The 55th Annual
Merck State Science Day Competition
May 17, 2005

Integrated Science

Directions:
PLEASE DO NOT OPEN THE EXAM BOOKLET UNTIL DIRECTED.

Be sure to fill in your name on the answer sheet both by printing it in the correct space, and by filling in the corresponding letter in the spaces provided.

Use a #2 pencil only.

Carefully erase any errors, and do not make any extraneous marks on the answer sheet.
Do NOT use *White-Out* on any portion of the answer sheet.

The test has **80 items**. You have **90** minutes in which to answer all the questions.

There is only one correct answer per question. Do not spend too much time on any one question. Do the items you find easier first, and then go back to those you find more difficult or time consuming during the time you have remaining. Your individual score will be computed on the basis of the number of correctly answered items. (There is no penalty for guessing.)

In addition to the periodic table, there are several subject-specific items below that you may find useful in answering certain questions. Be sure to read them immediately after you are told to begin. You may refer to them at any time during the test.

INFORMATION THAT MAY BE USEFUL IN SOLVING SOME PROBLEMS

1 calorie = 4.184 joules

$1/f = 1/d_o + 1/d_l$

$C = 2f$

$h_i/h_o = d_i/d_o$

$E = hf$

speed of light in vacuum = 3.0×10^8 m/sec

Planck's constant, $h = 6.63 \times 10^{-34}$ joule-sec

$v = c \sqrt{1 - v^2/c^2}$

Avogadro's Number = 6.02×10^{23}

$Q = mc\Delta T$

$KE_{ave} = 1/2mv^2$

$PE_{grav} = mgh$

$W = F \times S$

$W = Vq$

$v_{avg} = s/t$

$s = v_o t + 1/2at^2$

$v_f^2 = v_i^2 + 2as$

$v_f = v_i + at$

$c = f\lambda$

$P_1V_1/T_1 = P_2V_2/T_2$

$I = V/R$

1 C = 6.25×10^{18} e⁻

$D = M/V$

$\nu = f\lambda$

$P = W/t$

K_f water = 1.86 °C/m

K_b water = 0.51°C/m

Universal gas constant: R = 8.31 kPa-liter/(mole-K) = 0.0821 atm-liter/(mole-K)

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question. Questions #1-17 have four (4) answer choices. All the remaining questions have five (5) answer choices.

1. How do the effects of physical weathering differ most fundamentally from those of
       chemical weathering?

    A) Chemical weathering changes the composition of particles, whereas physical weathering
          does not.
    B) Chemical weathering changes the size of the particles, whereas physical weathering does
          not.
    C) Physical weathering changes the composition of particles, whereas chemical weathering
          does not.
    D) Physical weathering changes the size of particles, whereas chemical weathering does not.

2. Which statement best explains the present view of how the Hawaiian Islands were
       formed? The Hawaiian Islands are..

    A) part of a mid-ocean ridge system.
    B) part of a convergence zone at an ocean trench.
    C) the result of molten material that rose from a hot spot in the Earth's mantle.
    D) the result of melting formed by divergence of the mantle convection currents.

3. An eclipse of the Moon occurs only when...
    A) the Sun passes between the Earth and the Moon.
    B) the Moon passes between the Earth and the Sun.
    C) the Moon passes between the Earth and the Sun.
    D) the Earth, Sun, and Moon are in a straight line.
    This question was eliminated.
4. One side of the Moon always faces the Earth because the..
    A) Moon's axis is inclined towards the Earth.
    B) Earth's gravity pulls more on one side of the Moon than on the other side.
    C) Earth is rotating at the same speed as the Moon.
    D) Moon's period of rotation is the same as the period of revolution.

5. What is the major cause of the Earth's seasons?
    A) Earth's elliptical orbit and varying speed of revolution.
    B) Earth's greater distance from the Sun during winter than during the summer.
    C) The tilt of the Earth's axis of rotation to the plane of its orbit.
    D) Variations in the total amount of solar energy received by the Earth.

6. Why do constellations that can be observed from the Earth during the night change from season to season?

    A) The Earth's rotation about its axis.
    B) The Earth's revolution around the Sun.
    C) The Sun's revolution around the center of gravity.
    D) The apparent revolution of the constellations around the Earth.

7. Which statement best describes the general ocean circulation patterns in the Northern and Southern Hemisphere?
   A) Ocean currents are deflected to the right in the Northern Hemisphere and to the left in the Southern hemisphere.
   B) Ocean currents are deflected to the left in the Northern Hemisphere and to the right in the Southern hemisphere.
   C) All ocean currents run parallel to the equator.
   D) Ocean currents have identical circulation patterns in both hemispheres.

