

1 Mathematics

1.

$$\lim_{x \rightarrow 0} \frac{x - \ln(1+x)}{x^{2/3} - \sin(x^{2/3})} =$$

- A. 0
- B. $+\infty$
- C. 1
- D. 2
- E. 3

2. If $f(x) = \ln(\cos^2 x)$, then $f''(x) =$

- A. $\frac{1}{\cos x}$
- B. $-\frac{1}{\cos x}$
- C. $\frac{2}{\cos^2 x}$
- D. $-\frac{2}{\cos^2 x}$
- E. $-\frac{1}{\cos^2 x}$

3. $\int_0^2 \sqrt{4-x^2} dx = ?$

- A. $1/2$
- B. 1.5706
- C. 2.7183
- D. 3.1415
- E. 6.2830

4. The random number X is such that its expected value $E(X)$ is equal to 3, and its variance $\text{Var}(X)$ is equal to 4. Which of the following is equal to $E((X+1)^2)$?

- A. 9
- B. 11
- C. 13
- D. 16
- E. 20

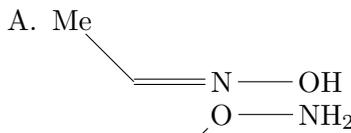
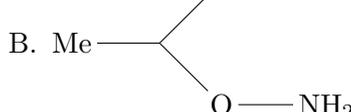
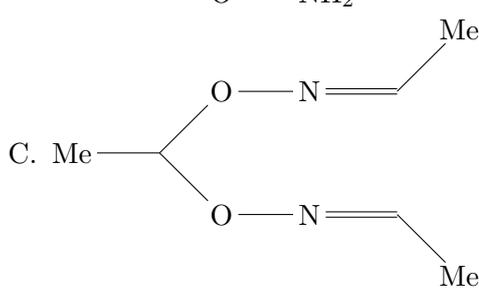
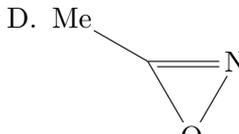
5. Which of the following statements hold for all $n \times n$ matrices?

- I. $A^2 - B^2 = (A+B)(A-B)$
- II. $(A+B)^2 = A^2 + 2AB + B^2$
- III. $(E-A)^3 = E - 3A + 3A^2 - A^3$

- A. I and II
- B. III only
- C. I and III
- D. II and III
- E. All of the above

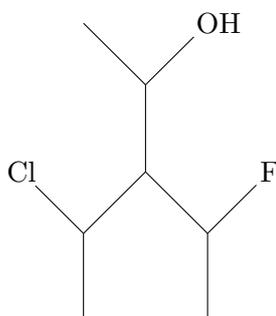
2 Chemistry

6. What are the products of the reaction $\text{CH}_3\text{CHO} + \text{NH}_2\text{OH}$?

- A. 
- B. 
- C. 
- D. 
- E. None of the above options

7. Cellulose is enzymatically synthesized from glucose in the reaction of

- A. living polymerization
 B. polycondensation
 C. ionic polymerization
 D. radical polymerization
 E. None of the above options
8. According to IUPAC nomenclature, which of the following is the correct name for the compound?



- A. 4-chloro-3-(1-fluoroethyl)pentan-2-ol
 B. 4-(1-fluoroethyl)-3-chloropentan-2-ol
 C. 3-(1-fluoroethyl)-4-chloropentan-2-ol
 D. 2-chloro-4-hydroxy-3-(1-fluoroethyl)pentan
 E. 2-hydroxy-3-(1-fluoroethyl)-4-chloropentan

9. What is the pH of 0,001 M aqueous solution of hydrogen selenide H_2Se ? The dissociation constants of hydrogen selenide are $k_1 = 1.55 \times 10^{-4}$ for $\text{H}_2\text{Se} = \text{HSe}^- + \text{H}^+$ and $k_2 = 1 \times 10^{-11}$ for $\text{HSe}^- = \text{Se}^{2-} + \text{H}^+$, respectively.
- A. 2.8
 - B. 3.2
 - C. 3.4
 - D. 3.9
 - E. 4.3
10. What metal should be used to make a vessel to store concentrated nitric acid?
- A. Al
 - B. Mg
 - C. Cu
 - D. Na
 - E. Ni

