Sarajevo School of Science and Technology
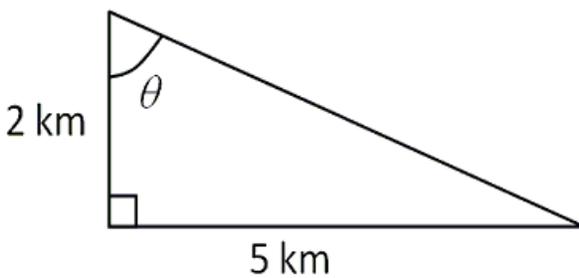**General Medicine and Dentistry**

PHYSICS

1. Which one of the following pairs of units may *not* be added together, even after the appropriate unit conversions have been made?
    A) grams and milligrams
    B) kilometers and kilograms
    C) miles and kilometers
    D) slugs and kilograms
    E) centimeters and yards

2. The surface of a lake has an area of 15.5 km². What is the area of the lake in m²?
    A) $1.55 \times 10^4 \, \text{m}^2$
    B) $1.55 \times 10^5 \, \text{m}^2$
    C) $1.55 \times 10^6 \, \text{m}^2$
    D) $1.55 \times 10^7 \, \text{m}^2$
    E) $1.55 \times 10^8 \, \text{m}^2$

3. Which one of the following expressions may be used to correctly find the angle θ in the drawing?

A) $\theta = \cos^{-1}\left(\dfrac{5}{2}\right)$

B) $\theta = \tan^{-1}\left(\dfrac{5}{2}\right)$

C) $\theta = \sin^{-1}\left(\dfrac{2}{5}\right)$

D)
$$\theta = \tan^{-1}\left(\frac{2}{5}\right)$$

E)
$$\theta = \sin^{-1}\left(\frac{5}{2}\right)$$

4. For which one of the following situations will the path length equal the magnitude of the displacement?
A) A toy train is traveling around a circular track.
B) A ball is rolling down an inclined plane.
C) A train travels 5 miles east before it stops. It then travels 2 miles west.
D) A ball rises and falls after being thrown straight up from the earth's surface.
E) A ball on the end of a string is moving in a vertical circle.

5. Carl Lewis set a world record for the 100.0-m run with a time of 9.86 s. If, after reaching the finish line, Mr. Lewis walked directly back to his starting point in 90.9 s, what is the magnitude of his average velocity for the 200.0 m?
A) 0 m/s
B) 1.10 m/s
C) 1.98 m/s
D) 5.60 m/s
E) 10.1 m/s

6. A racecar, traveling at constant speed, makes one lap around a circular track of radius r in a time t. Note: The circumference of a circle is given by $C = 2\pi r$.
When the car has traveled halfway around the track, what is the magnitude of its *displacement* from the starting point?
A) r
B) $2r$
C) πr
D) $2\pi r$
E) zero meters

7. Which one of the following statements must be true if the expression $x = v_0 t + \frac{1}{2}at^2$ is to be used?
A) x is constant.

B) *v* is constant.
C) *t* is constant.
D) *a* is constant.
E) Both v_0 and *t* are constant.

8. Complete the following statement: An inertial reference frame is one in which
A) Newton's first law of motion is valid.
B) the inertias of objects within the frame are zero.
C) the frame is accelerating.
D) the acceleration due to gravity is greater than zero m/s².
E) Newton's second law of motion is not valid.

9. The figure shows the velocity versus time curve for a car traveling along a straight line. Which of the following statements is false?
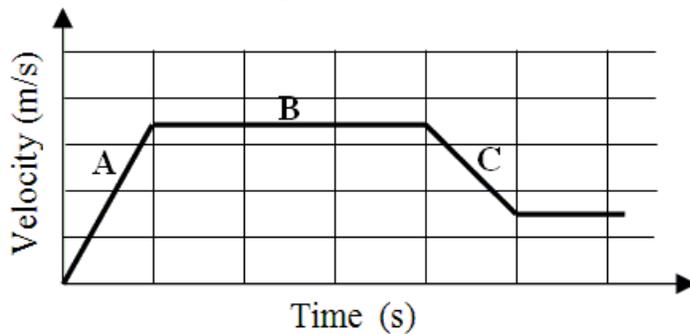
A) No net force acts on the car during interval **B**.
B) Net forces act on the car during intervals **A** and **C**.
C) Opposing forces may be acting on the car during interval **B**.
D) Opposing forces may be acting on the car during interval **C**.
E) The magnitude of the net force acting during interval **A** is less than that during **C**.

