PiXL Independence:

Physics – Student Booklet

KS5

Topic - Measurements and practical skills

Contents:

PiXL Independence – Level 1
Multiple Choice Questions
A Level Physics – Measurements and practical skills

1. Which of the following is not a base quantity?
    a. Force
    b. Length
    c. Quantity of matter
    d. Temperature

2. Which units can be shown by dimensional analysis to be equivalent to 1 Newton?
    a. $kgms^{-1}$
    b. kgm^2s^{-2}
    c. $kgms^{-2}$
    d. $kgms^2$

3. Which prefix corresponds to the smallest power of ten?
    a. micro
    b. nano
    c. pico
    d. femto

4. How many Joules are there in 5kWh?
    a. 1.8×10^7 J
    b. 5.0×10^7 J
    c. 3.6×10^6 J
    d. 1.8×10^6 J

5. Which value is the same as 650nm?
    a. 6.5×10^{-9} m
    b. 6.5×10^{-7} m
    c. 65×10^8 m
    d. 65×10^9 m

6. Which term can be used to describe a precise measurement?
    a. Repeatable
    b. Accurate
    c. Reproducible
    d. Valid

7. What is the resolution of a standard metre rule?
    a. 1cm
    b. 1m
    c. 1mm
    d. 1μm

8. In an investigation into how the time period squared varied with length of a pendulum the relationship was said to follow $T^2 = 4\pi^2 (l/g)$.

If T^2 was plotted on the y axis and length, l on the x axis, what is the gradient of the straight line?

    a. $4\pi^2$
    b. g
    c. $4\pi^2 /g$
    d. $4\pi^2 (l/g)$

9. If a voltmeter reads 3.72V what is the absolute uncertainty?
    a. 0.01
    b. 0.001
    c. 0.05
    d. 0.005

10. What is the percentage uncertainty in the following results collected?

1	2	3	avg
1.21	1.24	1.26	

    a. 4.0%
    b. 2.0%
    c. 0.5%
    d. 1.0%

11. The resistance of a metal wire was found by measuring the potential difference, V and current, I.

How would the uncertainty in R be found using these results?

    a. Absolute uncertainty in V ÷ absolute uncertainty in I
    b. Absolute uncertainty in V x absolute uncertainty in I
    c. Absolute uncertainty in V + absolute uncertainty in I
    d. Absolute uncertainty in V - absolute uncertainty in I

12. The radius of a circle is given as 6.0 $\pm$ 0.1cm.

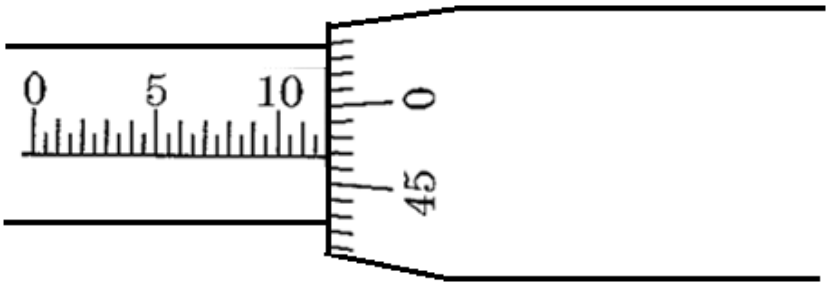
What is the percentage uncertainty in the area of the circle?