8. Salinity of surface seawater is significantly affected by all of the following *except...*

   A) evaporation of the water
   B) changing of the temperature
   C) precipitation
   D) trace elements present

9. You can sail from the United States to Europe fastest by..
   A) sailing within the Trade Winds.
   B) sailing within the Gulf Stream.
   C) sailing within the Atlantic Ocean density currents.
   D) sailing with the Coriolis effect at your back.

10. The original characteristics of an air mass are largely determined by the...
    A) characteristics of the surface over which the air mass formed.
    B) amount of solar energy the air mass receives.
    C) velocity of the Earth's rotation at the latitude of air mass formation.
    D) type of fronts that surround the air mass.

11. The barometric pressure is slowly falling, the wind speed has increased and stratus clouds appear. Which is the best prediction based on this information?

    A) A cold front will move through.
    B) A warm front will move through.
    C) Tornadoes will likely occur soon.
    D) The skies will clear in a few hours.

12. How does air move in an anticyclone (high pressure system) in the Northern Hemisphere?
    A) Clockwise and out from the center.
    B) Counterclockwise and in towards the center.
    C) Clockwise and in towards the center.
    D) Counterclockwise and out from the center.

13. The main process producing energy in the Sun is...

    A) The chemical burning of hydrogen .
    B) Nuclear fission of lightweight chemical elements.
    C) Nuclear fission of hydrogen to produce helium.
    D) The radioactive decay of carbon.
    This question was eliminated.

14. Which of the following is the best statement of uniformity of process?
   A) The basic laws of nature do not change with time.
   B) The Earth and all of its features are undergoing constant change.
   C) Earth processes produce change at a variable rate.
   D) The surface of the Earth is being gradually reduced to a level plain.

15. A chemical company wants to choose the safest site to bury toxic wastes. It owns four sites in non-polluted areas: (1) an abandon gravel pit of glacial deposited sediments; (2) land underlain by thick unfractured shale; (3) property which sits on highly fractured granite; and (4) land that is limestone that has many interconnected caves. Which site would be the best choice?

   A) The Glacial sediment site
   B) The Granite site
   C) The Shale site
   D) The Limestone site

16. What is the age relationship of early humans to the dinosaurs?
   A) Early humans appeared just after the dinosaurs died out.
   B) Early humans and the dinosaurs lived at the same time but in different places on Earth.
   C) The dinosaurs became extinct at least one billion years before humans appeared on Earth.
   D) The dinosaurs became extinct millions of years before the first humans appeared on Earth.

17. Which of the following is the most accurate word equation for cellular respiration?
   A) glucose + energy + oxygen --> carbon dioxide + water + energy
   B) glucose + oxygen --> carbon dioxide + energy
   C) glucose + carbon dioxide --> oxygen + energy
   D) glucose + carbon dioxide + energy --> water + oxygen + energy
   E) glucose --> carbon dioxide + water

18. If a cell has 23 pairs of chromosomes before mitosis, how many chromosmes should it have after mitosis?
   A) 46 pairs
   B) 23
   C) 23 pairs
   D) 46
   E) the cell will not undergo mitosis, because the chromosome number is odd

19. Which of the following clues would tell you whether a cell is prokaryotic or eukaryotic?
   A) the presence or absence of a rigid cell wall
   B) whether or not the cell is partitioned by internal membranes
   C) the presence or absence of ribosomes
   D) whether or not the cell carries out cellular respiration
   E) whether or not the cell contains DNA

20. Which of the following correctly ranks the structures in order of size, from largest to smallest?
   A) gene -- chromosome -- nucleotide -- codon
   B) chromosome -- gene -- codon -- nucleotide
   C) nucleotide -- chromosome -- gene -- codon
   D) chromosome -- nucleotide -- gene -- codon
   E) gene -- chromosome -- codon -- nucleotide

21. A type of cell called a lymphocyte makes proteins that are exported from the cell. It is possible to track the path of these proteins within the cell by labeling them with radioactive isotopes. Which of the following is the path of the protein from the site where its polypeptides are made to the lymphocytes plasma membrane?
    A) chloroplast . . . Golgi body . . . ribosomes . . . plasma membrane
    B) ribosomes . . . Golgi body . . . rough E.R. . . . plasma membrane
    C) ribosomes . . . rough E.R. . . . Golgi body . . . plasma membrane
    D) ribosomes . . . smooth E.R. . . . lysosome . . . plasma membrane
    E) nucleus . . . ribosomes . . . Golgi body . . . rough E.R. . . . plasma membrane