10. A 2.0-kg object moves in a straight line on a horizontal frictionless surface.

The graph shows the velocity of the object as a function of time. The various equal time intervals are labeled using Roman numerals: I, II, III, IV, and V.
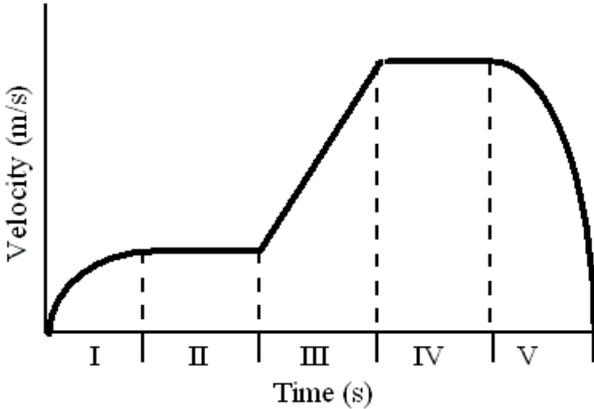
The net force on the object always acts along the line of motion of the object.
Which section(s) of the graph corresponds to a condition of *zero net force*?
A) V only
B) III only
C) II and IV
D) II, III, and IV
E) I, III, and V

11. A solar-powered car is traveling at constant speed around a circular track. What happens to the centripetal acceleration of the car if the speed is doubled?
A) The centripetal acceleration remains the same.
B) The centripetal acceleration increases by a factor of 2.
C) The centripetal acceleration increases by a factor of 4.
D) The centripetal acceleration is decreased by a factor of one-half.
E) The centripetal acceleration is decreased by a factor of one-fourth.

12. Two forces act on a hockey puck. For which orientation of the forces will the puck acquire an acceleration with the *largest* magnitude?

A)

B)

C) ⟶
   ⟶

D) ⟶
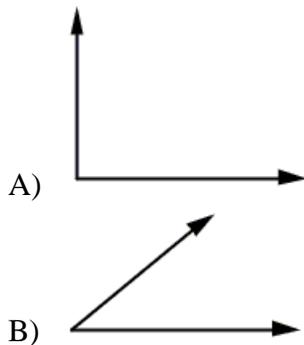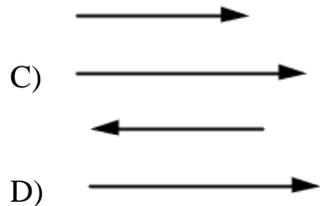
E) The magnitude of the acceleration will be the same in all four cases shown above.

13. Which force is responsible for holding a car in an *unbanked* curve?
A) the car's weight
B) the force of friction
C) the reaction force to the car's weight
D) the vertical component of the normal force
E) the horizontal component of the normal force

14. Complete the following statement: Work may be expressed using all of the following units *except*
A) N · m.
B) joule.
C) erg.
D) ft · lb.
E) watt.

15. An experimental 1500-kg car travels at a constant speed of 22 m/s around a circular test track that is 80 m across. What is the kinetic energy of the car?
A) zero joules
B) 3.6×10^5 J
C) 3.3×10^4 J
D) 1.6×10^4 J
E) 7.2×10^5 J

16. Jennifer is walking at 1.22 m/s. If Jennifer weighs 552 N, what is the magnitude of her momentum?
A) 97.0 kg · m/s
B) 137 kg · m/s
C) 68.6 kg · m/s
D) 672 kg · m/s
E) 951 kg · m/s

17. A projectile is launched with a momentum of 200 kg • m/s and 1000 J of kinetic energy. What is the mass of the projectile?
A) 5 kg
B) 10 kg
C) 20 kg
D) 40 kg
E) 50 kg

18. Complete the following statement: A body is in *translational* equilibrium
A) only if it is at rest.
B) only if it is moving with constant velocity.
C) only if it is moving with constant acceleration.
D) if it is either at rest or moving with constant velocity.
E) if it is moving with either constant velocity or constant acceleration.

