NEW ZEALAND SCHOLARSHIP 2004

SCIENCE

Sample of assessed candidate work – Outstanding Performance - Performance Descriptor 1

Note: These answers were not all from one student as no-one gained the equivalent of an Outstanding Performance pass in the 2004 exam. However, there were enough A answers among all the papers to give an idea of the standard that was required. Only three A passes were required, however, more have been given here to give an idea of the standard.

QUESTION ONE: SUNSPOTS, RADIOACTIVE ISOTOPES AND EARTH'S CLIMATE CYCLES

(a) Evaluate the use of beryllium-10 and carbon-14 to determine the different solar cycles. Consider in your answer the significance of:

- the half-life of each isotope
- the advantages and disadvantages of using each isotope
- the samples that are necessary
- the cross checking of results required.

Greater solar magnetic activity is known to deflect more cosmic rays so in a period of high activity less of the radioactive isotopes Be-10 and C-14 are produced. Be-10 and C-14 have very different half-lives, Be-10 is 1.52 million years so therefore you would use it to determine long cycles in sunspots. So it could be used for the cycles that might be 100 000 years long, which is very long. C-14 is only 5730 years so it is only used for the shorter cycles. For some of the cycles, like a 600 year one, you could use each isotope to cross check the other. Then is you match present day sunspots with C-14 and Be-10 measurements, then you can back relate and work out what the sunspots must have been a long time ago. Be-10 might check some of this too.
It must be much easier to count tree rings than get ice cores as trees are all over the world. Although I don't think that there can be many very old trees so maybe ancient trees have to be dug up. You might be able to match up some tree rings between living and dead trees and go back in time that way. Ice cores you can do really deep though, although that must be pretty hard and you have to make sure that you don't do it where ice is melting fast. That is why most samples would be got from Greenland or Antarctica. So you might not get as many ice cores as you get tree ring samples. Make sure that you get ice cores where there aren't any mineral deposits. And get lots of samples so that you can check them against each other.

The two different isotopes and the different cycles that they would show are discussed. The need for cross correlation and lots of samples from different places is evaluated and an understanding of the relative difficulty or ease in obtaining samples. The answer is supported by data from the passage. Critical thinking is shown by the mention of making sure that samples are taken away from ice melting and by matching up trees rings from live and dead trees.
A answer

(b) Discuss the relationship between temperature, sunspot numbers and the levels of carbon-14 and beryllium-10. Consider the implications for the Earth's climate of a more magnetically active sun.

During periods of increased solar activity greater shielding of the earth from cosmic waves would occur resulting in a decrease in the formation of the C-14 and Be-10 isotopes. The cloud cover also decreases and the Earth heats up. This is what must have happened during the Medieval maximum. What is interesting and worrying is that the sunspot numbers have been going up a lot since about 1950, much more than previously. If we look at the relationship shown in the Medieval maximum we can see that our temperatures must be going up now because the sunspot numbers are going up. This may be also adding to climate warming and there isn't much that we can do about that. This maybe the start of a long term warm cycle but we cannot tell how long yet. Maybe ice cores might tell us if we can go even deeper.

Accurate correlation between increased sunspot activity and increased temperature and decreased production of the key isotopes. Data on the graph has been used to enhance the answer. A relationship is made between the sun's magnetic activity and climate warming and a thoughtful comment made about the present day levels of sunspots.
A answer

QUESTION TWO: THE TREATMENT OF OIL SPILLS

(a) Discuss the chemistry involved in breaking up oil spills. Use a diagram if you wish. Include a discussion of the different types of detergent that might be used.

The use of detergents in breaking up an oil spill seems like an effective process for the mopping up of an oil spill. Detergents break up the oil molecules and spread them out into the ocean, breaking up the danger of an oil spill. They work because of the differing ends of the detergent molecule. One end is hydrophobic / nonpolar, and so is attracted to the non-polar oil molecules. The other end is polar and hydrophilic and are attracted to water which is polar. The hydrocarbon chain which is the rest of the detergent is nonpolar and hydrophobic, and is attracted to the oil molecules. The oil becomes broken into small droplets called micelles which become suspended below the surface of the water. Also the forces between the oil chains are broken which help in dispersal. The detergents must work in sea water. The type of detergent that may be used might be a negative anionic detergent like dishwashing detergent but stronger. This type of detergent can remove grease and oil from objects so it might work in the ocean. A non-ionic detergent may be used as it doesn't make any lather as this may leave unsightly and possibly dangerous amounts of bubbles in the ocean.

