PiXL Independence:

Physics – Student Booklet

KS5

Topic - Fields

Contents:

PiXL Independence – Level 1
Multiple Choice Questions
A Level Physics – Fields

INSTRUCTIONS **Score: /20**

- **Read the question carefully.**
- **Circle the correct letter.**
- **Answer all questions.**

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1. A capacitor stores 100 mC of charge for every 0.33 kV of potential difference across its plates. What is its capacitance?

   a. 0.30 mF
   b. 300 mF
   c. 3300 F
   d. 3.3 F

2. The acceleration of a bare helium nucleus in a uniform electric field of 0.6 V/mm would be:

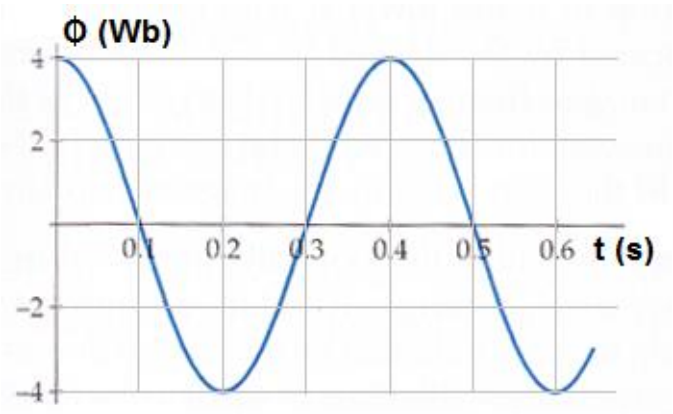
   a. 1.15×10^{-10} m/s^2
   b. 5.75×10^{10} m/s^2
   c. 1.15×10^{11} m/s^2
   d. 2.9×10^{10} m/s^2

3. What is the electrostatic potential energy possessed by an electron 1.00×10^{-10} m from a proton in eV?

   a. -12.7 eV
   b. -3.70×10^{-37} eV
   c. -14.4 eV
   d. -11.4 eV

4. Determine the approximate maximum EMF generated by an a.c. generator if the magnetic flux through its 20 turn coil is as shown in the flux-time graph below.

   a. 1200 V
   b. 120 V
   c. 60 V
   d. 6000 V



5. A -12 μC is located at x = 0 cm and a 3 μC charge at x = 4 cm. What is the strength of the electric field at location x = 6 cm, defining the positive x axis as positive?

   a. $+2.95 \times 10^5$ N/C
   b. 0
   c. $+3.75 \times 10^7$ N/C
   d. -2.95×10^7 N/C

6. Determine the maximum weight a 20.0 m length of wire could possess in order for it to float in the Earth's magnetic field per amp of current through it. Assume the Earth's field is uniform and perfectly horizontal with a magnitude of 50.0 μT.

   a. 1.0 N/A
   b. 1.0 mN/A
   c. 0.1 mN/A
   d. 100 mN/A

7. Three identical capacitors are placed in series. When discharged through a 33 kΩ resistor they lose 95% of their charge in 90 ms. What value is each capacitance?

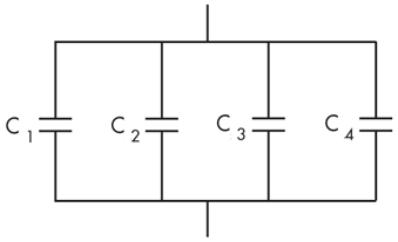
   a. 0.30 μF
   b. 2360 nF
   c. 0.024 mF
   d. 2.73×10^{-6} F

8. The two wires in the diagram have the currents indicated, both in the same direction, into the page. In the absence of any external magnetic fields they experience a force…

   a. of repulsion from each other, the forces being equal and opposite
   b. of attraction towards one another, the forces being equal and opposite
   c. of repulsion from each other, the force on the 1 A wire being twice that of the 2 A wire
   d. of attraction towards one other, the force on the 2 A wire being twice that of the 2 A wire

9. A simple circuit of a 12 V battery and 4 capacitors in parallel is made. The capacitors are identical in electrode area and material but the distance between their electrodes is different – this is shown in the data table.

