Department of Physics, Forman Christian College (A Chartered University)

Admission Test

Total Time Allowed: 60 Minutes

Note: Attempt all questions. There is no negative marking.

SECTION A (English)

SYNONYMS (Choose the word having nearly same meaning)

1. POIGNANT

a) Badly Injured
b) Married
c) Fast Moving
d) Delighted

2. MUFFLE

a) Folded
b) Suppresses
c) Shuffled
d) Rolled

3. NERVE

a) Weak
b) Fair
c) Popular
d) Strength

ANTONYMS (Choose the word having nearly same meaning)

4. MOROSE

a) Handsome
b) Naughty
c) Ugly
d) Cheerful

5. STIFLE

a) Beg

b) Encourage
c) Help
d) Hate

6. PARCH

a) Opened
b) Closed
c) Dry
d) Wet

Question 7 to 10 relates to the following passage:
There are three main groups of oils-animal, vegetable and mineral. Great quantities of animal oil come from whales, creatures of the sea, which are the largest of the animals remaining in the world. To protect the whales from the cold of the Artic seas, nature has provided them with a thick covering of fat, called blubber. When the whale is killed, the blubber is stripped off and boiled down. It produces a great quantity of oil which can be made into food for human consumption. A few other creatures yield oil, but none so much as the whale. The livers of the cod and halibut, two kinds of fish, yield nourishing oil. Both cod liver oil and halibut oil are given to sick children and other invalids who need certain vitamins. Vegetable oil has been known from very old times. No household can get on without it, for it is used in cooking. Perfumes may be made from the oils of certain flowers.

7. The main source of animal oil, is –

a) Fish
b) Whales
c) Seaweeds
d) Plants

8. Vegetable oil is mainly used for

a) Eating
b) Cooking
c) Frying
d) Lubricating

9. The _____ of fish yields nourishing oil.
a) Liver
b) Stomach
c) Eyes
d) Head

10. Perfumes are made from

a) oils of flowers
b) liver oil
c) halibut oil
d) vegetable oil

SECTION B (Mathematics)

1. What is the value of d/dx (sinx.tanx).

a) sin x + tanx secx
b) cos x + tanx secx
c) sin x + tanx
d) sin x + tanx sec^2x

2. Ali bought a $60 sweater on sale at 5% off. How much did she pay, including 5% sales tax?
a) $54.15
b) $57.75
c) $57.00
d) $59.85

3. $\int \frac{d}{dx} x^n$ dx =

(a) $\frac{x^{n+1}}{n}$ + c

(b) $\frac{x^{n-1}}{n-1}$ + c

(c) $\frac{x^{n+1}}{n+1}$ + c

(d) x^n + c

4. If the average (arithmetic mean) of 5,6,7 and w is 8, what is the value of w?
a) 8
b) 12
c) 14
d) 16

5. If x-4 = 9, what is the value of x^2-4?
a) 21
b) 77
c) 81
d) 165

6. Howard has three times as much money as Ronald. If Howard gives Ronald $50, Ronald will then have three times as much money as Howard. How much money do the two of them have together?
a) $75
b) $100
c) $125
d) $200

7. What is the area of a circle whose circumference is π?

a) π/4 b) π/2
c) π d) 2 π

8. There are 27 students on the college debate team. What is the probability that at least 3 of them have their birthdays in the same month?

a) 0 b) 3/27
c) 3/12 d) 1

9. Two sides of a right triangle are 12 and 13. Which of the following could be the length of the third side?

I. 5
II. 11
III $(313)^{1/2}$

a) I only b) II only
c) I and II only d) I and III only

10. Which of the following is equal to $(7^8 \times 7^9)^{10}$?

a) 7^{27} b) 7^{82}
c) 7^{170} d) 49^{170}

SECTION C (PHYSICS)

1. $$C = 3kN_A\left(\frac{h\nu}{kT}\right)^2 \frac{e^{h\nu/kT}}{(e^{h\nu/kT}-1)^2}$$

Einstein's formula for the molar heat capacity C of solids is given above. At high temperatures, C approaches which of the following?

A) 0
B) $3kN_A\left(\frac{h\nu}{kT}\right)$
C) $3kN_A h\nu$
D) $3kN_A$
E) $N_A h\nu$

2. X-rays are not charged particles, and hence

A) they do not undergo diffraction
B) they are easily reflected by electric field or magnetic field
C) they are not deflected by magnetic or electric fields
D) they produce Laue spots
E) Are not electromagnetic radiations

3. A particle can occupy two states with energies E_1 and E_2, where $E_2 > E_1$. At temperature T the probability of finding the particle in state 2 is given by which of the following expression

A) $\dfrac{e^{-E_1/kT}}{e^{-E_1/kT}+e^{-E_2/kT}}$

B) $\dfrac{e^{-E_2/kT}}{e^{-E_1/kT}+e^{-E_2/kT}}$

C) $\dfrac{e^{-(E_1+E_2)/kT}}{e^{-E_1/kT}+e^{-E_2/kT}}$

D) $\dfrac{e^{-E_1/kT}+e^{-E_2/kT}}{e^{-E_2/kT}}$

E) $\dfrac{e^{-E_1/kT}+e^{-E_2/kT}}{e^{-E_1/kT}}$

4. One mole of a monatomic ideal gas in a perfectly insulated cylinder is compressed from initial V volume V to V/2. If the temperature and pressure of the gas before this compression are T and P, what are their values after the compression?