a. 1.6%
b. 0.016%
c. 3.3%
d. 0.033%

13. What is the precision of a micrometer?

a. 0.1mm
b. 0.01mm
c. 0.001mm
d. 0.0001mm

14. What is the reading on the micrometer?

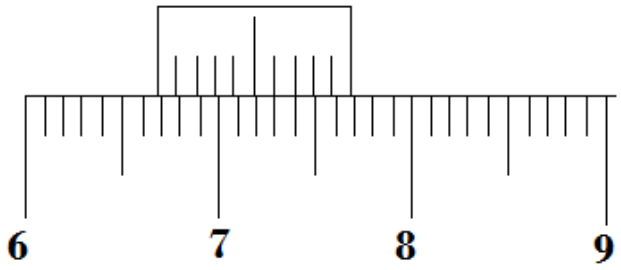


a. 11.03mm
b. 11.97mm
c. 11.42mm
d. 11.43mm

15. What is the precision on a Vernier calliper?

a. 0.01mm
b. 0.001mm
c. 0.1cm
d. 0.01cm

16. What is the reading on the conventional Vernier calliper?



a. 7.70mm
b. 6.67mm
c. 7.70cm
d. 6.67cm

17. A ball takes 10.0 s $\pm$ 2% to roll down the slope.

What is the absolute uncertainty in this measurement?

a. 20s
b. 2.0s
c. 0.2s
d. 0.02s

18. A car travels 522m in 37 seconds. Calculate the car's average speed, giving your answer to an appropriate number of significant figures.

a. 14.11 ms^{-1}
b. 14.1 ms^{-1}
c. 14.0 ms^{-1}
d. 14 ms^{-1}

19. The mass of the Moon is 7.3×10^{16} Gg.

What is this in kg?

a. 7.3×10^{13} kg
b. 7.3×10^{19} kg
c. 7.3×10^{22} kg
d. 7.3×10^{28} kg

20. The cross-sectional area of a wire is 0.0079 cm^2. Convert this into an area in mm^2

a. 0.0079 mm^2
b. 0.079 mm^2
c. 0.79 mm^2
d. 7.9 mm^2

PiXL Independence – Level 2
5 questions, 5 sentences, 5 words
A Level Physics – Measurements and practical skills

INSTRUCTIONS

- **For each statement, use either the suggested website or your own text book to write a 5-point summary. In examinations, answers frequently require more than 1 key word for the mark, so aim to include a few key words.**
- **It is important to stick to 5 sentences. It is the process of selecting the most relevant information and summarizing it, that will help you remember it.**
- **Write concisely and do not elaborate unnecessarily, it is harder to remember and revise facts from a big long paragraph.**
- **Finally, identify 5 key words that you may have difficulty remembering and include a brief definition. You might like to include a clip art style picture to help you remember it.**

Example: Base and derived units

QUESTION:	**What are the 7 base quantities and their units and how are all other units derived from these?**
Sources:	**Website** **1.** https://www.youtube.com/watch?v=remFanZq3x0 **2.** https://www.youtube.com/watch?v=TNQAMAs4Q9I **3.** https://www.youtube.com/watch?v=Sb8cxC4lOy8&t=4s

1. **Length, mass, time, electric current, temperature, amount of substance and luminous intensity**
2. **Metres (m), kilogram (kg), second (s), Amperes (A), Kelvin (K), mole (mol) and Candela (Cd)**
3. **For the derived quantity that you are interested in, consider the formula that you require to calculate its value. For example, speed = distance ÷ time**
4. **Express the formula speed = distance ÷time in terms of the units, therefore metres (m) ÷ seconds (s), the derived unit is therefore ms^{-1}.**
5. **Some derived units have their own names. For example, kinetic energy $E_k = ½ mv^2$ (½ is unitless) and therefore the unit for energy is kg m^2s^{-2} which is equivalent to the joule (J). Another example is the newton (N) which is derived from the formula F=ma and equivalent to kg ms^{-2}.**

SI – Système Internationale is a series of agreed standard quantities and their units	**Base quantity – the 7 physical quantities that all other quantities can be derived from**	**Mole – A mole is the amount of a substance containing the same number of atoms or molecules as there are atoms in exactly 12 grams of carbon-12**	**Electric current – the flow of charge measured in amperes (A)**	**1 metre - the length of the path travelled by light in vacuum during a time interval of 1/299792458 of a second**

QUESTION 1:	**What are the unit prefixes and how do you convert between them?**
Sources:	**Website** 1. https://www.youtube.com/watch?v=0fKBhvDjuy0 2. https://www.youtube.com/watch?v=O4tA6Nt_iig 3. https://www.youtube.com/watch?v=O4tA6Nt_iig

