

GCE 2004  
*June Series*



## Mark Scheme

### Environmental Science – ESC7 (6441 )

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*Dr Michael Cresswell Director General*

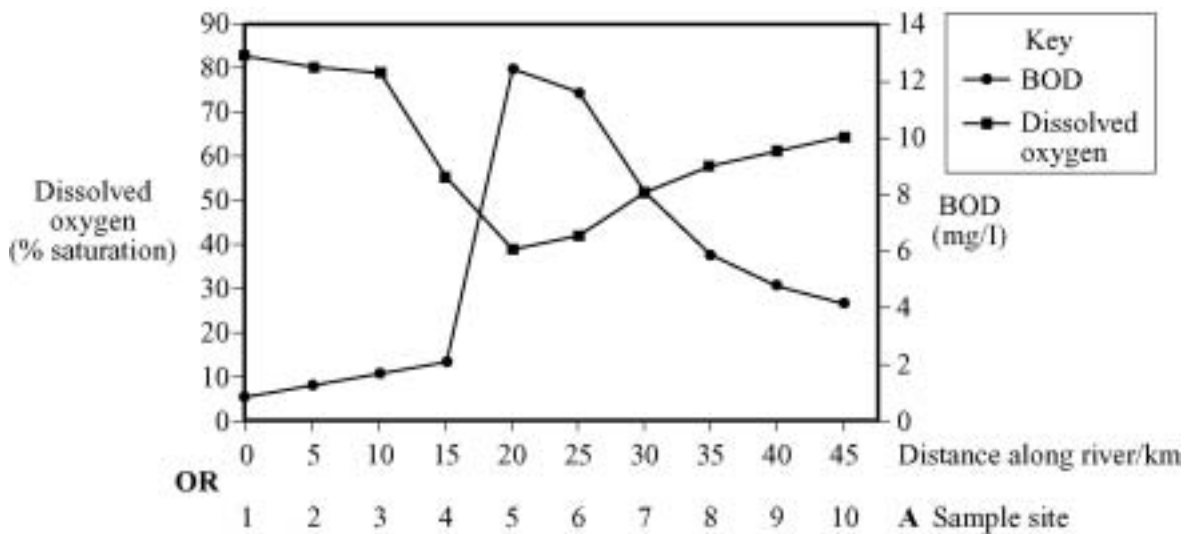
**Environmental Science****June 2004****ESC7****Instructions: ; = 1 mark / = alternative response A = accept R = reject****Question 1**

- (a) (i) Qualified reference to samples taken on same day at all sample points/same time of day;  
same distance from bank;  
minimise water disturbance;  
sample taken from constant depth;  
same volume used for testing/same methodology;  
rinse tubes first in river water/distilled water/sterile tubes/clean equipment;  
samples taken to lab kept in controlled/similar conditions/sealed;  
same site for each of the 3 visits; MAX 5
- (ii) Protective/suitable/clothing;  
hygiene with reference to pathogens/Weil's disease/first aid provision;  
appropriate reference to depth and current/steep banks;  
appropriate reference to isolated locations/working in groups; MAX 3
- (b) (i) Use of electronic probe;  
reference to calibration;  
principle of use; MAX 2

**OR** other appropriate method e.g. Winkler technique – max 2 marks

- (ii) Sealed water sample;  
kept in standard conditions of time/temperature/light (at least 2 mentioned);  
details of time (5 days);  
details of temperature (20 °C);  
measurement of oxygen content before and after;
- OR**  
A alternative method e.g. use of methylene blue/permanganate values:  
sealed water sample;  
kept in standard conditions;  
add appropriate reagent;  
description of colour change expected;  
rate of colour change measured; MAX 4

(c)