19. An 80-kg man balances the boy on a teeter-totter as shown. **Note**: *Ignore the weight of the board.*

boy   man
                    fulcrum
←——————— 4 m ———————→|←— 1 m —→
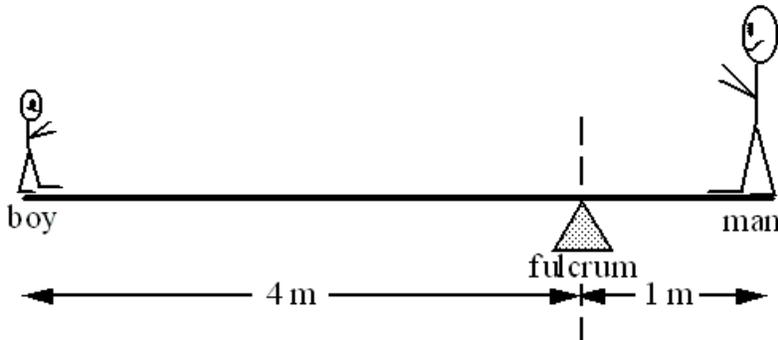
What is the approximate mass of the boy?
A) 10 kg
B) 20 kg
C) 40 kg
D) 45 kg
E) 50 kg

20. A column of oil of height 70.0 cm supports a column of an unknown liquid as suggested in the figure (not drawn to scale). Assume that both liquids are at rest and that the density of the oil is 840 kg/m³. Determine the density of the unknown liquid.

70.0 cm

27.0 cm

A) 3.2×10^2 kg/m³
B) 2.2×10^3 kg/m³
C) 2.6×10^3 kg/m³
D) 3.6×10^3 kg/m³
E) 4.9×10^3 kg/m³

21. A u-shaped tube is connected to a flexible tube that has a membrane-covered funnel on the opposite end as shown in the drawing. Justin finds that no matter which way he orients to membrane, the height of the liquid in the u-shaped tube does not change. Which of the following choices best describes this behavior?

A) Archimedes' principle
B) Bernoulli's principle
C) continuity equation
D) irrotational flow
E) Pascal's principle

22. Which one of the following statements concerning the buoyant force on an object submerged in a liquid is true?
A) The buoyant force depends on the mass of the object.
B) The buoyant force depends on the weight of the object.
C) The buoyant force is independent of the density of the liquid.
D) The buoyant force depends on the volume of the liquid displaced.
E) The buoyant force will increase with depth if the liquid is incompressible.

23. Complete the following statement: Bernoulli's principle is a statement of

A) hydrostatic equilibrium.
B) thermal equilibrium in fluids.
C) mechanical equilibrium in fluids.
D) energy conservation in dynamic fluids.
E) momentum conservation in dynamic fluids.

24. A curtain hangs straight down in front of an open window. A sudden gust of wind blows past the window; and the curtain is pulled out of the window. Which law, principle, or equation can be used to explain this movement of the curtain?

