1. Point A: Positive
Point B: Negative
4.7.2. The polystyrene sphere will be attracted to the cylinder and come into contact with the cylinder. The cylinder will transfer electrons to the sphere and they obtain the same charge, causing them to repel each other.
4.7.3. After contact with the sphere, the cylinder has a deficit of electrons. The deficit of electrons results in a positive cylinder, which exerts an attractive force on the ruler due to the difference in the nature of their charges (ruler is negative, cylinder is positive).

4.8.

4.8.1. The net charge of an isolated system remains constant.
4.8.2. The excess electrons on the rod attract the positive poles of polar water molecules, causing the water molecules to move towards the rod. This causes the water stream to bend. (there is a force of repulsion between the negative poles of the water molecules and the excess electrons on the ruler, but because the negative side has turned away from the rod, the force of repulsion is less than the force of attraction.
4.8.3. $Q = nq_e$
$Q = (1\times10^{14})(-1{,}6\times10^{-19})$
$Q = -3{,}52\mu C$

4.8.4. $Net\ charge = 3{,}52 - \frac{3{,}52}{10}$

$$= 3{,}17\mu C$$

4.8.5.

$$\Delta Q = \Delta n q_e$$

$$3{,}52 \times 10^{-6} - 3{,}17 \times 10^{-6} = \Delta n(-1{,}6 \times 10^{-19})$$

$$\frac{0{,}35\times10^{-6}}{-1{,}6\times10^{-19}} = \Delta n$$

$$\Delta n = 2{,}19 \times 10^{12}\ electrons$$

4.9.

4.9.1. $Q_{new} = \frac{Q_1+Q_2}{2}$

$$6 = \frac{Q_1+15}{2}$$

$$12 = Q_1 + 15$$

$$\therefore Q_1 = -3mC$$

4.9.2.

$$\Delta Q = \Delta n q_e$$

$$15 \times 10^{-3} - 6 \times 10^{-3} = \Delta n(-1{,}6 \times 10^{-19})$$

$$\frac{9\times10^{-3}}{-1{,}6\times10^{-19}} = \Delta n$$

$$\Delta n = 5{,}63 \times 10^{16}\ electrons$$

4.9.3. False. A neutral sphere does contain electrons; however the net charge is zero. In other words, the number of electrons and protons are the same.

4.9.4.

4.9.4.1. $Q_{new} = \frac{Q_1+Q_2}{2}$

$$= \frac{6+0}{2}$$

$$\therefore Q_{new} = 3mC$$

4.9.4.2.

$$\Delta Q = \Delta n q_e$$

$$6 \times 10^{-3} - 3 \times 10^{-3} = \Delta n(-1{,}6 \times 10^{-19})$$

$$\frac{3\times10^{-3}}{-1{,}6\times10^{-19}} = \Delta n$$

$$\Delta n = 1{,}88 \times 10^{16}\ electrons$$

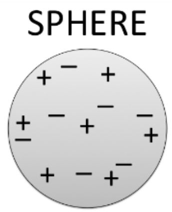
4.10.

4.10.1. During the rubbing process, the glass rod was charged by electrons being transferred form the glass rod to the cloth due to friction.

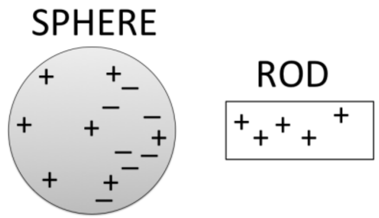
4.10.2. Negative

4.10.3. The sphere is neutral because the amount of positive charges (protons) and negative charges (electrons) are the same.

4.10.4.



4.10.5.



When the positively charged rod is brought close to the sphere, the electrons in the sphere are attracted to the rod, creating a temporary induced charge on either side of the sphere.

4.10.6. Induction

4.10.7. No. Because there is no contact between the sphere and the rod, the electrons will not be transferred between the objects. The electrons are only temporarily displaced to one side of the sphere

4.10.8. Decrease the distance between the sphere and the rod
Increase the charge on the rod

4.10.9. No. Wood is an electrical insulator, while graphite is an electrical conductor. The electrons in the wood can not flow from one side of the sphere to the other.

Electric Circuits

1.1.

1.1.1. Current = rate of flow of charge.

1.1.2. I = Q / t = 576 / (6 x 60 x 60) = 0.027 A (= 27 mA)

1.1.3. S1 closed, S2 open

1.1.4. W = V x Q = 3,6 x 576 = 2073.6 J

1.1.5. Solar → chemical → electrical → light

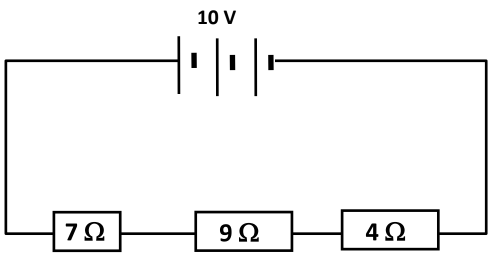
1.1.6. S2 closed (S1 does not matter)

1.1.7. t = Q / I = 576 / (2x 0,03) = 9600 s or 2,7 hrs

1.1.8. R = V / I = 3,6 / 0.03 = 120Ω
1.1.9. $1/R_{II} = 1/R_1 + 1/R_2$ = 1/120 + 1/120 -> R_{II} = 60Ω
1.1.10.
n series: more resistance -> less current -> less bright
If one light blows, open circuit, no current
1.1.11.
o batteries or candles needed. Free energy, etc.
1.1.12.
Might need light for longer period of time
Perhaps the sun doesn't shine, won't charge
1.1.13. V across light is not directly proportional to I in light.
Graph is not a straight line through the origin.

