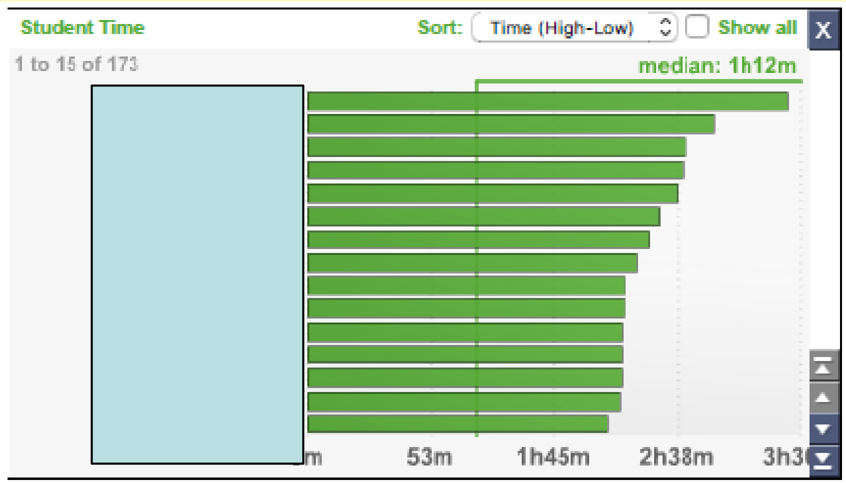
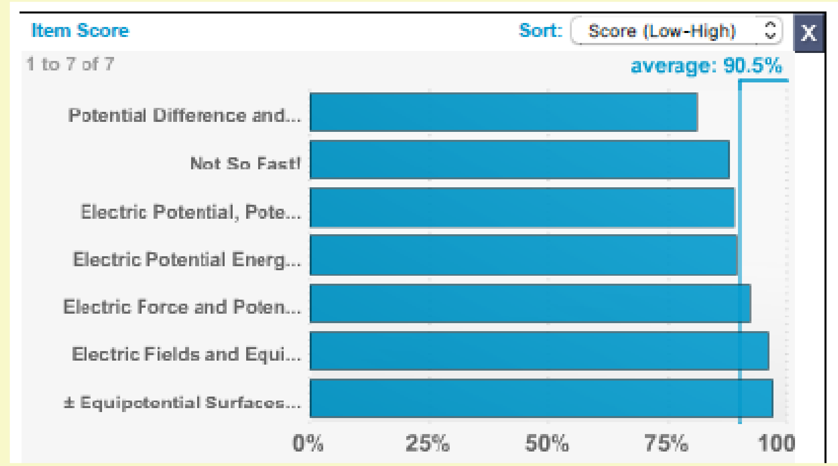
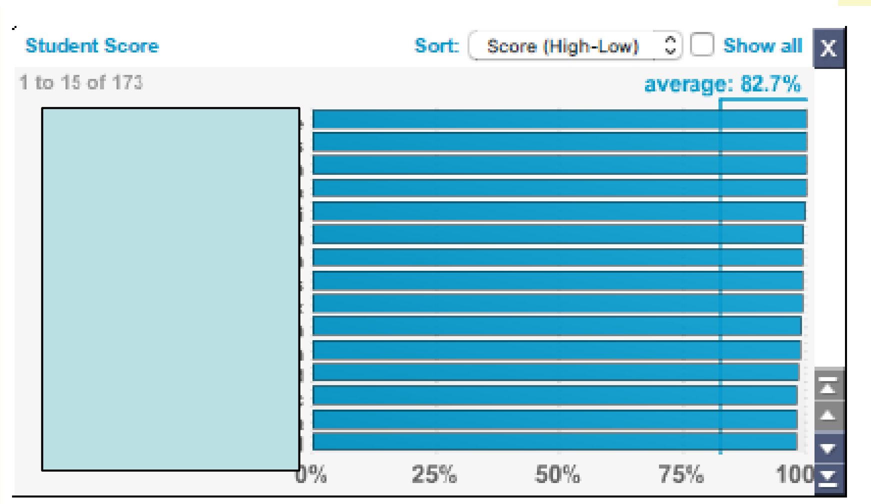
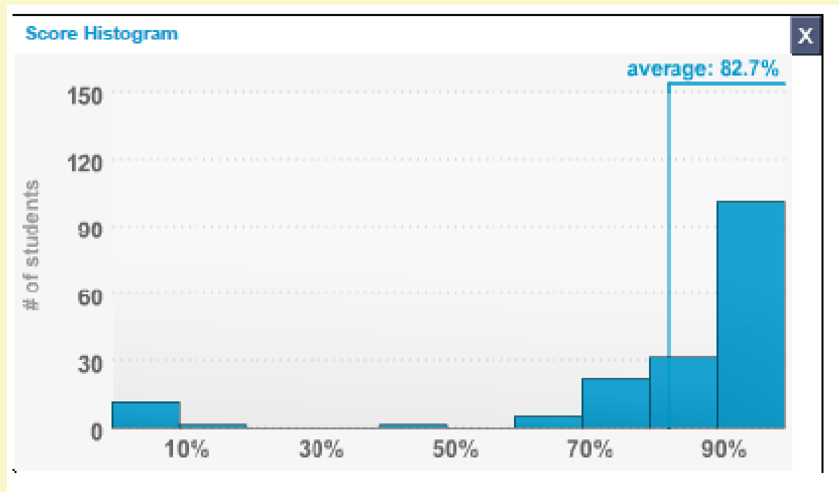
Average 77.2% ('18), 81.4%('17), 78.3% ('16) 81.6% ('15) 77.5% ('14) 84.5%('13), 81.6%('12), 82.8% ('11)