22. A geneticist found that a particular mutation had no effect on the polypeptide coded by a gene. This mutation probably involved;
    A) deletion of a nucleotide
    B) alteration of the start codon
    C) insertion of one nucleotide
    D) deletion of one entire gene
    E) substitution of one nucleotide

23. Once a plasmid has incorporated a specific gene, such as the gene coding for human insulin, the plasmid may be cloned by;
    A) inserting it into a virus to generate multiple copies
    B) treating it with restriction enzymes in order to cut the molecule into small pieces
    C) running it on a gel electrophoresis in order to determine the size of the gene of interest
    D) inserting it into a bacterium by transformation in order to produce multiple copies
    E) infecting it with a mutant cell in order to incorporate the gene of interest

24. During strenuous muscle exertion of a human, an insufficient supply of oxygen will lead to a build up of
    A) pyruvic acid   D) acetyl CoA
    B) glucose   E) ethanol
    C) lactic acid

25. Which of the following statements about enzymes is **not** true?
    A) They are organic compounds made of protein
    B) They are catalysts that alter the rate of a reaction
    C) The rate of catalysis is affected by the concentration of substrate
    D) They usually denature if exposed to high temperatures
    E) They are operative over a wide pH range

26. All of the following are true statements about meiosis in mammals EXCEPT?
    A) It serves as a factor in bringing about variation among offspring
    B) It follows DNA replication
    C) It occurs only in reproductive structures
    D) It produces cells with the haploid number of chromosomes
    E) It produces four genetically identical gametes

Refer to the following information for the next FOUR questions.

A sample of a marine ecosystem was sampled in order to determine its food chain.
The results of the study are shown below.

TYPE of ORGANISM	NUMBER OF ORGANISMS
Shark	2
Small crustaceans	400
Mackerel	20
Phytoplankton	1000
Herring	100

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27. Which of the following organisms has the largest biomass in this food chain?
   A) Phytoplankton
   B) Mackerel
   C) Herring
   D) Shrimp
   E) Shark

28. Which of the following organisms in this population are secondary consumers?
   A) Shark
   B) Mackerel
   C) Herring
   D) Shrimp
   E) Phytoplankton

29. If the herring population is reduced by predation, which of the following is most likely to occur in this aquatic ecosystem?
   A) The mackerels will be the largest predator in the pond
   B) The shrimp population will be greatly reduced
   C) The shrimp will become extinct
   D) The plankton population will be reduced over the next year
   E) There will be no change in the number of sharks in the pond

30. A pesticide, DDT, is used in this pond in the amount of 0.005 ppm. When local scientists take samples from several sharks, they find in the sharks tissue the level of DDT at 5000 ppm. What is the best explanation for the drastic change?
   A) eutrophication
   B) primary succession
   C) biological amplification
   D) interspecies competition
   E) None of the above: this is most likely an error in data collection

31. Natural selection is often described as 'survival of the fittest.' Which of the following most accurately measures an organism's fitness?
   A) how many fertile offspring it produces
   B) how strong it is when pitted against others of its species
   C) its mutation rate
   D) its ability to withstand environmental extremes
   E) how much food it is able to make or obtain

32. Certain populations of finches have been isolated on the Galapogos islands off the western coast of South America for a long time. Compared with the larger stock population of mainland finches, these separate populations exhibit far greater variation over a wider range of species. The variation among these numerous finch species is the result of;
    A) convergent evolution
    B) adaptive radiation
    C) disruptive selection
    D) stabilizing selection
    E) directional selection

33. In garden pea plants, a single gene controls stem length. The recessive allele (t) produces short stems when homozygous. The dominant allele (T) produces long stems. A short-stemmed plant is crossed with a heterozygous long-stemmed plant. Which of the following represents the expected phenotypes of the offspring and the ratio in which they will occur?
    A) 3 long-stemmed plants : 1 short-stemmed plant
    B) 1 long-stemmed plant : 1 short-stemmed plant
    C) 1 long-stemmed plant : 3 short-stemmed plant
    D) Long-stemmed plants only
    E) Short-stemmed plants only

34. Which of the following is an important characteristic of the tropical rain forest biome?
    A) High light levels on the forest floor
    B) The dominance of a small number of tree species
    C) More widely fluctuating temperatures than in most other biomes
    D) Rapid recycling of nutrients
    E) Distinct rainy and dry seasons

35. Which of the following combination of organelles gives support for the concept of   endosymbiosis?
    A) nucleus and chloroplast
    B) chloroplast and mitochondria
    C) Golgi apparatus and lysosomes
    D) rough ER and peroxisomes
    E) mitochondria and central vacuole

36. During germination in most angiosperm seeds, food for the growing embryo is provided by the
    A) microsporangium
    B) megasporangium
    C) megaspore mother cell
    D) hypocotyls
    E) endosperm

37. Phototropism in plants is regulated by which of the following plant hormones?
    A) Auxin
    B) Ethylene
    C) Gibberellins
    D) Abscisic acid
    E) Cytokinins

In a certain flock of sheep, 4 percent of the population has black wool and 96 percent has white wool. Assume that the population is in Hardy-Weinberg equilibrium.