Good description of how a micelle is formed with oil, mentioning the polarity of water and the hydrophilic end of detergents, and the non-polar nature of detergent and of oil. A good thoughtful discussion of the type of detergent that might be used.
A answer

(b) Discuss the key factors that need to be considered in the design of an investigation to evaluate the effectiveness of different naturally occurring bacteria in breaking down crude oil.
You are not required to design an actual experiment, but examples of specific techniques can be used to illustrate the relevant points.

Firstly, the nutrients used in the investigation must be fully and thoroughly tested to be sure that they are not toxic to the environment, in the way that phosphorus can cause eutrophication of waterways. Any management of the growth of the bacteria must be assessed for impact. When testing the effectiveness of the bacteria the conditions of the experiment must be kept in context i.e. concentrations of bacteria, oil, any spectator molecules or ions, and conditions matching the sea conditions replicated in the lab. Then the results would have to be scaled up to get an idea of what may happen in the wild. It also needs to be determined what bacteria convert the hydrocarbons into what compounds and whether these are then environmentally okay. Experiments must be repeated to get reliable data. You would use the actual sea water and the actual oil likely to be spilled and the bacteria wold be taken from different regions so as to get a good cross section.

Mention of the need for sufficient and reliable data before releasing large amounts of bacteria into the environment. Some indication of the need to measure relative effectiveness of the bacteria on the oil. This didn't gain an "A" pass because the need to test each bacteria separately or to test combinations wasn't mentioned, nor the need to time how long the bacteria would take to break down the hydrocarbons. It is a good "B" answer because scale is mentioned. B answer

(c) Evaluate the use of genetically engineered bacteria as compared with naturally occurring bacteria for environmental clean-ups. Consider:

- the relative effectiveness of each type of bacteria
- the possible impact on the environment
- the risks of gene transfer
- ethical considerations.

GE bacteria could be designed to be extremely efficient and effective agents in environmental clean-ups, but could pose risks unforeseen to the environment. One of these is that once these are released they are no longer contained like in a lab and they would not be able to be controlled if they got out of control. The introduction of another species of bacteria not normally found may unbalance the area and may lead to the extinction of the native bacteria. This could have repercussions as bacteria are at the bottom of the trophic levels so effects may be felt up the food chain. A thorough study of the GE bacteria would have to be undertaken to determine how effective they were as compared with the natural bacteria so to determine if it is worth releasing them. Of course if there are no native bacteria breaking up the oil then the GE ones would be really useful. It would be hard to tell if the GE bacteria may transfer genes to native bacteria though. And the GE bacteria may produce toxins in the wild that they didn't do while they were being tested. There are fewer ethical considerations when referring to bacteria so thorough pretesting can be carried out. You would have to tell what was better though, the oil spill or the bacteria!

This shows a justified stand in that the use of GE bacteria has been thoroughly considered as compared with native bacteria and the effects of the spill itself . A answer

QUESTION THREE: GEOLOGY OF THE SEA FLOOR

(a) Discuss factors that must be taken into account when sonar backscattering is used to determine the depth, the composition and the contours of the sea floor.

When using sonar to determine depth, composition, and contours of the sea floor you must take into account several factors. These are

- If the angle of the transmitter and the sea floor is very low 1.e.transmitter directly above the sea floor, the boat will receive a very strong clear signal. If the material below the boat is soft, eg. mud, the signal will return to the boat a lot weaker than it would if the material was hard eg. rock.
- Depth – to work out depth you time how long it takes for your sonar signal to return to your boat. From this you use v=d/t to find d. Once depth has been calculated you can analyse signal strength to discover more about floor composition and contour. If composition is solid, signal will return relatively strong whereas if it were soft, signal would be diminished.
- Contours – once deth has been stermined contours can be found. To do this you send off the sonar at different angles and compare strengths of the return signals.