Ave Time: 1 hr 10 min ('18), 1hr 6min ('17), 1hr 6min ('16) 1hr 10min ('15) 1 hr 8 min ('14), 1hr 8min ('13), 1hr 8min ('12), 1 hr 15min ('11)







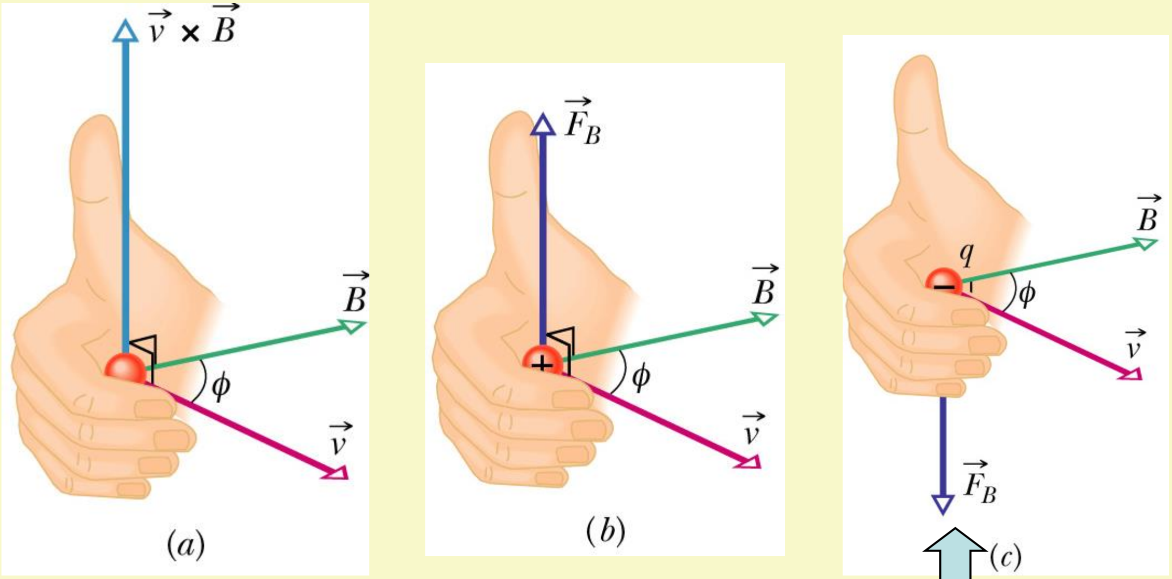


We hope to return your mid-term tests to you via your tutors this week....

Magnetic force and field

The definition of B

$$\underline{F} = q\underline{v} \times \underline{B}$$



The sign of q matters!

72 years of derivation…

André-Marie Ampère in 1820 was able to devise through experimentation the formula for the angular dependence of the force between two current elements. In all these descriptions, the force was always given in terms of the properties of the objects involved and the distances between them rather than in terms of electric and magnetic fields.

The modern concept of electric and magnetic fields first arose in the theories of Michael Faraday, particularly his idea of lines of force, later to be given full mathematical description by Lord Kelvin and James Clerk Maxwell. From a modern perspective it is possible to identify in Maxwell's 1865 formulation of his field equations a form of the Lorentz force equation in relation to electric currents, however, in the time of Maxwell it was not evident how his equations related to the forces on moving charged objects.

