

2007 HSC Physics Script of Andrew Harvey

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Examination Mark: 89/100

Multiple Choice:

- 1.A
- 2.A
- 3.B
- 4.D
- 5.D
- 6.D
- 7.C
- 8.D
- 9.C
- 10.A
- 11.D
- 12.A
- 13.C
- 14.D
- 15.A

Physics

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Centre Number

Section I (continued)

1	7	8	0	7	7	0	6	
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Student Number

Part B – 60 marks

Attempt Questions 16–27

Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 16 (5 marks)

Please turn over

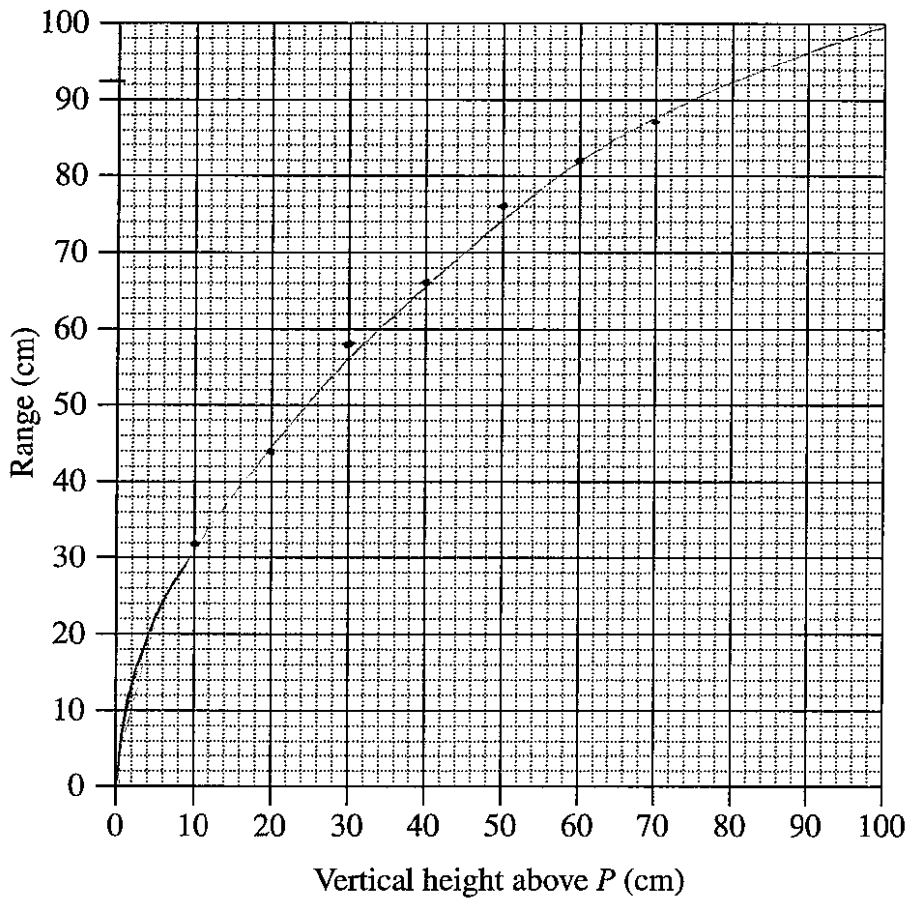
Question 16 (5 marks)

Question 16 continues on page 11

Question 16 (continued)

(a) I

2



(b) (i)

1

92 cm

(ii)

2

$$-300 \times 10^{-3} = u_x t + \frac{1}{2} \times -9.8 \times t^2$$

$$\sqrt{\frac{-30 \times 10^{-3}}{\frac{1}{2} \times -9.8}} = t = \cancel{0.47 \text{ sec}} \cdot 0.078 \text{ sec}$$

$$u_x = \frac{\Delta x}{t} = \frac{930 \times 10^{-3}}{0.078} = 11.76 \text{ ms}^{-1}$$

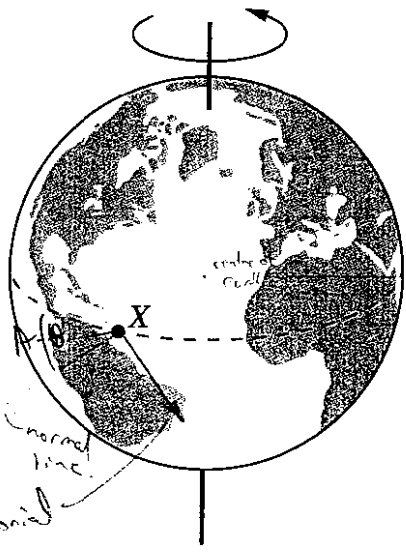
End of Question 16

(2/2)

plane to be in geostationary orbit.