A) T and $2P$
B) T and $2^{5/3}P$
C) $2^{1/3}T$ and $2^{2/3}P$
D) $2^{2/3}T$ and $2^{5/3}P$
E) $2^{5/3}T$ and $2^{5/3}P$

5. A table-tennis ball is thrown at a stationary bowling ball. The table-tennis ball makes a one-dimensional elastic collision and bounces back along the same line. Compared with the bowling ball after the collision, does the table-tennis ball have

A) a larger magnitude of momentum and more kinetic energy,
B) a smaller magnitude of momentum and more kinetic energy,
C) a larger magnitude of momentum and less kinetic energy,
D) a smaller magnitude of momentum and less kinetic energy, or
E) the same magnitude of momentum and the same kinetic energy?

6. A charged particle is released from rest in a region where there is constant electric field and a constant magnetic field. If the two fields are parallel to each other, the path of the particle is a

A) Circle
B) Helix
C) Straight line
D) parabola
E) cycloid

7. For blue light, a transparent material has relative permittivity (dielectric constant) of 2.1 and a relative permeability of 1.0. If the speed of light in vacuum is c, the phase velocity of blue light in an unbounded medium of this material is

A) $\sqrt{3.1}c$
B) $\sqrt{2.1}$ c
C) $c/\sqrt{1.1}$
D) $c/\sqrt{2.1}$
E) $c/\sqrt{3.1}$

8. The equation $y = A\,Si[2\pi(t/T - x/\lambda)]$, where A, T and λ are positive constants, represents a wave whose

A) amplitude is A
B) velocity is in the positive x-direction
C) period is T/λ
D) speed is A/t
E) speed is λ/T

9. A particle of charge q and mass m enters with speed v into a uniform magnetic field B that is perpendicular to the velocity. An electric field is applied in a direction perpendicular to B with a strength E just sufficient to keep the particle from bending. (In the units used below c is the speed of light and the electric and magnetic fields have the same units). The electric field is:

A) $E = 1/2(mv^2B)$
B) $E = vB/mc$
C) $E = ½ (vB/c)$
D) $E= vB/c$
E) The electric field cannot prevent the particle from bending.

10. A deep underwater explosion causes waves to spread out from point P. The amplitude of the waves decreases as a function of distance r from P as,

A) $1/r^2$
B) $1/r$
C) $1/r^{1/2}$
D) 1/log r
E) Log r

11. A mass m is tied to one end of a string of length L and whirled around in a vertical circle. What is the minimum kinetic energy that the mass must have at any point on the circle?

A) zero
B) 1/2(mgL)
C) mgL
D) 3/2 (mgL)
E) Cannot be determined

12. Suppose that 1Kg. of ice melts to water that changes its entropy by α. The same process changes the entropy of the environment by β. What is the relationship between α and β?

A) $\alpha = \beta$

B) $\alpha = -\beta$
C) $|\alpha| > |\beta|$
D) $|\alpha| < |\beta|$
E) None of the above

13. As a mercury atom absorbs a photon of energy, an electron in the atom changes from energy level d to energy level e. Determine the energy of the absorbed photon in electron volts.

A) 3.71 ev
B) 6.67 ev
C) 1.24 ev
D) 2.27ev
E) 5.55 ev

14. Which of the following functions could represent the radial wave function of an electron in an atom? (r is the distance of the electron from the nucleus and A, b is constants.)

$I.$ Ae^{-br}
$II.$ $A\,Sin(br)$
$III.$ A/r

A) I only
B) II only
C) $I\ and\ II$ only
D) $I\ and\ III$ only
E) $I, II\ and\ III$

15.

The wave functions of a particle of mass m in an infinite potential well of width L are $\phi_n(x) = \sqrt{\frac{2}{L}}\,\mathrm{Sin}\left(\frac{n\pi x}{L}\right)$ and energy eigenvalues $E_n = \frac{n^2\pi^2\hbar^2}{2mL^2}$ where $n = 1,2,3$ .... At time $t = 0$, the particle is in a state given by $\Psi(t=0) = \frac{1}{\sqrt{14}}[\phi_1 + 2\phi_2 + 3\phi_3]$. Which of the following is a possible result of measurement of energy for the state Ψ?

A) $2E1$
B) $5E1$
C) $7E1$
D) $9E1$
E) $14E1$

16. A free particle with initial kinetic energy E and de Broglie wavelength λ enters a region in which its potential energy is V. What is the particle's new de Broglie wavelength?

