TEAM NUMBER KEY

2010 SCIENCE OLYMPIAD ENVIRONMENTAL CHEMISTRY INVITE EXAM

ANSWER FORM

SCHOOL NAME: Patrick's Answer Key

I. SOIL COMPOSITION (p2-3)

Sand, Silt, Clay, Loam (p2 #s1-6)

01) D 02) A 03) C 04) C 05) B 06) C

/6

Short Answer (p2 #s7-12)

7) Iron 8) Loess

9) Eluviation (do NOT accept iluviation... it has a different meaning) 10) Podsol (AKA: PODZOL, SPODOSOL)

11) Saprists (AKA: Sapric soils, Muck, Black Muck) 12) Alfisols

/6

Soil Triangle (p3 #s 13-16)

13) 60 % Clay 10 % Silt 30 % Sand (+2)

14) 0 % Clay 90 % Silt 10 % Sand (+2)

15) Clay 16) Sandy clay Loam

/6

II. SOIL TESTING / SOIL POLLUTION (p4)

17. (+3) 200 ccs + 200mL... absorbs 200mL − 106mL = 94mL

ccs = mL $\frac{94\text{mL absorbed}}{200\text{mL volume}}$ = .47 porosity

18. (+3) CV = CV (40ppm)(?) = (12ppm)(1.0L) = 0.30L (-1pt if units aren't labeled)

/6

Soil Pollutants (p4 #s 19-30)

19) C 20) B 21) A 22) B 23) C

24) E 25) D 26) D 27) B 28) C 29) A 30) B

/12

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III. PLANT NUTRIENTS (p5-7)

Nutrient Functions (p5 #s31-40)

31) C 32) C 33) D 34) D 35) A 36) B 37) B 38) E 39) C 40) B

/10

Nitrogen Cycle (p6 #s41-45)

41) B 42) C 43) A 44) E 45) C @ 2 POINTS EACH

/10

Fertilizer (p7#s 46-48)

46) 20% Nitrogen × 100. kg = 20.0kg N

10% Diphosphorous pentaoxide × 100.kg = 10.0kg P_2O_5

% phosphorus = $\frac{31.0\times2}{31.0\times2+16.0\times5} = \frac{62.0}{141}$ = 44.0% P in P_2O_5

10.0kg × 44.0% = 4.40 kg P

5% Potash × 100.0kg = 5.0kg K_2O

% potassium = $\frac{2\times39.1}{2\times39.1+16.0}$ × = 83.0% k in K_2O 5.0kg × 83.0% = 4.1kg K

47) $100.\,\text{kg} \times \frac{2.20\,\text{lbs}}{\text{kg}} =$ 220. lbs

-1 if no unit label

-1 if not EXACTLY three sig figs

48) $50\,\text{lbs} \times \frac{\text{kg}}{2.2\,\text{lbs}} \times 10\%\ P_2O_5 \times \frac{44.0\%\ P}{P_2O_5} \times \frac{\text{mol P}}{.031\,\text{kg P}} \times \frac{6.022\times10^{23}\ \text{atoms}}{\text{mol P}} =$

(i.e. 31g P)

1.9×10^{25} atoms P

/10

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IV. Remediation (p7)

LTTD (p7 #s49-51)

+5

49) Soil must be extracted from the contaminated site and brought to the treatment facility. (i.e. Treatment is EX SITU) > +2

Soil is heated → +1

in order to boil out/separate contaminants. → +2

+4

50) Volatile Organic Compounds (VOCs) = +2/4 give!

Total petroleum hydrocarbons (TPE) or just petroleum/hydrocarbons = +3/4 give!

Volatile organic pollutants with a boiling point at or below 1200°C = +4/4

51) Low temperature thermal desorption

/10

Remediation Multiple Choice (p7#s 52-57)

52) E 53) B 54) A 55) C 56) E 57) D

/6

V. Gas Chromatography and Mass Spectroscopy (p8-9)

Reading Gas Chromatograms (p8 #s58-65)

ALL WORTH 2 pts.

58) 5.2s (accept 5.0s - 5.5s) -1pt for no unit/wrong unit

59) 210mV (accept -1 pt for no unit/wrong unit

60) Ethylbenzene

61) o-xylene

62) NOTHING (diff. chemicals produce different intensities... plus the height isn't the total signal, the AREA is)

63) 30. meters (30m)

64) FILM THICKNESS (AKA film distance) ↳ give half credit for "d_f"

65) Flame Ionization Detector ↳ give half credit for "FID"

66) It does not trigger the detector. (is invisible to the detector, can't be detected... etc.)

67) The output of a detector is an electrical signal.

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Gas Chromatography Factors (p9#s 68-72)

68) A 69) B 70) B 71) A 72) E.

/5

Mass Spectroscopy (p9#s 73-75)

+2 73) E

+3 74) The molecular ion peak represents the peak corresponding to the INTACT molecule (or ENTIRE molecule). → +3

(partial credit: +1pt for heaviest molecule or heaviest peak)

+3 75) The peak does appear to exist. +1

The fragments at about 285 & at about ~~320~~ & at about 355 all vary by small amounts, suggesting that they are varying due to isotopic differences and not structural differences. +2

The peaks at ~165 and ~235 are highly dominant. +1

That those fragments are formed so consistently suggests some stability. +1

/10

↳ Alternatively, students may KNOW that the molar mass of DDT is 354.5 g/mol (if someone has that on their cheat sheet esp.). This is ok for full credit assuming they explain that there is a peak at ~354 g/mol and this is the molecular ion peak.

