



Constants: $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N m}^2$; $k_e = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$; $e = 1.6 \times 10^{-19} \text{ C}$; $m_e = 9.1 \times 10^{-31} \text{ kg}$; $N_A = 6.02 \times 10^{23} \text{ atoms/mole}$

Answer all the following questions

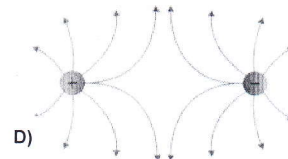
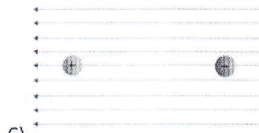
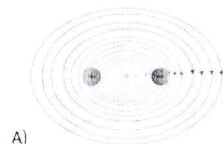
Question (I): In the following multiple-choice questions, please chose the correct answer

(45 Marks)

1. Two identical charges, **2.0 m** apart, exert forces of magnitude **4.0 N** on each other. The value of either charge in coulomb is:

A. 1.8×10^{-9} B. 2.1×10^{-5} C. 4.2×10^{-5} D. 1.9×10^5

2. Which of the following represents the electric field map due to a combination of one positive and one negative charge?

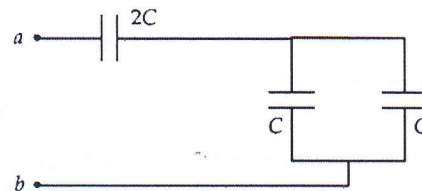


3. The electric force on a proton placed in an electric field of $2 \times 10^4 \text{ N/C}$ directed along the positive x -direction is:

A. $(3.2 \times 10^{-15}) \text{ N } \hat{i}$ B. $(3.2 \times 10^{-15}) \text{ N } \hat{j}$ C. $(4.8 \times 10^{11}) \text{ N } \hat{i}$ D. $(7.2 \times 10^6) \text{ N } \hat{j}$

4. The equivalent capacitance of the circuit shown below is (C is an arbitrary unit):

A. 0.5 C B. 1 C C. 1.5 C D. 2 C



5. The total negative charge on the electrons in **1 kg** of helium (atomic number **2**, molar mass **4**) is:

A. 48 C B. $2.4 \times 10^7 \text{ C}$ C. $4.8 \times 10^7 \text{ C}$ D. $9.6 \times 10^8 \text{ C}$

6. A small object has charge **Q**. Charge **q** is removed from it and placed on a second small object. The two objects are placed **1 m** apart. For the force that each object exerts on the other to be a maximum, **q** should be:

A. 2Q B. Q C. Q/2 D. Q/4

7. Two small charged objects attract each other with a force **F** when separated by a distance **d**. If the charge on each object is reduced to one-fourth of its original value and the distance between them is reduced to **d/2** the force becomes:

A. F/16 B. F/8 C. F/4 D. F/2

8. Particles **1**, with charge **q₁**, and **2**, with charge **q₂**, are on the x -axis, with particle **1** at $x=a$ and particle **2** at $x=-2a$. For the net force on a third charged particle, at the origin, to be **zero**, **q₁** and **q₂** must be related by **q₂=**:

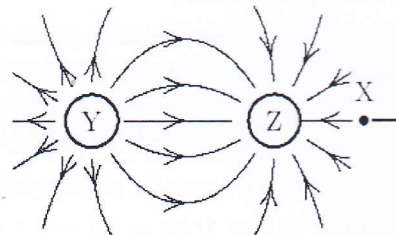
A. $2q_1$ B. $4q_1$ C. $-2q_1$ D. $-4q_1$

9. The unit of the electric field is:

A. J/(C·m) B. J/C C. J·C D. J/m

10. The diagram shows the electric field lines in a region of space containing two small charged spheres (Y and Z). Then:

- A. Y is negative and Z is positive
- B. the magnitude of the electric field is the same everywhere
- C. the electric field is strongest midway between Y and Z
- D. the electric field is not zero anywhere (except infinitely far from the spheres)



11. The electric field at a distance of **10 cm** from an isolated point particle with a charge of $2 \times 10^{-9} \text{ C}$ is:

- A. 1.8 N/C
- B. 180 N/C
- C. 18 N/C
- D. 1800 N/C

12. The diagram shows a particle with a positive charge **Q** and a particle with a negative charge **-Q**. The electric field at point **P** on the perpendicular bisector of the line joining them is:

- A. $\uparrow$
- B. $\downarrow$
- C. $\rightarrow$
- D. $\leftarrow$



13. Two point particles, one with charge $+8 \times 10^{-9} \text{ C}$ and the other with charge $-2 \times 10^{-9} \text{ C}$, are separated by **4 m**. The electric field in **N/C** midway between them is:

- A. 9×10^9
- B. 13500
- C. 36×10^{-9}
- D. 22.5

14. Two identical conducting spheres **A** and **B** carry equal charge. They are separated by a distance much larger than their diameters. A third identical conducting sphere **C** is uncharged. Sphere **C** is first touched to **A**, then to **B**, and finally removed. As a result, the electrostatic force between **A** and **B**, which was originally **F**, becomes

- A. $F/2$
- B. $F/4$
- C. $3F/8$
- D. $F/16$

15. Two thin spherical shells, one with radius **R** and the other with radius **2R**, surround an isolated charged point particle. The ratio of the number of field lines through the larger sphere to the number through the smaller is:

- A. 1
- B. 2
- C. 3
- D. 4

16. The magnitude of the force of a **400 N/C** electric field on a **0.02 C** point charge is:

- A. $8 \times 10^5 \text{ N}$
- B. $8 \times 10^{-5} \text{ N}$
- C. 8 N
- D. 0.8 N

17. The units of capacitance are equivalent to:

- A. J/C
- B. V/C
- C. V^2/C
- D. C^2/J

18. Each plate of a capacitor stores a charge of magnitude **1 mC** when a **100 V** potential difference is applied. The capacitance is:

- A. 5 μF
- B. 10 μF
- C. 15 μF
- D. 30 μF

19. If both the plate area and the plate separation of a parallel-plate capacitor are doubled, the capacitance is:

- A. doubled
- B. halved
- C. unchanged
- D. tripled

20. A parallel-plate capacitor has a plate area of 0.2 m^2 and a plate separation of 0.1 mm . To obtain an electric field of $2.0 \times 10^6 \text{ V/m}$ between the plates, the magnitude of the charge on each plate should be:

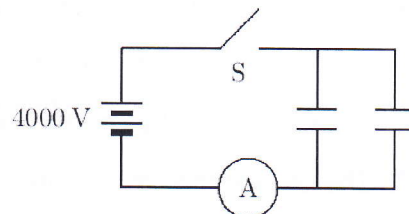
A. $8.9 \times 10^{-7} \text{ C}$ B. $1.8 \times 10^{-6} \text{ C}$ C. $3.5 \times 10^{-6} \text{ C}$ D. $7.1 \times 10^{-6} \text{ C}$

21. Two identical capacitors, each with capacitance C , are connected in parallel and the combination is connected in series to a third identical capacitor. The equivalent capacitance of this arrangement is:

A. $2C/3$ B. C C. $3C/2$ D. $3C$

22. Each of the two $25 \mu\text{F}$ capacitors shown is initially uncharged. How many coulombs of charge pass through the ammeter A after the switch S is closed?

A. 0.1 B. 0.2 C. 0.3 D. 0.4



23. A 20 F capacitor is charged to 200 V . Its stored energy is:

A. 100 J B. 50 J C. 6 J D. 0.4 J

24. A parallel-plate capacitor has a plate area of 0.3 m^2 and a plate separation of 0.1 mm . If the charge on each plate has a magnitude of $5 \times 10^{-6} \text{ C}$ then the force exerted by one plate on the other has a magnitude of about:

A. 1 N B. 5 N C. 9 N D. 15 N

25. The units of resistivity are:

A. ohm B. ohm/meter² C. ohm/meter D. ohm·meter

26. A wire with a length of 150 m and a radius of 0.15 mm carries a current with a uniform current density of $2.8 \times 10^7 \text{ A/m}^2$. The current is:

A. 2 A B. 5 A C. 10 A D. 15 A

27. Copper contains 8.4×10^{28} free electrons/ m^3 . A copper wire of cross-sectional area $7.4 \times 10^{-7} \text{ m}^2$ carries a current of 1 A . The electron drift speed is approximately:

A. $3 \times 10^8 \text{ m/s}$ B. $5 \times 10^3 \text{ m/s}$ C. 10^{-4} m/s D. $3 \times 10^{-4} \text{ m/s}$

28. Four 20Ω resistors are connected in parallel and the combination is connected to a 20 V emf device. The current in any one of the resistors is:

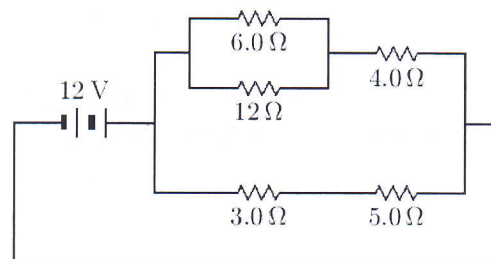
A. 0.25 A B. 0.5 A C. 1 A D. 2.3 A

29. A battery with an emf of 24 V is connected to a 6Ω resistor. As a result, current of 3 A exists in the resistor. The terminal potential difference of the battery is:

A. 5 V B. 9 V C. 12 V D. 18 V

30. The current in the 5Ω resistor in the circuit shown is:

A. ~~5 V~~
0.5 A B. ~~9 V~~
1.5 A C. ~~12 V~~
3 A D. ~~18 V~~
4.5 A



Question (II): Put (V) or (x) for all the following sentences:

(15 Marks)

31. Electric charge is conserved and quantized ().
32. The electric field lines must begin on a negative charge and terminate on a positive charge ().
33. Coulomb's law states that the electric force is directly proportional to the product of the charges on each sphere and inversely proportional to the distance between the charges ().
34. The number of electric field lines drawn is proportional to the magnitude of the charge that created the electric field ().
35. A charged capacitor stores **10 C** at **40 V**. Its stored energy is **400 J** ().
36. The equivalent capacitance for a parallel combination is always less than any individual capacitance in the combination ().
37. The capacitance of a single isolated spherical conductor with radius **R** is proportional to **R** ().
38. Kirchhoff's first law is based on the principle of law of conservation of charge ().
39. Ohm's law is applicable to all conductors of electricity ().
40. Electrons in a conductor have no motion in the absence of a potential difference across it ().
41. **50 electric bulbs** are connected across supply of **220 volts**. After one bulb is fused remaining **49 bulbs** are again connected to same supply. The illumination will be more with **50 bulbs** than with **49 bulbs** ().
42. Two bulbs one of **50 watt** and the other is of **25 watts** are connected in series, then current in each is same ().
43. To find the total capacitance of capacitors in parallel, sum the values of the individual capacitors ().
44. In a series capacitive circuit the smallest capacitor will have the largest voltage drop across it ().
45. The greater the distance between the plates of a capacitor, the smaller the capacitance value ().

