PRACBANK TEST - 2

By ProfPrac

PHYSICS

1. Which of these differential equations correctly describes the motion of a simple pendulum?

A. $\frac{d^2\theta}{dt^2} + \frac{g}{l}\sin\theta = 0$

B. $(\frac{d\theta}{dt})^2 + \frac{g}{l}\sin\theta = 0$

C. $(\frac{d\theta}{dt})^2 + \frac{g}{l}\cos\theta = 0$

D. $\frac{d^2\theta}{dt^2} + \frac{g}{l}\cos\theta = 0$

2. In a head collision between an alpha particle and a nucleus (atomic number Z), the square of the de Broglie wavelength of the alpha particle is dependent on the distance of closest approach d as $\lambda^2 = kd/Z$. Find k.

A. $\frac{\pi\varepsilon_0 h^2}{2me^2}$

B. $\frac{h^2}{m^2 2\pi e^2 \varepsilon_0}$

C. $\frac{\pi\varepsilon_0 h^2}{me^2}$

D. $\frac{\varepsilon_0 h^2}{2me^2}$

3. Galileo Galilei had devised an experiment to ascertain the speed of light which involved two observers, A and B, with lanterns at a considerable distance from each other, the time which observer A measures from uncovering his lantern until he catches sight of the light of B's lantern is the time which it would take the light to travel from A to B and from B back to A. His students performed the experiment with a distance $s_B - s_A = 1.609$ km with an almost instantaneous result. If the minimum time to record visual stimuli is around 13 μs, by how much should the distance be increased to prove that light is of finite speed?

A. 1950 m B. 341 m C. 682 m D. 170.5 m

4. For a light source of constant wavelength, what does the fringe width depend on?

   a. Slit width only
   b. Slit width and Screen distance
   c. Screen Distance and Slit-to-slit distance
   d. Screen Distance only

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5. A spherical body (of radius R) has the density profile $\rho(r) = r^2 - ar$, where a = k/R^6 is a constant and r is the radius. How is the moment of inertia related to r?

A. r^7 B. r^6 C. r D. r^3

6. A particle undergoes motion under the equation $x(t) = t^3 + \sin t$, where t is in seconds. Which of the following is **TRUE**?

A. The particle undergoes periodic displacement

B. The particle undergoes periodic acceleration

C. The particle undergoes periodic velocity

D. None of the above

7. A molecule of water is generally said to have 3 translational, 3 rotational and 3 vibrational degrees of freedom. In an experiment, the molecule is "locked" in place, so that it cannot move anywhere. What is the net change in the RMS velocity of said molecule?

A. $\sqrt{\frac{3RT}{M}}$ B. $-\sqrt{\frac{3RT}{M}}$ C. 0 D. $-\sqrt{\frac{6RT}{M}}$

8. For a human immersed in a container of a liquid with refractive index 1.155, find the approximate percentage by which the FOV (field of view) of a human decreases when looking directly up.

A. 67% B. 33% C. 50% D. 25%

9. Let B define the field at the center of a regular n-sided polygon, carrying a steady current I. Again, let R be the distance from the center to any side. Then which of the following is **FALSE**?

a. As $n \to \infty$, the equation reduces to $\mu_0 I/2R$

b. For a fixed side length, the contribution of each side of the polygon to the field is related to the angles subtended to the centre

c. The dependence of n varies as $B \propto n$

d. For a square, $B = \sqrt{2}\mu_0 I/\pi R$

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10. For a resistor, the slope (in appropriate units) of a resistivity-temperature graph is most likely to be:

A. 4.16 B. 0.02 C. 0.91 D. -5.61

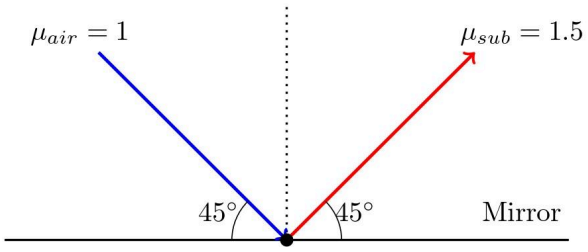
11. A circular loop dependent on the time-varying radius r(t) = $2t^2$i + tk is placed perpendicularly in a static magnetic field 2i + j - 2k. What is the EMF at 1s (in volts)?