38.

If black wool is a recessive trait, what percentage of the population is heterozygous for this trait?
A) 4% **B)** 20% **C)** 32% **D)** 64% **E)** 80%

39. What percentage of the population is homozygous for white wool?
A) 20% **B)** 40% **C)** 64% **D)** 80% **E)** 96%

Refer to the following for the next TWO questions:

In an experiment, a dialysis-tubing bag is filled with a mixture of 3% starch and 3% glucose solution and is placed in a beaker of distilled water that contains 5 drops of IKI. After 20 minutes, glucose is detected in the water outside the dialysis-tubing bag, and there has been a color change inside the dialysis bag to a dark purple. No color change is detected in the beaker water.

40. From the initial conditions of the experiment and results described, which of the following is a logical conclusion?
A) The initial state of the dialysis bag is isotonic to the solution in the beaker
B) The pores of the bag are larger than the glucose molecules, but smaller than
    the starch molecules
C) A net movement of water into the beaker has occurred
D) The initial state of the dialysis bag is hypertonic to the solution in the beaker
E) Both B and D are correct

41. Which of the following best describes the condition expected after 2 hours?
A) The bag will contain more water that it did in the original condition
B) The contents of the beaker fluid will turn dark purple
C) A glucose test on the solution in the bag will be negative
D) Water molecules will continue to pass out of the bag in a net flow
E) Water potential in the bag will be greater than water potential in the
    surrounding solution

This graph shows the change in two different populations of wild boars that were introduced to an isolated geographic area in 1905.
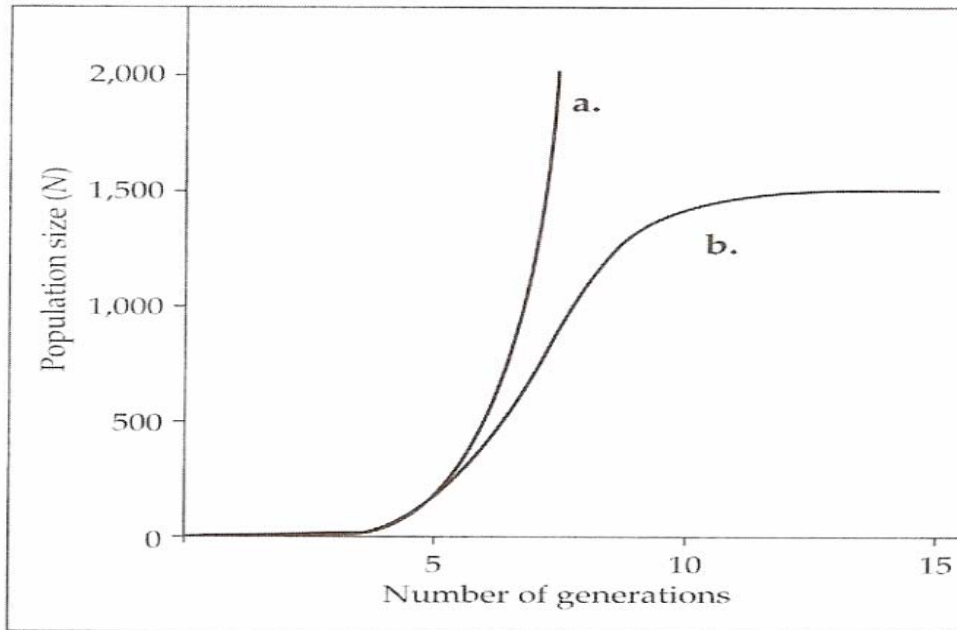
**42.** The type of population growth exhibited by population A is;
   A) logistic   **D)** exponential
   B) stable   **E)** diversifying
   C) density-dependent

43. Population B reaches its carrying capacity at about what size?
   A) 0 members   **D)** 1,500 members
   B) 500 members   **E)** 2,000 members
   C) 1,000 members

44. The lack of increase in numbers of population B at carrying capacity is due most likely to which of the following?
   A) density-dependent factors   **D)** natural disaster
   B) density-independent factors   **E)** migration
   C) massive viral infection in the population

45. The split that occurred in the two populations may have been the direct result of;
   A) convergent evolution   **D)** geographic isolation
   B) speciation   **E)** bottleneck effect
   C) segregation