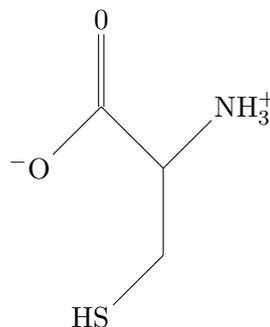
3 Physics

11. A half of 100 ml chamber is filled with water at room temperature 25°C . The other half is filled with the air. The chamber is hermetically sealed. Then its temperature is increased to 50°C . How much the pressure will change inside the chamber?
- A. Will increase in ~ 2 times
 - B. Will increase on $\sim 50\%$
 - C. Will increase on $\sim 8.4\%$
 - D. Will increase on $\sim 6.3\%$
 - E. None of these options
12. You are weighing a reference mass of 1000 g at different locations on the Earth. Where will the minimum weight be?
- A. Equator
 - B. North Pole
 - C. South Pole
 - D. 45 degree of north latitude
 - E. Weight will be the same at all locations
13. A laser beam with the wavelength 400 nm falls perpendicularly on the diffraction grating with the grating pitch of 6 micrometers. How many primary maxima can possibly be observed?
- A. 15
 - B. 30
 - C. 31
 - D. 42
 - E. 45

14. Two concentric spheres with radii of 10 cm and 10.5 cm form a capacitor. It was charged to 10 V, after that the temperature was increased by 500 K. Estimate the change of the electric energy of the capacitor has changed as a result of heating. The temperature coefficient of linear expansion of the material of the condenser is $2 \cdot 10^{-5} K^{-1}$.
- Decreased by 2%
 - Decreased by 1%
 - Didnt change
 - Increased by 1%
 - Increased by 2%
15. The second line in Lyman series of hydrogen atom corresponds to the transition from $n = 3$ to $n = 1$. The first line in Balmer series corresponds to the transition from $n = 4$ to $n = 2$. Select the correct relation between corresponding photon frequencies.
- $27\omega_1 = 128\omega_2$
 - $8\omega_1 = 3\omega_2$
 - $128\omega_1 = 27\omega_2$
 - $3\omega_1 = 8\omega_2$
 - None of these options

4 Molecular Biology

16. Which molecule is depicted below?



- dATP
 - tryptophane
 - cysteine
 - serine
 - alanine
17. To start polymerization DNA polymerase needs
- RNA or DNA primer
 - nucleosome
 - promoter
 - complete set of 20 aminoacids
 - AUG start codon

18. Where does bacterial RNA polymerase terminate transcription?
- A. at stop codons
 - B. at polyadenylation sites
 - C. at the binding sites of termination (release) factors RF1 and RF2
 - D. at GC-rich hairpins followed by oligoU tracts
 - E. at enhancers
19. Aminoacyl-tRNA synthetases catalyze
- A. GTP-dependent polymerization of amino acids at the end of tRNA
 - B. formylation of the aminogroup of the methionine attached to tRNA
 - C. transfer of a peptide chain from tRNA in the P-site to the aminogroup of the aminoacid attached to tRNA in the A-site
 - D. ATP-dependent addition of free aminoacid to the amino group of the peptide chain attached to tRNA in the P-site
 - E. ATP-dependent addition of free aminoacid to tRNA
20. The main mechanism used to regulate progression through eukaryotic cell cycle is
- A. AcCoA oxidation coupled to ATP production
 - B. cyclization of DNA by DNA ligase
 - C. synthesis and breakdown of cyclins and regulation of cyclin-dependent kinases
 - D. cAMP-regulated storage and depolymerization of glycogen
 - E. nucleo-cytoplasmic transport activation