A. -18π B. 27π C. -54π D. -162π

12. During refraction, which of the following does **NOT** change?

A. Wave Speed
B. Wavelength
C. Frequency
D. Wavefront Direction

13. A plane progressive wave in air $y = 0.6\sin(2\pi(t - x/2))$ is incident on a reflective surface (x = 0) as shown below. Following the reflection, the wave enters a region filled with some unknown substance. If the amplitude of the wave is dampened by 1/3rd, what is the new wave equation after reflection?



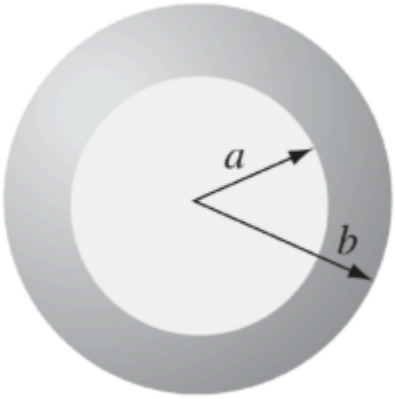
A. $y = 0.2\sin(2\pi(t - 3x/4))$
B. $y = -0.4\sin(2\pi(t - x/2))$
C. $y = -0.4\sin(2\pi(t - 3x/4))$
D. $y = 0.4\sin(2\pi(t - 3x/4))$

14. One mole of an ideal monoatomic gas expands along the polytrope $PV^3 = k$ from V_1 to V_2 at a constant pressure P_1. The temperature during the process is such that molar specific heat $C_V = 3R/2$. The total heat absorbed during the process can be expressed as [$W_1 = P_1V_1$]:

A. $W_1(\frac{V_1^2}{V_2^2} + 1)$ B. $W_1(\frac{V_1^2}{V_1V_2} + 1)$ C. $W_1(\frac{V_1V_2}{V_2^2} + 1)$ D. $W_1(\frac{V_1^2}{V_2^2} - 1)$

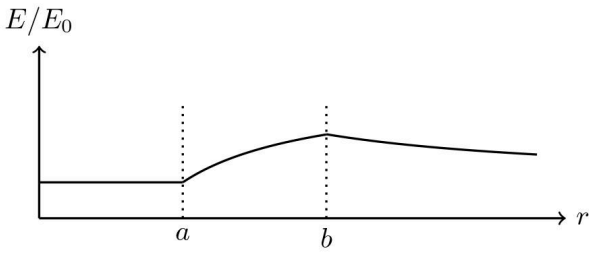
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15. A thick spherical shell carries charge density $\rho = k/r$ $(a \leq r \leq b)$ as shown.

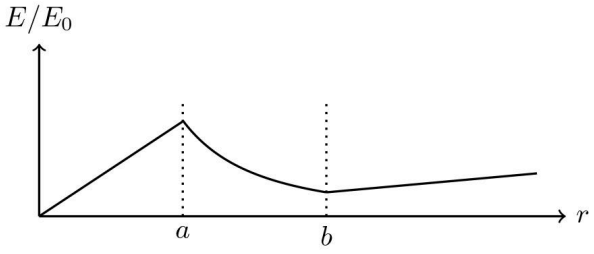


Which of these plots represent the electric field as a function of distance r?

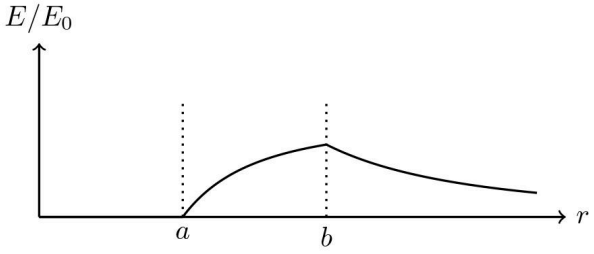
A.



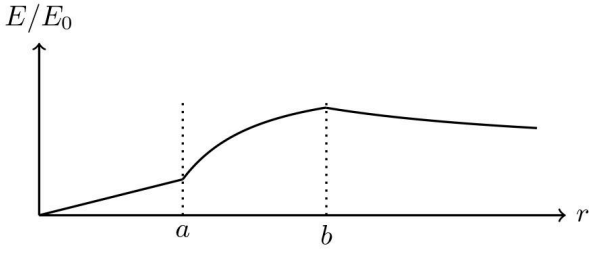
B.



C.



D.



CHEMISTRY

16. A four step reaction undergoes as follows:

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E$$

With enthalpies H_1 (2A → B) = 256 kJ, H_2 (B → C) = 720 kJ, H_3 (C → 3D) = 360 kJ, H_4 (D → E) = 542 kJ. Find the standard enthalpy of reaction by the alternate pathway: A → C → B → E.