1ST TIEBREAKER = First team to make a sig figs error where the other team did not.

2ND TIEBREAKER = Subjective evaluation of quality of free response answers.

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Some extra MS info...

For #s 68 -72 use the following answer choices:

A. All retention times would increase
B. All retention times would decrease
C. All signal intensities would increase
D. All signal intensities would decrease
E. Some retention times would increase, some retention times would decrease

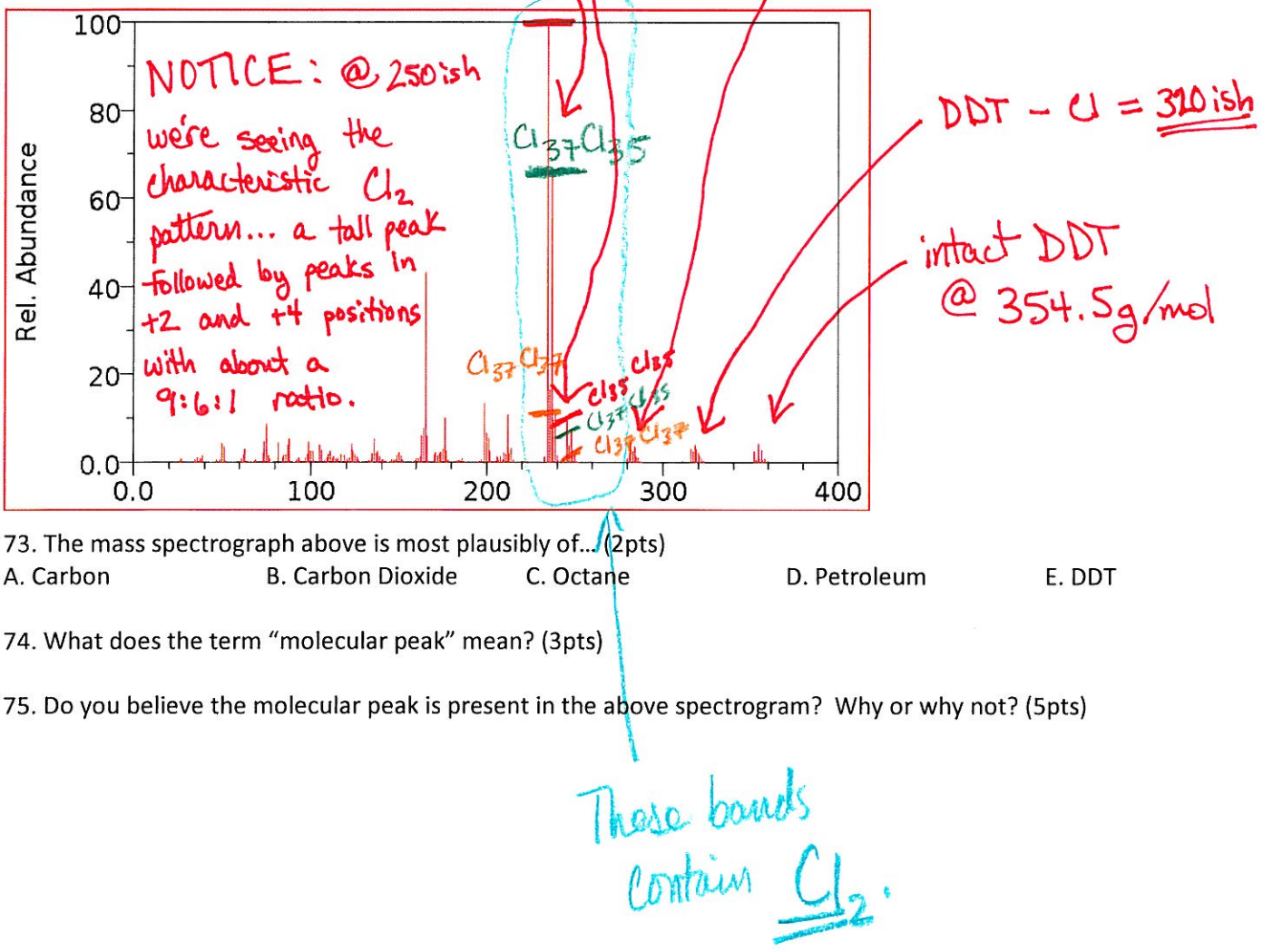
68. A longer column is used.

69. A higher temperature is used.

70. The carrier gas is sped to a higher velocity.

71. A thinner column is used.

72. A different carrier gas is used.



73. The mass spectrograph above is most plausibly of... (2pts)

A. Carbon B. Carbon Dioxide C. Octane D. Petroleum E. DDT

74. What does the term "molecular peak" mean? (3pts)

75. Do you believe the molecular peak is present in the above spectrogram? Why or why not? (5pts)