Other factors would be is interference due to schools of fish, strong ocean currents, reefs, density of water due to salt, temperature variations etc. Perhaps before the boat sets out it can investigate how much each bottom type eg. Mud, rock, gravel dampens the returning signal.

Answer shows good understanding of the effect of the angle of the sonar and mentions most of the important factors. This shows evidence of critical thinking as the need for calibration using known terrain is mentioned.
A answer.

(b) Compare the processes that occur and the main rocks that are usually formed when:

- oceanic crust is subducted under continental crust
- oceanic crust is subducted under oceanic crust.

Oceanic crust subducting under continental crust results in trenches such as the Hikurangi Trough east of the North Island. Oceanic crust hasn't got much silica and it is really dense. When this crust gets deep in the mantle it melts and the melted magma rises up to the surface forcing its way through cracks in the crust. When the magma gets to the surface andesitic or rhyolite volcanoes are formed depending on how the crust mixes with the continental crust. Oceanic crust is made up of basalt and when oceanic crust is subducting under oceanic really deep trenches are formed like the Kermadec trench. Magma is formed and rises to the surface making basalt volcanoes. Sometimes the volcanoes have andesite too if the magma has come up under sediments.

Good understanding of both forms of subduction showing an understanding of the type of crust, the amount of silica and the density of the magma and the types of vocanoes formed. Answer has also given New Zealand examples.
B answer

(c) Discuss reasons as to why some volcanoes in the Kermadec Trench, such as that shown in Photo one, erupt dacite and form calderas.

The Kermadec trench is probably being formed by oceanic crust subducting under oceanic crust. Therefore you would expect the volcanoes to be basalt or andesite. However dacite is a silica rich rock so there must be something different going on here as well. Some of the ridge may still be continental crust as it is close to New Zealand. Continental crust is made of silica rich rock so maybe when the magma is rising it melts and mixes with this to form dacite. Silica rich rocks can cause violent eruptions especially when they meet sea water too so this is why there are calderas. Another reason may be that as the oceanic crust subducts it carries down sediments which are saturated with water. The heat generated by the subducting plate drives the water off as superheated water and the sediments are melted. The sediments are silica rich so they erupt as dacite.

This candidate has discussed two reasons as to why dacite may have erupted. The second one is more accurate but what was important here was the candidate drew on his/her knowledge to try and explain something unusual.
A answer

QUESTION FOUR: ACCEPTABLE RISKS OF MEDICAL X-RAYS

Evaluate the information in the above paragraphs and Tables One to Three, and give an informed opinion on the safety levels of medical procedures involving radiation on people, and the circumstances under which these procedures should be used for research. You may wish to consider each of the four risk categories as a starting point.

It is quite safe to use X-rays when comparing the outcome if no X-rays are used and the person dies from something that an X-ray could have prevented. But it isn't safe if unnecessary X-rays are taken. For medical procedures involving radiation of people it is quite safe if the X-ray has a dose in the risk categories 1, 2a, or 2b. This because the radiation from the X-rays isn't much more than background radiation i.e. a chest X-ray is equivalent to about 10 days of background radiation. This shows that X-rays aren't exposing the people to much radiation at all so the risk of not having an X-ray and the consequences is much greater than the risk of contacting cancer from that X-ray. *(more cross correlation of data was given which hasn't been reproduced here).* People increase their risk of dying willingly when they smoke, if 10 are smoked in a day the risk of dying is higher than dying from cancer which could have been caused by radiation from X-rays. People can reduce their risk of dying from known causes such as smoking so that they don't get diseases which mean that they need more X-rays for diagnosis. Using X-rays for research must be done cautiously balancing this with the need to advance knowledge and treatment. It seems like the use of CT scans especially must be moderated as these are much more dangerous and so they shouldn't be used routinely.

Good use of cross correlation of data showing understanding of the statistics. Thoughtful comments evaluating the risks. Specific examples could have been used to complement the risk statements.
Borderline A answer

Sample of assessed candidate work – Performance Descriptor 3: Performance Category 5

Note: These examples of student answers are in some cases abridged from the original. Parts of the answers that had not addressed the questions were omitted.

