Gas Chromatography

15 Very Difficult Multiple-Choice Questions

Circle the single best answer for each question. Questions include calculations, theory, instrumentation, inlet modes, columns, detectors, retention time, and resolution.

Question 1

A compound is being considered for direct GC analysis. Which property combination provides the strongest justification for using GC?

A) High polarity and complete solubility in water

B) Sufficient volatility and thermal stability under the analytical conditions

C) High molecular weight regardless of decomposition temperature

D) Nonvolatility combined with high detector response

Question 2

A GC peak appears at a total retention time t_R = 8.60 min. If the mobile-phase travel time is t_M = 1.35 min, what is the time associated with retention by the stationary phase t_S?

Use: $t_R = t_M + t_S$

A) 7.25 min

B) 9.95 min

C) 6.15 min

D) 1.35 min

Question 3

Two adjacent GC peaks are separated by a distance d = 6.0 mm. Their respective peak widths are t_{w1} = 3.0 mm and t_{w2} = 5.0 mm.

Using $R = 2d / (t_{w1} + t_{w2})$, what is the resolution and the most appropriate interpretation?

A) R = 0.75; complete baseline separation

B) R = 1.00; 99.7% separation

C) R = 1.50; baseline separation is achieved

D) R = 2.50; peaks must be completely unresolved

Question 4

Two peaks have widths of 4.0 mm and 6.0 mm. What minimum distance between their centers is required to achieve R = 1.5?

A) 5.0 mm

B) 6.0 mm

C) 7.5 mm

D) 15.0 mm

Question 5

In the split-mode diagram, the split vent flow is 46 mL/min while the column flow is 1 mL/min. Ignoring the septum purge when calculating how the vaporized sample divides between the split vent and column, approximately what percentage of that divided sample enters the column?

A) 1.0%

B) 2.13%

C) 46%

D) 97.9%

Question 6

A researcher must analyze a very low-concentration sample and wants to maximize the fraction transferred to the column. Which operating sequence is most consistent with the lecture?

A) Keep the split valve permanently open so most analyte is vented

B) Use splitless mode, initially close the split valve, trap the sample at the column head, then open the valve to remove residual solvent vapor

C) Use split mode because capillary columns require all injected sample to enter the column

D) Inject directly into a heated split vent without using the column head

Question 7

Which statement best distinguishes cool-on-column injection from conventional split/splitless injection?

A) Cool-on-column introduces the whole sample directly into the column and can reduce sample discrimination and degradation

B) Cool-on-column requires most of the sample to be discharged through a split vent

C) Cool-on-column is used only for gaseous samples

D) Cool-on-column deliberately causes thermal degradation to improve volatility

Question 8

A conventional packed GC column has an inner diameter of approximately 5 mm, whereas a representative capillary column has an inner diameter of 250 micrometers. How many times larger is the packed-column inner diameter?

A) 5 times

B) 10 times

C) 20 times

D) 200 times

Question 9

Which comparison between packed and capillary GC columns is correct?

A) Capillary columns have lower separation efficiency but much greater resistance to overloading

B) Packed columns usually have stationary phase coated only on a fused-silica inner wall

C) Capillary columns generally provide much higher separation efficiency but are more easily overloaded by excessive sample

D) Packed columns are typically 10-100 m long with an inner diameter around 250 micrometers

Question 10

A capillary column contains a porous solid support attached to the inner wall, but no liquid stationary phase is added to that support. Which column type is described?

A) WCOT

B) PLOT

C) SCOT

D) Packed column

Question 11

A mixture contains an early-eluting volatile compound and several much less volatile components that remain strongly retained at a low oven temperature. Which strategy is most appropriate according to the lecture?

A) Maintain a permanently low isothermal temperature regardless of retention

B) Ramp the oven temperature during the run to facilitate elution of all compounds

C) Turn off the carrier gas once the first compound elutes

D) Reduce the detector temperature instead of changing column temperature

Question 12

A laboratory wants to selectively detect a trace halogenated compound in a complex GC sample. Which detector is specifically matched to this type of analyte?

A) Flame ionization detector

B) Electron capture detector

C) Nitrogen-phosphorus detector

D) Flame photometric detector

Question 13

A sample contains two compounds:
- Compound X contains nitrogen and phosphorus
- Compound Y contains sulfur and phosphorus

Which detector pairing is most appropriate?

A) X -> ECD; Y -> TCD

B) X -> NPD; Y -> FPD

C) X -> FID; Y -> ECD

D) X -> TCD; Y -> MSD only

Question 14

A GC system uses two detectors in series. The first detector must permit the analyte stream to continue to the second detector. Which arrangement best follows the lecture?

A) FID first -> TCD second

B) TCD first -> FID second

C) FID first -> another destructive detector second

D) Detector order is irrelevant because every GC detector is nondestructive

Question 15

Two unknown samples are analyzed on the same GC column under identical operating conditions. Both generate a peak at exactly the same retention time, but no mass-selective detector is being used. Which conclusion is the most scientifically appropriate based on the lecture?

A) They are unquestionably the same compound because retention time uniquely determines molecular structure

B) Retention time can provide qualitative identification evidence, but ordinary GC lacks strong confirmatory information beyond retention time

C) Retention time is quantitative only and cannot provide any qualitative information

D) The peak area, rather than retention time, conclusively identifies molecular structure

End of Questions

Model Answer Key

Use this section only after completing all 15 questions.

Question	Answer	Question	Answer	Question	Answer
1	B	6	B	11	B
2	A	7	A	12	B
3	C	8	C	13	B
4	C	9	C	14	B
5	B	10	B	15	B

Model Answers and Key Reasoning

Question 1 - Answer: B

GC is best suited to compounds with sufficient volatility and thermal stability under the analysis conditions.

Question 2 - Answer: A

$t_S = t_R - t_M = 8.60 - 1.35 = 7.25$ min.

Question 3 - Answer: C

R = 2(6.0)/(3.0 + 5.0) = 12/8 = 1.50, which corresponds to baseline separation in the lecture.

Question 4 - Answer: C

From R = 2d/(w1+w2): d = R(w1+w2)/2 = 1.5(10)/2 = 7.5 mm.

Question 5 - Answer: B

Fraction entering column = 1/(46 + 1) = 0.0213 = 2.13%.

Question 6 - Answer: B

Splitless mode is suited to low-concentration samples: close the split valve during injection/trapping, then open it to vent residual solvent.

Question 7 - Answer: A

Cool-on-column introduces the whole sample directly into the column and reduces discrimination and thermal degradation.

Question 8 - Answer: C

250 micrometers = 0.250 mm; 5/0.250 = 20 times.

Question 9 - Answer: C

Capillary columns provide higher separation efficiency but have lower sample capacity and are more easily overloaded.

Question 10 - Answer: B

PLOT uses a porous solid support attached to the inner wall without the added liquid stationary phase characteristic of SCOT.

Question 11 - Answer: B

Temperature programming (ramping) helps elute less volatile or more strongly retained compounds during the same run.

Question 12 - Answer: B

ECD is designed for electron-capturing compounds, including many halogenated compounds.

Question 13 - Answer: B

NPD targets nitrogen/phosphorus compounds; FPD targets sulfur/phosphorus compounds.

Question 14 - Answer: B

In serial detection, the nondestructive detector must come first; the lecture illustrates TCD before FID.

Question 15 - Answer: B

Retention time supports qualitative identification under fixed conditions, but ordinary GC lacks independent confirmatory data unless coupled to mass spectrometry.