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PASSAGE V

Petroleum, or crude oil, is refined by separating it into different by-products. This process is called *fractional distillation*, whereby the crude oil is heated and each different product is distilled, or drawn off, at different stages. Each product is distilled at certain temperature ranges and collected in separate receivers. Petroleum refining is carried out in a boiler and a fractionating tower. The crude oil is super-heated in the boiler to about 600°C, which vaporizes the crude oil. The vapors then rise in the tower to certain levels where they cool and condense, according to their chemical structure. When the vapor reaches a height in the tower where the temperature in the column is equal to the boiling point of the substance, the vapor turns into liquid (condenses), collects in troughs, and flows into various tanks for storage, as shown in Figure 1. Table 1 below summarizes the characteristics of the by-products obtained from the fractional distillation of petroleum.

Table 1

Petroleum by-product	Condensation temperature (°C)
Petroleum gas	20–40
Gasoline	40–70
Kerosene	100–120
Gas oil	120–200
Lubricating oil stocks	200–300
Residue	600

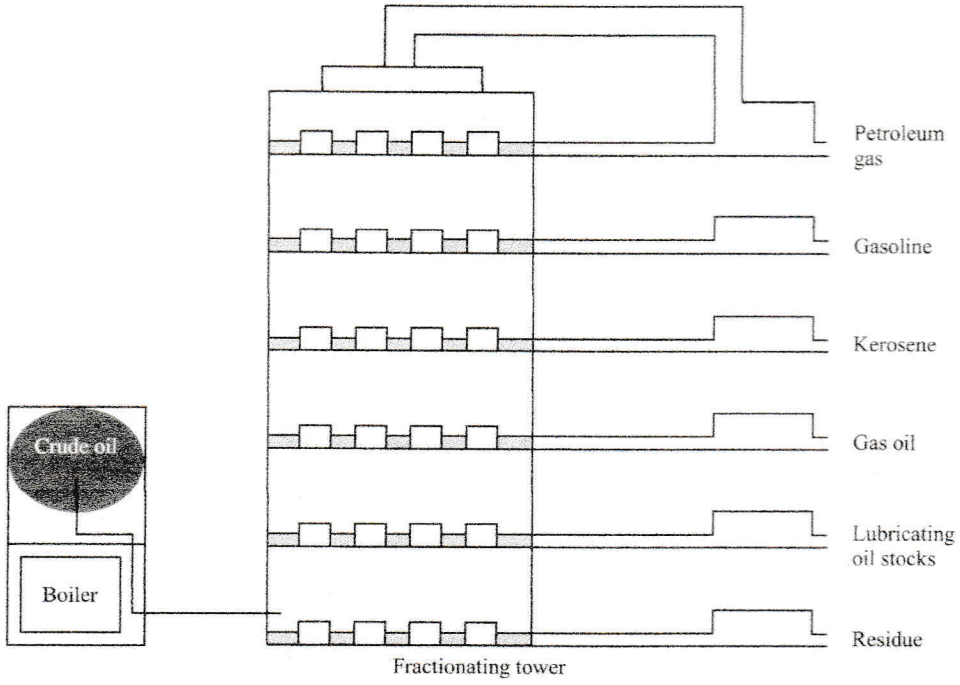

Figure 1

23. According to the passage, the temperature at which gasoline condenses is most likely:
    - **A.** less than 0°C.
    - **B.** less than 40°C.
    - **C.** greater than 20°C.
    - **D.** greater than 70°C.

24. According to the passage, which by-product formed in the fractionating tower condenses first?
    - **F.** Petroleum gas
    - **G.** Kerosene
    - **H.** Gas oil
    - **J.** Residue

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25. According to Figure 1, fractional distillation uses which of the following as a raw material?
    A. Gasoline
    B. Residue
    C. Crude oil
    D. Gas oil

26. Given that naptha, another by-product of petroleum distillation, has a condensation point of approximately 90°C, between which two petroleum by-products would this substance be found in a fractionating tower?
    F. Gasoline and kerosene
    G. Lubricating oil stocks and gas oil
    H. Kerosene and gas oil
    J. Residue and lubricating oil stocks

27. According to the passage, at what temperature is most of the crude oil vaporized?
    A. 600°C
    B. 300°C
    C. 100°C
    D. 20°C

28. According to the passage, as the vapor rises in the fractionating tower:
    F. the condensation temperature increases only.
    G. the condensation temperature decreases only.
    H. the condensation temperature increases quickly, then slowly decreases.
    J. the condensation temperature remains stable at 600°C.