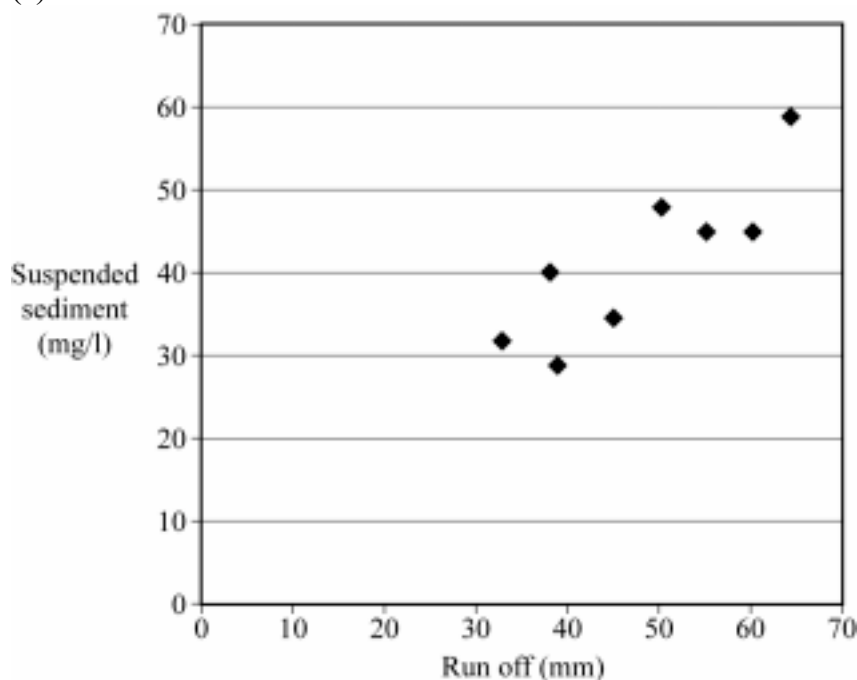
Appropriate scales and labels on y axis  $\times 2$ ;  
 appropriate x axis – sample site or distance downstream and labels;  
 accurate plotting of points;

4

**Total marks = 18**

**Question 2**

(a)



Use of scattergraph;  
 appropriate scale and labels for run off levels on one axis;  
 appropriate scale and labels for suspended sediment on other axis;  
 points plotted correctly;  
 trend line drawn;

MAX 4

(b) Positive correlation/relationship between run off levels and amount of sediment; 1  
 [A description of relationship]

(c) (i) Spearman Rank;  
 test of strength of relationship/correlation between two variables (qualified);  
 paired data;  
 non-parametric/distribution free;  
 suitable comparative comment on other statistical test(s);  
 suitable quantity of data;

MAX 3

(ii) Correct ranking of run off data;  
 correct ranking of sediment data;  
 correct calculation of  $\sum D^2$ ;  
 correct calculation of  $(n^3 - n)$ ;  
 correct value of  $r_s$ ;  
 correct statement of critical value at  $p = 0.05$  for  $n = 8$ ;  
 correct conclusion;

7

(iii) possibility of results obtained by chance alone is only 5%/confidence level is 95%;

1

**Total marks = 16**

**Question 3**

- (a) Selection of suitable site within river with reason;  
disturbance of sediment;  
net placed downstream to capture;  
count/identify;  
repeat test at same site;  
work upstream; MAX 4
- (b) (i)  $D = \frac{56 \times 55}{(12 \times 11) + 23 \times 22 + (9 \times 8) + (6 \times 5) + (2 \times 1) + (4 \times 3)}$
- $\frac{3080}{754}$  ; 4.08 ; 3  
(4.0848806)  
[A 4.1]
- (ii) Correct plotting of candidates calculated figure on graph; 1
- (iii) Index takes relative abundance into account;  
minimises effect of rare species; 2
- (c) (i) Algae/bacteria/phytoplankton/otters/aquatic birds/mammals/amphibians;  
[R plants(unqualified)] 1
- (ii) Suitable technique described;; 2

**Total marks = 13****Question 4**

- (a) Credit any relevant conclusions from the data given:  
increased acidity/lower pH at Site 1/conifer plantation (compared to rest of river);  
decreased oxygen content at Site 4–5/general trend for dissolved O<sub>2</sub>;  
increased BOD at Site 4-5/general trend for BOD;  
increased ammonia content at Site 4/adjacent to farmland;  
phosphate levels increase at Site 4/adjacent to farmland;  
nitrate levels increase at Site 3/adjacent to farmland;  
high species diversity at Site 1/2/reduced diversity at Site 4/general trend for diversity;