QUESTION 2:	What are order of magnitude estimations and why are they useful?
Sources:	**Website** 1. https://www.youtube.com/watch?v=0YzvupOX8Is&t=181s 2. https://www.youtube.com/watch?v=Gze6fdakGhs 3. https://www.youtube.com/watch?v=BDzU536zXtg&t=1s

QUESTION 3:	**How can we use Vernier calipers and a micrometer screw gauge to make precise measurements of length?**
Sources:	**Website –** 1. https://www.youtube.com/watch?v=vkPlzmalvN4 2. http://www.stefanelli.eng.br/en/virtual-vernier-caliper-simulator-05-millimeter/ 3. https://www.youtube.com/watch?v=StBc56ZifMs

QUESTION 4:	**How is absolute, fractional and percentage uncertainty found?**
Sources:	**Website –** **1.** https://www.youtube.com/watch?v=eJg8rb5n5a8 **2.** https://www.youtube.com/watch?v=1dTn2pt5PuA **3.** https://www.youtube.com/watch?v=SNRp92jIq9s

QUESTION 5:	**How do you plot a graph, find the gradient and y intercept and find the uncertainty in the line of best fit?**
Sources:	**Website** 1. https://www.youtube.com/watch?v=luz27XsnLz4 2. http://www.cyberphysics.co.uk/general_pages/plottinggraph.htm 3. https://www.youtube.com/watch?v=9_qxohScVbk

PiXL Independence – Level 3
Physics in The News
A Level Physics – Measurements and practical skills

Fake news

Sensationalised news stories have been around for some time, but with the mass growth of social media, the problem seems to have grown in recent years. At the very least, the US Presidential election has certainly highlighted the impact that misleading information can have. www.tiny.cc/fakenews2

At home, the Brexit vote also suffered from the circulation of misleading news stories www.tiny.cc/fakenews3

Therefore, the ability to identify real information, track it back to the source article and make your own judgement is a very important skill. This activity will help you develop that skill.

Scientists at CERN break the speed of light

News article http://www.telegraph.co.uk/news/science/8782895/CERN-scientists-break-the-speed-of-light.html

Discussion article http://www.telegraph.co.uk/news/science/science-news/9100009/Scientists-did-not-break-speed-of-light-it-was-a-faulty-wire.html

Real article https://www.theguardian.com/science/2016/nov/28/theory-challenging-einsteins-view-on-speed-of-light-could-soon-be-tested

Task 1:

You need to produce a 1 page essay on 'Why was news of the speed of light being broken so astounding and what was responsible for the miscalculation?'

Essay section	Activity
Introduction	What led scientists to believe they had broken the universal speed limit?
Describe	Why is the universal speed limit of great importance to the fundamental laws of Physics?
Explore	What was responsible for the miscalculation and how small was the error?
Evaluate	What measures will scientists take in the future to prevent further errors?

Theory of general relativity proven 100 years after Einstein's prediction

News article http://www.independent.co.uk/news/science/gravitaional-waves-albert-einstein-general-theory-of-relativity-a6867876.html

Discussion article https://www.nytimes.com/2016/02/12/science/ligo-gravitational-waves-black-holes-einstein.html

Real article https://www.ligo.caltech.edu/news/ligo20160211

Task 2:

You need to produce a 1 page essay on the existence of gravitational waves and how are they proof of Einstein's theory of general relativity

Essay section	Activity
Introduction	What is Einstein's theory of general relativity?
Describe	What are gravitational waves and how are they detected?
Explore	What cosmological events have the waves been used to detect?
Evaluate	Now that evidence of the existence of pairs of black holes has been obtained, what are scientist's suggesting is responsible for their existence?

PiXL Independence – Level 4
Scientific Podcast
A Level Physics – Measurements and practical skills

INSTRUCTIONS

Scientific Podcasts
There are several types of evidence you will be asked to produce at university. In addition to the traditional essay and scientific poster, the use of Podcasts is becoming increasingly common. It is actually harder than you think to produce a short concise, detailed and accurate podcast, therefore this task will help you get ahead of the game when you get to university.