A) $\lambda(1+E/V)$
B) $\lambda(1-E/V)$
C) $\lambda(1 + E/V)^{-1}$
(D) $\lambda(1 + V/E)^{1/2}$

(E) $\lambda(1 - V/E)^{-1/2}$

17. In a Maxwell-Boltzmann system with two states of energy ε and 2ε, respectively, with degeneracy of 2 for each state, the partition function is

A) $e^{-\varepsilon/kT}$
B) $2e^{-2\varepsilon/kT}$
C) $2e^{-3\varepsilon/kT}$
D) $e^{-\varepsilon/kT} + e^{-2\varepsilon/kT}$
E) $2[e^{-\varepsilon/kT} + e^{-2\varepsilon/kT}]$

18. The mean kinetic energy of electrons in metals at room temperature is many times the thermal energy kT. Which of the following can best be used to explain this fact?

A) The energy-time uncertainty relation
B) The Pauli exclusion principle
C) The degeneracy of the energy levels
D) The Born approximation
E) The wave-particle duality

19. Which statement is true about thermodynamic processes? P, V, S, T have usual meanings i.e., pressure, volume, entropy and temperature

A) A reversible process is the same as a cyclic process
B) Entropy of a system increases in an irreversible cyclic process
C) An irreversible process cannot be drawn in $PV - ST$ space
D) Efficiency of some modern hybrid engines is higher than Carnot engine
E) None of the above

20. A system has three energy levels at $E_1 = 1$, $E_2 = 2$, $E_3 = 3$ that have degeneracies 10^1, 10^2, 10^3, respectively. Suppose $P1$, $P2$, $P3$ are the occupation probabilities of these levels when the system is in thermal equilibrium with a reservoir at temperature T. Taking $k_BT = 1$ where k_B is the Boltzmann constant, which statement is true?

A) $P1 > P2 > P3$
B) $P1 > P2 = P3$
C) $P1 = P2 = P3$
D) $P1 < P2 < P3$
E) $P1 = P2 > P3$

21. Which of the following is an eigenfunction of the linear momentum operator $-i\hbar\,\partial/\partial x$ with a positive eigenvalue $\hbar k$

A) $Co(kx)$
B) $Si(kx)$
C) e^{-ikx}
D) e^{ikx}
E) e^{-kx}

22. In a given orthonormal basis, an operator A has the values $A|e1\rangle = 2|e1\rangle + |e2\rangle$ and $A|e2\rangle = 2|e2\rangle + |e1\rangle$. The matrix form of A in this basis is

A) $\begin{pmatrix} 2 & 1 \\ 1 & 2 \end{pmatrix}$

(B) $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

(C) $\begin{pmatrix} 1 & 2 \\ 1 & 2 \end{pmatrix}$

(D) $\begin{pmatrix} 1 & 2 \\ 1 & 0 \end{pmatrix}$

(E) $\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$

23. Fourier transform of $(x) = e^{-x^{2/}\sigma^2}$ in momentum space is the following function

(A) $(k) = \sigma k$
(B) $(k) = \sqrt{\pi} e^{-\sigma^2 k}$
(C) $(k) = \sigma\sqrt{\pi} e^{-\sigma^2 k}$
(D) $(k) = \sigma\sqrt{\pi} e^{-\sigma^2 k^{2/4}}$
(E) $(k) = \sqrt{\pi} e^{-\sigma^2 kx}$

24. The function xex expressed as a sum of an even and an odd function is
A) $x + ex$
B) $Si(x) + Cos(x)$
C) $Sinh(x)$
D) $Sinh(x) + Cosh(x)$
E) $xSinh(x) + xCosh(x)$

25. The complex conjugate of the complex number $z = {}^{(4y^+ i^7 x)}$ where $w = 2x - 7i$ is
A) $(2x - 7i)^{4y^- i^7 x}$
B) $(2x + 7i)^{4y^- i^7 x}$
C) $(2x - 7i)^{4y^+ i^7 x}$
D) $(2x + 7i)^{4y^+ i^7 x}$
E) $(4y + i7x)$

26. Consider the object subject to two forces of equal magnitude, as shown in Figure. Choose the correct statement with regard to this situation

A) The object is in force equilibrium but not torque equilibrium.
B) The object is in torque equilibrium but not force equilibrium.
C) The object is in both force equilibrium and torque equilibrium.
D) The object is in neither force equilibrium nor torque equilibrium.

E) Impossible to determine

27. A solid sphere and a hollow sphere have the same mass and radius. They are rotating with the same angular speed. Which one has the higher angular momentum?
A) the solid sphere
B) the hollow sphere
C) both have the same angular momentum
D) impossible to determine
E) They have no angular momentum

28. A rock of mass m is dropped to the ground from a height h. A second rock, with mass 2m, is dropped from the same height. When the second rock strikes the ground, what is its kinetic energy?
A) twice that of the first rock
B) four times that of the first rock
C) the same as that of the first rock
D) half as much as that of the first rock
E) impossible to determine

29. A cube has a constant electric potential V on its surface. If there are no charges inside the cube, the potential at the center of the cube is
A) V/8
B) V/6
C) V/2
D) 0
E) V

30. A particle moves in a circular path of radius r with speed v. It then increases its speed to 2v while traveling along the same circular path. The centripetal acceleration of the particle has changed by what factor? Choose one:
A) 0.25
B) 0.5
C) 2
D) 4
E) 8