A) Poiseuille's law
B) Bernoulli's equation
C) the equation of continuity
D) Archimedes' principle
E) Pascal's principle

25. A large tank is filled with water to a depth of 15 m. A spout located 10.0 m above the bottom of the tank is then opened as shown in the drawing. With what speed will water emerge from the spout?
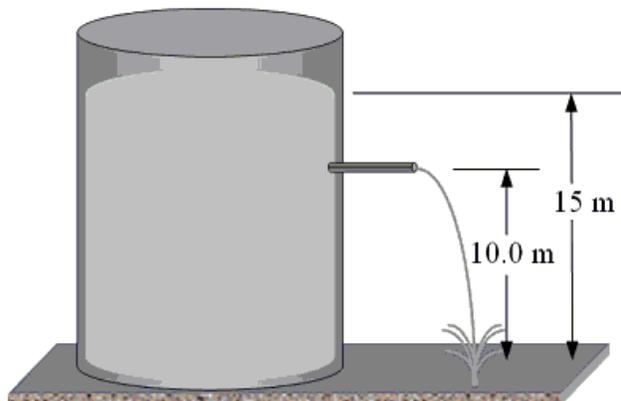
A) 3.1 m/s
B) 9.9 m/s
C) 14 m/s
D) 17 m/s
E) 31 m/s

26. Selena uses a garden hose to fill a bucket of water. The water enters the hose through a faucet with a 6.0-cm diameter. The speed of the water at the faucet is 5 m/s. If the faucet and the nozzle are at the same height, and the water leaves the nozzle with a speed of 20 m/s, what is the diameter of the nozzle?

A) 1.5 cm
B) 2.0 cm
C) 3.0 cm
D) 4.0 cm
E) 6.0 cm

27. A vertical block-spring system on earth has a period of 6.0 s. What is the period of this same system on the moon where the acceleration due to gravity is roughly 1/6 that of earth?

A) 1.0 s
B) 2.4 s
C) 6.0 s
D) 15 s
E) 36 s

28. When a force of 19 N is applied to a spring, it elongates 0.085 m. Determine the period of oscillation of a 4.0-kg object suspended from this spring.

A) 0.8 s
B) 1.2 s
C) 3.1 s
D) 4.1 s
E) 6.3 s

29. A wave has a frequency of 58 Hz and a speed of 31 m/s. What is the wavelength of this wave?

A) 1.9 m
B) 3.5 m
C) 0.29 m
D) 0.53 m
E) 31 m

30. Which one of the following statements concerning waves is false?
A) A wave can have both transverse and longitudinal components.
B) A wave carries energy from one place to another.
C) A wave does not result in the bulk flow of the material of its medium.
D) A wave is a traveling disturbance.
E) A transverse wave is one in which the disturbance is parallel to the direction of travel.

31. Complete the following statement: The term *heat* most accurately describes
A) the internal energy of an object.
B) a measure of how hot an object is.
C) the absolute temperature of an object.
D) the molecular motion inside of an object.
E) the flow of energy due to a temperature difference.

32. The units of heat are equivalent to those of which one of the following quantities?
A) force/time
B) work
C) temperature
D) specific heat capacity
E) power

33. Heat is added to a sample of water in an insulated container. Which one of the following
statements is *necessarily* true?
A) The temperature of the water will rise.
B) The volume of the water must decrease.
C) The mass of the system must decrease.
D) Under certain conditions, the temperature of the water can decrease.
E) The type of change that will occur depends on the original temperature of the water.

34. Note the following six properties:

|		
(1) pressure	*(3) volume*	*(5) number of molecules*
(2) moment of inertia	*(4) latent heat*	*(6) temperature*

Which four of the listed properties are needed to describe an ideal gas?

A) *1, 2, 4, 6*
B) *1, 3, 5, 6*
C) *1, 3, 4, 6*
D) *1, 4, 5, 6*
E) *2, 4, 5, 6*

35. Complete the following statement: A bicycle tire explodes after lying in the hot afternoon sun. This is an illustration of

A) Charles' law.
B) Boyle's law.
C) Fick's law.
D) the ideal gas law.
E) the Maxwell speed distribution.