J. J. Thomson was the first to attempt to derive from Maxwell's field equations the electromagnetic forces on a moving charged object in terms of the object's properties and external fields. Interested in determining the electromagnetic behavior of the charged particles in cathode rays, Thomson published a paper in 1881 wherein he gave the force on the particles due to an external magnetic field as ½ v x B . Thomson was able to arrive at the correct basic form of the formula, But got the ½ wrong…

It was Oliver Heaviside, who had invented the modern vector notation and applied them to Maxwell's field equations, that in 1885 and 1889 fixed the mistakes of Thomson's derivation and arrived at the correct form of the magnetic force on a moving charged object.

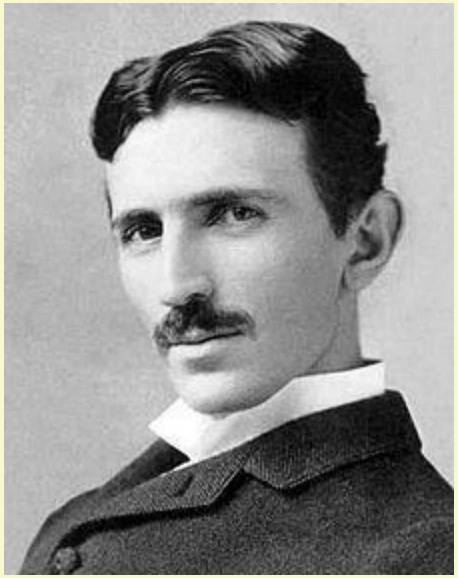
Finally, in 1892, Hendrik Lorentz derived the modern day form of the formula for the electromagnetic force… using Lagrangian mechanics…

Wilhelm Eduard Weber (1804–1891) was a German physicist and, together with Carl Friedrich Gauss, inventor of the first electromagnetic telegraph.

Acoustics was a favourite science

The 'mechanism of walking in mankind' was another study

One of his most important works was the *Atlas des Erdmagnetismus* ("atlas of geomagnetism"), a series of magnetic maps



Nikola Tesla (1856–1943) was a Serbian-American inventor, mechanical engineer, and electrical engineer.

1886 He invented the induction motor while working for Edison.

He ended up in a big battle for the US energy market with Edision (AC vs DC)

1887, Tesla began investigating what would later be called X-rays.

Tesla demonstrated wireless energy transmission as early as 1891.

In St. Louis, Missouri, Tesla made a demonstration related to radio communication in 1893.

1898 he demonstrated a radio-controlled boat to the US military

Tesla observed unusual signals that he later thought may have been evidence of extraterrestrial radio wave communications.

Tesla started to exhibit pronounced symptoms of obsessive-compulsive disorder in the years following. He became obsessed with the number three; he often felt compelled to walk around a block three times before entering a building, demanded a stack of three folded cloth napkins beside his plate at every meal, etc.

Tesla worked on plans for a directed-energy weapon from the early 1900s until his death.

Tesla died on January 7, 1943 in the 86th year of his life, from the consequences of a heart thrombus, alone in room 3327 of the New Yorker Hotel.

Urn with Tesla's ashes, Nikola Tesla Museum, Belgrade

Next Monday’s lecture will be in the 12-1pm slot only.

84 responses

How do you rate the lecturer? Average: 4.32
How do you rate the module? Average: 4.11

9 said lectures easy to follow but 3 thought the course too hard
21 said the pace was too fast but 6 said it was good
7 liked the web page, 1 wanted content on blackboard
6 liked the notes, 4 liked MP, 13 liked the historical interludes

Comment: it's difficult to teach to a large class like this and probably impossible to please everyone at once - though we try.