1.2.
1.2.1. Non-Ohmic. Graph is not a straight line. V not directly proportional to I.
1.2.2. Reading from the graph →0.55A
1.2.3. Reading from the graph →1A would require 15V
1.2.4. R at 10V = V / I = 10 / 0,5 = 20Ω
R at 20V = V / I = 20 / 1,5 = 13,3Ω

1.3. Series Circuit



1.3.1. There are no branches so all the current flows through each resistor.
1.3.2.
1.3.2.1. Total resistance = 7+9+4 = 20Ω
1.3.2.2. Total current I = V/R = 10/20 = 0,5A
1.3.2.3. V across 7Ω = IxR = 0.5x7 = 3.5V
1.3.2.4. V across 9Ω = IxR = 0.5x9 = 4.5V
1.3.2.5. V across 4Ω = IxR = 0.5x4 = 2V
1.4.
1.4.1. $1/R_{TOT} = 1/R_1 + 1/R_2 + 1/R_3$ = ½ + 1/3 + 1/ 4 = 13/ 12
R_{TOT} = 12 / 13 = 0,92Ω
1.4.2. Total current I = V/R = 12 / 0.92 = 13A
1.4.3. V across 2Ω = 12V
1.4.4. V across 3Ω = 12V
1.4.5. V across 4Ω = 12V
1.4.6. I through 2Ω = V / R = 12 / 2 = 6A
1.4.7. I through 3Ω= V / R = 12 / 3 = 4A
1.4.8. I through 4Ω= V / R = 12 / 4 = 3A

1.5.
1.5.1.

1.5.2. 1.5V
1.5.3. R_{II} = (1,5 x 2) / (1,5 + 2) = 3 / 3,5 = 0.86Ω
1.5.4. Total current = V/R = 1,5/0.86 = 1,75A
1.5.5. Current through the 1.5 Ω resistor = V/R = 1,5/1,5 = 1A

1.6.
1.6.1. Current is the rate at which charge flows.
1.6.2. 12V
1.6.3. $R_T = R_1 + R_2$.
=6+4
=10Ω

V=IR
12=I 10
I=1.2A
1.6.4. V=IR
12=1.5R
R=8Ω
1.6.5. $R_T = R_S + R_P$
8 = 6 + R_P

$R_P = 2\Omega$

$1/R_p = 1/R_2 + 1/R_3$
$½ = ¼ + 1/R_3$
$¼ = 1/R_3$
$R=4\Omega.$

1.6.6. When the switch closes the resistors (R_2 and R_3) are now connected in parallel. This causes the resistance in the circuit to drop and this causes the current to increase.

1.6.7. $V_{//}= V_{tot} – V_6 = 12 – (6x1,5) = 12-9 = 3V$

1.7.

1.7.1. V_1 only

1.7.2. $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{R_P} = \frac{1}{22.5} + \frac{1}{18}$
$\frac{1}{R_P} = \frac{1}{10}$
$R_p=10\Omega$

1.7.3. $V_3 = IR_p$
$= 1.5(10)$
$= 15V$

1.7.4. $V_1 = V_2+V_3$
$120 = V_2+15$
$V_2 = 105V$

1.7.5. $V_3 = I_2R$
$15 = I (22,5)$
$I = 0.67A$

1.7.6. $V_2 = IR_S$
$105 = (1,5)R$
$R = 70\ \Omega$
$R_S = R_1 + R_2$
$70 = 35 + R$
$R = 35\ \Omega$

1.7.7. $R_S= R_1 + R_2 + R_3$
$= 33 +35 +22,5$
$= 92,5\ \Omega$

1.7.8. Decrease, total current is inversely proportional to total resistance.

1.8.

1.8.1. $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{R_p} = \frac{1}{8} + \frac{1}{4}$
$\frac{1}{R_p} = \frac{3}{8}$
$R_p = 2,67\Omega$

1.8.2. $V_{4\Omega} = IR$
$V = (3)(2,67)$
$V = 8,01V$

$V_{8\Omega} = V_{4\Omega}$
$V_{8\Omega} = 8,01V$

1.8.3. $V = I_{A_2}R$
$8,01 = I_{A_2}(8)$
$I_{A_2} = \frac{8,01}{8}$
$I_{A_2} = 1A$

$V = I_{A_3}R$
$8,01 = I_{A_3}(4)$
$I_{A_3} = \frac{8,01}{4}$
$I_{A_3} = 2A$

1.8.4. Current is the rate of flow of charge. Because charges cannot be created or destroyed, all charges that enter the circuit must exit at the end of the circuit.

1.8.5.

1.8.5.1. The current will increase. Current is directly proportional to the potential difference. The more potential energy is present, the more charges will move through the resistors per second.

1.8.5.2. The current will decrease. By removing the 4 Ω resistor, the total effective resistance increases. The increase in resistance will decrease the current through A_2.

1.8.5.3. The current will decrease. An increase in temperature results in increased resistance. The increase in resistance will decrease the current through A_2.

1.8.5.4. The current will stay the same. Total resistance of the circuit will double, effectively halving the total current to only 1,5A. However, due to the resistance ratios, the current will remain the same.

1.9.

1.9.1. The rate of flow of charge.

1.9.2. The current in all ammeters- A_1,A_2 and A_3- will be the same.

1.9.3. $A_1 = A_2 = A_3 = 1{,}5A$

$$\therefore Total\ current = A_1 + A_2$$
$$= 1{,}5 + 1{,}5$$
$$= 3A$$

1.9.4. $\frac{1}{R_p} = \frac{1}{R_1+R_2} + \frac{1}{R_3}$

$$\frac{1}{R_p} = \frac{1}{6+4} + \frac{1}{10}$$
$$\frac{1}{R_p} = \frac{2}{10}$$
$$\therefore R_p = 5\Omega$$

$$V_T = I_T R_T$$
$$V_T = (3)(5)$$
$$V_T = 15V$$

1.9.5. Work done per unit charge

$$Q = It$$
$$Q = (3)(120)$$
$$Q = 360C$$

1.9.6. $V = \frac{W}{Q}$

$$15 = \frac{W}{360}$$
$$W = (15)(360)$$
$$W = 5400J$$

1.9.7. While using a battery in a circuit, the chemical energy is converted into other forms of energy such as heat, light and movement. This energy is then dissipated into the environment. When there is no more stored chemical energy in the cells (the chemical reactions have been completed), the battery is "flat".