A. 0 kJ B. 430 kJ C. 438 kJ D. 670 kJ

17. In Finkelstein reaction, dry acetone promotes a forward reaction by Le Chatelier's Principle because:

A. The product R-I formed is heavier than reactant R-Cl, causing the product to float and not reinterfere with the reaction.
B. Acetone cannot resolvate chloride and bromide products to the constituent ions.
C. Absence of hydration allows the iodide ion to invert the halide via the SN2 mechanism without the hydroxide ion's interference.
D. Evaporation of the acetone is an endothermic process.

18. The **INCORRECT** statement among the following is:

A. The first ionization potential of Al is less than the first ionization potential of Mg.
B. The second ionization potential of Mg is greater than the second ionization potential of Na.
C. The first ionization potential of Na is less than the first ionization potential of Mg.
D. The third ionization potential of Mg is greater than that of Al.

19. Which of these quantities is **NOT** constant in an atom with atomic number Z?

A. Potential Energy × Radius
B. Velocity × Radius
C. (Velocity × Energy) / Orbital Frequency
D. Kinetic Energy × (Angular Momentum)^2

20. When two liquids A and B with same volumes are mixed in a container, the resultant is a little less than the total. In the pressure-mole fraction slope, what deviation is expected?

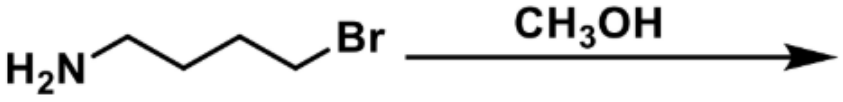
A. No deviation B. Mixed C. Positive D. Negative

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21. In an oxidative environment, Vanadium undergoes continuous oxidation. The compounds that form throughout are: VO, V_2O_3, V_2O_4 and V_2O_5. Which of these show the chemical natures of the oxides?

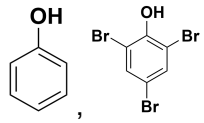
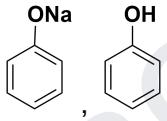
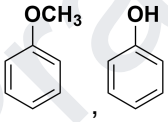
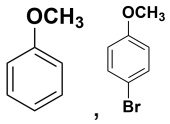
A. Basic, Weakly Basic, Neutral, Acidic
B. Neutral, Basic, Neutral, Acidic
C. Basic, Basic, Weakly Basic, Amphoteric
D. Basic, Weakly Basic, Neutral, Amphoteric

22. What is formed at the end of the reaction?



A. 4-aminobutan-1-ol
B. 1-Butanamine
C. Pyrolidine
D. 4-bromobutan-1-ol

23. Match the bromination pathways:

INITIAL AND FINAL COMPOUND	REACTANTS
(a) 	**(i)** HBr
(b) 	**(ii)** HBr-CH_3OCH_3
(c) 	**(iii)** Br_2-CH_3COOH
(d) 	**(iv)** Br_2

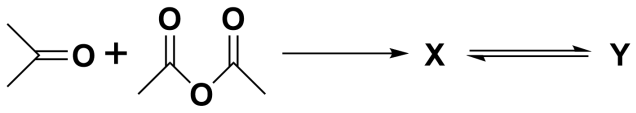
A. (a)-(iv); (b)-(i); c-(ii); (d)-(iii)
B. (a)-(iv); (b)-(i); c-(iii); (d)-(iii)
C. (a)-(i); (b)-(ii); c-(iii); (d)-(iv)
D. (a)-(iv); (b)-(ii); c-(i); (d)-(iii)

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24. For equiconcentrated mixtures of Na_2SO_4, K_2CO_3, Li_2SO_4, $(NH_4)_2CO_3$ in water at 25°C, which of these quantities is constant?

A. $\Lambda_m + \Lambda^0_m$ B. $\Lambda^2_m + \Lambda^{0\ 2}_m$ C. $\Lambda_m - \Lambda^0_m$ D. $\Lambda^2_m - \Lambda^{0\ 2}_m$

25. In the reaction, the products **X** and **Y** for a BF_3 catalyst are:



A. Metamers
B. Chain Isomers
C. Functional Isomers
D. Positional Isomers

26. For monoxides of Period 2 elements, which of these shows the **CORRECT** order of bond order?

A. N > C > B > Be
B. C > N > B > Be
C. Be > N > C > B
D. B > C > N > Be

27. For the conversion of bromomethane to methanol, the rate constants of reactions at 300 K and 400 K are 0.03 and 0.1 s^{-1} respectively. At 500K with rate constant 0.15 s^{-1}, the reaction mixture undergoes 10^8 collisions per second per unit volume, what is the approximate probability that the collisions lead to successful intermediate formation?