36. When the gas enclosed beneath the piston shown in the figure receives 2170 J of heat, Q, from its surroundings, it performs 2840 J of work in raising the piston. What is the change in the internal energy of the gas?
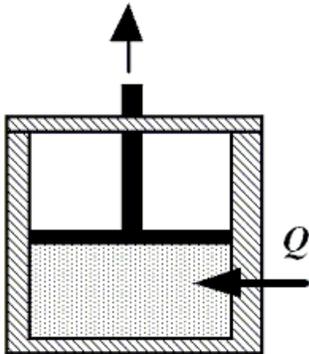

A) +670 J
B) −670 J
C) −5010 J
D) +5010 J
E) zero joules

37. Complete the following statement: Fiber optics make use of
A) total internal reflection.
B) polarization.
C) chromatic aberration.
D) Brewster's angle.
E) dispersion.

38. A ray of blue light travels through air and is refracted as it enters a glass prism shown in the figure. An unknown liquid is in contact with the right side of the prism. The light then follows the path shown. Which one of the following statements concerning this situation is true?
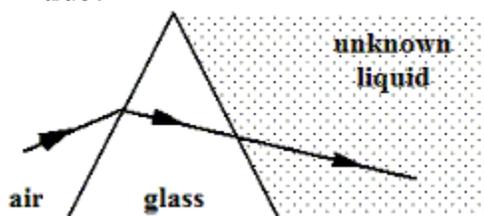
A) The frequency of the light changes inside the prism.
B) The index of refraction of the glass is smaller than that of air.
C) The index of refraction of the unknown liquid is the same as that of the glass.
D) The speed of light is larger in the liquid than in the glass.
E) The refractive index of the liquid is the same as that of air.

39. An object with a height of 4.0 cm is placed 30.0 cm from a lens. The resulting inverted image has a height of 1.5 cm. What is the focal length of the lens?
A) 7.5 cm
B) 8.2 cm
C) 15 cm
D) 17 cm
E) 21 cm

40. To which model of atomic structure does the *Pauli exclusion principle* apply?
A) the nuclear atom
B) the quantum mechanical atom
C) the billiard ball atom
D) the plum-pudding model
E) the planetary model

41. Which one of the following statements concerning the electrons specified by the notation $3p^4$ is true?

A) The electrons are in the M shell.
B) The electrons are in the $\ell = 2$ subshell.
C) The electrons are necessarily in an excited state.
D) They have principal quantum number 4.
E) There are 3 electrons in the specified subshell.

42. Which one of the following pairs of symbols represents two isotopes?

A) $^{16}_{8}O$, $^{14}_{7}N$

B) $^{12}_{6}C$, $^{14}_{6}C$

C) $^{16}_{8}O$, $^{23}_{11}Na$

D) $^{14}_{7}N$, $^{14}_{6}O$

E) $^{14}_{7}N$, $^{13}_{6}C$

43. This question refers to the figure shown. Which one of the following concepts explains why heavy nuclei do not follow the $N = Z$ line (or trend) in the figure?
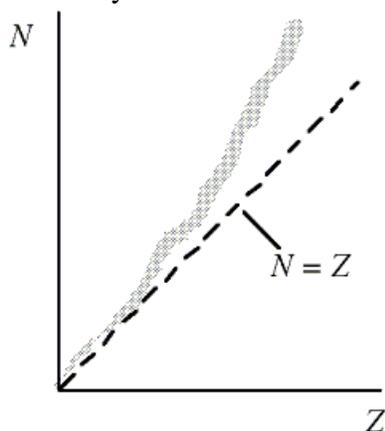
A) transmutation
B) Coulomb repulsion
C) particle-wave duality
D) Pauli exclusion principle
E) Heisenberg uncertainty principle

44. Which one of the following expressions relates the terms *binding energy* and *mass defect*?

A) $\Delta E_0 = (\Delta m)c^2$

B) $\Delta(mc) = \frac{h}{\Delta \lambda}$

C) $\Delta E = h\Delta f$

D) $\lambda = \frac{hc}{\Delta E}$

E) $E_0 = \frac{1}{2}mv^2$

45. Which one of the following processes is illustrated by the reaction: $^{238}_{92}U \rightarrow \, ^{234}_{90}Th + \, ^4_2He$?

A) beta decay

B) alpha decay

C) gamma decay

D) neutrino emission

E) positron emission