1.10.

1.10.1. Potential difference is the work done per unit charge

1.10.2.

1.10.2.1. $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$$\frac{1}{R_p} = \frac{1}{3} + \frac{1}{5}$$
$$\frac{1}{R_p} = \frac{8}{15}$$
$$R_p = 1{,}88\Omega$$

1.10.2.2. $V_P = IR_P$

$$4 = I(1{,}88)$$
$$I = 2{,}12A$$

$$V_T = IR_T$$
$$= (2{,},12)(1{,}88 + 4)$$
$$= 12{,}47V$$

1.10.2.3. $V_2 = IR$

$$= (2{,}12)(4)$$
$$= 8{,}48V$$

1.10.2.4. $Q = It$

$$Q = (2{,}12)(4 \times 60)$$
$$Q = 508{,}8C$$

VECTORS AND SCALARS

6.1.

6.1.1. David

$sin55° = \frac{o}{h}$

$2,0sin55° = 1,64m.s^{-1}$

Sean

$sin60° = \frac{o}{h}$

$2,5sin60° = 2,17m.s^{-1}$

6.1.2. David:

$v = \frac{s}{t}$

$2,71 = \frac{50}{t}$

$\therefore t = 18,45s$

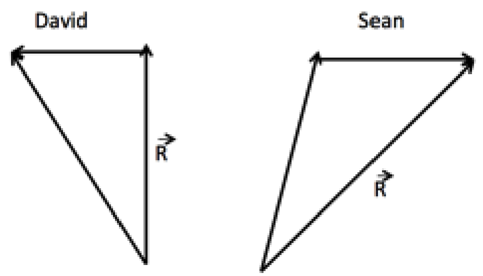
Sean:

$v = \frac{s}{t}$

$1,64 = \frac{50}{t}$

$\therefore t = 30,49s$

6.1.3.



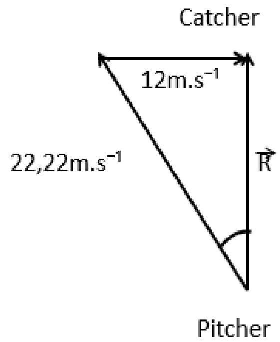
David would have a decreased resultant velocity as he was swimming against the current.
Sean would have an increased resultant velocity as he was not swimming against the current.

6.2.

6.2.1. $80km.h^{-1} \div 3,6 = 22,22m.s^{-1}$

6.2.2. Displacement s a vector and needs direction to be specified.

6.2.3.



6.2.4. $tan\theta = \frac{o}{a}$

$= \frac{12}{22,22}$

$\therefore \theta = 28,37°$ west of north

6.2.5. $\vec{R}^2 = (22,22)^2 + (12)^2$

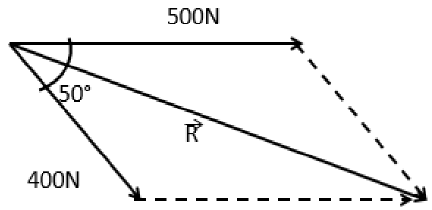
$\therefore \vec{R} = 25,25m.s^{-1}$

6.2.6. $25,25 \times 3,6 = 90,91km.h^{-1}$

6.3.

6.3.1. Physical quantity that has both magnitude and direction

6.3.2.



6.3.3. $\vec{R}^2 = (0,5)^2 + (2)^2$

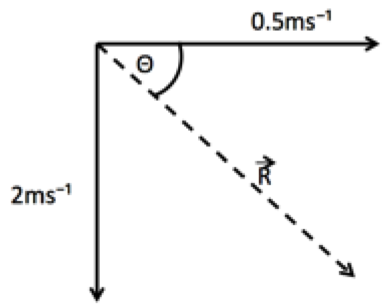
$\vec{R} = 2,06ms^{-1}$

$tan\theta = \frac{o}{a}$

$= \frac{2}{0,5}$

$\therefore \theta = 75,96°$

The resultant is 2,06m.s^{-1} at an angle of 75,96°

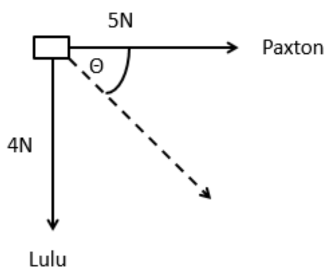


6.3.4. $speed = \frac{distance}{time}$

$2,06 = \frac{distance}{3 \times 60}$

$distance = 370,8m$

6.4.



6.4.1.

6.4.2. $\vec{R}^2 = (4)^2 + (5)^2$

$\therefore \vec{R} = 6,40N$

$tan\theta = \frac{o}{a}$

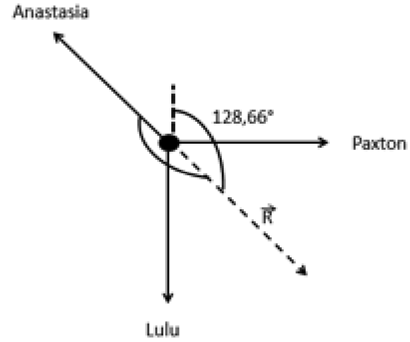
$= \frac{4}{5}$

$\therefore \theta = 38,66°$

$\therefore resultant\ force = 6,40N\ on\ a\ bearing\ of\ 128,66°$

6.4.3. With a Force of 6.40N

6.4.4. $128,66° + 180° = 308,66°$



6.5.

6.5.1.

6.5.1.1. 0m

6.5.1.2. 60m South

6.5.1.3. AC^2= AB^2 +BC^2

AC=$\sqrt{100^2 + 60^2}$

= 116.62m

Tan θ =$\frac{o}{a}$

Θ= tan^{-1} ($\frac{60}{100}$)

Θ= 30,96°

The resultant displacement= 11,6,62m at an angle of 30,96°

6.5.2.