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PASSAGE VI

Scientists theorize that the release of X-rays by distant stars and the amount of distortion or "bending" the X-rays endure as they travel out of their solar system can help indicate the presence of planets orbiting these stars. The distortion of the X-rays would be caused by the gravitational pull exerted by the planets. Specifically, high 'bending' in these rays would indicate the presence of large planets, while a low level of bending would most likely signify the presence of smaller planets.

In addition to determining whether or not there are planets circling a distant star, the amount of X-ray distortion can determine the planets' orbital pattern. A circular orbit produces increasing or decreasing distortions of the same level. For instance, if a star's X-rays are bent 1 meter the first day, 2 meters the fourth day, 4 meters the seventh day, and so on, it indicates a circular orbit. See Figure 1. If however, the pattern of bending is random, as in a bending of 5 meters the first day, 3 meters the second day, 0 meters the third day, and 7 meters the fourth day, then the planet's orbit is elliptical. See Figure 2. Further, if the paths of the X-rays are not bent in any way, it is assumed that the star lacks any planets.

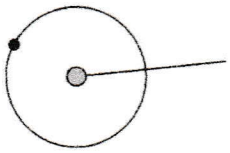

Figure 1 Circular orbit

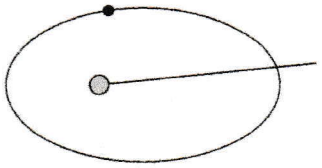

Figure 2 Elliptical orbit

Table 1 shows the amount of distortion of X-rays released by 4 different stars over a period of 10 days.

Table 1

	X-ray distortion (m)			
	Day 1	Day 4	Day 7	Day 10
Star 1	1.00	1.75	2.50	3.25
Star 2	0.00	0.00	0.00	0.00
Star 3	8.00	4.00	2.00	1.00
Star 4	0.20	0.10	0.11	0.11

Note: Assume that there are no other objects that could affect the X-rays.

29. According to Table 1, which star most likely has no planets?
- **A.** Star 1
- **B.** Star 2
- **C.** Star 3
- **D.** Star 4

30. Based on the information in the passage, how many of the stars listed in Table 1 have at least one planet with a circular orbit?
- **F.** 0
- **G.** 2
- **H.** 3
- **J.** 4

31. Which of the following statements is best supported by information in the passage?
- **A.** Star 3 is likely orbited by at least one large planet.
- **B.** Star 4 has a circular orbit.
- **C.** Star 1 has an elliptical orbit.
- **D.** Star 2 is likely orbited by several small planets.

32. If X-ray distortion were observed for an additional three days, one could predict that the path of the X-rays produced by Star 1 on day 13 would be distorted by:
- **F.** 0.75 meters.
- **G.** 1.00 meter.
- **H.** 3.75 meters.
- **J.** 4.00 meters.

33. According to information in the passage, which of the following assumptions could be true?
- **A.** X-rays are affected by certain physical forces.
- **B.** X-rays are simply bits of energy and are, therefore, unaffected by physical forces.
- **C.** Planets with elliptical orbits are more common than are planets with circular orbits.
- **D.** The presence of planets orbiting a star can only be detected using X-ray distortion.

34. Based on information in the passage, which of the following stars most likely has at least one planet with an elliptical orbit?
- **F.** Star 2 only
- **G.** Star 4 only
- **H.** Stars 1 and 3 only
- **J.** Stars 1, 3, and 4 only

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PASSAGE VII

Bacteria can be categorized by how they respond, as indicated by reproduction and growth, to certain temperatures. They are grouped into four categories—psychrophiles, psychrotrophs, mesophiles, and thermophiles—based on their growth response to certain temperatures. Minimal growth temperature is the lowest point at which the bacteria will reproduce. Optimum growth point is the temperature at which the bacteria reproduce most efficiently. Maximum growth point is the very highest temperature to which the bacteria will respond, beyond which the bacteria will not reproduce at all. Table 1 lists the types of bacteria as well as the growth points for each.

Table 2 represents a list of common bacteria and their growth points.