Question 17 (4 marks)

Marks



This vector lies in the equatorial plane.

like if it was normal to earth it would fall back down. If it was not be in geostationary orbit. then it would not be in geostationary orbit.

(a)

$$\frac{mv^2}{r} = \frac{GMm}{r^2}$$

(b)

$$v = \sqrt{\frac{GM}{r}}$$

orb vel. is ↓ as r ↑.

It will be ~~staying~~ straight up when viewed from the surface as the ~~As the orbital radius becomes~~ radius is large, the orbital velocity is less. It must travel faster than that of earth's rotation so that it will travel far enough so that it matches the curvature of earth.

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$T = 24 \text{ hrs} = 86400 \text{ sec}$$

$$r^3 = \frac{GM}{4\pi^2} T^2 = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{4\pi^2} \times (86400)^2 = 42297523.87 \text{ m}$$

1
3

Marks

Question 18 (7 marks)

(a)

2

Because speed of light, (denoted c) is constant regardless of the motion of the source and observer, time and space must vary dependently on speed. i.e. An object moving at speed v will ~~appear to~~ have time slowed ~~when viewed~~ for the moving frame of reference. i.e.

(b)

2

$$E = mc^2$$

$$10 \text{ grams} = 10 \times 10^{-3} \text{ kg}$$

$$E = (10 \times 10^{-3}) \times (3 \times 10^8)^2$$

$$= 9 \times 10^{14} \text{ J}$$

$$t_v = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

(c)

3

$$\frac{0.37}{100} = 3.7 \times 10^{-3}$$

$$\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = 1.0037$$

$$\sqrt{1 - \frac{v^2}{c^2}} = \frac{1}{1.0037}$$

$$1 - \frac{v^2}{c^2} = 0.9926 \dots$$

$$\therefore v = 25\,735\,614.45 \text{ ms}^{-1}$$

Question 19 (6 marks)

Question 19 continues on page 15

The problem was that they detected no relative motion between the aether and the Earth. Thus Einstein said that the speed of light is constant regardless of the motion of the source and observer. Through thought experiments, such as the one involving a mirror, he said that if the speed of light is constant, then time and space must be relative, i.e. change depending on your speed.

Experimental ~~data~~ evidence for special relativity can be by ~~over~~ means like reaching earth compared with their life span in a stationary frame of reference. And atomic clocks that fly around earth and stay on earth.

However, Einstein's theory of Special Relativity is not a very good example for the scientific method as he never did any experiments, and he never collected ~~data~~. He did ~~the~~ thought experiments ~~method~~. Also he did not really make any observations. He simply did some mathematics to explain what would happen if the speed of light was constant.

I guess the problem initially raised was that no relative motion between the Earth and the aether existed. Which led to Einstein saying that there ⁻¹⁵⁻ was no ether. He then came us with the relativity postulate & speed of light postulate, which

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Centre Number

Section I – Part B (continued)

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Student Number

Marks

Question 20 (4 marks)

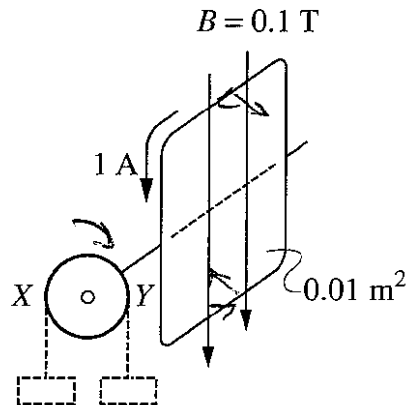
4

AC generators have allowed for the production of AC electricity. This has affected society by allowing things like street lights, which minimise crime rates, and all kinds of electrical devices which use electricity.