6.5.2.1. 100m

6.5.2.2. 160m

6.5.2.3. 260m

6.5.3.

6.5.3.1. Speed = $\frac{d}{t}$
$= \frac{160}{18}$
= 8.89ms^{-1}

6.5.3.2. Speed =$\frac{d}{t}$
=$\frac{160}{8+5+11}$
=6.67ms^{-1}

6.5.4. v =$\frac{\Delta x}{\Delta t}$
= $\frac{60}{18+5+11}$
=$\frac{60}{34}$
=1.76 ms^{-1} south

6.5.5. speed= $\frac{distance}{time}$
1.5= $\frac{60}{t}$
t=$\frac{60}{1.5}$
t= 40s

6.6.

6.6.1. 100m

6.6.2. 0m

6.6.3. speed = distance/time
= 100/52.51
= 1.9 ms^{-1}

6.6.4. speed is a scalar and uses total distance travelled, Velocity is a vector and requires direction therefore only uses displacement travelled.

6.6.5.

6.6.5.1.

6.6.5.2. 50-10 = 40N

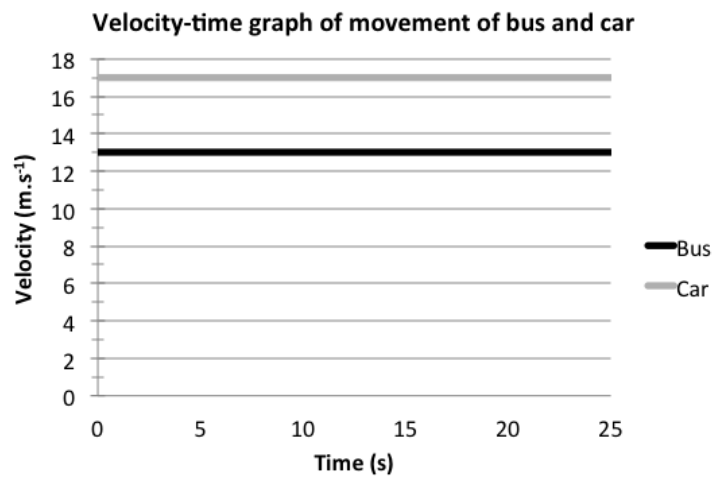
6.7.

6.7.1. $13 \times \frac{3600}{1000}$
$= 46{,}8km \cdot h^{-1}$
$\therefore 46{,}8km \cdot h^{-1}\ East$

6.7.2. $\bar{v} = \frac{\Delta x}{\Delta t}$
$13 = \frac{900}{\Delta t}$
$\Delta t = \frac{900}{13}$
$\Delta t = 69{,}23s$

6.7.3. 12m·s^{-1} east

6.7.4.



6.7.5. $Distance\ covered\ by\ the\ car$

$$area = l \times b$$

$$area = 20 \times 17$$

$$area = 340$$

$$\therefore displacement = 340\ m$$

$Distance\ covered\ by\ the\ bus$

$$area = l \times b$$

$$area = 20 \times 13$$

$$area = 260$$

$$\therefore displacement = 260\ m$$

$Difference\ in\ distance = 340 - 260 = 120m$

6.7.6. $17 \times \frac{3600}{1000}$

$= 61{,}2km \cdot h^{-1}$

Yes, the man is exceeding the speed limit

6.8.

6.8.1. A single vector that has the same effect as a combination of vectors.

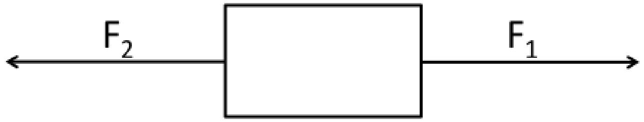
6.8.2. $F_{res} = F_1 + F_2$

$50 = 30 + F_2$

$F_2 = 20N$

6.8.3. Decrease

6.8.4.



6.8.5. The two vectors will be in opposite directions:

$F_{res} = 30 - 20$

$F_{res} = 10N$

6.9.

6.9.1. A physical quantity that has both magnitude and direction.

6.9.2. $Take\ west\ as\ positive$:

$$F_{res} = F_A + F_f$$

$$= 750 + (-200)$$

$$= 550N\ west$$

6.9.3. 0km

6.9.4. $v = \frac{D}{\Delta t}$

$= \frac{240}{3{,}5}$

$= 68{,}57km \cdot h^{-1}$

6.9.5. $Westward\ net\ velocity$:

$$v = \frac{\Delta x}{\Delta t}$$

$$= \frac{120}{2}$$

$$= 60km \cdot h^{-1}$$

$Eastward\ net\ velocity$:

$$v = \frac{\Delta x}{\Delta t}$$

$$= \frac{120}{1{,}5}$$

$$= 80km \cdot h^{-1}$$

$Difference\ in\ v\ is \frac{20km}{h}\ Hence\ the\ current\ is \frac{10km}{h}, hence\ the\ speed\ of\ the\ boat\ relative\ to\ the\ water\ is \frac{70km}{h}$

6.10.

6.10.1. $32 \times \frac{1000}{3600}$

$= 8{,}89m \cdot s^{-1}$

6.10.2. $v = \frac{D}{\Delta t}$

$$8{,}89 = \frac{D}{600}$$

$$D = (8{,}89)(600)$$

$$D = 5334m$$

6.10.3. $v_{res} = v_{boat} + v_{current}$

$32 = 40 + v_{current}$

$v_{current} = 32 - 40$

$v_{current} = -8$

$\therefore v_{current} = 8m \cdot s^{-1}$ *in the opposite direction of the boat*

6.10.4. $v_{res} = v_{boat} + v_{current}$

$= 40 + 8$

$= 48$

$\therefore v_{res} = 48m \cdot s^{-1}$

MOTION IN 1 DIMENSION

7.1.