QUESTION ONE: SUNSPOTS, RADIOACTIVE ISOTOPES AND EARTH'S CLIMATE CYCLES

(a) Evaluate the use of beryllium-10 and carbon-14 to determine the different solar cycles. Consider in your answer the significance of:
- the half-life of each isotope
- the advantages and disadvantages of using each isotope
- the samples that are necessary
- the cross checking of results required.

Both isotopes would be useful in determining the different solar cycles. Be-10, with the half-life of 1.52 million years would be useful in determining the longer cycles that range from 10 000 – 100 000 years. C-14, with its half life of 5730 years would be useful in determining the shorter solar cycles. Cross checking could then be used to determine the specifics of each solar cycle. Be-10 may be harder to trace and record as it is trapped within layers of ice on polar ice caps from Greenland and Antarctica. C-14 would be easier to obtain as it can be measured from tree rings. You will definitely need to get lots of samples of both isotopes from different areas to see all the cycles, short and long. It might be hard with trees because there aren't many really old trees. You might be able to dig up old trees and use them. Getting lots of ice cores might be hard as they are hard to get.

Comparison of the two different isotopes and the different cycles that they would show.
Mention of the need for lots of samples and cross correlation and an understanding of the relative difficulty or ease in obtaining samples.
B answer

(b) Discuss the relationship between temperature, sunspot numbers and the levels of carbon-14 and beryllium-10. Consider the implications for the Earth's climate of a more magnetically active sun.

It seems from the graph that as the sunspot activity goes up the temperature increases and you find decreased amounts of C-14 in tree rings and Be-10 in ice cores. This is shown within the time of the Medieval maximum and through the fact that the Earth is currently in a warm period. During the Maunder Minimum the C-14 level was very high but there were no sunspots. This leads one to believe that it is the magnetic activity of the sun that may be making our climate warm up now.

Accurate correlation between increased sunspot activity and increased temperature directly related to data on the graph. A relationship is made between the sun's magnetic activity and climate warming.
B answer

QUESTION TWO: THE TREATMENT OF OIL SPILLS

(a) Discuss the chemistry involved in breaking up oil spills. Use a diagram if you wish. Include a discussion of the different types of detergent that might be used.

Detergents break up oil molecules and spread them out in the ocean breaking up the danger of an oil spill. Detergents work because of the differing ends of detergent molecules. One end of the detergent molecule is polar / hydrophilic and is attracted to the water particles of the ocean. The opposite end, the non-polar / hydrophobic one is attracted to the oil molecules. Oil molecules are non-polar.

Good description of how a micelle is formed with oil, mentioning the polarity of the hydrophilic end of detergents, and the non-polar nature of detergent and of oil. Polarity of water not mentioned.
C answer

(b) Discuss the key factors that need to be considered in the design of an investigation to evaluate the effectiveness of different naturally occurring bacteria in breaking down crude oil.
You are not required to design an actual experiement, but examples of specific techniques can be used to illustrate the relevant points.

The different bacteria considered / tried would need to be tested on different types of oil, and in different environmental conditions such as cold or warm environment, salinity of the water, amount of sunlight etc. It would be important that their use would be investigated in a large scale manner. Also, as the levels of these bacteria would be increased through their use in clean-ups, the environmental implications of this, and their effects on other wildlife would also have to be monitored. Initial testing could include the collection of samples of actual sea water taken from different regions, and with the temperature kept the same as it would be in that region and the salinity of the water from that region taken into account, it could be determined by placing oil into the water and then treating it with the bacteria, what effects the different conditions have on the different bacteria, to see whether certain types are more suited to certain conditions and types of oil. Also how effective they would be. All conditions / variables not being tested would have to remain constant. Enough reliable data would need to be obtained.

