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ASSESSMENT and QUALIFICATIONS ALLIANCE

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; MAX 2
[**A** soil nutrients/named nutrient]

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

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 <u>distance</u> 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 <u>angle</u>;
ref to relationship between moisture content and slope <u>angle</u>; 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 Σd^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);; MAX 4
[**A** comments relating to suitability of above techniques]

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^2
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
					$\sum d^2$	**23.5**

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

r_s = 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;