Good Luck,



General Phys. P100

Final Exam

1st semester 2020/2021

Date: 04/03/2021

Student Name:

ID:

Time Exam: 2 h

"يتم طمس (تسويد) الإجابة المختارة من قبل الطالب باستخدام القلم الجاف فقط"

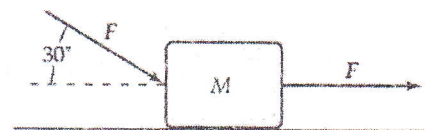
First part (I): (50 Marks)

Q1: Choose the correct answer A, B, C or D:

(1.5 Mark each)

1. The position, x , of an object is given by the equation $x = A + Bt + Ct^2$, where t refers to time. What are the dimensions of A , B , and C ?
A. m, m, m
B. m, s, s^2
C. $m, m/s, m/s^2$
D. $m/s, m/s^2, m/s^3$
2. Which of the following quantities has the same dimensions as kinetic energy, $\frac{1}{2}mv^2$?
A. ma
B. mvx
C. mvt
D. mgh
3. A rock is thrown straight up with an initial velocity of 24.5 m/s. What maximum height will the rock reach before starting to fall downward?
A. 9.80 m
B. 19.6 m
C. 30.6 m
D. 24.5 m
4. The position of a particle moving along the x axis is given by $x = (21 + 22t - 6t^2)$ m, where t is in s. What is the average velocity during the time interval $t = 1.0$ s to $t = 3.0$ s?
A. -6.0 m/s
B. -4.0 m/s
C. -2.0 m/s
D. -8.0 m/s
5. An object moving in the $+x$ axis experiences an acceleration of 2.0 m/s^2 . This means the object is.
A. traveling at 2.0 m in every second.
B. traveling at 2.0 m/s in every second.
C. changing its velocity by 2.0 m/s.
D. increasing its velocity by 2.0 m/s in every second.
6. If vector $A = (-3.0, -4.0)$ and vector $B = (+3.0, -8.0)$, what is the magnitude of vector $C = A - B$?
A. 13.3
B. 16.6
C. 14.4
D. 7.2
7. When you sit on a chair, the resultant net force on you is.....
A. zero.
B. up.
C. down.
D. depending on your weight.

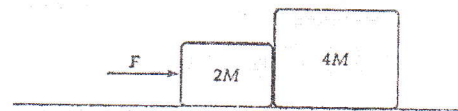
8. Ignoring air resistance, the horizontal component of a projectile's velocity.....
- is zero.
 - remains constant.
 - continuously increases.
 - continuously decreases.
9. A ball is thrown with a velocity of 20 m/s at an angle of 60° above the horizontal. What is the instantaneous velocity at the exact top of its trajectory?
- 10 m/s
 - 17 m/s
 - 20 m/s
 - Zero
10. A projectile is launched with an initial velocity of 60.0 m/s at an angle of 30.0° above the horizontal. How far does it travel?
- 152 m
 - 160 m
 - 184 m
 - 318 m
11. An object of mass m is hanging by a string from the ceiling of an elevator. The elevator is moving up at constant speed. What is the tension in the string?
- less than mg .
 - exactly mg .
 - greater than mg .
 - cannot be determined without knowing the speed.
12. A person of weight 480 N stands on a scale in an elevator. What will the scale be reading when the elevator is accelerating downward at 4.00 m/s^2 ?
- 196 N
 - 284 N
 - 676 N
 - 480 N
13. The horizontal surface on which the block slides is frictionless. If $F = 20 \text{ N}$ and $M = 5.0 \text{ kg}$, what is the magnitude of the resulting acceleration of the block?
- 5.3 m/s^2
 - 6.2 m/s^2
 - 7.5 m/s^2
 - 4.7 m/s^2



14. If the only forces acting on a 2.0 kg mass are $F_1 = (3\mathbf{i} - 8\mathbf{j}) \text{ N}$ and $F_2 = (5\mathbf{i} + 3\mathbf{j}) \text{ N}$, what is the magnitude of the acceleration of the particle?
- 1.5 m/s^2
 - 6.5 m/s^2
 - 4.7 m/s^2
 - 9.4 m/s^2

15. The horizontal surface on which the objects slide is frictionless. If $M = 1.0 \text{ kg}$ and the magnitude of the force of the small block on the large block is 5.2 N , determine F .

A. 6.0 N
B. 9.0 N
C. 7.8 N
D. 4.8 N



16. A stunt pilot weighing 0.70 kN performs a vertical circular dive of radius 0.80 km . At the bottom of the dive, the pilot has a speed of 0.20 km/s which at that instant is not changing. What force does the plane exert on the pilot?

A. 3.67 kN up
B. 4.27 kN up
C. 2.92 kN down
D. 2.92 kN up

17. A 0.50 kg mass attached to the end of a string swings in a vertical circle (radius $= 2.0 \text{ m}$). When the mass is at the highest point of the circle the speed of the mass is 8.0 m/s . What is the magnitude of the force of the string on the mass at this position?

A. 21 N
B. 11 N
C. 16 N
D. 26 N

18. A 50 N object was lifted 2.0 m vertically and is being held there. How much work is being done in holding the box in this position?

A. 10^7 dyne
B. 100 J
C. 10 erg
D. 0 J

19. A 2.5 kg object falls vertically downward in a viscous medium at a constant speed of 2.5 m/s . How much work is done by the force the viscous medium exerts on the object as it falls 80 cm ?

A. $+1.96 \text{ J}$
B. $+19.6 \text{ J}$
C. -1.96 J
D. -19.6 J

20. A 5.0 kg object is pulled along a horizontal surface at a constant speed by a 15 N force acting 20° above the horizontal. How much work is done by this force as the object moves 6.0 m ?

A. 78 J
B. 85 J
C. 74 J
D. 43 J

Q2: Choose the correct answer A, B, C or D:

(1 Mark each)

21. All of the following are base units of the SI system except:

A. kilogram.
B. kelvin.
C. meter.
D. volt.

22. Which expression is dimensionally consistent with an expression that would yield a value for t^{-1} ?
- A. v/x
 - B. v^2/x
 - C. x/t
 - D. $v^2.t$
23. When is the average velocity of an object equal to the instantaneous velocity?
- A. always
 - B. never
 - C. only when the velocity is constant
 - D. only when the velocity is increasing at a constant rate
24. An automobile traveling along a straight road increases its speed from 30.0 m/s to 50.0 m/s in a distance of 180 m. If the acceleration is constant, how much time elapses while the auto moves this distance?
- A. 6.00 s
 - B. 4.50 s
 - C. 3.60 s
 - D. 4.00 s
25. When an object experiences uniform circular motion, the direction of the acceleration is ..
- A. in the same direction as the velocity vector.
 - B. in the opposite direction of the velocity vector.
 - C. is directed toward the center of the circular path.
 - D. is directed away from the center of the circular path.
26. The acceleration of an object is inversely proportional to....
- A. the net force acting on it.
 - B. its position.
 - C. its velocity.
 - D. its mass.
27. An object sits on a frictionless surface. A 16 N force is applied to the object, and it accelerates at 2.0 m/s^2 . What is the mass of the object?
- A. 4.0 kg
 - B. 8.0 kg
 - C. 32 kg
 - D. 78 N
28. An airplane travels 80 m/s as it makes a horizontal circular turn which has a 0.80 km radius. What is the magnitude of the resultant force on the 75 kg pilot of this airplane?
- A. 0.69 kN
 - B. 0.63 kN
 - C. 0.66 kN
 - D. 0.60 kN

29. A constant force of 12 N in the positive x direction acts on a 4.0 kg object as it moves from the origin to the point $(6\mathbf{i} - 8\mathbf{j})$ m. How much work is done by the given force during this displacement?

- A. +60 J
- B. +84 J
- C. +72 J
- D. +48 J

30. The cartesian coordinates of a point in the X-Y plane are (3.5, 2.5) m, the polar coordinates (r, θ) are.

- A. (4.3, 54.5°)
- B. (4.3, 35.5°)
- C. (2.45, 144.5°)
- D. (2.45, 35.5°)

Q3: Answer (T) for True sentences or (F) for False sentences:

(1 Mark each)

	Sentence	True	False
31.	The distance travelled is the magnitude of the displacement vector.	(T)	(F)
32.	Physical quantities that have both magnitude and direction are represented by vectors.	(T)	(F)
33.	If an object is at rest, then there are no forces acting upon the object.	(T)	(F)
34.	The acceleration of a projectile is equal to zero when it reaches the top of its trajectory.	(T)	(F)
35.	The magnitude of the velocity is called the average velocity.	(T)	(F)
36.	The object accelerates only if the net force acting on it is not equal to zero.	(T)	(F)
37.	The direction of $\mathbf{f}_s$ is always parallel to the direction of the motion of the object.	(T)	(F)
38.	Newton's first law of motion is applicable to both moving and non-moving objects.	(T)	(F)
39.	When no force acts on an object, the acceleration of the object is zero.	(T)	(F)
40.	If the particle does not move the force does work on it.	(T)	(F)

Second Part (II) "Oral": (10 Marks)

Q4: Answer (T) for True sentences or (F) for False sentences:

(2 Marks each)

	Sentence	True	False
41.	A scalar quantity has only magnitude and no direction.	(T)	(F)
42.	Speed of a particle is not equal to the magnitude of its instantaneous velocity.	(T)	(F)
43.	Motion of an object in a circular path with changed speed, is called uniform circular motion.	(T)	(F)
44.	If the net force acting on a body is zero, the body is said to be in equilibrium.	(T)	(F)
45.	The direction of $\mathbf{f}_k$ is opposite to the direction of motion.	(T)	(F)



Question 1: Choose the correct answer of each point respectively:

(30 Marks)

- 1) An Operating system goal is to _____ user programs.
a. Mask b. Alter c. Execute d. None of the previous terms
- 2) Some computers have little or no user interface, such as _____.
a. PC b. Shared systems c. Embedded computers d. Mobiles
- 3) Home systems use _____ to protect computers from Internet attacks.
a. Guards b. Antivirus c. Firewalls d. None of the previous terms
- 4) _____ systems are a collection of separate systems networked together.
a. Embedded b. PC c. Hand-held d. Distributed
- 5) PC running Windows host, can run Linux as a guest using _____.
a. Cast-device b. 2 Keyboards c. Virtualization d. network
- 6) Open-Source OS code is _____.
a. Standard b. Closed-source c. Digital-analog d. Available
- 7) $(110*)_2 + (100*)_2 = (10110)_2$, the missing digit (*) is:
a. 0 b. 1 c. 2 d. 3
- 8) $(701)_8 = (\text{_____})_{16}$
a. 1D0 b. 1ED c. 1C1 d. 3401
- 9) $(701)_{16} = (\text{_____})_8$
a. 1D0 b. 121 c. 151 d. 3401
- 10) $(521)_8 = (\text{_____})_2$
a. 011100000001 b. 111001001 c. 11101101 d. 101010001
- 11) $(521)_{16} = (\text{_____})_2$
a. 011100000001 b. 111001001 c. 10100100001 d. 11001101
- 12) $(701)_8 + (70*)_8 = (1610)_8$, the missing digit (*) is:
a. 0 b. 1 c. 7 d. 5
- 13) Which of the following is a hexa-decimal number?
a. A b. B c. C d. All previous terms
- 14) A programming task can be divided into two phases: Problem solving phase, and _____ phase.
a. Execution b. Fixing c. Implementation d. Working
- 15) A _____ is a graphical representation of the sequence of operations of the program.
a. Flowchart b. Algorithm c. Pseudocode d. Code
- 16) In the flowchart, a parallelogram diagram  is used to represent _____.
a. Start / Stop b. Input / Output c. Process d. Decision
- 17) In the flowchart, a hexagon  is used to represent _____.
a. Start / Stop b. Input / Output c. Process d. Loops
- 18) In the flowchart, a rectangle  is used to represent _____.
a. Decision b. Input / Output c. Process d. Decision
- 19) In the flowchart, a diamond  is used to represent _____.
a. Start / Stop b. Input / Output c. Process d. Decision
- 20) One byte is group of _____ bits.
a. 4 b. 8 c. 16 d. 32
- 21) The base of Hexa-decimal number system is _____.
a. 4 b. 8 c. 16 d. 32
- 22) The sum of $7 + 7$ in the octal number system results _____.
a. 14 b. 18 c. 16 d. 13
- 23) The _____ is connecting the main PC components.
a. RAM b. Common bus c. CPU d. HDD

