



**General Certificate of Education**

**Environmental Science 6441**

**ESC7      Alternative to Practical  
Investigation**

**Mark Scheme**

*2008 examination – June series*

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## Environmental Science

June 2008

ESC7

**Instructions: ; = 1 mark / = alternative response A = accept R = reject**

### Question 1

- 1 (a) (i) Random/systematic sampling;  
grid and co-ordinates;  
5 or more samples;  
[A repeats if qualified]  
apparatus used stated (trowel/auger/corer);  
constant amount of soil;  
constant depth;  
sealed container for transport; MAX 5
- 1 (a) (ii) Soil sieve method  
dry soil sample;  
place in nest of soil sieves/description of sieves;  
shake;  
weigh each fraction;
- OR**
- Sedimentation  
mix soil sample with water;  
placed in suitable container;  
[R beaker]  
allow to settle;  
measure band widths; MAX 3
- 1 (b) Subjective/estimate/requires judgement against colour standard;  
ref to level of precision/logarithmic scale;  
limited use for stats (as subjective); MAX 2
- 1 (c) Water holding capacity/drainage;  
[A water content]  
organic matter/humus content;  
soil temperature;  
soil biota/earthworms/micro-organisms;  
soil pollutants/heavy metals;  
[A soil nutrients/named nutrient] MAX 2

- 1**     (d)    Low pH;  
              release of heavy metals;  
              deficiency of clay particles;  
              low ion exchange capacity;  
              excess of sand;  
              soil freely draining/poor water retention;  
              difficulty in establishing root systems/anchorage;  
              rapid leaching/run off;  
              liable to erosion/instability;  
              little organic matter;  
              few soil biota/decomposers;  
              poor structure/few stable peds;  
              nutrient deficiency (especially N)/N critical limiting factor;  
              nutrient imbalance;  
              needs addition of fertiliser/organic matter;  
              neutralise pH (eg using powdered limestone);  
              replant using tolerant species  
              ref to economic cost of fertilising/remediation;

MAX 6

**Total marks = 18**

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**Question 2**

- 2 (a) (i) Environmental gradient present;  
factors change with distance down slope (so change in vegetation expected);  
correct ref to unsuitability of random quadrat sampling;  
tests association between 2 factors – distance and cover; MAX 3
- 2 (a) (ii) Position of point quadrat at right angles to transect;  
description of point quadrat;  
[A diagram]  
score number of hits on vegetation;  
% cover determined by proportion of hits falling on vegetation/10; MAX 3
- 2 (b) Line graph correctly labelled;  
X axis with distance in metres from top of slope;  
2 separate scales for y-axis;  
points plotted accurately; 4
- 2 (c) With distance down slope:  
% vegetation cover increases;  
slope angle decreases;  
moisture content increases;  
ref to relationship between vegetation cover and soil moisture;  
ref to relationship between vegetation cover and slope angle;  
ref to relationship between moisture content and slope angle; MAX 3
- 2 (d) (i) Positive correlation between moisture content and vegetation cover; 1  
[A description of relationship]
- 2 (d) (ii) Spearman rank;  
  
test of strength of correlation/relationship between two variables (rather than  
significance or association);  
paired data;  
non-parametric/distribution free;  
suitable quantity of data/more than 5 pairs of data; MAX 3
- 2 (d) (iii) Attempt to rank datasets;  
correct ranking of vegetation cover data;  
correct ranking of moisture data;  
correct calculation of  $\sum d^2$  (23.5);  
correct calculation of  $n^3 - n$  (990);  
correct value for  $r_s$  (0.86/0.858); 6  
(allow one error to be carried through)
- 2 (d) (iv) Correct statement of critical value at  $p = 0.05$  for  $n = 10$  (0.65);  
correct conclusion (based on candidates calculation); 2