They have affected the environment in two ways. Firstly they have caused the burning of fossil fuels such as coal to turn the AC generators turbines. This has released CO_2 and other detrimental chemicals into the environment. However AC generators also allow for clean, green sources such as wind power, and hydroelectric.

AC generators have had a positive impact on society, and both a detrimental and ~~with~~ a neutral effect on the environment.

Question 21 (5 marks)



(a)

1

~~to~~ X. Because as shown the motor will rotate clockwise, hence to stop this the weight needs to be on

(b)

the ~~left~~ left,

$$\tau = Fd = (0.2 \times 9.8) \times (200 \times 10^{-3}) = 0.392 \text{ Nm}$$

(c)

2

$$\tau = 0.392$$

$$\tau = nBI A \cos \theta$$

$$\therefore n = \frac{0.392}{0.1 \times 1 \times 0.01 \times \cos 0^\circ} = 392 \text{ turns}$$

	5	2		
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Centre Number

Section I – Part B (continued)

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Student Number

Marks

Question 22 (4 marks)

4

Because solid state devices are lighter, cheaper, more reliable, less fragile (as thermions are made from glass, whereas solid state ^{devices} are made from semiconductors), have no start up time (thermions have to warm up), smaller.

Please turn over

Question 23 (4 marks)

(a)

1

A superconductor with a high critical temperature (ideally room temp.)

(b)

1

Electrical resistance drops to zero.

(c)

2

This is due to the Meissner effect. As in superconductors below their critical temperature, when a magnet is placed above (or near) the superconductor, the superconductor will have currents induced to create a magnetic field that opposes the magnet's magnetic field. As the magnetic fields oppose, there will be a force of repulsion.

This is not due to eddy currents as the magnetic field does not need to be changing.

	5	2		
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Centre Number

Section I — Part B (continued)

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Student Number

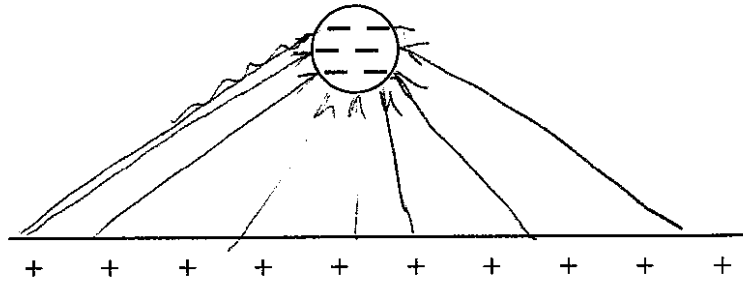
Question 24 (3 marks)

Please turn over

Question 24 (continued)

(a)

1



(b)