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- 25) The dual-mode operation in an OS consists of user mode and _____ mode.
 a. Hardware b. Kernel c. ROM d. RAM
- 26) To change mode from user mode to kernel mode the OS use: _____.
 a. Keyboard b. CPU c. ROM d. System call
- 27) Program is a/an _____ entity.
 a. Working b. Passive c. Active d. Marking
- 28) Process is a/an _____ entity.
 a. Working b. Passive c. Active d. Marking
- 29) An example of a primary storage is _____.
 a. ROM b. HDD c. SSD d. Pen-drive
- 30) One of the main OS responsibilities is: _____.
 a. Build and maintain b. Mark and match c. Protection and Security d. Pen drive

Question 2: Choose True (T) or False (F):

(20 Marks)

- 31) OS is resources allocator.
 • True • False
- 32) Shared computer such as mainframe are general purpose machines.
 • True • False
- 33) Handheld computers are optimized for high-performance and ignoring battery life.
 • True • False
- 34) A process is a program in execution.
 • True • False
- 35) Operating system is responsible for creating and deleting both user and system processes.
 • True • False
- 36) The operating System (OS) is a limited word processing application.
 • True • False
- 37) OS is a control program.
 • True • False
- 38) OS Decides between conflicting requests for efficient resource use.
 • True • False
- 39) Leaders in smartphones OS in the past decade are Microsoft and Google Android.
 • True • False
- 40) PC is a stand-alone general-purpose machine.
 • True • False
- 41) Mobile computers could interconnect via wireless networks.
 • True • False
- 42) Network Operating System provides illusion of a single system across network.
 • True • False
- 43) Virtualization allows an operating system to run as an application over another OS.
 • True • False
- 44) Real-time embedded systems are special and limited purpose OS.
 • True • False
- 45) Real-time OS has well-defined fixed time constraints.
 • True • False
- 46) In Open-Source OS, you are free to use, modify, and distribute the OS code.
 • True • False
- 47) Windows OSs are free and open-Source Operating Systems.
 • True • False
- 48) Dual-mode operation allows OS to protect itself and other system components.
 • True • False
- 49) An operating system is interrupt driven.
 • True • False



الاختبار النهائي لمقرر الديناميكا الحرارية (223P) للفصل الأول من العام الدراسي 2021/2020م
لطلاب كلية العلوم (فيزياء + فيزياء الكتلونيات)

Q1: True or False Questions (20 Marks)

1. When two objects are in thermal equilibrium with each other, they are at the same temperature.
2. The thermodynamic variables of the ideal gas are (P, V, T) only.
3. The real gas behaves as an ideal gas when its density is high.
4. In Joule's experiment, 4.186 J of the mechanical energy raises the temperature of 1 g of water by 1°C .
5. During the phase change of the substance from one state to another, its temperature changes also.
6. The work done by or on a system in the thermodynamic processes does not depend on the path taken by the system from the initial state to the final state.
7. The first law of thermodynamics states that the heat energy transferred to a system equals the change in the internal energy of the system plus the work done by the system.
8. According to the kinetic theory of the gases, the pressure of the monatomic ideal gas is given by the equation $P = \frac{2}{3} \left(\frac{N}{V} \right) \left(\frac{1}{2} m \overline{v^2} \right)$.
9. The change in the internal energy for n moles of any ideal gas when the temperature changes by ΔT is $\Delta E_{int} = nC_p \Delta T$.
10. When the temperature of n moles from an ideal gas changes by ΔT , the amount of the heat energy transferred to the gas at constant pressure is greater than the amount of the heat energy transferred to the gas at constant volume.
11. When an ideal gas undergoes an adiabatic process from an initial state (i) to a final state (f), the temperatures and the volumes of the gas are related by the expression $T_i V_i^{\gamma-1} = T_f V_f^{\gamma-1}$, where $\gamma = C_p/C_v$.
12. When an ideal gas transfers from an initial state i to a final state f during an adiabatic process, the work done by or on the gas is $W = \frac{P_i V_i}{(\gamma-1)} \left[1 - (V_i/V_f)^{\gamma-1} \right]$.
13. The heat engine is a device operating in a cyclic process by using a working substance that absorbs heat energy from a hot reservoir, and converts part from that energy to mechanical work, and expels the residual from that energy to a cold reservoir.
14. It is possible to construct a heat engine operates in a cycle and converts all the heat energy absorbed from the hot reservoir to an equal amount of the mechanical work.

15. The heat energy can be transferred spontaneously from a cold object to a hot object without doing work.
16. Carnot's theorem states that no real heat engine operating between two energy reservoirs can be more efficient than a Carnot engine operating between the same two reservoirs.
17. The change in entropy of a system during a reversible process is equal to the amount of heat energy transferred to the system multiplied by the absolute temperature of the system.
18. The change in entropy of an ideal gas during a reversible process depends only on the initial and the final states of the system and does not depend on the path that the system takes between them.
19. The change in entropy of an ideal gas during a reversible process can be positive or negative depending on values of the initial and the final temperatures and volumes.
20. The change in entropy for a system in the irreversible processes is always positive.

Constants

$$R = 8.314 \text{ J/mol.K}$$

$$1 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$$

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$$

$$k_B = 1.38 \times 10^{-23} \text{ J/K}$$

$$c_{\text{water}} = 4186 \text{ J/kg.}^\circ\text{C}$$

Q2: Multiple Choice Questions (30 Marks)

21. Carbon dioxide forms into a solid (dry ice) at approximately (-157°F). What temperature in degrees Celsius does this correspond to?
 (A) -157°C (B) -93°C (C) -121°C (D) -105°C
22. The isolated closed system
 (A) allows by exchange both the matter and the energy with the surrounding medium
 (B) allows by exchange the matter only with the surrounding medium
 (C) allows by exchange the energy only with the surrounding medium
 (D) does not allow by exchange the matter nor the energy with the surrounding medium
23. A room has a volume of 60 m^3 and is filled with air of an average molecular mass of 29 g/mole . What is the mass of the air in the room at the atmospheric pressure and temperature of 22°C ?
 (A) 2.4 kg (B) 2400 kg (C) 72 kg (D) 700 kg
24. A pressure of $1 \times 10^{-7} \text{ mm of Hg}$ is achieved in an air vacuum system. How many gas molecules are present per liter volume if the temperature of the air is 293 K ? ($1 \text{ atm} = 760 \text{ mm Hg}$)
 (A) 16×10^{18} (B) 4.7×10^{16} (C) 3.3×10^{12} (D) 3.4×10^9
25. The internal energy of the diatomic gases includes
 (A) the translational kinetic energy of the molecules
 (B) the rotational and the vibrational kinetic energies of the molecules
 (C) the potential energy within and between the molecules
 (D) all types of the previous energies

26. When a cold object is placed in thermal contact with a hot object inside an isolated vessel, the law of the conservation of energy at the thermal equilibrium is

- (A) $Q_{\text{cold}} = Q_{\text{hot}}$ (B) $Q_{\text{cold}} = -Q_{\text{hot}}$ (C) $-Q_{\text{cold}} = Q_{\text{hot}}$ (D) $Q_{\text{cold}} = -0.5Q_{\text{hot}}$

27. A 10-kg piece of aluminum (which has a specific heat of $900 \text{ J/kg}\cdot^{\circ}\text{C}$) is heated so that its temperature increases by 5°C . How much heat energy was transferred into it?

- (A) $4.5 \times 10^4 \text{ J}$ (B) $9.0 \times 10^4 \text{ J}$ (C) $1.4 \times 10^5 \text{ J}$ (D) $2.0 \times 10^5 \text{ J}$

28. How much heat energy is required to vaporize a 1.0-g ice cube at 0°C ? [$L_f(\text{ice}) = 80 \text{ cal/g}$ and $L_v(\text{water}) = 540 \text{ cal/g}$].

- (A) 620 cal (B) 720 cal (C) 820 cal (D) 1 kcal

29. The mathematical expression of the first law of thermodynamics is

- (A) $Q = \Delta E_{\text{int}} + W$ (B) $Q = \Delta E_{\text{int}} - W$ (C) $Q = -\Delta E_{\text{int}} + W$ (D) $Q = -\Delta E_{\text{int}} - W$

30. A 1.0-mole of an ideal gas is kept at 0°C during an expansion from 3 L to 10 L. How much work is done by the gas during the expansion?

- (A) 2733 J (B) -1733 J (C) 709.1 J (D) -709.1 J

31. In the cyclic process, the first law of thermodynamics is in the form

- (A) $Q = \Delta E_{\text{int}} + P\Delta V$ (B) $\Delta E_{\text{int}} = -W$ (C) $Q = nRT \ln(V_f/V_i)$ (D) $Q = W$

32. A bottle contains an ideal gas of a volume 2.0 m^3 and a pressure $1 \times 10^5 \text{ Pa}$ at a temperature of 300 K. The bottle is placed on a metal block at a temperature 900 K, where the gas expands at constant pressure until the temperature of the gas reaches 900 K. The change in the internal energy of the gas is $+6 \times 10^5 \text{ J}$. How much heat energy did the gas absorb?

- (A) 0 (B) $4.0 \times 10^5 \text{ J}$ (C) $6.0 \times 10^5 \text{ J}$ (D) $10 \times 10^5 \text{ J}$

33. A tank is used for filling helium balloons has a volume of 0.300 m^3 and contains 2 moles of helium gas at 20°C . What is the average translational kinetic energy per molecule?

- (A) $2.022 \times 10^{-21} \text{ J}$ (B) $6.065 \times 10^{-21} \text{ J}$ (C) $10.09 \times 10^{-21} \text{ J}$ (D) none of the previous

34. A tank has a volume of 0.300 m^3 and contains 2 moles of helium gas at 20°C . What is the internal energy of the gas molecules?