Mention of the need for sufficient and reliable data before releasing large amounts of bacteria into the environment. Some indication of the need to measure relative effectiveness of the bacteria on the oil.
B answer

(c) Evaluate the use of genetically engineered bacteria as compared with naturally occurring bacteria for environmental clean-ups. Consider:

- the relative effectiveness of each type of bacteria
- the possible impact on the environment
- the risks of gene transfer
- ethical considerations.

The use of genetically engineered bacteria as compared with naturally occuring bacteria may have some advantages. These include the fact that if testing of naturally occuring bacteria were found to work best in certain conditions on certain types of oil the genes which make them more effective in these ways could be introduced to bacteria which already contain desirable genes. The new bacteria would contain both genes and would be effective in both ways. A wider range of environmental conditions could be covered. The clean-up might go faster and the oil have less of an effect on wildlife. However, these genetically engineered super bugs would be impossible to control once let out into the environment and they might out-compete the naturally occurring bacteria, maybe even wiping them out completely.

Both types of bacteria considered. Valid points made but in a general way.
C answer

QUESTION THREE: GEOLOGY OF THE SEA FLOOR

(a) Discuss factors that must be taken into account when sonar backscattering is used to determine the depth, the composition and the contours of the sea floor.

The depth can be accurately estimated by the time it takes from emission and receiving of the acoustic pulses. If the density of the water changes however, be it a result of increased / decreased pressure, debris, minerals etc, this distance would be less accurate as the pulses would travel faster in denser medium. The composition of the sea floor could be measured by the intensity of the pulses reflected. Tests done under controlled conditions could give an idea of what material absorbs / reflects and to what degree. The information gained could be compared to this data, and the composition of the sea floor assumed. When waves are reflected they follow the equal angle rule. If reflected at an unequal angle it can be assumed that the seafloor is not flat. The degree to which the reflected angle is out would indicate the aspect of the sea floor, and repeating the process can give an outline of the contours.

Good discussion on the effect on the reflected beam and the determination of depth.
B answer

(b) Compare the processes that occur and the main rocks that are usually formed when:
- oceanic crust is subducted under continental crust
- oceanic crust is subducted under oceanic crust.

When oceanic crust subducts beneath oceanic crust because both crusts are equally dense one pulls the edge of the other one down with it forming a trench. Much friction is created between the two plates causing melting and formation of volcanoes. Oceanic crust is low in silica. When oceanic crust subducts under continental crust the continental crust floats and is crumpled up. A trench forms but it is not as deep. The magma caused by the friction is moderate to high silica so the magma is sticky or a bit sticky. Volcanoes are formed which instead of spewing out lava build up pressure until they reach a critical point and then explode forming a crater like region.

A good answer for oceanic crust subducting under continental crust but an incomplete understanding of oceanic under oceanic crust.
C answer

(c) Discuss reasons as to why some volcanoes in the Kermadec Trench, such as that shown in Photo one, erupt dacite and form calderas.

The composition of the oceanic crust melted when subducted may alter the type of rock it solidifies into, so it does not form the usual basalt. The crust of the plates may be very weakened and thinned, so form caldera volcanoes, and contain a lot of dissolved gas that would be under an incredible amount of pressure being so deep, so that they are as explosive as caldera volcanoes on land.

A good attempt to explain the dacite and calderas although short on detail.
C answer

QUESTION FOUR: ACCEPTABLE RISKS OF MEDICAL X-RAYS

Evaluate the information in the above paragraphs and Tables One to Three, and give an informed opinion on the safety levels of medical procedures involving radiation on people, and the circumstances under which these procedures should be used for research. You may wish to consider each of the four risk categories as a starting point.

Much consideration should be taken with the use of radiation on people for medical and research purposes. It is possible that the risk of the radiation may out weigh the risk of the reason for using the radiation. The risk factors should both be heavily considered so as to understand what would be best for the person involved. Category I is obviously the least risk involved category and the reason behind it is if the research leads to knowledge. Therefore category 1 does not cause harm and maybe used without overuse. Category IIa also has a low risk rating but this dose is of more use to medical researches as it increases knowledge leading to a health benefit. Category III on the other hand has to be far more managed. Although the use of the doses in Category III can lead to direct patient benefits, the overuse of these doses may lead to an over riding risk over the original problem. For example, if a patient had cancer (which has an annual risk of death of 1 in 400, a lifetime risk of 1 in 4) and they had initial scans and X-rays to determine the size and the danger of the tumour and then CT scans their risk levels may well outweigh their original risk levels. Yet despite this it is probably more likely that their death risk has diminished after the treatment as the risk in Category III is greater than 1 in 1400 but thsat is still a far lower risk than that of the annual risk of cancer. Each patient has to have their own risks worked out.