**Total marks = 25**

**Question 3**

- 3 (a) (i) Ref to safety/awareness of risk;  
selection of suitable sites within river with reason;  
use of surber sampler/D shaped net;  
disturbance of sediment;  
standardisation of technique (area/time/number);  
net placed downstream to capture;  
count/identify;  
repeat test at same site;  
work upstream; MAX 5
- 3 (a) (ii) Only samples substrate dwellers;  
some may cling on tightly/not dislodged;  
some may drift outside the net/swim away;  
difficult to standardise level of disturbance;  
only provides snapshot in time;  
site limited by depth/current; MAX 3
- 3 (a) (iii) Additional sampling techniques for invertebrates used (eg nets for swimming species);  
testing for other heavy metals/pollutants in the water;  
sampling intensity same/at same intervals from mine;  
same stream but sampling above and below mine workings;  
same stream but sampling at intervals/replicates;  
sampling at different times/seasons;  
collect primary data for Cu and Zn/water chemistry;  
identify invertebrates to species level;  
measurement of flow rate; MAX 3
- 3 (b) Calculate means for species present;  
bar graph for invertebrates;  
(compared with) bar graph of abiotic factors/Zn/Cu/pH;  
calculation of biotic index/diversity index;  
[A classification based on oxygen requirements]  
named, appropriate statistical test(s) (eg Mann Whitney U test to compare mean values of each taxon above and below discharge);;  
[A comments relating to suitability of above techniques] MAX 4
- 3 (c) Distribution: more abundant upstream/more scarce downstream;  
reason stated (sensitivity to high levels of zinc/copper/low pH/lack of food/  
effect of some other influence not measured); 2
- 3 (d) (i) Algae/bacteria/phytoplankton/fish/aquatic birds/mammals/  
amphibians/floating or emergent plants;  
[A named representative of these groups] 1  
[R 'plants' unqualified/aquatic plants]
- 3 (d) (ii) Suitable technique named;  
description; 2

**Total marks = 20**

**Question 4**

- 4 (a) (i) To detect the range of values/find extremes of values;  
minimise 'snapshot in time'/pollution washed downstream from test site; MAX 1
- 4 (a) (ii) Flow rate/river volume/oxygen levels/turbulence/temperature/turbidity/colour; 1
- 4 (b) *Quality of Written Communication is assessed in this answer.*

**Trends****Major elements**

Show positive correlation/follow same pattern;  
concentrations higher in range pH 5-5.9;  
except for Si;  
concentrations lowest at pH>7; (*allow once only*)  
except for Ca;  
silicon follows same pattern as trace elements;  
sulphur/sulphate most abundant element;

**Trace elements**

show positive correlation/all follow same pattern;  
concentration decreases as pH increases/negative correlation with pH;  
concentrations lowest at pH>7; *if not already credited for major elements*  
high levels of Fe and/or Zn;  
indicates pollutants from mine discharge;  
pH highly variable from strongly acidic to >7;

MAX 6

**Remediation**

Data act as a benchmark/standard;  
to monitor success of remediation;  
ref to remediation strategies;;  
suggests need to increase pH levels (to reduce levels of toxic elements);

MAX 2

*Quality of Written Communication*

Mark	Descriptor
2	All material is logically presented in clear, scientific English and continuous prose. Technical terminology has been used effectively and accurately throughout. At least half a page of material is presented.
1	Account is logical and generally presented in clear, scientific English. Technical terminology has been used effectively and is usually accurate. Some minor errors. At least half a page of material is presented.
0	The account is generally poorly constructed and often fails to use an appropriate scientific style to express ideas.

MAX 2

**Total marks = 12**

## Calculation for Q2 (d)(iii)

Quadrat	Vegetation cover/%	Rank	Moisture content of soil/%	Rank	Diff in rank (d)	D <sup>2</sup>
1	60	1	14.3	1	0	0
2	68	2.5	17.2	3	0.5	0.25
3	70	4	14.9	2	2	4
4	68	2.5	20.3	4.5	2	4
5	73	5	22.7	8	3	9
6	98	9	23.5	10	1	1
7	93	7	21.2	6	1	1
8	88	6	20.3	4.5	1.5	2.25
9	95	8	22.0	7	1	1
10	100	10	22.9	9	1	1
					$\Sigma d^2$	<b>23.5</b>

$$r_s = 1 - \frac{6 \times 23.5}{n^3 - n} \quad 1 - \frac{141}{990} \quad 1 - 0.142; \quad 0.858(0.86)$$

$$r_s = \mathbf{0.86 (0.858)};$$

Calculated value > critical value of 0.65 for  $r_s$  for  $n = 10$  (at  $p = 0.05$ );  
 Positive correlation/hypothesis accepted/null hypothesis rejected;