- (A) $2.436 \times 10^3 \text{ J}$ (B) $3.248 \times 10^3 \text{ J}$ (C) $4.872 \times 10^3 \text{ J}$ (D) $7.308 \times 10^3 \text{ J}$

35. Helium gas at a temperature of 0°C . The root-mean-square speed of the gas molecules is

- (A) 1305 m/s (B) 1065 m/s (C) 753.3 m/s (D) 532.6 m/s

36. A cylinder contains 3 moles of helium gas at a temperature of 300 K. How much the heat energy that transfers to the gas when its temperature increases to 500 K at constant pressure?

- (A) 200 J (B) $4.14 \times 10^{-21} \text{ J}$ (C) $7.5 \times 10^3 \text{ J}$ (D) $12.5 \times 10^3 \text{ J}$

37. Air at 20°C in the cylinder of a diesel engine is compressed during an adiabatic process from an initial pressure of 1 atm and volume of 800 cm^3 to a volume of 60 cm^3 . Assume that the air behaves as an ideal gas with ($\gamma = 1.40$), what is the final temperature of the air?

- (A) 20°C (B) 267°C (C) 553°C (D) 752°C

38. Air at 20°C in the cylinder of a diesel engine is compressed during an adiabatic process from an initial pressure of 1 atm and volume of 800 cm^3 to a volume of 60 cm^3 . Assume that the air behaves as an ideal gas with ($\gamma = 1.40$), what is the value of the work done to compress the air?

- (A) $+368.4\text{ J}$ (B) -368.4 J (C) $+386.4\text{ J}$ (D) -386.4 J

39. The ratio of $\lambda_{\text{isothermal}}$ to $\lambda_{\text{adiabatic}}$ is equal to

- (A) C_P (B) C_V (C) C_P/C_V (D) R

40. A gas contains ten molecules with speeds 6, 9, 12, 13, 13, 15, 17, 19, 20, and 22 m/s. What is the root-mean-square speed of the gas molecules?

- (A) 13 m/s (B) 14.6 m/s (C) 15.36 m/s (D) 22 m/s

41. It is impossible to construct a heat engine operating in a cycle and converts all the heat energy absorbed from the hot reservoir to an equal amount of mechanical work. This sentence is the text of

- (A) Joule's law (B) The first law of thermodynamics

(C) Kelvin-Planck form of the second law of thermodynamics (D) none of the previous

42. The heat energy input to an engine is equal to 3 times the work that it produces, what is the percent of the energy that is expelled to the cold reservoir?

- (A) 66.6% (B) 33.3% (C) 100% (D) impossible to determine

43. It is impossible to construct a heat pump that transfers the heat continuously from a cold object to a hot object without input work to the pump. This sentence is the text of

- (A) Joule's law (B) The first law of thermodynamics
(C) Clausius form of the second law of thermodynamics (D) none of the previous

44. The system cannot be returned from its final state to its initial state along the path of the PV diagram in

- (A) the isobaric process (B) the irreversible process
(C) the adiabatic process (D) the reversible process

45. Which of the following Carnot engines has the highest theoretical possible efficiency?

- (A) Engine A: $T_h = 1000\text{ K}$ and $T_c = 700\text{ K}$ (B) Engine B: $T_h = 800\text{ K}$ and $T_c = 500\text{ K}$
(C) Engine C: $T_h = 600\text{ K}$ and $T_c = 300\text{ K}$ (D) cannot be determined from the stated information

46. In the reversible process of an ideal gas,

- (A) $\Delta S = nC_V \ln(T_f/T_i) + nR \ln(V_f/V_i)$ (B) $\Delta S = nC_V \ln(T_i/T_f) + nR \ln(V_f/V_i)$
(C) $\Delta S = nC_V \ln(T_f/T_i) + nR \ln(V_i/V_f)$ (D) $\Delta S = nC_V \ln(T_i/T_f) + nR \ln(V_i/V_f)$

47. One kilogram of water at 1 atm is heated until all the water vaporizes. What is the change in entropy? (For water, $L_v = 2.26 \times 10^6\text{ J/kg}$)

- (A) 12100 J/K (B) 6059 J/K (C) 3030 J/K (D) 1220 J/K

48. When a hot object at a temperature T_h loses a heat energy Q to a cold object at a temperature T_c , the change in entropy of the system is

- (A) $\Delta S = 0$ (B) $\Delta S = Q/T_c$ (C) $\Delta S = Q/T_h$ (D) $\Delta S = (Q/T_c) - (Q/T_h)$

49. The temperature of the surface of the Sun is approximately 5700 K and the temperature of the Earth's surface is about 290 K. What is the change in entropy when 1000 J of heat energy is transferred from the Sun to the Earth?

(A) 2.89 J/K

(B) 3.27 J/K

(C) 3.62 J/K

(D) 3.97 J/K

50. Suppose that 1 kg of water at 0°C is mixed with an equal mass of water at 100°C . After equilibrium is reached, the mixture has a uniform temperature of 50°C . What is the change in entropy of the system?

(A) -602.5 J/K

(B) 0

(C) 101.53 J/K

(D) 704 J/K

Answer the following:

Q1: Choose True (T) or False (F) in the following: (1 mark each)

1. The speed of light is not the same in all reference frames ().
2. Proper time is the longest time interval between two events ().
3. Newton's second law $F = ma$, is variant under Galilean transformation. ().
4. The length contraction occurs only in the direction of relative motion ().
5. The relativistic γ (gamma factor) can be any number equal to or larger than one. ()
6. Suppose one twin travels in a space ship moving at a very high speed to a distant star and back again, while the other twin remains on Earth. The twin that remained on Earth predict that the astronaut twin is older. ().
7. Relative to a stationary observer, a moving object A appears longer than normal ().
8. As the speed of a particle approaches the speed of light, the mass of the particle decrease ().
9. Consider a relativistic particle of mass m and rest mass m_0 . The correct expression for kinetic energy of such a particle is equals to $(mc^2 - m_0c^2)$ ().
10. Moving clock runs slower than a clock at rest by a factor γ (gamma) ().
11. The position and momentum of a particle cannot both be measured precisely at the same time ().
12. If the accuracy in measuring the position of a particle increases, the accuracy in measuring its velocity will Increase ().
13. The momentum of a moving particle with relativistic speed v is given by $P = m_0v$ ().
14. The probability of finding an electron in a hydrogen atom is directly proportional to its wave function. ().
15. If r_1 is the smallest orbital radius around a single proton, then r_6 is equal to $6r_1$ ().
16. In the particle in a box model, the energy E_n is inversely proportional to n^2 ().
17. In the particle in a box model, the quantization of energy becomes very clear when the particle mass (m) and the box width L are small ().
18. The complementary principal states that: the wave model and particle model complement each other ().
19. Pair production process can occurs in empty space ().
20. Electron - positron annihilation results in the creation of more than two gamma photons ().

Q2 Choose the correct answer A, B or C: (1 Mark each)

21. The Michelson-Morley experiment was designed to measure: A) The relativistic mass of the electron. B) The relativistic energy of the electron. C) The velocity of the Earth relative to the ether.
22. The theory of special relativity: A) is based on a complex mathematical analysis. B) has not been verified by experiment. C) does not agree with Newtonian mechanics.
23. One of Einstein's postulates in formulating the special theory of relativity was that, the laws of physics are the same in reference frames that: A) accelerate. B) move at constant velocity with respect to an inertial frame. C) oscillate.
24. Relative to a stationary observer, a moving clock A) Always runs slower than normal. B) Always runs faster than normal. C) Keeps its normal time.
25. When the kinetic energy of relativistic particle is double its rest mass, γ factor equals (A) $1/3$ (B) 3 (C) $4/3$.
26. According to Planck theory, the black body radiation spectrum depends on:
(A) wavelength (B) temperature (C) both (a) and (b)

27. When 1 kilogram of matter transforms into energy, the amount of energy liberated is
(A) 9×10^{16} erg (B) 9×10^{16} joules (C) 9×10^{16} watt.
28. An object moves in a direction parallel to its length with a velocity that approaches the velocity of light. The length of this object, as measured by a stationary observer,
(A). Approaches infinity. B) Contracted. C) Increases slightly.
29. What happens to the total relativistic energy of a speedy proton when its relativistic mass Doubles ? A) It doubles. B) It more than doubles. C) It less than doubles.
30. Consider a particle of mass m and rest mass m_0 . Which of the following is the correct expression for the kinetic energy of such a particle?
A) $m_0 v^2/2$ B) $m v^2/2$ C) $mc^2 - m_0 c^2$.
31. Planck's constant
A) sets an upper limit to the amount of energy that can be absorbed or emitted.
B) sets a lower limit to the amount of energy that can be absorbed or emitted.
C) relates mass to energy.
32. The ratio of energy to frequency for a given photon gives
A) its amplitude. B) its velocity. C) Planck's constant.
33. A photon is a particle that:
A) has zero mass B) has zero electric field associated with it. C) cannot travel in a vacuum.
34. Which of the following is an accurate statement?
A) In vacuum, ultraviolet photons travel faster than infrared photons. B) Photons can have positive or negative charge. C) An ultraviolet photon has more energy than an infrared photon.
35. The energy of a photon depends on
A) its amplitude. B) its velocity. C) its frequency.
36. If the wavelength of a photon is halved, by what factor does its energy change?
A) 4 , B) 2 , C) $1/4$.
37. In order for a photon to eject an electron from a metal's surface in the photoelectric effect, the photon's
A) frequency must be greater than a certain minimum value. B) speed must be greater than a certain minimum value. C) wavelength must be greater than a certain minimum value.
38. The kinetic energy of the photoelectron depends on which of the following ?
A) intensity of light
B) duration of illumination
C) wavelength of light.
39. A metal surface is illuminated with blue light and electrons are ejected at a given rate each with a certain amount of energy. If the intensity of the blue light is increased, electrons are ejected :
A) at the same rate, but with more energy per electron.
B) at the same rate, but with less energy per electron.
C) at an increased rate with no change in energy per electron.
40. A beam of X-rays of frequency f is incident upon a substance that scatters the beam in various directions. If we measure the frequency of the scattered X-rays, we will find
A) X-rays with frequency less than f .
B) X-rays with frequency greater than f .
C) only X-rays with frequency f .
41. When a photon is scattered from an electron, there will be an increase in its A) energy. B) frequency. C) wavelength.
42. In a Compton scattering experiment, what scattering angle produces the greatest change in wavelength?
A) zero degree
B) 90 degree
C) 180 degree

43. When a proton passes through matter, it is possible for it to interact with the matter in such a way that an electron and a positron are produced; this interaction is referred to as A) photoelectric effect. B) the Compton effect. C) pair production.
44. As a particle travels faster, its de Broglie wavelength
A) increases.
B) decreases.
C) remains constant.
45. When an electron is accelerated to a higher speed, there is a decrease in its
A) energy.
B) frequency.
C) wavelength.
46. What advantage might an electron microscope have over a light microscope?
A) Electrons are more powerful.
B) Shorter wavelengths are possible.
C) Longer wavelengths are possible.
47. When an electron jumps from an orbit where $n = 4$ to one where $n = 3$
A) a photon is emitted.
B) a photon is absorbed.
C) two photons are emitted.
48. The distance between adjacent orbit radii in a hydrogen atom
A) increases with increasing values of n .
B) decreases with increasing values of n .
C) remains constant for all values of n .
49. If r_1 is the smallest orbital radius around a single proton, then r_6 is equal to
A) $36r_1$.
B) $12r_1$.
C) $6r_1$.
50. The binding energy of the hydrogen atom in its ground state is -13.6 eV . What is the energy when it is in the $n = 5$ state?
A) 2.72 eV
B) -2.72 eV
C) -0.544 eV