46. Which of the following is LEAST likely to be associated with diabetes mellitus?
   A) Liver cells absorb sugar from the blood at a rate that is greater than normal
   B) Pancreatic islet cells are destroyed
   C) Muscle cells readily oxidize fats and proteins
   D) Insulin receptors are insensitive to insulin
   E) Urinalysis indicates a high concentration of sugar in urine

Refer to diagram and information given below for the following TWO questions:

In the pedigree below, squares represent males, and circles represent females. The shaded symbols show the individuals that express the trait being studied.
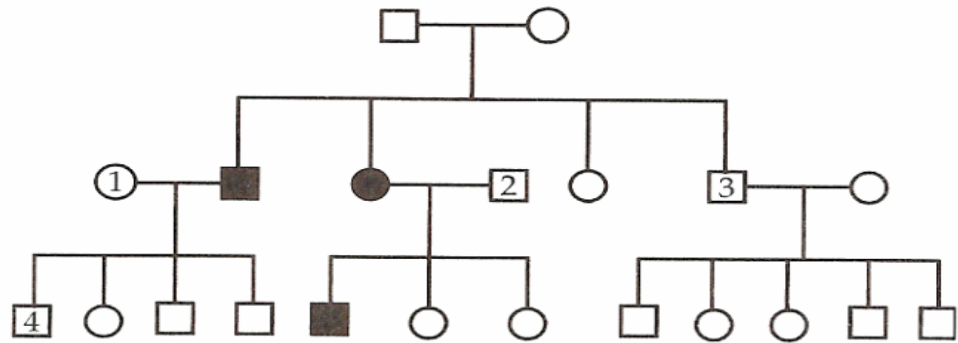
47. Which of the following patterns of inheritance best explains how this trait is transmitted?
   A) autosomal recessive   **D)** sex-linked dominant
   B) autosomal dominant   **E)** incomplete dominance
   C) sex-linked recessive

48. Based on the pedigree above, if individual 4 married an affected women, their chance of having an affected child would be;
   A) 0%
   B) 25%
   C) 50%
   D) 75%
   **E)** there is not enough information given to determine the probability

This gel electrophoresis was produced from four samples of radioactively-labeled DNA that were cut with one type of restriction enzyme. The samples were separated by gel electrophoresis. Lane 1 is the blood collected at the crime scene and 2, 3, and 4 are blood samples taken of 'suspects'.

49. What was the purpose in radioactively labeling the DNA fragments in the experiment?
 A) to visualize them
 B) to make them travel through the gel
 C) to hydrolyze them into fragments
 D) to get rid of contaminants
 E) to destroy their polarity

50. Which of the following is true about the DNA samples that were loaded onto the gel;
 A) The DNA strand of sample 2 was originally the longest
 B) The DNA strand of sample 4 was originally the shortest
 C) Samples 2 and 4 are the same DNA sample
 D) Sample 2 was cut at more restriction sites than was sample 4
 E) Sample 4 was cut at more restriction sites than was sample 2

51. Which of the following could be concluded from the gel fragments;
 A) Suspect 2 is the most likely individual to have committed the crime
 B) Suspects 3 and 4 have equal likelihood of being the final suspects
 C) All three suspects should be kept for further testing, as the results conclude that all have equal probability of being the criminal
 D) None of the suspects are the likely criminals based on the above results
 E) the gel should have been run longer to get more accurate results

52. Which one of the following processes is illustrated by the reaction:

$$^{238}_{90}\text{Th} \rightarrow \, ^{234}_{88}\text{Ra} + \, ^{4}_{2}\text{He}$$
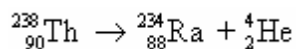
A) beta decay
B) alpha decay
C) gamma decay
D) neutrino emission
E) positron emission

53. Which of the following is an exothermic process?
A) ice melting
B) water evaporating
C) boiling soup
D) condensation of steam
E) temperature decrease when ammonium thiocyanate and barium hydroxide are mixed.

54. If the rate of evaporation from the surface of a liquid exceeds the rate of condensation,

A) The liquid is boiling.
B) The concentration of the vapor is increasing.
C) Heat energy is no longer available.
D) the system is in equilibrium.
E) The vapor pressure is decreasing.

55. 25,500 J of energy is added to 3.0 mol (54 g) of ice at 0°C. The mole heat of fusion is 6.02 kJ/mol. The specific heat of liquid water is 4.18 J/g-K. The molar heat of vaporization is 40.6 kJ/mol. The resulting sample contains which of the following?