A. 2.7×10^{-8} B. 5.6×10^{-2} C. 1.5×10^{-9} D. 1.8×10^{-7}

28. What is the preferred chemical during chlorination of a carboxylic acid?

A. Thionyl Chloride
B. Hydrochloric Acid
C. Phosphorous Trichloride
D. Phosphorous Pentachloride

29. Consider a metal undergoes a series of reactions to form the complex as follows:

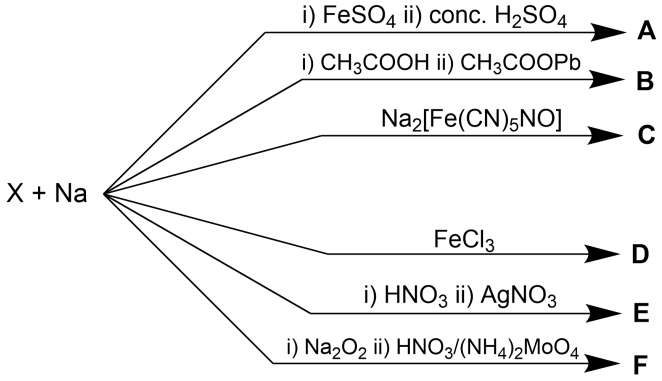
$$X \longrightarrow [XClBr(NH_3)(CO)]$$

If X = Pt, Ni, what describes the chirality of the complexes?

A. Chiral, Achiral
B. Achiral, Chiral
C. Chiral, Chiral
D. Achiral, Achiral

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30. The Lassaigne test for an organic compound X undergoes as follows:



Which of these statements is **CORRECT**?

a. All three coordinate compounds formed in the reactions **A**, **C** and **D** consist of an iron (II) center.
b. **B, C** and **E** give the same indication in terms of results.
c. In the final step of **C**, there is a slight shift in the absorbed frequencies towards red.
d. The indicator compound formed in **F** is a double salt.

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MATHEMATICS

31. A function is defined as following:

$$\delta_{ij} = \begin{cases} 1 & \text{if } i = j \\ 0 & \text{if } i \neq j \end{cases}$$

Let a function $\delta(x) = \delta_{i(x)j(x)}$ be defined for $\forall\, x > 0 \mid x \in Z$ which is dependent on two functions $i(x) = x$ and $j(x) = x + \sin(\pi\frac{(x-1)!+1}{x})$. What is **TRUE** for the defined function?

a. The function $\delta(x)$ has local maxima, iff x is a prime number
b. The function $\delta(x) = 1$, for all odd integers x
c. The function is differentiable, with a constant slope of 0
d. The function is monotonically increasing over Z^+

32. Given an equation: $x^8 - 256 = 0$, which of these tuples represent the total number of real roots and total number of roots respectively?

A. (2,6) B. (2,2) C. (2,8) D. (2,4)

33. Consider a set S defined by a general $m \times m$ matrix A such that $S = \{a_{ij} \mid a_{ij} \in A\}$. Then which of these statements is **CORRECT**?

a. $S(A) = S(A^{-1})$
b. $S(A) = S(A^T)$
c. For an $m \times m$ identity matrix I, S(I) has m^2 objects.
d. For an $m \times m$ null matrix O, S(O) has m^2 objects.

34. In a standard game of chess, find the total number of legal opening moves by white.

A. 16 B. 18 C. 20 D. 24

35. Find:

$$\int_0^{2\pi} \cos^{-1}(\cos x)dx$$

A. $\pi/2$ B. $\pi^2/2$ C. π D. π^2

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36. Which of these conditions does **NOT** explicitly describe a unit vector?

    a. The vector (-1,8,-4) divided by the dot product of the vectors (3,6,2) and (5,-2,3).
    b. In the complex plane, a complex number determined only by $z = (\sin\theta,\ \cos\theta)$.
    c. A 1 x n null matrix with one entry being replaced by 1.
    d. In a 3D space, a point within a sphere of radius 1.