$h = 6.626 \times 10^{-34} \text{ J.s}$, Rydberg constant $R = 1.097 \times 10^7 \text{ m}^{-1}$, $m_e = 9.1 \times 10^{-31} \text{ kg}$, $m_p = 1.67 \times 10^{-27} \text{ kg}$
 , electronic charge $= 1.6 \times 10^{-19} \text{ C}$

With my best wishes Prof. Dr. Ali A. Othman



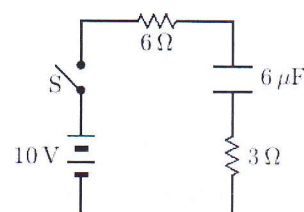
Constants: $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N m}^2$; $\mu_0 = 4\pi \times 10^{-7} \text{ N/A}^2$; $e = 1.6 \times 10^{-19} \text{ C}$; $m_e = 9.1 \times 10^{-31} \text{ kg}$; $N_A = 6.02 \times 10^{23} \text{ atoms/mole}$

Answer all the following questions

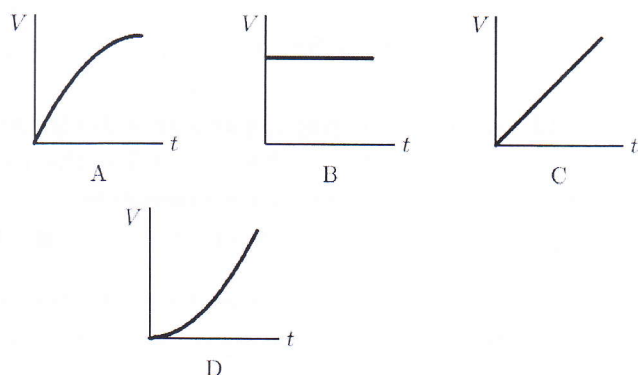
In the following multiple-choice questions, please chose the correct answer (1½ Mark each point)

1. In the circuit shown, the capacitor is initially uncharged. At time $t = 0$, switch **S** is closed. If τ denotes the time constant, the approximate current through the 3Ω resistor when $t = \tau/10$ is:

A. 0.38 A B. 0.75 A C. 1.0 A D. 1.5 A



2. Suppose the current charging a capacitor is kept constant. Which graph below correctly gives the potential difference **V** across the capacitor as a function of time?



3. A certain capacitor, in series with a resistor, is being charged. At the end of **10 ms** its charge is half the final value. The time constant for the process is about:

A. 0.43 ms B. 2.3 ms C. 10 ms D. 14 ms

4. A Faraday's law states that an induced emf is proportional to:

A. the rate of change of the magnetic field
B. the rate of change of the electric field
C. the rate of change of the magnetic flux
D. the rate of change of the electric flux

5. certain capacitor, in series with a **720 Ω** resistor, is being charged. At the end of **10 ms** its charge is half the final value. The capacitance is about:

A. 9.6 μF B. 20 μF C. 7.2 F D. 10 F

6. One hundred turns of insulated copper wire are wrapped around an iron core of cross-sectional area **0.100 m²**. The circuit is completed by connecting the coil to a **10 Ω** resistor. As the magnetic field along the coil axis changes from **1.00 T** in one direction to **1.00 T** in the other direction, the total charge that flows through the resistor is:

A. 2 C B. 0.02 C C. 1 C D. 0.2 C

7. A **10 turn** ideal solenoid has an inductance of **3.5 mH**. When the solenoid carries a current of **2.0 A** the magnetic flux through each turn is:

A. Zero B. $3.5 \times 10^{-4} \text{ Wb}$ C. $7.0 \times 10^{-4} \text{ Wb}$ D. $7.0 \times 10^{-2} \text{ Wb}$

8. A **10 turn** ideal solenoid has an inductance of **4.0 mH**. To generate an emf of **2.0 V** the current should change at a rate of:

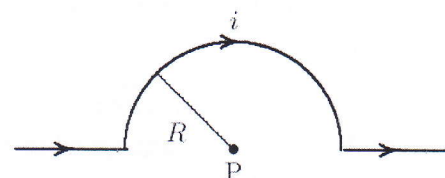
A. 5.0 A/s B. 50 A/s C. 250 A/s D. 500 A/s

9. An **8.0 mH** inductor and a **2.0 Ω** resistor are wired in series to an ideal battery. A switch in the circuit is closed at time **0**, at which time the current is **zero**. The current reaches half its final value at time:
- A. 2.8 ms B. 3 s C. 170 s D. 250 s
10. An **8.0 mH** inductor and a **2.0 Ω** resistor are wired in series to a **20 V** ideal battery. A switch in the circuit is closed at time **0**, at which time the current is **zero**. After a long time the current in the resistor and the current in the inductor are:
- A. 0, 0 B. 10 A, 10 A C. 2.5 A, 2.5 A D. 10 A, 0
11. A current of **10 A** in a certain inductor results in a stored energy of **40 J**. When the current is changed to **5 A** in the opposite direction, the stored energy changes by:
- A. 20 J B. 30 J C. 40 J D. 50 J
12. A **6.0 mH** inductor is in a series circuit with a resistor and an ideal battery. At the instant the current in the circuit is **5.0 A** the energy stored in the inductor is:
- A. 7.5×10^{-2} J B. 15×10^{-2} J C. 30×10^{-2} J D. 30×10^2 J
13. A charged capacitor and an inductor are connected in series. At time **t = 0** the current is **zero**, but the capacitor is charged. If **T** is the period of the resulting oscillations, the next time after **t = 0** that the current is a maximum is:
- A. T B. T/4 C. T/2 D. 2T
14. A charged capacitor and an inductor are connected in series. At time **t = 0** the current is zero, but the capacitor is charged. If **T** is the period of the resulting oscillations, the next time after **t = 0** that the energy stored in the electric field of the capacitor is a maximum is:
- A. T/4 B. T/2 C. 2T D. None of these
15. A capacitor in an **LC** oscillator has a maximum potential difference of **15 V** and a maximum energy of **360 μ J**. At a certain instant the energy in the capacitor is **40 μ J**. At that instant what is the potential difference across the capacitor?
- A. 5 V B. 10 V C. 15 V D. 20 V
16. We desire to make an **LC** circuit that oscillates at **100 Hz** using an inductance of **2.5 H**. We also need a capacitance of:
- A. 1 mF B. 1 μ F C. 100 μ F D. 1 pF
17. Radio receivers are usually tuned by adjusting the capacitor of an **LC** circuit. If **C = C₁** for a frequency of **600 kHz**, then for a frequency of **1200 kHz** one must adjust **C** to:
- A. C₁/2 B. C₁/3 C. C₁/4 D. 4C₁
18. A capacitor in an **LC** oscillator has a maximum potential difference of **15 V** and a maximum energy of **360 μ J**. At a certain instant the energy in the capacitor is **40 μ J**. At that instant what is the emf induced in the inductor?
- A. 30 V B. 10 V C. 5 V D. 2 V
19. An **RLC** circuit has a resistance of **200 Ω** and an inductance of **15 mH**. Its oscillation frequency is **7000 Hz**. At time **t = 0** the current is **25 mA** and there is no charge on the capacitor. After five complete cycles the current is:
- A. 1.8×10^{-6} A B. 2.1×10^{-4} A C. 2.3×10^{-3} A D. 3.5×10^{-2} A
20. An **RLC** circuit has a capacitance of **12 μ F**, an inductance of **25 mH**, and a resistance of **60 Ω** . The current oscillates with an angular frequency (in **rad/s**) of:
- A. 1.2×10^3 B. 1.8×10^3 C. 2.2×10^3 D. 1.4×10^3

21. A coil has a resistance of $60\ \Omega$ and an impedance of $100\ \Omega$. Its reactance, in ohms, is:
 A. 60 B. 80 C. 100 D. 120
22. A $45\ \text{mH}$ inductor is connected to a source of sinusoidal emf with a frequency of $400\ \text{Hz}$ and a maximum emf of $20\ \text{V}$. The maximum current is:
 A. $0.18\ \text{A}$ B. $1.1\ \text{A}$ C. $360\ \text{A}$ D. zero
23. An RL series circuit is connected to an ac generator with a maximum emf of $20\ \text{V}$. If the maximum potential difference across the resistor is $16\ \text{V}$, then the maximum potential difference across the inductor is:
 A. $4\ \text{V}$ B. $6\ \text{V}$ C. $12\ \text{V}$ D. $16\ \text{V}$
24. An RLC series circuit has $L = 100\ \text{mH}$ and $C = 1\ \mu\text{F}$. It is connected to a $1000\ \text{Hz}$ source and the source emf is found to lead the current by 75° . The value of R is:
 A. $12.6\ \Omega$ B. $126\ \Omega$ C. $175\ \Omega$ D. $1750\ \Omega$
25. An RLC series circuit is connected to an oscillator with a maximum emf of $100\ \text{V}$. If the voltage amplitudes V_R , V_L , and V_C are all equal to each other, then V_R must be:
 A. $33\ \text{V}$ B. $50\ \text{V}$ C. $67\ \text{V}$ D. $100\ \text{V}$
26. An ac generator producing $10\ \text{V}$ (rms) at $200\ \text{rad/s}$ is connected in series with a $50\ \Omega$ resistor, a $400\ \text{mH}$ inductor, and a $200\ \mu\text{F}$ capacitor. The rms current in amperes is:
 A. 0.135 B. 0.18 C. 0.20 D. 0.40
27. A series circuit consists of a $15\ \Omega$ resistor, a $25\ \text{mH}$ inductor, and a $35\ \mu\text{F}$ capacitor. If the frequency is $100\ \text{Hz}$ the power factor is:
 A. 0 B. 0.45 C. 0.89 D. 1
28. An ac generator producing $10\ \text{V}$ (rms) at $200\ \text{rad/s}$ is connected in series with a $50\ \Omega$ resistor, a $400\ \text{mH}$ inductor, and a $200\ \mu\text{F}$ capacitor. The rms voltage (in volts) across the capacitor is:
 A. 2.5 B. 3.4 C. 6.7 D. 10
29. The main reason that alternating current replaced direct current for general use is:
 A. ac generators do not need slip rings
 B. electric clocks do not work on dc
 C. ac voltages may be conveniently transformed
 D. ac minimizes magnetic effects
30. An ac generator produces $10\ \text{V}$ (rms) at $400\ \text{rad/s}$. It is connected to a series RL circuit ($R = 17.3\ \Omega$, $L = 0.025\ \text{H}$). The rms current is:
 A. $0.50\ \text{A}$ and leads the emf by 30°
 B. $0.50\ \text{A}$ and lags the emf by 30°
 C. $0.71\ \text{A}$ and lags the emf by 30°
 D. $1.40\ \text{A}$ and lags the emf by 60°