7.1.1. $v = u + at$

$90 = 0 + a(0,3)$

$\therefore a = 300m.s^{-2}$ *north*

7.1.2. $s = ut + \frac{1}{2}at^2$

$= 0 + \frac{1}{2}(300)(0,3)^2$

$= 13,5m$

7.1.3.

$s = 20 - 13,5 = 6,5m$

$s = ut + \frac{1}{2}at^2$

$6,5 = 90(t) + 0$

$t = 0,072s$

Total time= $0,3 + 0,072 = 0.372$s

7.2.

7.2.1. 0-0,2s: constant/uniform acceleration

0,2-1,5s: constant velocity; zero acceleration

1,5-1,6s: constant acceleration in negative direction, velocity decreasing until he stops

1,6-1,7s: constant acceleration from rest in negative direction

7.2.2. $a = \frac{\Delta y}{\Delta x}$

$= \frac{100-70}{0,2}$

$= 150m.s^{-2}$

7.2.3. $distance = area$

$= \frac{1}{2}bh + lb + lb + \frac{1}{2}bh$

$= \frac{1}{2}(0,2)(100-70) + (0,2)(70) + (1,5-0,2)(100) + \frac{1}{2}(1,6-1,5)(100)$

$= 3 + 14 + 130 + 5$

$= 152m$

7.2.4. $displacement = area\ above - area\ below$

$= 152 - \left(\frac{1}{2}\right)(1,7-1,6)(50)$

$= 152 - 2,5$

$= 149,5m$ *west*

7.2.5.

7.2.5.1. $\therefore 100 - 25 = 75m.s^{-1}$ $\therefore$ *Barry relative to the bus is* $75m.s^{-1}$*west*

7.2.5.2. $\therefore 25 + 50 = 75m.s^{-1}$ $\therefore$ *Barry relative to the bus is* $75m.s^{-1}$*east*

7.2.6. Physical quantity that has both magnitude and direction.

7.2.7. After 1,6s Barry turned around ∴ moving back to the reference point ∴ displacement would decrease. Total path length would however increase as he is still covering extra distance.

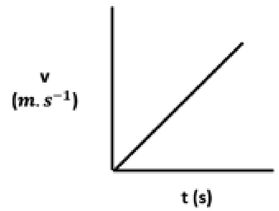
7.3.

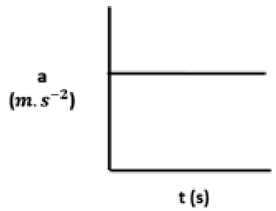
7.3.1. $v^2 = u^2 + 2as$

$= 0 + 2(6,25)(200)$

$\therefore v = 50m.s^{-1}$

7.3.2.





7.3.3. $v = u + at$

$50 = 0 + (6,25)t$

$\therefore t = 8s$

7.3.4. $s = 200 - 20 = 180m$
$v^2 = u^2 + 2as$
$(50)^2 = 0 + 2(a)(180)$
$\therefore a = 6{,}94m.s^{-2}$

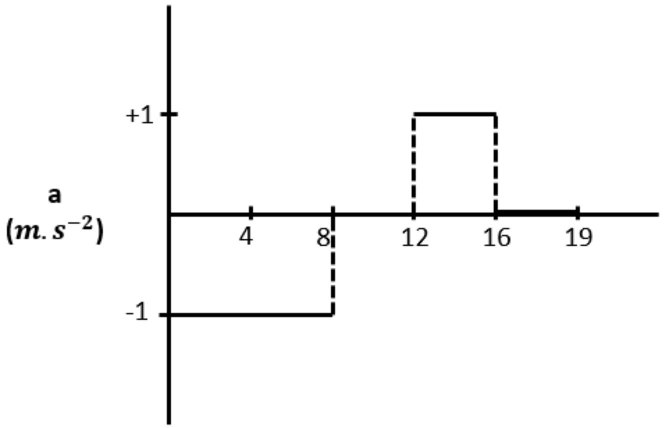
7.4.

7.4.1. $a = \frac{\Delta y}{\Delta x}$
$= \frac{-4-4}{8}$
$= -1m.s^{-2}$

7.4.2. $displacement = area\ above - area\ below$
$= \frac{1}{2}bh - \left[\frac{1}{2}bh + lb + \frac{1}{2}bh\right]$
$= \frac{1}{2}(4)(4) - \left[\frac{1}{2}(4)(4) + (4)(4) + \frac{1}{2}(4)(4)\right]$
$= 8 - [8 + 16 + 8]$
$= -24m$
$\therefore 24m\ south$

7.4.3. $t = 8s - 12s\ ; t = 16s - 20s\ ; t = 24s - 30s$

7.4.4.



7.4.5. at t=4s and t=20s

7.5. A car approaching a yield sign at 20ms^{-1} slows uniformly from 20ms^{-1} to 4ms^{-1} over a 4 second period.

Calculate ...

7.5.1. $v = u + at$
$4 = 20 + a(4)$
$\therefore a = -4m.s^{-2}$

7.5.2. $s = ut + \frac{1}{2}at^2$
$= 20(4) + \frac{1}{2}(-4)(4)^2$
$= 80 - 32$
$= 48m$

7.5.3. $v^2 = u^2 + 2as$
$0 = (4)^2 + 2(-4)s$
$s = 2m$

7.5.4. $60km.h^{-1} \div 3{,}6 = 16{,}67m.s^{-1}$
$\therefore 20m.s^{-1} -\ was\ speeding$

7.6.

7.6.1. The vehicle accelerated for the first 5s and then drove at a constant velocity for 10s . If then experienced a negative acceleration. It was stationary from t=25s to t=30s and then accelerated again in the positive direction.