Credit any relevant points of discussion to explain significance of the results:  
appropriate reason for increased acidity near conifer plantation;  
origin of nitrate/phosphate linked to fertiliser run off/leaching;  
suitable comments on delay of phosphate reaching river compared to nitrate;  
relative solubility of nitrate and phosphate;  
comments on sediment resulting from heavy rainfall and run off;  
comments on silage crop density/bare soil present;  
high ammonia levels linked to farm effluent from pig unit;  
suitable comment on provision of plant nutrients for plant/algal growth;

high sediment levels linked to farming practices/soil erosion;  
 reference to possible eutrophication/deoxygenation;  
 eutrophication/deoxygenation explained;  
 reason for reduction in species diversity;  
 suitable comment on increase in biodiversity in Country Park;  
 linked to absence of agriculture;  
 suitable comment on presence of indicator organisms at site 6;  
 link to reduction in species diversity and lack of fish in the river;  
 tubifex/midge larvae as indicators of fairly high pollution levels;  
 suitable comment on water quality related to GQA standards of:  
     BOD;  
     dissolved oxygen;  
     ammonia;  
     plant nutrients;  
     macro-invertebrates;  
 suitable comments on EC standards for nitrate levels;

MAX 15

## (b) Valid comments on:

problems of species identification/counting;  
 inaccuracy of test kits for plant nutrients;  
 lack of sample before conifer plantation;  
 lack of repeats/inadequate sample sizes;  
 limitation of using Diversity Index rather than a Biotic Index;  
 problems of kick sampling/ref. to riffles and pools/only samples substrate dwellers;  
 problems of measurement of physical and chemical factors/idea of snapshot  
 in time;  
 seasonal variations in landuse;  
 influence of dilution/flow rate on concentration of pollutants;  
 suitable comment on use of Biotic Index to show pollution events;  
 B.O.D tests unreliable/need repeat tests;  
 influence of temperature changes on oxygen levels;  
 populations (of invertebrates) fluctuate seasonally;

MAX 5

## (c) Valid comments on:

increase sample size/more repeats;  
 use of a Biotic Index;  
 surveys of other groups of organisms/algae/phytoplankton/fish etc;  
 measurement of aesthetic quality;  
 detail of aesthetic measurement      e.g.    litter survey;  
    oil/scum;  
 measurement at different seasons;  
 increase frequency of observations for chemical/nutrient factors;  
 measurement of flow rate/temperature;  
 impact of different crops/different methods of cultivation/different landuse;  
 sampling before conifer plantation;  
 [R extensions including climate and geology therefore not landuse linked]

MAX 4

- (d) Valid suggestions such as:  
 control of source of pollution;  
 stricter control on farm effluents;  
 ref. to polluter pays principle;  
 control of fertiliser application;  
 control of planting regimes;  
 reference to nitrate limits; MAX 4  
 [A ref to reed beds as buffers/methods to reduce soil erosion]

**Total marks = 28**

**Working for Stats 2 c(ii)**

**Spearman Rank Correlation Test**

Sediment	Rank	Run off	Rank	D	D <sup>2</sup>
32	2	33	1	1	1
29	1	39	3	-2	4
35	3	45	4	-1	1
59	8	64	8	0	0
45	5.5	55	6	-0.5	0.25
48	7	50	5	2	4
40	4	38	2	2	4
45	5.5	60	7	-1.5	2.25
				<b>Σ D<sup>2</sup></b>	<b>16.5</b>
	<i>1 mark</i>		<i>1 mark</i>		<i>1 mark</i>

$$r_s = 1 - \frac{6 \times 16.5}{n(n^2 - 1)} = 1 - \frac{99}{504} = 0.196 (0.2) \quad \text{correct calculation of } n(n^2 - 1) = 1 \text{ mark}$$

$$1 - 0.196 (0.2) = \underline{0.804 (0.8)} \quad \text{correct value for } r_s = 1 \text{ mark}$$

Exceeds critical value of 0.7/0.74 for  $r_s$  for  $n=8$  (at  $p=0.05$ ) = 1 mark

Positive correlation/hypothesis accepted/reject null hypothesis = 1 mark

**Total marks = 7**

(Allow 1 error to be carried through)