31. The magnitude of the magnetic field at point P, at the center of the semicircle shown, is given by:

A. $2\mu_0 i/R$ B. $3\mu_0 i/2R$ C. $\mu_0 i/4R$ D. $\mu_0 i/2R$



32. The magnetic field a distance $2\ \text{cm}$ from a long straight current-carrying wire is $2.0 \times 10^{-5}\ \text{T}$. The current in the wire is:
 A. $0.16\ \text{A}$ B. $2\ \text{A}$ C. $6\ \text{A}$ D. $7.3\ \text{A}$

33. Lines of the magnetic field produced by a long straight wire carrying a current are:

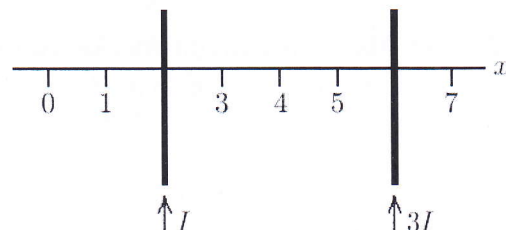
- A. in the direction of the current
- B. opposite to the direction of the current
- C. circles that are concentric with the wire
- D. radially outward from the wire

34. Two long straight wires are parallel and carry current in the same direction. The currents are **8.0** and **12 A** and the wires are separated by **0.40 cm**. The magnetic field in tesla at a point midway between the wires is:

- A. 0 B. 4×10^{-4} C. 1.6×10^{-2} D. 6×10^{-3}

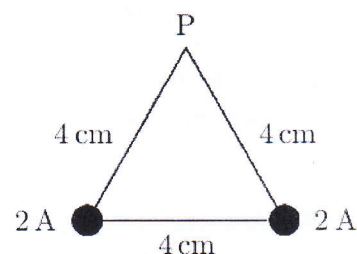
35. Two long straight current-carrying parallel wires cross the x-axis and carry currents **I** and **3I** in the same direction, as shown. At what value of x is the net magnetic field zero?

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



36. Two long straight wires pierce the plane of the paper at vertices of an equilateral triangle as shown below. They each carry **2 A**, out of the paper. The magnetic field at the third vertex (P) has magnitude (in T):

- A. 1.7×10^{-5} B. 1.6×10^{-2} C. 1.5×10^{-4} D. 1.8×10^{-8}



37. Solenoid **2** has twice the radius and six times the number of turns per unit length as solenoid **1**. The ratio of the magnetic field in the interior of **2** to that in the interior of **1** is:

- A. 6 B. $1/3$ C. $1/6$ D. 3

38. A **2-T** uniform magnetic field makes an angle of **30°** with the z-axis. The magnetic flux through a **3-m²** portion of the xy plane is:

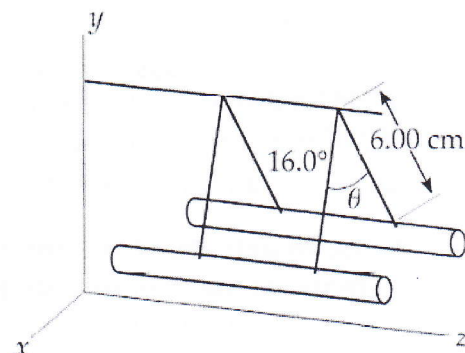
- A. 2.3 Wb B. 5.2 Wb C. 16 Wb D. 32.4 Wb

39. The normal to a certain **1-m²** area makes an angle of **60°** with a uniform magnetic field. The magnetic flux through this area is the same as the flux through a second area that is perpendicular to the field if the second area is:

- A. 0.5 m² B. 3.1 m² C. 6.8 m² D. 20 m²

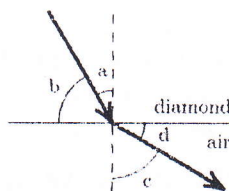
40. Two long, parallel wires, each having a mass per unit length of **40 g m⁻¹**, are supported in a horizontal plane by strings **6 cm** long. When both wires carry the same current, **I**, the wires repel each other so that the angle, **θ**, between the supporting strings is **16°**, the magnitude of the current is:

- A. 3.2 mA B. 67.8 A C. 12 mA D. 12 A



Choose the correct answer for the following questions:

1. Newton's theory of light treated light as _____ while Young demonstrated that light behaved as _____ with _____ behavior.
A. particles, waves, refractive
B. particles, waves, interference
C. waves, particles, interference
D. waves, particles, refractive
2. In a plane electromagnetic wave in vacuum, the ratio E/B of the amplitudes in SI units of the two fields is:
A. the speed of light
B. an increasing function of frequency
C. a decreasing function of frequency
D. $\sqrt{2}$
3. In a Young's double-slit experiment, the slit separation is doubled. To maintain the same fringe spacing on the screen, the screen-to-slit distance D must be changed to:
A. $D/2$
B. $D/\sqrt{2}$
C. $\sqrt{2}D$
D. $2D$
4. The resolving power R of a grating can have units:
A. cm
B. degree/nm
C. watt
D. nm/nm
5. In optical fiber waveguide, the core section is surrounded by the cladding section which is made of glass or plastic with
A. a lower refractive index than the core
B. equal refractive index of the core
C. a higher refractive index than the core
D. lower or higher depend on the application
6. The relation $n_1 \sin \theta_1 = n_2 \sin \theta_2$, which applies as a ray of light strikes an interface between two media, is known as:
A. Gauss' law
B. Snell's law
C. Faraday's law
D. Cole's law
7. Bragg's law x-ray diffraction is $2d \sin \theta = m\lambda$, θ is the angle between the incident beam and:
A. a reflecting plane of atoms
B. the scattered beam
C. the normal to a reflecting plane of atoms
D. the refracted beam
8. For an electromagnetic wave the direction of the vector $\vec{E} \times \vec{B}$ gives:
A. the direction of the electric field
B. the direction of the magnetic field
C. the direction of wave propagation
D. the direction of the emf induced by the wave
9. Once the power of an optical pulse in optical fiber is reduced to a point where the receiver is unable to detect the pulse, an error occurs. Attenuation is mainly a result of light
A. absorption
B. absorption
C. bending losses
D. all of them
10. Which property limits how fast information is transferred. An error occurs when the receiver is unable to distinguish between input pulses caused by the spreading of each pulse?
A. distortion
B. dispersion
C. losses
D. scattering
11. In the equation $\phi = (2\pi a/\lambda) \sin \theta$ for single-slit diffraction, ϕ is:
A. the angle to the first minimum
B. the angle to the second maximum
C. the phase angle between the extreme rays
D. $N\pi$ where N is an integer
12. The critical angle of a diamond-air interface is 25° . if light is incident at an angle of θ with the normal. Total internal reflection will occur if the incident medium is:
A. diamond and $\theta < 25^\circ$
B. air and $\theta = 25^\circ$
C. diamond and $\theta > 25^\circ$
D. air and $\theta > 25^\circ$
13. The numerical aperture is an important quantity because it is used to determine the coupling and dispersion characteristics of the fiber. The numerical aperture values are
A. less than one
B. greater than one

- C. equal one
D. variable values
14. The reason there are two slits, rather than one, in a Young's experiment is:
A. to increase the intensity
B. one slit is for v , the other for λ
C. to create a path length difference
D. one slit is for E , the other is for B
15. In the equation $d \sin \theta = m\lambda$ for the lines of a diffraction grating m is:
A. the number of slits
B. the slit separation
C. the slit width
D. the order of the line
16. If light ray is transmitted through an air-to-glass boundary, what happens to the wavelength?
A. increases
B. decreases
C. remains unchanged
D. equal zero
17. In the equation $\sin \theta = \lambda/a$ for single-slit diffraction, θ is:
A. the angle to the first minimum
B. the angle to the second maximum
C. the phase angle between the extreme rays
D. $N\pi$ where N is an integer
18. Maxwell's equations predict that the speed of electromagnetic waves in free space is given by:
A. $\mu_0 \epsilon_0$
B. $\sqrt{\mu_0 \epsilon_0}$
C. $1/\mu_0 \epsilon_0$
D. $1/\sqrt{\mu_0 \epsilon_0}$
19. In a Young's double-slit, light of wavelength 500 nm illuminates two slits that are separated by 1 mm. The separation between adjacent bright fringes on a screen 5 m from the slits is:
A. 0.10 cm
B. 0.25 cm
C. 0.50 cm
D. 1.0 cm
20. The diamond refraction index is 2.5. Which of the following is correct for the situation shown?
A. $(\sin a)/(\sin b) = 2.5$
B. $(\sin b)/(\sin d) = 2.5$
C. $(\cos a)/(\cos c) = 2.5$
D. $(\sin c)/(\sin a) = 2.5$
- 
21. How many lines in a grating must be illuminated to obtain a resolving power of 300 in a third-order spectrum?
A. 900
B. 300
C. 10
D. 100
22. A fiber has a core index of 1.499 and a cladding index of 1.479. When surrounded by air the numerical aperture is:
A. 14.1
B. 28.2
C. 0.244
D. 0.5
23. A plane wave with a wavelength of 500 nm is incident normally on a single slit with a width of $5.0 \times 10^{-6} \text{ m}$. Consider waves that reach a point on a far-away with an angle of 1.0° with the normal. The difference in phase for waves from the top and bottom of the slit is:
A. 0
B. 0.55 rad
C. 1.1 rad
D. 1.6 rad
24. What is the minimum number of slits required in a diffraction grating to just resolve light with wavelengths of 471.0 nm and 471.6 nm?
A. 99
B. 197
C. 393
D. 786
25. An electromagnetic wave carries magnetic field component with a peak of $1.5 \times 10^{-7} \text{ T}$. The average power per unit area is: ($\mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$ and $c = 3 \times 10^8 \text{ m/s}$)



Assiut University
Faculty of Science
Physics Department



Principles of Solid-State Physics (350)
Date: 12/03/2021

Final Exam
Friday

1st semester 2020/2021
Time Exam: 2 h

"يتم طمس (تسويد) الإجابة المختارة من قبل الطالب باستخدام القلم الجاف فقط"

Q1: Choose the correct answer A, B, C or D:

(1 Mark each)

1. Any deviation from the perfect atomic arrangement in a crystal is said to Contain.....
 - A. Defects
 - B. Effects
 - C. Dislocations
2. Solids havebonds between molecules and atoms than liquids.
 - A. Strong
 - B. Weak
 - C. High
3. Amorphous materials have order only within aatomic or molecular dimension.
 - A. Many
 - B. Few
 - C. Some
4. Amorphous materials do not have any, but they have varying degrees of
 - A. long-range order, Short-range order
 - B. Short-range order, long-range order
 - C. long-range order, medium-range order
5. Atoms or ions of a solid are arranged in a pattern that repeats itself in three dimensions; they form a solid that is said to have astructure.
 - A. Lattice
 - B. Crystal
 - C. Polycrystal
6. Materials arranged in short range order are calledmaterials.
 - A. Crystal
 - B. Polycrystal
 - C. Amorphous
7. The strength and ductility of metals are controlled by
 - A. Surface
 - B. Dislocations
 - C. Defects
8. A change in the stacking sequence over a few atomic spacing's produces a stacking faults whereas a change over many atomic spacing produces a
 - A. Crystal
 - B. Twin region
 - C. Grain boundaries
9. Generally, rapid cooling produces whereas slow cooling result in larger grains
 - A. Smaller grains
 - B. Larger grains
 - C. Medium grains