Table 1

Growth points or ranges (°C)			
Classifications	Minimum	Optimum	Maximum
Psychrophile	below 0	10–15	below 20
Psychrotroph	0–5	15	30
Mesophile	5–25	18–45	30–50
Thermophile	25–45	50–60	60–90

Table 2

Cardinal growth points (°C)			
Bacteria name	Minimum	Optimum	Maximum
Anoxybacillus flavithermus	30	60	72
Bacillus flavothermus	30	60	72
Clostridium perfringens	15	45	50
Escherichia coli	10	37	45
Listeria monocytogenes	1	34	45
Micrococcus cryophilus	0	15	30
Staphylococcus aureus	10	37	45
Streptococcus pyogenes	20	37	40
Streptococcus pneumoniae	25	37	42

35. The category of bacteria appearing the most frequently in Table 2 is:
- **A.** psychrophile.
- **B.** psychrotroph.
- **C.** mesophile.
- **D.** thermophile.

36. The type of bacteria found in Table 2 that does not fit exactly into any of the categories listed in Table 1 is:
- **F.** *Clostridium perfringens.*
- **G.** *Listeria monocytogenes.*
- **H.** *Micrococcus cryophilus.*
- **J.** *Streptococcus pneumoniae.*

37. Average human body temperature is 40°C. According to Table 2, which of the following bacteria would grow most successfully in the human body?
- **A.** *Anoxybacillus flavithermus.*
- **B.** *Clostridium perfringens.*
- **C.** *Escherichia coli.*
- **D.** *Listeria monocytogenes.*

38. A new bacteria was discovered by scientists. It reproduces best at 55°C and does not show any new growth if exposed to temperatures above 65°C. This bacteria can most likely be categorized as a:
- **F.** psychrophile.
- **G.** psychrotroph.
- **H.** mesotroph.
- **J.** thermophile.

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39. Based on the information in Table 2, which bacteria has the smallest growth range?

A. *Listeria monocytogenes.*
B. *Micrococcus cryophilus.*
C. *Streptococcus pneumoniae.*
D. *Streptococcus pyogenes.*

40. According to information provided in the passage, *Listeria monocytogenes* stop reproducing at what temperature?

F. >1°C, but <10°C
G. >10°C, but <34°C
H. >34°C, but <45°C
J. >45°C

END OF THE SCIENCE REASONING TEST.
STOP! IF YOU HAVE TIME LEFT OVER, CHECK YOUR WORK ON THIS SECTION ONLY.

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PASSAGE III

A *solute* is any substance that is dissolved in another substance, which is called the *solvent*.

A student tested the *solubility* (a measure of how much solute will dissolve into the solvent) of six different substances. The solubility of a substance at a given temperature is defined as the concentration of the dissolved solute that is in equilibrium with the solvent.

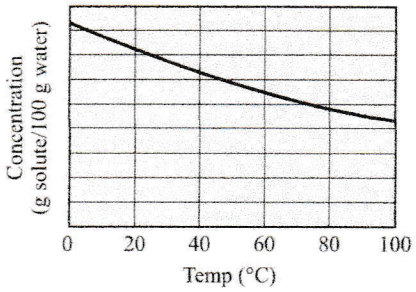
Table 1 represents the concentration of dissolved substances in 100 grams of water at various temperatures. The concentrations are expressed in grams of solute per 100 grams of water.

Table 1

	Concentration of solute (g/100 g H_2O)					
Temp (°C)	KCl	$NaNO_3$	HCl	NH_4Cl	NaCl	NH_3
0	28	72	83	29	37	90
20	33	86	72	37	37	55
40	39	105	63	46	38	36
60	45	125	55	55	38	23
80	51	145	48	66	39	14
100	57	165	43	77	40	8

13. According to Table 1, the concentrations of which of the following substances varies the least with temperature?
- **A.** HCl
- **B.** NH_3
- **C.** NaCl
- **D.** KCl

14. The graph below best represents the relationship between concentration and temperature for which of the following substances?



- **F.** HCl
- **G.** $NaNO_3$
- **H.** NaCl
- **J.** KCl

15. The data shown in Table 1 support the conclusion that, for a given substance, as the temperature of the water increases, the amount of solute that can be dissolved:
- **A.** increases only.
- **B.** decreases only.
- **C.** varies, but there is a trend depending on the substance.
- **D.** varies, but with no particular trend.

16. According to Table 1, HCl would most likely have which of the following concentrations at 70°C?
- **F.** 25.5 g/100g H_2O
- **G.** 37.0 g/100g H_2O
- **H.** 48.5 g/100g H_2O
- **J.** 51.5 g/100g H_2O

17. A scientist wants to dissolve at least 50 grams of NH_4Cl in 100 g of water in order for the solution to be the proper concentration for use in an experiment. A reasonable minimum temperature for the solution would be:
- **A.** 25°C
- **B.** 30°C
- **C.** 35°C
- **D.** 50°C