Creating your Podcast
There are lots of pieces of software to create podcasts and edit them, however, the easiest would be the voice recorder on your phone, just check that it runs for long enough and you can save it in a suitable format, e.g. MP3 before you complete your master piece and find you need to do it again! Alternatively, get set up with Audacity which is free and will help you familiarize yourself with it.

The University of Southampton has produced some excellent guidance on creating Podcasts, which you can access at www.tiny.cc/podcasts3 and select the producing academic podcasts link.
Here are three of the key tips:

1. Write out your objective and share it at the start of the podcast.
2. Give it structure like you would in an essay
3. Whilst it is important to plan a structure, sometimes it is harder to listen to someone who is reading than someone who is more naturally talking, therefore, try to have an outline and allow some natural speech.
4. Think about the recording, pick a quiet room and speak a bit louder than normal. Do a few trial runs and check the quality.

Examples
The naked scientists produce a series of podcasts (and is also a really useful website). Check out an example about a why rainbows are curved https://tinyurl.com/ybnqa9kc

What is the difference between accuracy and precision?

Background
The terms accuracy and precision are very often confused. This confusion can lead to loss of marks in examinations and a general confusion when people are reading about science in the media.

Source articles:
https://sciencenotes.org/what-is-the-difference-between-accuracy-and-precision/

https://ed.ted.com/lessons/what-s-the-difference-between-accuracy-and-precision-matt-anticole

Task
Read the articles on the difference between accuracy and precision then produce a podcast using the guidance below

Explain	Explain the meanings of the terms accuracy and precision and give examples of where these terms would be used correctly.
Describe	Describe the difference between the terms accuracy and precision and use an analogy to help the audience understand.
Discuss	Give examples of where the terms have been used incorrectly and explain how the examples could be corrected.

PiXL Independence – Level 5
Video summaries
A-level Physics – Measurements and practical skills

Cornell Notes

At A level and University, you will make large amounts of notes, but those notes are only of use if you record them in a sensible way. One system for recording notes is known as the Cornell notes system. This method encourages you to select relevant information, rather than trying to write a transcript of everything said. More importantly, it forces you to spend a few minutes reviewing what you have written, which has been scientifically proven to aid learning and memory retention.
The ideal is to write everything on one page, but some students may prefer to type and others will to handwrite their notes. Whichever option you use, remember the aim is to summarise and condense the content with a focus on the objectives that you are trying to learn and understand.

There are three main sections to the Cornell notes

1. **Cue/ Objectives** – This can be done before or after the lecture. You may have been provided with the objectives or you may need to decide what they were or you may want to make the link to your learning if this is an additional task or lecture you are viewing, such as this video.
2. **Notes** – In this space you record concisely, simply the things you are LESS likely remember - **The NEW knowledge.**
3. **Summary** – The most important step that is carried out after the lecture or video. This helps to reinforce learning.

Background

The following short video clips present two topics that link to your learning. The first is on errors and uncertainty and how to calculate and combine uncertainties. The second video is on the use of significant figures.

Take care in the AQA specification the absolute uncertainty is half of the smallest increment in the measuring device. Video 1 suggests it is it is the smallest increment of the measuring device.

Source article:
Video 1 - https://www.youtube.com/watch?v=T78cXi-72Eg
Video 2 - http://www.bozemanscience.com/significant-digits

Task:
You need to produce a set of Cornell notes for the videos given above.
Use the following objective to guide your note taking, this links to your learning.

Objectives What are the main learning outcomes that have been shared with you? This will help guide you to taking the RIGHT notes during the video.	Title Date Sketch down note and key words Do not write in full sentences whilst you listen, put quick sketches, single words, mind maps, short hand etc. To help train you for university, try not to pause the video because you could not pause a live lecture (However, a lecture may give more natural pauses for you to catch up).

Summary (after the video)
What are your main points of learning from this video.
This is your chance to make sense of your notes.
Make clear connections to the things you need to know

Objectives: Finding the absolute and percentage uncertainties when reading from a measuring device or using significant figures	**Title:** Finding the absolute and percentage uncertainties when reading from a measuring device or using significant figures **Date:**
Summary:	

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