A) only ice   **D)** liquid water and water vapor
B) ice and liquid water   **E)** only water vapor
C) only liquid water

56. The correct formula for copper II hydroxide is

A) $CuOH_2$ **B)** $Cu(OH)_2$ **C)** Cu_2OH **D)** $CuOH$ **E)** Cu_2OH_2

57. What type of bonding exists in potassium dihydrogen phosphate?
A) ionic only   **D)** both covalent and metallic
B) covalent only   **E)** both ionic and metallic
C) both ionic and covalent

58. Which of the following species would be expected to have the lowest ionization energy?

A) Ar   **B)** Ca^{2+} **C)** Cl^- **D)** K^+ **E)** S^{2-}

59. An unknown solid has no electrical conductivity at room temperature and appears insoluble in water. When heated to 800°C, it melts and conducts an electrical current. The solid has which type of bonding:
A) ionic bonding   **D)** van der Waals forces
B) covalent bonding   **E)** covalent network bonding
C) metallic bonding

60. What is the pH of a 0.0253M solution of the strong acid $HClO_4$?

A) 0.600
B) 1.597
C) 1.145

D) 12.403
E) 13.975

Use the following information for the next TWO questions

Zinc metal is added to hydrochloric acid to generate hydrogen gas and is collected over a liquid whose vapor pressure is the same as pure water at 20.0°C (18 torr). The volume of the mixture is 1.7 L and its total pressure is 0.810 atm..

61. Determine the partial pressure of the hydrogen gas in this mixture.

A) 562 torr   **B)** 580 torr   **C)** 598 torr   **D)** 616 torr   **E)** 634 torr

62. Determine the number of moles of hydrogen gas present in the sample.

A) 42 mol   **B)** 0.82 mol   **C)** 1.3 mol   **D)** 0.056 mol   **E)** 22 mol

63. A solution is prepared by dissolving 516.5 mg of oxalic acid, $C_2H_2O_4$ to make 100.0 mL of solution. A 10.00 mL portion is then diluted to 250.0 mL. What is the molarity of the final solution?

A) 5.738×10^{-2}
B) 2.295×10^{-3}
C) 2.295

D) 5.737
E) 5.737×10^{-2}

64. How many grams of lithium chlorate ($LiClO_3$) are in 153 mL of a 1.764 M solution?

A) 19.0   **B)** 21.7   **C)** 24.4   **D)** 28.0   **E)** 37.7

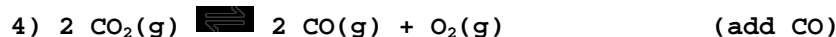**65.** Identify all the spectator ions in the following reaction:

$$Pb(NO_3)_2(aq) + 2NaI(aq) \rightarrow PbI_2(s) + 2NaNO_3(aq)$$
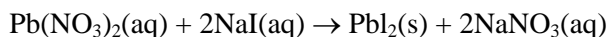
(1) $Pb^{2+}(aq)$
(2) $NO3^-(aq)$
(3) $Na + (aq)$
(4) $I^-(aq)$

A) (3) only
B) (1) and (3) only
C) (1) and (4) only

D) (2) and (3) only
E) (1), (2) and (4) only

66. Consider the following reactions at equilibrium and determine which of the indicated changes will cause the reaction to proceed to the right.

1) $CO(g) + 3 H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$ (remove CO)

2) $CO_2(g) + C(s) \rightleftharpoons 2 CO(g)$ (add CO_2)

3) $N_2(g) + 3 H_2(g) \rightleftharpoons 2 NH_3(g)$ (add nitrogen)

4) $2 CO_2(g) \rightleftharpoons 2 CO(g) + O_2(g)$ (add CO)

5) $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$ (remove CH_3OH)
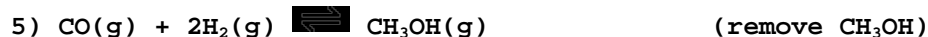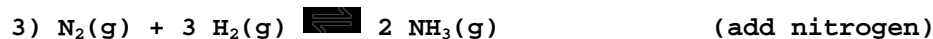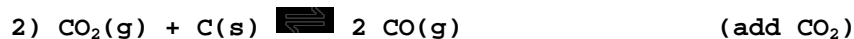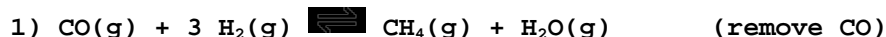
A) 1,4   **B)** 2,4   **C)** 3,4   **D)** 2,3   **E)** 2,3,5

67. Given $[CS_2] = 0.120$ M, $[H_2] = 0.200$ M, $[H_2S] = 0.100$ and $[CH_4] = 5.38 \times 10^{-3}$ M for the following reaction at 900°C calculate the equilibrium constant.

$$CS_2(g) + 4 H_2(g) \rightleftharpoons CH_4(g) + 2 H_2S(g)$$

A) 0.054   **B)** 0.098   **C)** 0.075   **D)** 0.280   **E)** 0.150

68. Which one of the following measurements is the longest length?

A) 10^0 meters   **C)** 10^4 millimeters   **E)** 10^7 nanometers
B) 10^2 centimeters   **D)** 10^5 micrometers

This information applies to the next **THREE** *questions.*

A FormulaOne race car, traveling at constant speed, makes one lap around a circular track of radius r in a time t.