10. The term 'phase' refers to that region of space occupied by a physically homogeneous material. These regions are often called
- A. Dislocations
 - B. Precipitates
 - C. Faults
11. When a void occurs due to the shrinkage of a material as it solidifies, it is called
- A. Porosity
 - B. Cavitation
 - C. Velocity
12. When voids occur due to air bubbles becoming trapped when a material solidifies, it is commonly called.....
- A. Porosity
 - B. Cavitation
 - C. Velocity
13. Grain boundaries are a kind ofdefects.
- A. Point
 - B. Volume
 - C. Surface
14. Vacancy is a kind ofdefects.
- A. Point
 - B. Volume
 - C. Surface
15. Voids are a kind ofdefects.
- A. Point
 - B. Volume
 - C. Line
16. The combination of anion cation vacancies (in pairs) is called..... imperfections.
- A. Columb
 - B. Schottkey
 - C. Frankel
17. The combination of a vacancy and interstitial is called a imperfections.
- A. Columb
 - B. Schottkey
 - C. Frankel
18. Neutron does not interact with electrons in the crystal. Thus, unlike the x-ray, which is scattered entirely by, the neutron is scattered entirely by nuclei.
- A. Electrons
 - B. Nuclei
 - C. Protons
19. Neutron diffraction is an important tool in the investigation ofordering that occur in some materials.
- A. Electrical
 - B. Optical
 - C. Magnetic
20. Electron diffraction is a useful technique forstructure studies.

- A. Surface
 - B. Body
 - C. Internal
21. Electrons are scattered strongly in air, so diffraction experiment must be carried out in avacuum.
- A. Low
 - B. High
 - C. Medium
22. In crystals the typical interatomic spacing aboutso the suitable radiation is X-rays.
- A. 1-2 Å°
 - B. 2-3 Å°
 - C. 2-3 nm
23. Neutrons are more useful than X-rays for determining the crystal structures of solids containingelements.
- A. Heavy
 - B. Light
 - C. Small
24. The physical basis for the diffraction of electron andbeams is the same as that for X-rays diffraction.
- A. Proton
 - B. Deuteron
 - C. Neutron
25. Neutron radiations have an energy equal to 0.08 eV but the X-rays have an energy equal to 10 KeV but they have the same wavelength about
- A. 1 Å°
 - B. 2 Å°
 - C. 3 Å°
26. X-rays can be created by bombarding a metal target with high energy electrons.
- A. $< 10^4$
 - B. $> 10^4$
 - C. $\approx 10^4$
27. Neutron energy magnitude as the thermal energy kT for this reason we speak of
- A. Thermal electrons
 - B. Thermal neutrons
 - C. Thermal protons
28. The three general types of solids are.....,,
- A. Crystal, Lattice, Polycrystal
 - B. Polycrystal, Single Crystal, Precipitates
 - C. Single Crystal, Polycrystalline, Amorphous
29. The branch of science that deals with the geometric description of crystals and their internal arrangement is
- A. The polymorphism
 - B. The crystallography
 - C. The condensed matter

30. An imaginary network of lines, with atoms at intersection of lines, representing the arrangement atoms is called
- Space lattice.
 - Space group
 - Twin regions
31. is that block of atoms which repeats itself to form space lattice.
- Crystal lattice
 - Unit cell
 - Graine boundary
32. is an extra atom that has crowded its way into an interstitial void in the crystal structure.
- Substitutional impurity
 - Interstitial impurity
 - Self interstitial
33. is an atom of a different type than the bulk atoms, which has replaced one of the bulk atoms in the lattice.
- Substitutional impurity
 - Interstitial impurity
 - Self-interstitial
34. are regions where there are a large number of atoms missing from the lattice.
- Vacancies
 - Voids
 - Grains
35. a phenomenon that material has more than one crystal structure.
- The polymorphism
 - The crystallography
 - The condensed matter
36. has an atomic structure that repeats periodically across its whole volume.
- Polycrystal
 - Single crystal
 - Amorphous
37. Polycrystals with grains that are <10 nm in diameter are called.....
- Single crystals
 - Nanocrystalline
 - Polycrystalline
38. The type of defect that influences the mechanical properties of a material is called.....
- Dislocations
 - Precipitates
 - Faults
39. Graphite is a metal, diamond is an insulator and buckminsterfullerene is a they are all just carbon.
- Semiconductor
 - Superconductor
 - Conductor
40. have mobile molecules, but a type of long range order can exist.
- Amorphous
 - Polycrystals
 - Liquid crystals

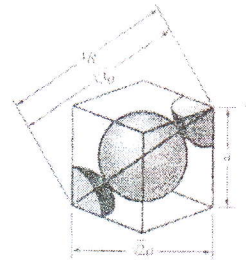
Q2: Choose the correct answer A, B, C or D:

(2 Mark each)

41. Copper has an FCC crystal structure and a unit cell with a lattice constant of 0.361 nm. What is its interplanar spacing d_{220} ?
- A. 0.128 nm
 - B. 7.834 nm
 - C. 0.180 nm

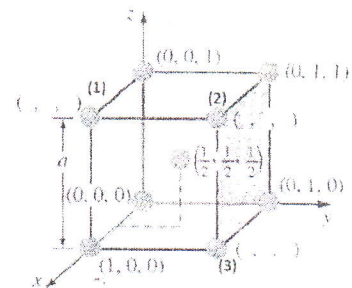
42. Iron at 20 °C is BCC with atoms of atomic radius 0.124 nm. Calculate the lattice constant (a) for the cube of the iron unit cell.

- A. 0.350 nm
- B. 0.286 nm
- C. 0.859 nm



43. The position coordinates of the absent atoms with numbers (1), (2) and (3) in the BCC crystal structure are.....

- A. (1, 0, 1), (1, 1, 1), (1, 1, 0)
- B. (0, 0, 1), (1, 1, 1), (1, 1, 0)
- C. (1, 0, 1), (1, 1, 0), (1, 1, 0)



44. The d-spacing's for the same planes in a crystal with unit cell $a = b = 7 \text{ \AA}$, $c = 9 \text{ \AA}$. Is
- A. 4.3 nm
 - B. 2.3 nm
 - C. 0.43 nm

45. A cubic crystal has $a=5.2 \text{ \AA}$ the d-spacing of the (1 1 0) plane of this cubic crystal is.....
- A. 2.7 nm
 - B. 3.6 nm
 - C. 0.36 nm



Assiut University

Final Exam + Oral : Electronics

Code:361P

Date: 13/3/2021

Time: 3 hours



Faculty of Science
Physics Department

لاحظ :

- في حالة اختيار اكثر من اجابة للنقطة الواحدة سيتم احتساب الاجابة خاطئة
- يجب ان يكون التظليل واضح و معتم للدائرة
- لا يمكن تعديل الاجابة بعد تظليل الدائرة و من حق الطالب ورقة اجابة واحدة فقط
- لن يلتفت الى اى اجابات خارج الجدول فى الورقة الاخيرة
- كل اجابة صحيحة تقابلها درجة واحدة
- بعض الثوابت التى قد تحتاج اليها

Color	Construction	Typical Forward Voltage (V)
Amber	AlInGaP	2.1
Blue	GaN	5.0
Green	GaP	2.2
Orange	GaAsP	2.0
Red	GaAsP	1.8
White	GaN	4.1
Yellow	AlInGaP	2.1

- Electron charge $1.6 \times 10^{-19} \text{ C}$,
- Boltzmann's constant $1.38 \times 10^{-23} \text{ J/K}$,
- Forward voltage V_K for:
Si 0.7 V, Ge 0.3 V, GaAs 1.2 V

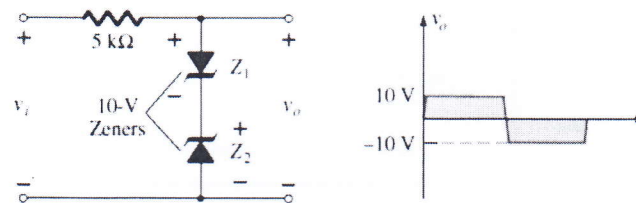
First Question

True or false

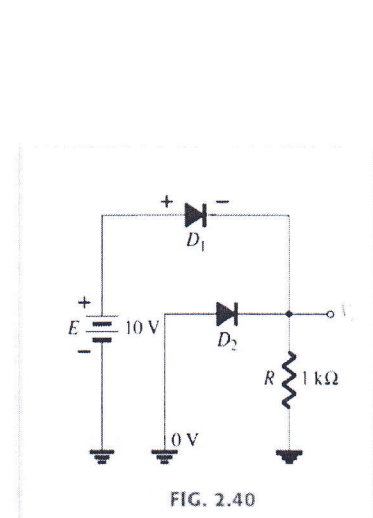
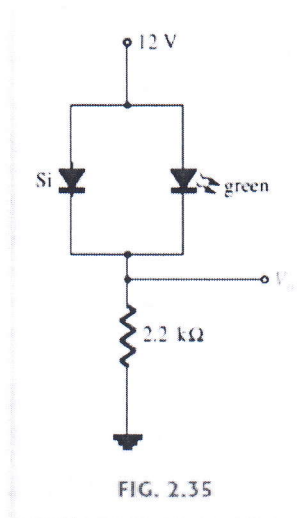
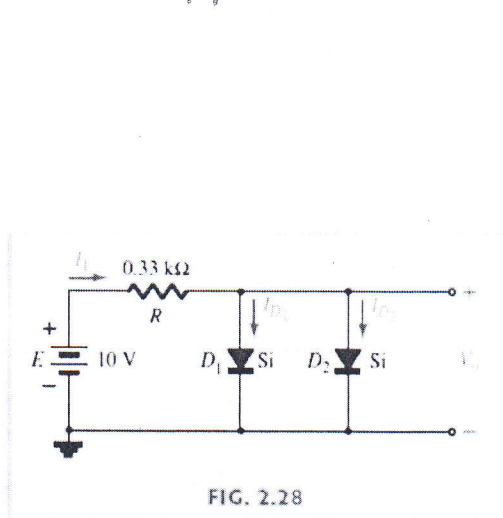
(1.25 Mark for each = 50 Marks)

1. Semiconductors are a special class of elements having conductivity between that of a good conductor and that of an insulator.
2. The three semiconductors used most frequently in the construction of electronic devices are Ge, Si, and GaAs.
3. This bonding of atoms, strengthened by the sharing of electrons, is called covalent bonding.
4. Semiconductor materials have a negative temperature coefficient.
5. $1\text{eV} = 1.6 \times 10^{-19} \text{ J}$
6. There is always a wide energy gap between the valence band and the conduction band in insulators.
7. A semiconductor material that has been subjected to the doping process is called an extrinsic material.
8. A P-type semiconductor is created by doping Si, Ge, or GaAs with three valence-impurities.
9. In N-type material, the electron is the majority charge carrier and the hole is the minority carrier.
10. The region of uncovered positive and negative ions is called the depletion region due to the "depletion" of free carriers in the region.
11. The wide end of the arrow on a diode schematic indicates the p-type material.
12. Under normal conditions, the PN-junction is conducting current when it is forward-biased.