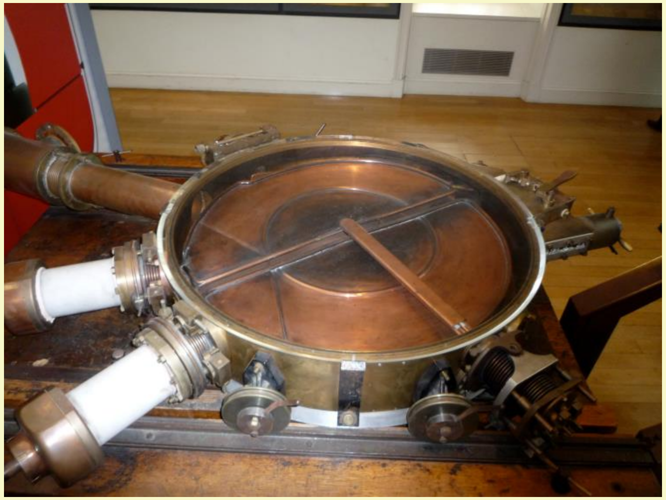
Apologies if there have been fast bits this year – that seems more pronounced than normal in the responses – I'll try to slow down.

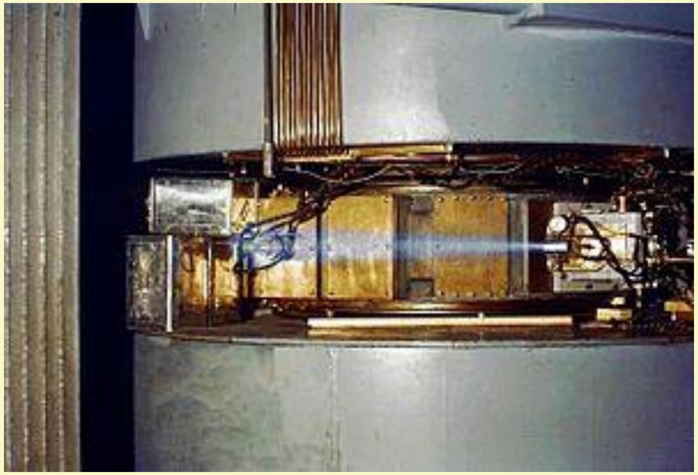
There is a lot of help with integration on the web site and there will be a lot more practice to come. (It's not unreasonable of us to expect you to know A-level content).

There is an online text book available through the MP pages – its discussions support the lecture material - it contains many more problems including more challenging problems.

Cyclotrons

A French cyclotron, produced in Zurich, Switzerland in 1937 in the *Musee des Arts et Metiers* in Paris





60-inch cyclotron, circa 1939, showing a beam of accelerated ions (likely protons or deuterons) escaping the accelerator and ionizing the surrounding air causing a blue glow

Leó Szilárd (Hungarian: 1898 – 1964) was an Austro-Hungarian physicist and inventor who conceived the nuclear chain reaction in 1933, patented the idea of a nuclear reactor with Enrico Fermi, and in late 1939 wrote the letter for Albert Einstein's signature that resulted in the Manhattan Project that built the atomic bomb. He also conceived three revolutionary devices: the electron microscope, the linear accelerator and the cyclotron. Szilárd himself did not build all of these devices, or publish these ideas in scientific journals, and so their credit often went to others. As a result, Szilárd never received the Nobel Prize, but two of his inventions did.

During the 1926-1930 period, he worked with Einstein to develop a refrigerator, notable because it had no moving parts.

During 1947, Szilárd switched topics of study because of his horror of atomic weapons, changing from physics to molecular biology. In February 1950 Szilárd proposed a cobalt bomb, a new kind of nuclear weapon, which he said might destroy all life on the planet.

Ernest Orlando Lawrence (1901 – 1958) was an American physicist and Nobel Laureate, known for his invention, utilization, and improvement of the cyclotron atom-smasher beginning in 1929
, and his later work in uranium-isotope separation for the Manhattan Project. Lawrence had a long career at the University of California, Berkeley, where he became a Professor of Physics. In 1939, Lawrence was awarded the Nobel Prize in Physics for his work in inventing the cyclotron and developing its applications. Chemical element number 103 is named "lawrencium" in Lawrence's honor.

Sir **Joseph John "J. J." Thomson**, (1856 – 1940) was a British physicist and Nobel laureate. He is credited for the discovery of the electron and of isotopes, and the invention of the mass spectrometer. Thomson was awarded the 1906 Nobel Prize in Physics for the discovery of the electron and for his work on the conduction of electricity in gases.

One of Thomson's greatest contributions to modern science was in his role as a highly gifted teacher, as seven of his research assistants and his son, George, won Nobel Prizes in physics.

Edwin Herbert Hall (1855 - 1938) was an American physicist who discovered the "Hall effect". The Hall effect was discovered by Hall in 1879, while working on his doctoral thesis. Hall conducted thermoelectric research at Harvard and also wrote numerous

physics textbooks and laboratory manuals.