Capacitor	Separation of plates (mm)
C_1	0.1
C_2	0.2
C_3	0.3
C_4	0.4

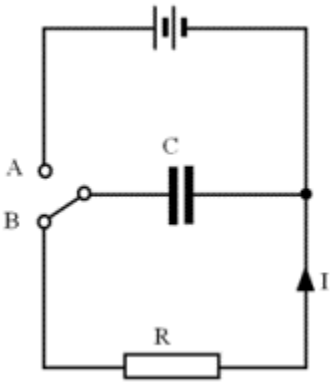


If capacitor C1 has a capacitance of 3600 nF, how much energy is stored by the capacitance combination in the circuit?

a. 0.54 mJ
b. 540 nJ
c. 450 µJ
d. 0.045 mJ

10. A graph of ln (potential difference across capacitor) on the y-axis against time on the x-axis for the discharging curve of a capacitor, resistor with resistance R and a power supply of voltage V_0 as shown would provide you with:

a. a gradient of 1/RC and an intercept of V_0
b. a gradient of -1/RC and an intercept of V_0
c. a gradient of -RC and an intercept of ln V_0
d. a gradient of -1/RC and an intercept of ln V_0



11. i) Uniform magnetic fields do not change the speed of charged particles within them.
ii) A uniform magnetic field applies no force on a stationary charge.
iii) Uniform electric fields apply a constant acceleration to a charged particle in the direction of the field.

Which of these statements is true?

a. Only i)
b. i) and ii)
c. i) and iii)
d. All three

12. What uniform magnetic flux density would need to be present in order to balance the force on a proton travelling at 3.5×10^6 m/s as it passes through parallel plate electrodes 4 cm apart with a potential difference of 20 kV between them i.e. so that the proton passes through in a straight line?

    a. 0.14 T
    b. 1.4 mT
    c. 7.0 T
    d. 7 mT

13. Different value capacitors in parallel, connected to a power supply, all possess the same…

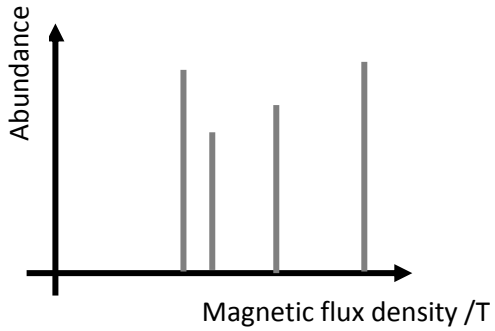
    a. Current through them
    b. Charge on each one
    c. Potential difference across each one
    d. Electric field in each one

14. An a.c. generator is altered so that the EMF it produces is changed. It is given twice as many turns, rotated 25% slower, has the coil diameter increased by a factor of 1.25 and improved magnets installed with a field strength 1.5 times stronger than before. What affect will this have on the EMF generated?

    a. 2.81 times higher amplitude, 25% lower frequency
    b. 4.69 times higher amplitude, 25% lower frequency
    c. 3.52 times higher amplitude, 25% lower frequency
    d. 2.81 times higher amplitude, 25% higher frequency

15. The graph shown is a mass spectrograph in which the detector position was fixed and the magnetic field strength is varied to change the ion that reaches it. Only 4 different oxygen isotopes were being studied. Which one of these represents the ions detected, from left to right?

    a. $^{18}O^{2+}$, $^{16}O^{2+}$, $^{17}O^{3+}$, $^{16}O^{4+}$
    b. $^{16}O^{4+}$, $^{17}O^{3+}$, $^{16}O^{2+}$, $^{18}O^{2+}$
    c. $^{16}O^{4+}$, $^{16}O^{2+}$, $^{17}O^{3+}$, $^{18}O^{2+}$
    d. $^{18}O^{2+}$, $^{17}O^{3+}$, $^{16}O^{2+}$, $^{16}O^{4+}$



16. The base SI units for magnetic flux linkage are which of the following?

    a. $kgm^2s^{-1}C^{-1}$
    b. $kgms^{-2}A^{-1}$
    c. $kgm^{-2}s^2A^{-1}$
    d. $kgm^2s^{-2}A^{-1}$