Good integration of the data from more than one table
B answer

Sample of asssessed candidate work – Performance Descriptor 3: Performance Category 7

Note: These examples of student answers are in some cases abridged from the original. Parts of the answers that had not addressed the questions were omitted.

QUESTION ONE: SUNSPOTS, RADIOACTIVE ISOTOPES AND EARTH'S CLIMATE CYCLES

(a) Evaluate the use of beryllium-10 and carbon-14 to determine the different solar cycles. Consider in your answer the significance of:
- the half-life of each isotope
- the advantages and disadvantages of using each isotope
- the samples that are necessary
- the cross checking of results required.

The use of the radioactive isotope Carbon-14 in determining solar cycles through the study of growth rings on trees seems to be more useful for the shorter term cycles. These include the 11 year cycles as well as possibly the 200 year cycles. It probably would only be possible to study 600 year cycles if different trees were examined as it is difficult to find a large enough proportion of very old (over 600 year old, probably at least 1800+in order to determine an actual cycle) of which to study. For use in determining the longer cycles the radioactive isotope Be-10 would be much more useful as it has an incredibly long half life. It would last long enough within the ice to in order to show a sufficient period of the Sun's magnetic activity in order to study the longer cycles. You'd need to get lots of different samples from different areas and compare them.

Comparison of the two different isotopes and the different cycles that they would show.
Mention of the need for lots of samples and cross correlation.
C answer

(b) Discuss the relationship between temperature, sunspot numbers and the levels of carbon-14 and beryllium-10. Consider the implications for the Earth's climate of a more magnetically active sun.

The relationships shown on this graph, between temperature, sunspot numbers and the levels of C-14 are not totally clear. Although it is possible to see a trend between warmer temperatures, higher numbers of sunspots and higher levels of C-14. A more magnetically active sun will lead to warmer temperatures across Earth. Apparently global warming is the greatest threat to mankind as if temperature continue to rise the ice caps of Greenland and Antarctica.

Accurate correlation between increased sunspot activity and increased temperature. A relationship is made between the sun's magnetic activity and climate warming with a general comment about global warming.
C answer

QUESTION TWO: THE TREATMENT OF OIL SPILLS

(a) Discuss the chemistry involved in breaking up oil spills. Use a diagram if you wish. Include a discussion of the different types of detergent that might be used.

The detergent molecule is a surfactant. Oil, mostly always nonpolar, can be suspended in an emulsion in water with the action of detergent. One end is polar and hydrophilic and are attracted to water which is also polar. The hydrocarbon chain which is the rest of the detergent is nonpolar and hydrophobic, and is attracted to the oil molecules. A micelle is formed with the water molecules on the outside. The water particles have more strength than oil molecules and pulls the oil apart as micelles.

Good description of how a micelle is formed with oil, mentioning the polartity of water and the hydrophilic end of detergents, and the non-polar nature of detergent and of oil.
B answer

(b) Discuss the key factors that need to be considered in the design of an investigation to evaluate the effectiveness of different, naturally occurring bacteria in breaking down crude oil.
You are not required to design an actual experiment, but examples of specific techniques can be used to illustrate the relevant points.

The investigation to evaluate the effectiveness of different naturally occurring bacteria in breaking down crude oil would need to be a fair test. Therefore there are key factors to be considered. A neutral sample would be required so that there would be something to compare the effectiveness of each bacteria to. The conditions of the experiment must be carefully monitored to ensure that they stay fair. Conditions of the experiment would be the temperature, light, air and what the bacteria is growing on. Another condition would be to discover whether the bacteria is able to break down the crude oil while in sea water and how long it would take. You would need to repeat the experiment a lot of times.