37. For a point P(x,y), the distance from the vertex of the parabola $x^2 = 4y$ is twice the distance of P from the focus. The locus of P is:

    A. Parabola B. Hyperbola C. Circle D. Ellipse

38. From a standard deck of playing cards, two cards are drawn one after the other without replacement. Further, you can add values of the ace and numbered cards but not of the face cards.

    What is the probability that addition is not possible?

    A. 6/17 B. 7/17 C. 10/17 D. 11/17

39. Let f be a function defined in $R \rightarrow C$. If $f(x, n) = x^n$ and both n and x are non-zero, for what value of n will the equation f(x, n) = x yield 5 solutions?

    A. 3 B. 4 C. 5 D. 6

40. Let C(x) be a real-valued function that determines the circumference of a circle. Now, consider the following i) Continuity ii) Differentiability iii) Monotonicity

    For some initial valued $C_i(x) = 0$ to some final valued $C_f(x)$, what describes (i)-(iii) for C(x) in the construction of a standard cone?

    a. Continuous on $[0,C_f^{-1}(x)]$, Differentiable on $[0,C_f^{-1}(x)]$, Monotone
    b. Continuous on $(0,C_f^{-1}(x))$, Differentiable on $[0,C_f^{-1}(x)]$, Monotone
    c. Continuous on $[0,C_f^{-1}(x)]$, Differentiable on $(0,C_f^{-1}(x))$, Non-Monotone
    d. Continuous on $[0,C_f^{-1}(x)]$, Differentiable on $(0,C_f^{-1}(x))$, Monotone

41. Consider two lines: y = 2x + 7 and 2y = 12 - ax. For what values of a will a non-zero dot product exist between vectors extrapolated from these two lines?

    A. $(-\infty, \infty)$ B. $(-\infty, 1) \cup (1, \infty)$

    C. $(1, \infty)$ D. $[1, \infty)$

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42. In a set consisting of elements from a series in AP with sum S, two elements a and b (with harmonic mean H) are chosen. Now, these elements are symmetrically placed around some number c such that a > c > b. Which expression shows the number of elements in the set?

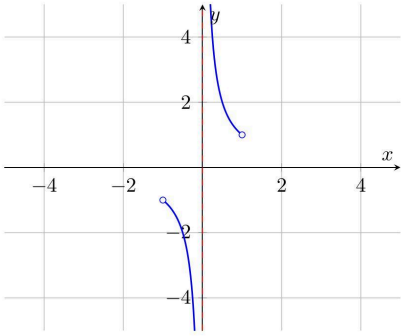
A. Sab/H B. S(a+b)/H C. SH/ab D. H/abS

43. For a non-zero x, the ODE $(x^2+y^2)dx + xydy = 0$ gives y(1) = 0. For an unit circle centered at the origin, how many times does the curve touch the circle?

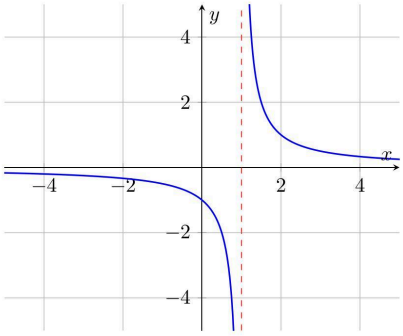
A. 0 B. 1 C. 2 D. 3

44. For some convergent GP with starting term 1, which of these curves show the possible values of the sum?

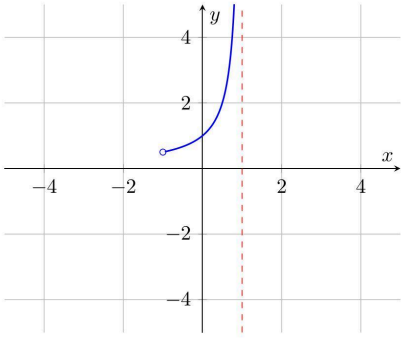
A.



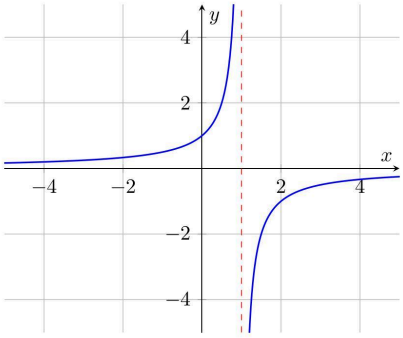
B.



C.



D.



45. For 3×3 matrices A and B in a set M, define a relation R by A R B if $A^T = B$. Then R is:

A. Reflexive B. Symmetric C. Equivalent D. Translative

Practice Test 2