7.6.2. a=$\frac{\Delta v}{\Delta t}$
=$\frac{30-0}{5-0}$
=6 ms^{-2}

7.6.3. 30ms $^{-1}$

7.6.4. a=$\frac{\Delta v}{\Delta t}$
=$\frac{0-30}{25-15}$
=-3 ms^{-2}

7.6.5. Area 0-5s = ½ l x b
= ½ 5 x 30
= 75m
Area 5-15s = l x b
= 10 x 30
= 300m
Total distance = 375m

7.7.

7.7.1. t=20s

7.7.2. Car: Area Δ= ½ l x b
= ½ (30) (22,5)

= 337.5m

Truck: Area= l x b

= 30 x 15

= 450m

Difference in distance= 112,5m

7.7.3. $a=\frac{\Delta v}{\Delta t}$

$=\frac{22.5-15}{30-20}$

$=0.75ms^{-2}$

7.8.

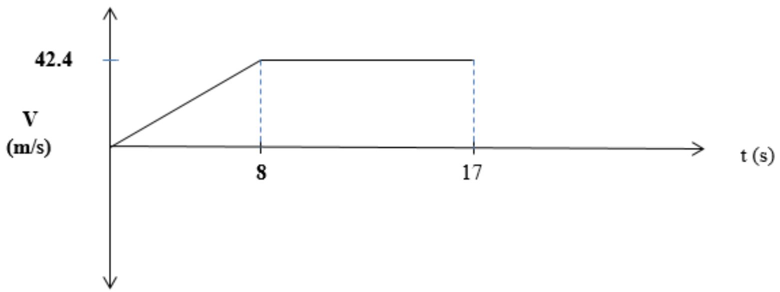
7.8.1. Average acceleration is the change in velocity divided by the time taken.

7.8.2. v = u + at

v = 0 + 5.3(8)

v = 42.4 ms^{-1} forward

7.8.3.



7.8.4. V = s/t

42,4= s/9

381.6 m = s

7.8.5. Distance is scalar and is the total path taken.

Displacement is a vector and is a change in position.

7.9.

7.9.1.

7.9.1.1. Take to the east as positive:

$v_f^2 = v_i^2 + 2a\Delta x$

$v_f^2 = 0^2 + 2(0{,}4)(260)$

$v_f = \sqrt{208}$

$\therefore v_f = 14{,}42m \cdot s^{-1}\ east$

$v_f = v_i + a\Delta t$

$14{,}42 = 0 + (0{,}4)\Delta t$

$\Delta t = \frac{14{,}42}{0{,}4}$

$\Delta t = 36{,}05s$

7.9.1.2. $v_f = 14{,}42m \cdot s^{-1} east$

7.9.1.3. $v = \frac{\Delta x}{\Delta t}$

$14{,}42 = \frac{600}{\Delta t}$

$\Delta t = \frac{600}{14{,}42}$

$\Delta t = 41{,}61s$

7.9.1.4. $\Delta x = 1000 - 260 - 600 = 140m$

$v_f^2 = v_i^2 + 2a\Delta x$

$0^2 = 14{,}42^2 + 2a(140)$

$a = \frac{-207{,}94}{2(140)}$

$a = -0{,}74$

$\therefore a = 0{,}74m \cdot s^{-2}\ west$

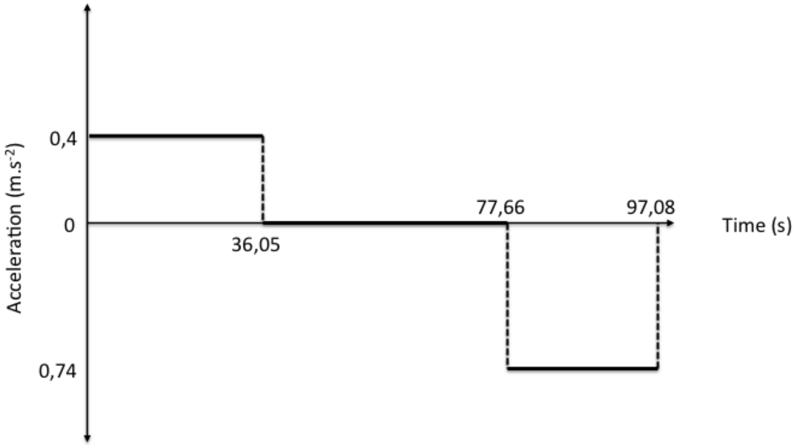
7.9.1.5. $\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$

$140 = \frac{1}{2}(14{,}42 + 0)\Delta t$

$\Delta t = \frac{140}{7{,}21}$

$\Delta t = 19{,}42s$

7.9.2.



7.9.3.

7.9.3.1. $\Delta v = area$

$area = l \times b$

$area = 19{,}42 \times 0{,}74$

$area = 14{,}37$

$\therefore v = 14{,}37 m \cdot s^{-1}\ east$

7.9.3.2. $\Delta v = area$

$area = l \times b$

$area = 36{,}05 \times 0{,}4$

$area = 14{,}42$

$\therefore v = 14{,}42 m \cdot s^{-1}\ east$

7.10.

7.10.1. The rate of change of velocity

7.10.2. $75 \times \frac{1000}{3600}$

$= 20{,}83 m \cdot s^{-1}$

7.10.3. $v_f = v_i + a\Delta t$

$30 = 0 + 2{,}5t$

$t = \frac{30}{2{,}5}$

$t = 12s$

7.10.4. $Displacement\ of\ police\ car:$

$\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$

$\Delta x = \frac{1}{2}(0 + 30)(12)$

$\Delta x = 180m$

$Displacement\ of\ police\ car:$

$$\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$$

$$\Delta x = \frac{1}{2}(20{,}83 + 20{,}83)(12)$$

$$\Delta x = 249{,}96m$$

$\therefore$ *the motorcycle will be ahead*

7.10.5. $249{,}96 - 180$

$= 69{,}96m$

$\therefore$ *the policeman has already traveled* $180m$ *while accelerating, and has to travel the same distance as the motorcyclist, plus an aditional* $69{,}96m$

police car:

$$v_p = \frac{\Delta x + 69{,}96}{t}$$

$$t = \frac{\Delta x + 69{,}96}{v_p}$$

motorcycle:

$$v_m = \frac{\Delta x}{t}$$

$$t = \frac{\Delta x}{v_m}$$

$$t = t$$

$$\therefore \frac{\Delta x + 69{,}96}{v_p} = \frac{\Delta x}{v_m}$$

$$v_m(\Delta x + 69{,}96) = \Delta x v_p$$

$$20{,}83x + 1457{,}27 = 30x$$

$$1457{,}27 = 30x - 20{,}83x$$

$$1457{,}27 = 9{,}17x$$

$$x = 158{,}92m$$

The total distance covered by the motorcycle is thus:

$180m(distance\ from\ start\ to\ maximum\ velocity)$
$+158{,}92m\ (distance\ traveled\ by\ car\ and\ motorcycle\ \ at\ maximum\ velocity)$
$+69{,}96m\ (the\ distance\ between\ then\ when\ car\ reaches\ maximum\ velocity)$
$= 408{,}88m$

7.10.6. $v = \frac{\Delta x+69{,}96}{t}$

$30 = \frac{158{,}92+69{,}96}{t}$

$t = \frac{228{,}88}{30}$

$t = 7{,}63s$

The total time is thus:

$12s\ (time\ to\ reach\ maximum\ velocity)$
$+7{,}63s\ \ (time\ to\ catch\ up\ with\ motorcycle\ at\ maximum\ velocity)$
$= 19{,}63s$

Energy

8.1.

8.1.1. $E_m = E_p + E_k$

$= mgh + \frac{1}{2}mv^2$

$= (3)(9{,}8)(8) + \frac{1}{2}(3)(0^2)$

$= 147\ J$

8.1.2. $0\ J$

8.1.3. $E_m = E_p + E_k$

$147 = 0 + E_k$

$E_k = 147\ J$

8.1.4. $E_m = E_p + E_k$

$147 = 100 + E_k$

$E_k = 47\ J$

8.1.5. $E_k = \frac{1}{2}mv^2$

$47 = \frac{1}{2}(3)v^2$

$\frac{47}{(0{,}5)(3)} = v^2$

$v = 5{,}6m.s^{-1}$

8.2.

8.2.1. $E_p = mgh$

$= (50)(9{,}8)(10)$

$= 4900\ J$

8.2.2. $E_k = \frac{1}{2}mv^2$

$= \frac{1}{2}(50)(14)^2$

$= 4900\ J$

8.2.3. Yes because at top $E_{mech} = E_p + E_k$

$= 4900 + 0$

and at the bottom $E_{mech} = E_p + E_k$

$= 0 + 4900$

$\therefore Because\ E_p\ top\ \&\ E_k\ bottom\ are\ equal\ we\ know\ it\ is\ conserved$

8.3.

8.3.1. $(E_k + E_p)_A = (E_k + E_p)_B$

$\frac{1}{2}mv^2 + mgh = \frac{1}{2}mv^2 + mgh$

$\frac{1}{2}(180)(0^2) + (180)(9{,}8)(80) = \frac{1}{2}(180)v^2 + (180)(9{,}8)(0)$

$141120 = \frac{1}{2}(180)v^2$

$$\frac{141120}{\left(\frac{1}{2}\right)(180)} = v^2$$
$v = 39{,}6 m.s^{-1}$

8.3.2. No, because there is friction between the truck and the road ∴ it will have a lower velocity in reality.

8.4.

8.4.1. $E_m = E_k + E_p$
$= \frac{1}{2}mv^2 + mgh$
$= \frac{1}{2}(200)(10^2) + (200)(9{,}8)(70)$
$= 147200\ J$

8.4.2. Minimum

8.4.3. Minimum

8.4.4. $(E_p + E_k)_A = (E_p + E_k)_B$
$mgh + \frac{1}{2}mv^2 = mgh + \frac{1}{2}mv^2$
$(200)(9{,}8)(70) + \frac{1}{2}(200)(10^2) = (200)(9{,}8)h + \frac{1}{2}(200)(0^2)$
$147200 = 1960h$
$\frac{147200}{1960} = h$
$h = 75{,}1m$

8.5.

8.5.1. Law of Conservation of Mechanical Energy: in a closed system without dissipative forces, the mechanical energy of an object is conserved.

8.5.2. $E_p = mgh$
$= (90)(9{,}8)(8)$
$= 7056\ J$

8.5.3. $(E_p + E_k)_A = (E_p + E_k)_B$
$mgh + \frac{1}{2}mv^2 = mgh + \frac{1}{2}mv^2$
$(90)(9{,}8)(8) + \frac{1}{2}(90)(0^2) = (90)(9{,}8)(0) + \frac{1}{2}(90)(v^2)$
$7056 = 45v^2$
$\frac{7056}{45} = v^2$
$v = 12{,}52 m.s^{-1}$

8.5.4. Friction between his hands and the pole.

8.6.

8.6.1. Potential Energy

8.6.2. E_p = 1911 / 2 = 955,5J

8.6.3. $E_K = ½ mv^2$
955.5 =½65v^2
v = 5,4 ms^{-1} down the slope

8.6.4. 0 J

8.6.5. Law of Conservation of Mechanical Energy: in a closed system without dissipative forces, the mechanical energy of an object is conserved.

8.6.6. 1911 – 196 = 1715 J

8.6.7. $E_K = ½ mv^2$
1715 =½65 v^2
v = 7,26 ms^{-1} to the right from D to E.

8.7.