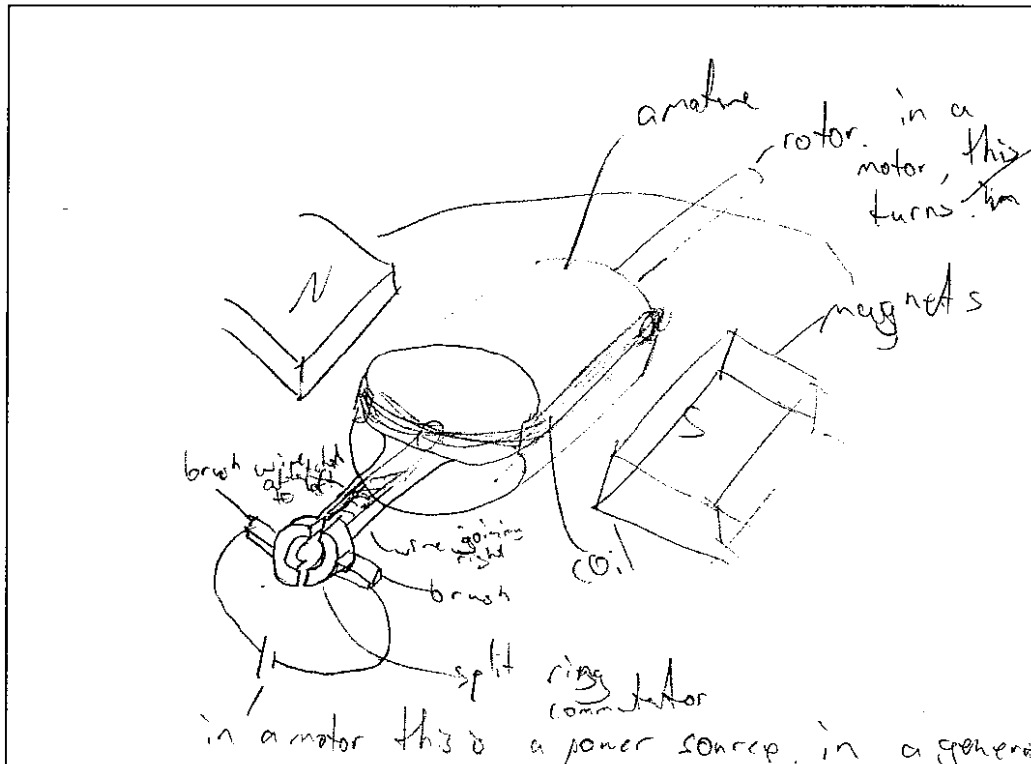
2

$$E = \frac{F}{q} \quad f = ma$$

$$= \frac{ma}{q} = \frac{10^{-30} \times 7 \times 10^{21}}{5 \times 10^{-12}} = 1.4 \times 10^7 \text{ N/C}$$

Question 25 (4 marks)

4



due to provided current. in a generator it is turned and a current is induced

in a motor this is a power source. in a generator, a current is induced

This claim is true. They have the same structure, but in a motor a current is supplied which turns the rotor, due to the torque. but in a generator the torque is provided and a current is induced.

Structure

The split ring commutator ensure that the current induced is pulsating DC. i.e. pm for in the case of a motor, it ensure that the ~~rotor turn~~ rotor keeps spinning in the same direction.

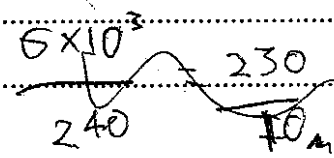
Question 26 (6 marks)

(a) 2
 Because a transformer needs a changing magnetic field in order to induce a current in the secondary coil. As AC is changing direction, the magnetic field will be changing direction, this would not happen in DC.

(b) 2
 Eddy currents would be induced in the core, due to the changing magnetic field. Due to resistance, these eddy currents would create heat energy, which is a form of energy loss.

(c) 2

$$\frac{V_p}{V_s} = \frac{I_s}{I_p} = \frac{N_s}{N_p}$$



energy = VIt

energy in = $6 \times 10^3 \times 10 \times 8$

energy out = $240 \times 230 \times 8$

energy lost = ~~out~~ in - out

= $38\,400 \text{ Whrs.}$

= $38.4 \text{ RWhrs. (kilo Whrs.)}$

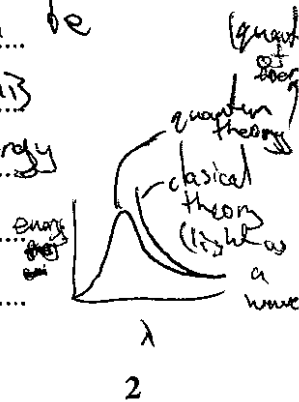
Marks

Question 27 (8 marks)

(a)

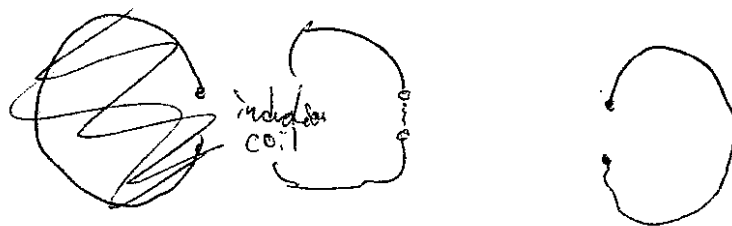
3

Quantum theory explains ~~why~~ that the energy radiated out of the black body will be in discrete packets of energy ($E = hf$). This explains why at low frequencies the energy emitted is low.