17. Uses for capacitors do not include:

    a. Smoothing out dips and spikes in power supplies and a.c. voltages
    b. Emergency power for blackouts (e.g. hospitals)
    c. Camera flashes
    d. Nuclear fusion experiment

18. An anti-proton is crossing the page from top to bottom. There is a uniform magnetic field coming out of the page towards you. In which direction will the anti-proton initially feel a force?

    a. Directly into the page
    b. To the right
    c. To the left
    d. Directly out of the page

19. Choose the **incorrect** ending to the sentence. Transformers…

    a. require an iron core to conduct the electricity from the primary to the secondary.
    b. require that the core be laminated to reduce eddy currents.
    c. require an a.c. input voltage to create a changing magnetic field.
    d. multiply the voltage based on the ratio of the number of turns in the secondary coil to the primary coil.

20. The a.c. voltage from a household plug is 230 V. the power plant generates electricity at 25 kV and 1000 A, and the current transmitted along transmission lines is 62.5 A. What must the turns ratio be for the step down transformer from the transmission lines to households. Assume any transformers involved are 100% efficient.

    a. 6.8 : 1
    b. 1740 : 1
    c. 109 : 1
    d. 1440 : 1

PiXL Independence – Level 2
5 questions, 5 sentences, 5 words
A Level Physics – Fields

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:	**Explain how a generator is able to produce electrical energy from input mechanical energy.**
Sources:	**Website** **1.** https://youtu.be/nRMZ3K2pzcE?t=3m9s **2.** (alternative) https://www.youtube.com/watch?v=zUvQCJOnGcY **3.** https://learn.sparkfun.com/tutorials/alternating-current-ac-vs-direct-current-dc

1. **Changing flux linage through a rotating coil of wire within a magnetic field.**
2. **Each arm of the coil has an EMF induced across it from the motion of the conductor through the magnetic field; the direction of the EMF is determined by the arm moving up or down through the coil.**
3. **Via slip rings and conductive brushes, the coil is connected to an external circuit so that a current is produced in this circuit.**
4. **An a.c. current is produced due to each arm of the coil moving first up, then down through the magnetic field in turn.**
5. **The magnitude of the current is a function of the speed of rotation, the strength of the magnetic field and number of turns of the coil.**

Induced EMF – potential difference created at ends of the arms of wire.	**Fleming's right hand rule to determine the direction of the current induced.** **$F = BIL(\sin\theta)$**	**Slip rings & brushes. Ensure constant contact between rotating coil and external circuit without tangling wires.**	**A.C. current induced is alternating due to the varying directions of each arm within the magnetic field**	**EMF = - rate of change of magnetic flux linkage. Lenz's law and Faraday's law.**

QUESTION 1:	**How does a transformer work and how is its efficiency maximized? Why are they useful?**
Sources:	**Website** **1.** https://www.youtube.com/watch?v=Min9oTvcYX8 **2.** http://www.cyberphysics.co.uk/topics/magnetsm/electro/Transfromer/trnsfrmr.htm

QUESTION 2:	**Describe difference and similarities between electric and gravitational fields.**
Sources:	**Website** **1.** https://youtu.be/KfZIjNY7Cp0 **2.** https://www.s-cool.co.uk/a-level/physics/a-comparison-electric-and-gravitational-fields/revise-it/a-comparison-electric-and

QUESTION 3:	**How are electric AND magnetic fields used in mass spectrometers?**
Sources:	**Website** 1. https://www.youtube.com/watch?v=Re9eXGrrgcg 2. https://www.youtube.com/watch?v=mBT73Pesiog 3. http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/maspec.html

QUESTION 4:	**How can the value of an unknown capacitor be determined using a power supply, voltmeter, ammeter, stopwatch and a known capacitance of appropriate value?**
Sources:	**Website –** **1.** https://www.youtube.com/watch?v=Fbb38SoKChM **2.** https://www.youtube.com/watch?v=auCGXn7xb-8 **3.** https://www.youtube.com/watch?v=J4swp-cm9Qk **4.** http://tap.iop.org/electricity/capacitors/129/page_46197.html

QUESTION 5:	**How to determine the strength of a magnetic field using scales, a current carrying conductor, and an ammeter.**
Sources:	**Website** **1.** https://www.youtube.com/watch?v=3nGc44rYXww **2.** https://youtu.be/o0yfYTtR6go?t=13m45s

PiXL Independence – Level 3
Physics in The News
A Level Physics – Fields

Fake news

Sensationalized 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.