8.7.1. The sum of the gravitational energy and kinetic energy of a closed system remains constant.

8.7.2. $E_M = E_P + E_K$
$E_M = mgh + \frac{1}{2}mv^2$
$E_M = (1500)(9{,}8)(3{,}5) + \frac{1}{2}(1500)(2^2)$
$E_M = 51450 + 3000$
$E_M = 54\ 450 J$

8.7.3. Maximum velocity is at bottom-most position, where E_P=0 and E_M=E_K;
$E_M = E_K$
$E_M = \frac{1}{2}mv^2$
$54\ 450 = \frac{1}{2}(1500)v^2$
$v = \sqrt{\frac{54\ 450}{750}}$
$\therefore v = 8{,}52 m \cdot s^{-1}$

8.7.4. $E_M = E_P + E_K$

$E_M = mgh + \frac{1}{2}mv^2$

$54\,450 = (1500)(9{,}8)(1{,}8) + \frac{1}{2}(1500)v^2$

$750v^2 = 54\,450 - 26\,460$

$v = \sqrt{\frac{27990}{750}}$

$\therefore v = 6{,}11 m\cdot s^{-1}$

8.7.5. Greater than

8.7.6. Total mechanical energy at end: 54 450J

Energy lost along track: 17 000J

Energy needed at start: 71 450J

At start, E_K=0, E_M=E_P;

$E_M = E_P$

$E_M = mgh$

$71\,450 = (1500)(9{,}8)h$

$h = \frac{71450}{(1500)(9{,}8)}$

$h = 4{,}86m$

8.8.

8.8.1. $E_P = mgh$

$E_P = (0{,}05)(9{,}8)(30)$

$E_P = 14{,}7J$

8.8.2. E_P at maximum height is the same as E_K at the minimum height due to the conservation of mechanical energy;

$E_{K(bottom)} = E_{P(top)}$

$\frac{1}{2}mv^2 = E_K$

$\frac{1}{2}(0{,}05)v^2 = 14{,}7$

$v = \sqrt{\frac{14{,}7}{0{,}025}}$

$\therefore v = 24{,}25 m\cdot s^{-1}\ upwards$

8.8.3. $E_M = E_P + E_K$

$E_M = mgh + \frac{1}{2}mv^2$

$14{,}7 = (0{,}05)(9{,}8)(15) + \frac{1}{2}(0{,}05)v^2$

$14{,}7 - 7{,}35 = 0.025v^2$

$v = \sqrt{\frac{7{,}35}{0{,}025}}$

$\therefore v = 17{,}15 m\cdot s^{-1}\ downwards$

8.8.4. *Take down as positive*:

$v_f^2 = v_i^2 + 2a\Delta x$

$17{,}15^2 = 2a(15)$

$a = \frac{17{,}15^2}{30}$

$a = 9{,}8 m\cdot s^{-2}\ downwards$

8.9.

8.9.1. $E_P = mgh$

$E_P = (2)(9{,}8)(10)$

$E_P = 196J$

$E_K = \frac{1}{2}mv^2$

$E_K = \frac{1}{2}(2)(1{,}8)^2$

$E_K = 3.24J$

8.9.2. As the object falls towards the ground, the potential energy is converted into kinetic energy. At ground level, E_P will equal 0, as all potential energy has been converted.

$$E_{M(bottom)} = E_{M(start)}$$
$$E_{K(bottom)} = E_{K(start)} + E_{P(start)}$$
$$E_K = 196 + 3,24$$
$$E_K = 199,24J$$

8.9.3. $E_K = \frac{1}{2}mv^2$

$$199,24 = \frac{1}{2}(2)v^2$$
$$v = \sqrt{199,24}$$
$$\therefore v = 14,12m \cdot s^{-1} downwards$$

8.9.4. In order to reach its maximum height, the total mechanical energy needs to be converted into potential energy, with zero kinetic energy:

$$E_{P(top)} = E_M$$
$$mgh = E_M$$
$$(2)(9,8)h = 199,24$$
$$h = \frac{199,24}{19,6}$$
$$h = 10,17m$$

8.10.

8.10.1. $E_P = mgh$

$$E_P = (0,8)(9,8)(0,13)$$
$$E_P = 1,02J$$

8.10.2. $E_{M(start)} = E_{M(bottom)}$

$$E_P + E_K = E_K$$
$$mgh + \frac{1}{2}mv^2 = \frac{1}{2}mv^2$$
$$1,02 + \frac{1}{2}(0,8)(3^2) = \frac{1}{2}(0,8)v^2$$
$$4,62 = 0,4v^2$$
$$v = \sqrt{\frac{4,62}{0,4}}$$
$$\therefore v = 3,39m \cdot s^{-1}$$

8.10.3. $E_{P(top)} = E_M$

$$mgh = E_M$$
$$(0,8)(9,8)h = 4,62$$
$$h = \frac{4,62}{7,84}$$
$$\therefore h = 0,59m$$

8.10.4. $E_P = mgh$

$$E_P = (0,8)(9,8)(0,11)$$
$$E_P = 0,86J$$

$$\therefore energy\ transferred = 4,62 - 0,86$$
$$= 3,76J$$

8.10.5. The energy transferred to the object will cause it to accelerate, therefore converting the energy into kinetic energy.

$$E_K = \frac{1}{2}mv^2$$
$$3,76 = \frac{1}{2}(0,3)v^2$$
$$v = \sqrt{\frac{3,76}{0,15}}$$
$$\therefore v = 5m \cdot s^{-1}$$

8.11.

8.11.1. $200J$

8.11.2. $E_M = E_K + E_P$

$$E_M = mgh + \frac{1}{2}mv^2$$
$$200 = (3)(9,8)(5) + \frac{1}{2}(3)v^2$$
$$200 - 147 = 1,5v^2$$
$$\sqrt{\frac{53}{1,5}} = v$$
$$\therefore v = 1,88m \cdot s^{-1}$$

8.11.3. $E_P = mgh$

$E_P = (3)(9{,}8)(7)$

$E_P = 205{,}8J$

$No, the\ potential\ energy\ required\ to\ move\ the\ ball\ over\ the\ top\ is\ more$

$than\ the\ mechanical\ energy\ of\ the\ ball$