69. What is the *average speed* of the car for one complete lap?

A) $\dfrac{r}{t}$ **B)** $\dfrac{2r}{t}$ **C)** $\dfrac{\pi r}{t}$ **D)** $\dfrac{2\pi r}{t}$ **E)** zero

**70.** Determine the *magnitude* of the *average velocity* of the race car above for one complete lap.

A) $\dfrac{r}{t}$ **B)** $\dfrac{2r}{t}$ **C)** $\dfrac{\pi r}{t}$ **D)** $\dfrac{2\pi r}{t}$ **E)** zero

71. Which one of the following statements concerning the car above is necessarily true?

A) The displacement of the car does not change with time.
B) The instantaneous velocity of the car is constant.
C) The average speed of the car is the same over any time interval.
D) The average velocity of the car is the same over any time interval.
E) The average speed of the car over any time interval is equal to the magnitude of the average velocity over the same time interval.

72. A passenger at rest on a moving subway train tosses a quarter straight up from his seat. The event is viewed by observers at rest on the station platform as the train moves by the platform with constant velocity. What is the trajectory of the quarter as described by the observers on the platform?

A) a straight horizontal path in the direction of the train's velocity
B) a straight vertical path up and down
C) a circular path centered on the gun
D) a straight diagonal path
E) a parabolic path

73. A physics student records velocity and time of an object is moving along a straight line. The graph shows the student's graphical data.
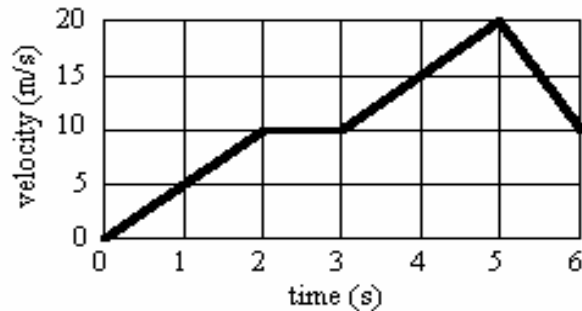
During which interval(s) of the graph does the speed of the object *increase by equal amounts* in *equal times*?

A) 0 to 2 s
B) 2 s to 3 s
C) 3 s to 5 s

D) 0 to 2 s and 3 s to 5 s
E) 0 to 2 s, 3 to 5 s, and 5 to 6 s

74. Two soccer players make contact with the ball simultaneously. Thereby, causing two forces to act on the ball. For which orientation of the forces will the ball acquire an acceleration with the *largest* magnitude?
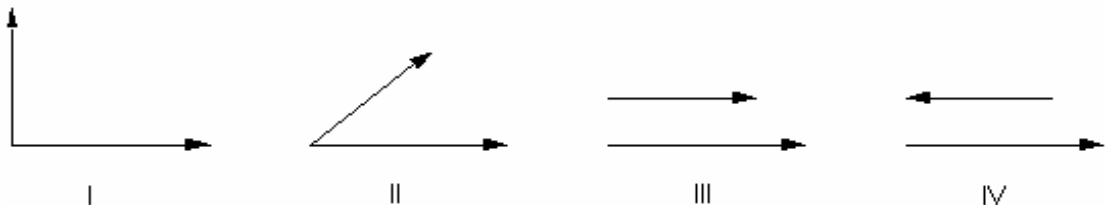
A) I
B) II
C) III
D) IV
**E)** The magnitude of the acceleration will be the same in all four cases shown above.

75. Which force is responsible for holding a car in a *frictionless* banked curve?

A) the reaction force to the car's weight
B) the vertical component of the car's weight
C) the vertical component of the normal force
D) the horizontal component of the car's weight
E) the horizontal component of the normal force

76. Which one of the following is characteristic of an *inelastic* collision?

A) Total mass is not conserved.
B) Total energy is not conserved.
C) Linear momentum is not conserved.
D) Kinetic energy is not conserved.
E) The change in momentum is less than the total impulse.