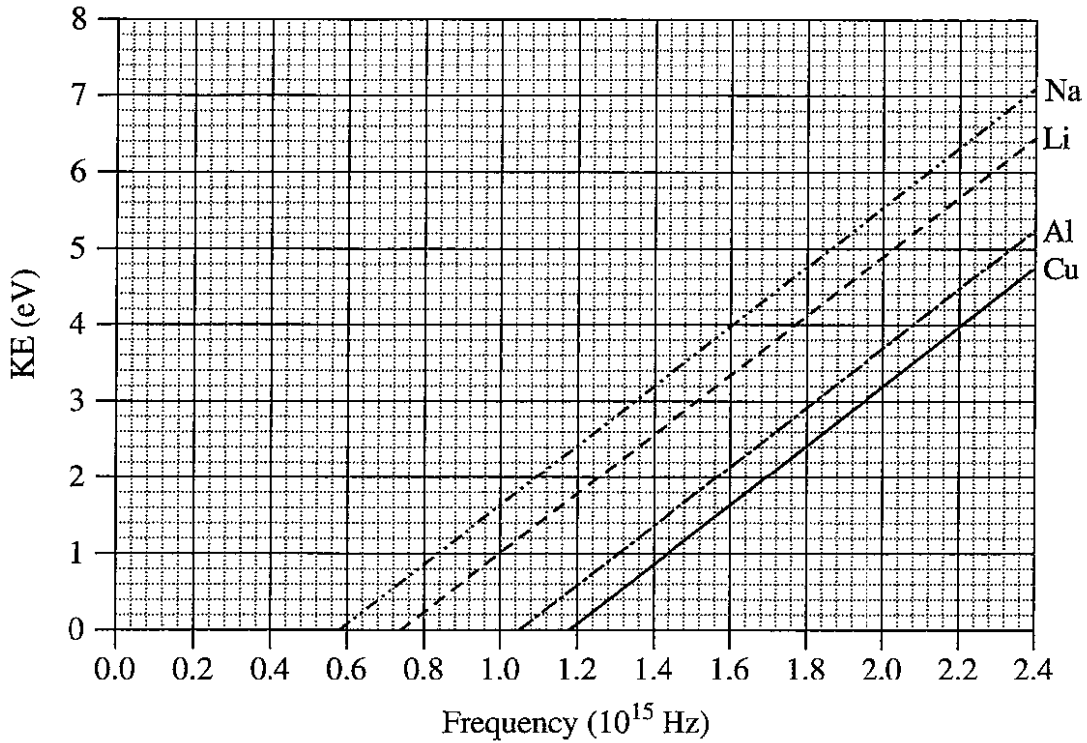
(b)

A spark was created by an induction coil connected to a loop of wire with a split in it. This produced radio waves. Hertz noticed that when ~~the~~ the first coil sparked, the second coil also sparked with a slight delay. This is the photo electric effect as when the radio waves hit the second loop with a split, electrons were given the energy to ~~escape~~ jump the gap. Hertz noticed also that the gap could be made smaller if UV light was shone on the second coil.



Question 27 (continued)

(c)



(i)

$$\text{gradient} = \frac{\Delta y}{\Delta x} = \frac{7.05}{(2.4 - 0.58)} = 3.87 \text{ (2dp)}$$

$$= 3 \frac{159}{182} \frac{\text{eV}}{10^{15} \text{ Hz}}$$

$$= 3.87 \times 10^{-15} \text{ eV Hz}^{-1} \text{ (3 sig figs)}$$



(ii)

1

~~The threshold frequency depends on the material.~~
 That Planck's constant is constant.

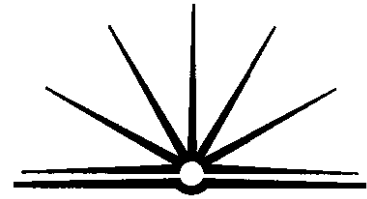
End of Question 27

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Centre Number

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Student Number



BOARD OF STUDIES
NEW SOUTH WALES

2007

HIGHER SCHOOL CERTIFICATE
EXAMINATION

Examination

Physics

8

WRITING BOOKLET

Section	Part	Question Number
II		31

Date

SA 5/11/07.