Consideration of general scientific method although very generally.
C answer

(c) Evaluate the use of genetically engineered bacteria as compared with naturally occurring bacteria for environmental clean-ups. Consider:

- the relative effectiveness of each type of bacteria
- the possible impact on the environment
- the risks of gene transfer
- ethical considerations.

There are many factors to consider when evaluating the use of genetically engineered bacteria with naturally occurring ones for environmental clean-ups. Although bacteria may be enhanced by genetic engineering many tests would have to be done. This genetic engineering is said to be done so that the bacteria is able to break down a wider range of hydrocarbons. But how much wider is this range? Will it be significantly bigger or just a few more? Is the difference so substantial that the genetically engineered bacteria is truly required? Would this new bacteria cause any harm to the environment? Naturally occurring bacteria has been selected for this reason and has no impact on the environment but will the new bacteria be the same?

Both types of bacteria considered. Valid points made but in a general way.
C answer

QUESTION THREE: GEOLOGY OF THE SEA FLOOR

(a) Discuss factors that must be taken into account when sonar backscattering is used to determine the depth, the composition and the contours of the sea floor.

It must be taken into account that there could be something between the sea floor and the transmitter such as a school of fish. Also because of the strength of the returning signal is affected by the density and the reflective properties of the sea floor, it would be able to determine certain properties about these. The denser the water the faster the sound will travel. This will measure depth. The movement of the water, including currents etc could also affect it as this may distort the sound. This could affect the back scattering regions by disrupting them, making accurate mapping difficult.

A good attempt with some accuracy and mentioning of key points.
C answer

(b) Compare the processes that occur and the main rocks that are usually formed when:
- oceanic crust is subducted under continental crust
- oceanic crust is subducted under oceanic crust.

Oceanic crust subducting under continental crust results in deep sea trenches such as the Hikurangi Trough east of the N.I. Melting of the oceanic crust as it goes deep underground creates magma below the continental crust, resulting in volcanism. Oceanic crust is Si depleted and dense. This crust is melted when at a certain depth in the aesthenosphere and it is this magma which creates the volcanoes on the continental crust. The volcanoes are andesitic or rhyolite. Oceanic crust subducting under oceanic crust results in very deep trenches such as the Kermadec trenches and volcanic island arcs. The magma is basaltic forming basalt or andesite volcanoes.

Good understanding of both forms of subduction. Answer supported by New Zealand examples.
B answer

(c) Discuss reasons as to why some volcanoes in the Kermadec Trench, such as that shown in Photo one, erupt dacite and form calderas.

When oceanic crust subducts under oceanic crust deep trenches such as the Kermadec trench and a volcanic arc is formed. Usually the volcanoes are made up of andesite. Dacite is silica rich whereas as andesite only has moderate silica. So this silica rich rock might have come from a time when oceanic crust was colliding with younger continental crust. Some sediment might have been left behind. Sediment has more silica in it. Silica rich rocks cause violent, explosive eruptions the type needed to form a caldera. There is also a high amount of pressure, gases and water to create such a violent explosion. After the eruption the crater that was formed collapses in on itself, to form a large crater such as Lake Taupo.

Answer shows how a caldera is formed and gives one idea as to why there may be silica rich dacite.
B answer

QUESTION FOUR: ACCEPTABLE RISKS OF MEDICAL X-RAYS

Evaluate the information in the above paragraphs and Tables One to Three, and give an informed opinion on the safety levels of medical procedures involving radiation on people, and the circumstances under which these procedures should be used for research. You may wish to consider each of the four risk categories as a starting point.

The Category I medical uses of radiation are not very likely to cause an increased risk of cancer as generally they equate to at the most several days worth of background radiation, meaning that long term they will only have been exposed to 3 days extra (per treatment). Category IIb would be more harmful as it would take a smaller number of doses to get to a significant level of radiation. These should only be applied if the benefit outweighs the risk. The category III doses are incredibly harmful, and may cause cancer. So they should not be used for medical research unless the patient is going to die without treatment and the use of radiation will prolong their life.

Application of the data, using data for at least one risk factor.
C answer