News Article http://news.bbc.co.uk/1/hi/health/4602315.stm

Research http://www.ox.ac.uk/news/2014-02-07-power-lines-dont-raise-risk-leukaemia-children
https://www.clinicalcorrelations.org/?p=1425 (see also calculations in comments)

Electrical Engineering article (discussion) http://electrical-engineering-portal.com/how-hv-transmission-lines-affects-humans-plants

Task:

You need to produce a 1-page essay on the risk to public living near high-voltage transmission lines.

Essay section	Activity
Introduction	Outline why people associate risk with living near power lines that carry a high voltage / current.
Describe	Describe what HV (transmission) lines do, the need for them and what effect they have on their surroundings in terms of electromagnetism.
Explore	Calculate/discuss calculations of the strength of electric and magnetic fields due to the potential and current in HV lines at realistic distances from humans.
Evaluate	Evaluate the relative risk posed to members of the UK public living near transmission lines.

PiXL Independence – Level 4
Scientific Posters
A Level Physics – Fields

Scientific Posters - Scientists communicate research findings in three main ways. Primarily, they write journal articles much like an experiment write up. These are very concise, appraise the current literature on the problem and present findings. Scientists then share findings at conferences through talks and scientific posters. During a science degree, you would practise all three of these skills.

Scientific posters are a fine balance between being graphically interesting and attracting attention and sharing just the right amount of text to convey a detailed scientific message. They are more detailed than a talk and less detailed than a paper.
Use this information to help structure your poster – www.tiny.cc/posterskills
More detailed guidance is available at www.tiny.cc/posterskills2

Creating your poster
It is easiest to create a poster in PowerPoint, however you need to add custom text boxes rather than using the standard templates.

Posters need to be eye catching, but readable from a distance. If you use PowerPoint, start with a 4:3 slide (for easier printing, it can then be printed on A3) and use a 14-16 pt font. The first box could be larger to draw people in. You can use a background image, but pick a simple one that is of high quality. Select 'text box fill' and select 'change the transparency' to maintain the contrast and partially show the picture.
You can experiment with different layouts and you should include images. Avoid a chaotic layout, posters are read from top left column downwards.
Remember to include the authors and references.
Finally, look at the examples given on the University of Texas website which also offers an evaluation of each www.tinyurl.com/postereg

Electromagnetism and the motor industry

Background
The revolution is here, electric cars but in what form exactly? There are competing technologies for the next generation of vehicle. Discuss the two that are related to this module – electric motors, deriving their power from batteries, and magnetic regenerative braking, which turns uses electromagnetic braking to recharge the batteries when braking or going downhill.

Source articles:

https://www.youtube.com/watch?v=LAtPHANEfQo

https://youtu.be/kBrNbTyw-qc

https://en.wikipedia.org/wiki/Eddy_current_brake

http://www.explainthatstuff.com/eddy-current-brakes.html

Use other sources as necessary.

Task:
Produce a scientific poster on the role of electromagnetism in the motoring industry.

Recall	How an electromagnetic motor and induction work.
Describe	The benefits of such engines both environmentally and mechanically.
Compare	For braking, compare the advantages and disadvantages of magnetic brakes versus friction brakes.
Evaluate	Look for more resources to briefly evaluate how power production will have to change to match the switch to electric vehicles.

PiXL Independence – Level 5

Video summaries
A-level Physics – Fields

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 ultimate use for electric and magnetic fields is in the large particle accelerators used to smash fundamental particles together and probe our understanding of the universe. A basic form of particle accelerator is called a "synchrotron". You have the tools at your disposal to explain the principals of operation of such a device; the videos will help you further.

Source articles:
Video 1 – simpler explanation
https://www.youtube.com/watch?v=m2jp0klZHEE

Video 2 – university style lecture
https://www.youtube.com/watch?v=sDnG1JhZ2N4

(extra: https://www.youtube.com/watch?v=qOsgRPhlVB8)

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:	**Title:** **Date:**
Summary:	

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