Number of booklets used for this question

--

Instructions

- Write your Centre Number and Student Number at the top of this page and of each page that you use.
- In the boxes provided write the name and date of this examination, and the number(s) of the question(s) attempted in this booklet.
- If you have not attempted the question, you must still hand in the Writing Booklet, with the words 'NOT ATTEMPTED' written clearly on the front cover.
- Write the number of each question or part in the margin at the beginning of each answer.
- Write using black or blue pen.
- Write on the ruled pages only. You may use the unruled pages for rough work.
- You may ask for an extra Writing Booklet if you need more space.
- Do NOT remove any pages from this booklet.
- You may NOT take any Writing Booklets, used or unused, from the examination room.**

Q 31.

a) i) i.e. moves up a shell.

$$n_i = 2$$

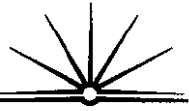
$$n_f = 3$$

$$\frac{1}{\lambda} = R \left(\frac{1}{3^2} - \frac{1}{2^2} \right)$$

$$\lambda = 6.56 \times 10^{-7} \text{ (391.5 nm)}$$

- ii) • The relative intensities of spectral lines. Some lines were more intense than others, this could not be explained by the Rutherford Bohr model.
- The Zeeman effect. i.e. the splitting of spectral lines in a magnetic field.
- The hyperfine spectral lines. Some ~~the~~ spectral lines were found to be made up of many that when viewed ~~at~~ at low magnification appeared as one.

b) i) Dry ice was used to vaporise the air in the cloud chamber. A radioactive source was placed inside and the path was ~~obs~~ observed. The radiation ionised the vapour. As a safety measure, we made ~~sure~~ sure to ~~not~~ not touch the radiation source and use a low-energy emitting source.

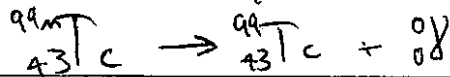


i.)

Medicine:

Technetium- 99m , used for detecting cancers, blood flow abnormalities, etc.

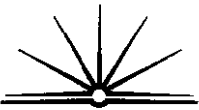
It decays producing gamma rays,



These γ rays can be detected and hence blood flow can be detected as ${}^{99m}\text{Tc}$ attaches to blood.

Engineering

Iridium-192 will decay producing γ radiation. As γ rays travel at different speeds through different densities, it can be used to test materials and civil structures for cracks or other weaknesses in the material.



9) de Broglie proposed that all particles have both a ~~wave~~ particle and wave like nature. He said that particles would have a wavelength given by $\lambda = \frac{h}{mv}$.

This theory was confirmed by Davison and Germer. They during an experiment using glass vacuum, the glass cracked and air rushed in. This annealed the metal which created large crystals. When they fired electrons at the metal they noticed that as the electrons passed through the crystal lattice they diffracted forming a diffraction pattern. They observed the same diffraction pattern as when X-rays were shone on the material. As diffraction is a wave property, they confirmed that electrons must have a wave like nature. This shifted the view to quantum physics.

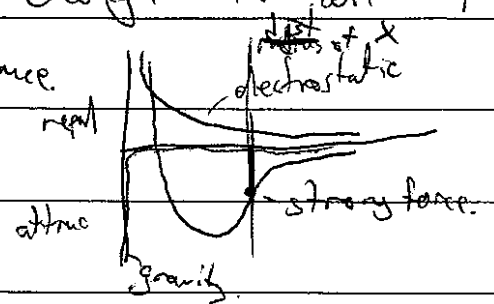


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d) i) They would be attracted. (i.e. experience a force of attract.)
As the electrostatic force between them would not be enough to alter this.
Also gravity force is very weak at this distance.

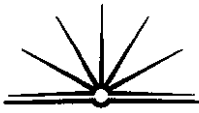


ii) The control rods. ~~the~~ the control rods are made from a material that absorbs neutrons. Thus by lowering them into the water the neutrons are ~~absorbed~~ absorbed so less are free to ~~react with~~ be accepted into the fuel's nucleus. Thus lowering the rate of fission. By removing the rod, more neutrons are free to be captured by the fuel and cause more fission.

iii) The neutrons can be used in neutron scattering. They can be fired at ~~the matter~~ ^{matter} and the scattering pattern can be investigated and can reveal the structure of the matter.

Neutrons are used as because of:

- their neutral charge means that they are



not repelled by the nucleus and hence can collide with it.

• Also their de Broglie wavelength is small enough so that the ~~part~~ neutron can pass through the spaces between atoms.

• Also neutrons possess a magnetic moment which can be used to detect magnetic field lines.

This is because a neutron is made up of a + and - charge, but as they are not distributed evenly they create a magnetic moment.