77. A ball of mass M moves in a circular path on a horizontal, frictionless surface. It is attached to a light string that passes through a hole in the center of the table. If the string is pulled down, thereby reducing the radius of the ball's path, the speed of the ball is observed to increase.
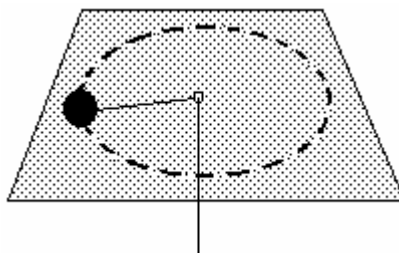
This occurs because

A) the linear momentum of the ball is conserved.
B) it is required by Newton's first law of motion.
C) the angular momentum of the ball is conserved.
D) the angular momentum of the ball must increase.
E) the total mechanical energy of the ball must remain constant.

78. Which one of the following will result in *standing waves* ?

A) the superposition of waves that travel with different speeds
B) the superposition of identical waves that travel in the same direction
C) the superposition of identical waves that travel in opposite directions
D) the superposition of nearly identical waves of slightly different amplitudes
E) the superposition of nearly identical waves of slightly different frequencies

79. The magnitude of the electric field at a distance of 10 meters from a negative point charge is E. What is the magnitude of the electric field at the same location if the magnitude of the charge is doubled?

A) $E/4$ **B)** $E/2$ **C)** E **D)** $2E$ **E)** $4E$

80. A double slit is illuminated with monochromatic light of wavelength 600 nm. The $m = 0$ and $m = 1$ bright fringes are separated by 3.0 cm on a screen which is located 4.0 m from the slits. What is the separation between the slits?

A) 4.0×10^{-5} m
B) 8.0×10^{-5} m
C) 1.2×10^{-4} m
D) 1.6×10^{-4} m
E) 2.4×10^{-4} m

Answer Section

MULTIPLE CHOICE

  1. ANS: D
  2. ANS: C
  3. ANS: C
  4. ANS: D
  5. ANS: C
  6. ANS: B
  7. ANS: A
  8. ANS: D
  9. ANS: B
10. ANS: A
11. ANS: D
12. ANS: A
13. ANS: C
14. ANS: A
15. ANS: C
16. ANS: D
17. ANS: A
18. ANS: C
19. ANS: B
20. ANS: B
21. ANS: C
22. ANS: E
23. ANS: D
24. ANS: C
25. ANS: E
26. ANS: E
27. ANS: A
28. ANS: C
29. ANS: D
30. ANS: C
31. ANS: A
32. ANS: B
33. ANS: B
34. ANS: D
35. ANS: B
36. ANS: E
37. ANS: A
38. ANS: C
39. ANS: C
40. ANS: E
41. ANS: A
42. ANS: D
43. ANS: D

44. ANS: A
45. ANS: B
46. ANS: A
47. ANS: A
48. ANS: C
49. ANS: A
50. ANS: D
51. ANS: D
52. ANS: B
53. ANS: D
54. ANS: B
55. ANS: C
3 x 6.02 kJ= 12.06 kJ to melt at 0°C
25,500 - 12060J = 7440 J to heat 54g water

7400J = 54g x 4.18 j/g-K x ∅t
 33°C = ∅t

Energy is used up to melt and warm water to 33°C
Only water is present
56. ANS: B
57. ANS: C
58. ANS: E
59. ANS: A
60. ANS: B
61. ANS: C
62. ANS: D
63. ANS: B
64. ANS: C
65. ANS: D
66. ANS: E
67. ANS: D
68. ANS: C
69. ANS: D
70. ANS: E
71. ANS: C
72. ANS: E
73. ANS: D
74. ANS: C
75. ANS: E
76. ANS: D
77. ANS: C
78. ANS: C
79. ANS: D
80. ANS: B

MULTIPLE CHOICE

1. D	41. A
2. C	42. D
~~3. C~~ **eliminated**	43. D
4. D	44. A
5. C	45. B
6. B	46. A
7. A	47. A
8. D	48. C
9. B	49. A
10. A	50. D
11. B	51. D
12. A	52. B
~~13. C~~ **eliminated**	53. D
14. A	54. B
15. C	55. C
16. D	56. B
17. A	57. C
18. C	58. E
19. B	59. A
20. B	60. B
21. C	61. C
22. E	62. D
23. D	63. B
24. C	64. C
25. E	65. D
26. E	66. E
27. A	67. D
28. C	68. C
29. D	69. D
30. C	70. E
31. A	71. C
32. B	72. E
33. B	73. D
34. D	74. C
35. B	75. E
36. E	76. D
37. A	77. C
38. C	78. C
39. C	79. D
40. E	80. B