13. In the absence of an applied bias across a semiconductor diode, the net flow of charge in one direction is zero.
14. Forward bias is applying an external potential across the PN-junction such that the positive terminal is connected to the P-type material and the negative terminal is connected to the N-type material.
15. As the forward potential difference through a silicon diode increases, the internal resistance decreases.
16. The maximum reverse-bias potential that can be applied before entering the breakdown region is called the peak inverse voltage or the peak reverse voltage.
17. The thermal voltage V_T is around 40 mV if the temperature is 191 °C.
18. When the diode is used as a rectifier, the PIV must equal or exceed the peak value $V_{\max}$ of the applied voltage.
19. The Zener diode is conducting when it is forward or reversed biased with enough large potential difference.
20. For large values of a sinusoidal input wave v_i , the output waveform v_o is as shown for this circuit.



21. For a forward-biased diode, the barrier potential remains constant as temperature increases.
22. Diodes constructed of Si and Ge emit light in the infrared (invisible) zone during the recombination process at the p-n junction.
23. The wavelength and frequency of light of a specific color are not related to the energy bandgap of the material.
24. A short circuit can have any voltage across its terminals, but the current is always 0.
25. For the circuit shown in Fig. 2.28, I_{D1} and I_{D2} are not of the same magnitude.
26. For the circuit shown in Fig. 2.35, the green diode is in the "off" state.
27. For the circuit shown in Fig. 2.40, $V_O = 9.3$ volts if the diodes are Silicone.



28. In the half-wave rectifier shown in Fig. 2.44, the output voltage v_o equals $(0.318 V_m)$ for an ideal diode.

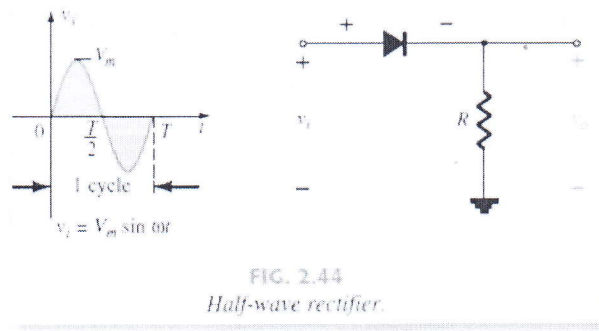
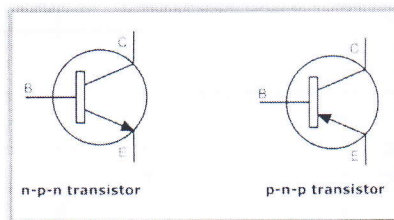


FIG. 2.44
Half-wave rectifier.

29. Clippers are networks that employ diodes to clip away a portion of an input signal without distorting the remaining part of the applied waveform.

30. The terminal with an arrow in the bipolar junction transistor represents the emitter of this transistor.



31. The common base transistor configuration circuit is characteristic with no current gain but has a voltage gain.

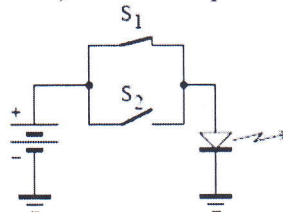
32. The quantity alpha ($\alpha = \frac{I_C}{I_E}$) relates the collector and emitter currents and is always close to one.

33. The quantity beta ($\beta = \frac{I_C}{I_B}$) provides an important relationship between the base and collector currents and is usually between 50 and 400.

34. The NOT function (as $B = \bar{A}$) provides the complementary state to a given variable, so if $A=0$, then $B=1$.

35. The output of the AND function takes the high logic level ($= 1$), if and, only if, the input variables are at the high logic level ($= 1$).

36. A simple representation for the OR function is this circuit, if the switches S_1 and S_2 are the inputs and the LED state (on/off) is the output.



37. For any logic variable A , $(0 \cdot A = A \cdot 0 = 0)$.

38. For any logic variable A , $(A + \bar{A} = 1)$.

39. In Boolean Algebra, $A + (B \cdot C) = (A + B) \cdot (A + C) = A + B \cdot A + C$.

40. De Morgan's Theorem states that for any two logic variables A and B , $(\overline{A + B} = \bar{A} \cdot \bar{B})$.

Second Question (Oral)

(1.25 Mark for each = 10 Marks)

1st part

Choose the output waveform from **Table II** for each network in **Table I** if the input is as shown

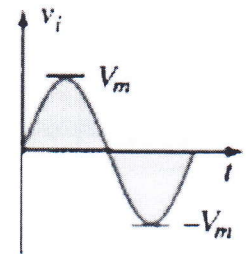


Table I

41		42	
43		44	

Table II

A		B	
C		D	

2nd part

Choose the output waveform from **Table IV** for each network in **Table III** if the input is as shown

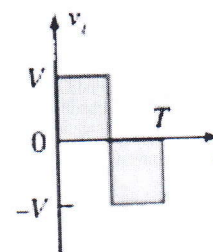


Table III

45		46	
47		48	

Table IV

A		B	
C		D	

Answer Sheet

First Question

True or false

(1.25 Mark for each = 50 Marks)

- | | | | | | | | | | | | |
|----|-------------------------|-------------------------|----|-------------------------|-------------------------|----|-------------------------|-------------------------|----|-------------------------|-------------------------|
| 1 | ☐ T | ☐ F | 6 | ☐ T | ☐ F | 11 | ☐ T | ☐ F | 16 | ☐ T | ☐ F |
| 2 | ☐ T | ☐ F | 7 | ☐ T | ☐ F | 12 | ☐ T | ☐ F | 17 | ☐ T | ☐ F |
| 3 | ☐ T | ☐ F | 8 | ☐ T | ☐ F | 13 | ☐ T | ☐ F | 18 | ☐ T | ☐ F |
| 4 | ☐ T | ☐ F | 9 | ☐ T | ☐ F | 14 | ☐ T | ☐ F | 19 | ☐ T | ☐ F |
| 5 | ☐ T | ☐ F | 10 | ☐ T | ☐ F | 15 | ☐ T | ☐ F | 20 | ☐ T | ☐ F |
| 21 | ☐ T | ☐ F | 26 | ☐ T | ☐ F | 31 | ☐ T | ☐ F | 36 | ☐ T | ☐ F |
| 22 | ☐ T | ☐ F | 27 | ☐ T | ☐ F | 32 | ☐ T | ☐ F | 37 | ☐ T | ☐ F |
| 23 | ☐ T | ☐ F | 28 | ☐ T | ☐ F | 33 | ☐ T | ☐ F | 38 | ☐ T | ☐ F |
| 24 | ☐ T | ☐ F | 29 | ☐ T | ☐ F | 34 | ☐ T | ☐ F | 39 | ☐ T | ☐ F |
| 25 | ☐ T | ☐ F | 30 | ☐ T | ☐ F | 35 | ☐ T | ☐ F | 40 | ☐ T | ☐ F |

Second Question (Oral)

1st part

(1.25 Mark for each = 10 Marks)

- | | | | | |
|----|-------------------------|-------------------------|-------------------------|-------------------------|
| 41 | ☐ A | ☐ B | ☐ C | ☐ D |
| 42 | ☐ A | ☐ B | ☐ C | ☐ D |
| 43 | ☐ A | ☐ B | ☐ C | ☐ D |
| 44 | ☐ A | ☐ B | ☐ C | ☐ D |

2nd part

- | | | | | |
|----|-------------------------|-------------------------|-------------------------|-------------------------|
| 45 | ☐ A | ☐ B | ☐ C | ☐ D |
| 46 | ☐ A | ☐ B | ☐ C | ☐ D |
| 47 | ☐ A | ☐ B | ☐ C | ☐ D |
| 48 | ☐ A | ☐ B | ☐ C | ☐ D |

جامعة أسيوط - كلية العلوم - قسم الفيزياء
الاختبار النهائي - الفصل الدراسي الأول 2020 - الفيزياء الإحصائية ٣١٣ ف -
الزمن: ثلاث ساعات. اجب عن الآتي.

السؤال الأول

- ١ - اكتب ثلاث معادلات تعرف ثلاث دوال حالة.
- ب - اكتب ثلاث معادلات حالة. تخير إحداها لحساب المعامل الفريالي الثاني لنظام تصفه هذه المعادلة.

السؤال الثاني

- ١ - اكتب ثلاث تعبيرات للانتروبي.
- ب - مستخدما تعبيرين مما ذكرت في الجزء السابق من هذا السؤال، احسب التغير في الانتروبي عندما يتمدد غاز إلى ضعف حجمه مع بقاء طاقة ثابتة.

السؤال الثالث

- ١ - اثبت أن $\langle x^2 \rangle > \langle x \rangle^2$
- ب - احسب التغير في الطاقة الداخلية وفي الإنتالبي لغاز مثالي أثناء عملية أيزوثيرمية. ماذا عن التغير في طاقة هلمهولتز الحرة وكذلك التغير في طاقة جيبس.

السؤال الرابع

- ١ - اكتب توزيع ذات الحدين.
- ب - لقيم كبيرة لكل من N و n_1 ، بدلالة N احسب قيمة n_1 التي يكون عندها معامل ذات الحدين نهاية عظمى.

السؤال الخامس

- ١ - تحصل على الحجم المتاح أمام نظام عبارة عن متذبذب توافقي في بعد واحد كتلته m وثابت القوة له k .
- ب توصل لصيغة تعبر عن عدد خلايا الطور $\Omega(E)$ في مدى الطاقة من 0 إلى E للنظام السابق ومن ثم تعبيرا لطاقة المتذبذب إذا قيّدت حركته بحيث تأخذ $\Omega(E)$ أعدادا صحيحة. في عبارة واحدة، فسّر المدلول الفيزيائي للنتيجة التي حصلت عليها ومن ثم أشر إلى تعريف كل من الفوتون والفونون.

=====

Choose the correct answer A, B, C, or D : (One mark each)

- 1- When a neutral sodium atom loses one electron, it becomes
(A) Na^- ion (B) Na^{--} ion (C) Na^+ ion (D) Na^{++} ion
- 2- The maximum number of electrons for the energy level $n=3$ are equal to
(A) 12 (B) 9 (C) 18 (D) 15
- 3- The maximum number of electrons fill d -shell equals
(A) 10 (B) 8 (C) 6 (D) 2
- 4- In orthorhombic crystal structure, the primitive lattice vectors are
(A) $a = b \neq c$ (B) $a = b = c$ (C) $a \neq b \neq c$ (D) $a \neq b = c$
- 5- In tetragonal crystal structure, the primitive lattice vectors are
(A) $a = b \neq c$ (B) $a = b = c$ (C) $a \neq b \neq c$ (D) $a + b = c$
- 6- In a simple cubic structure, the relation between the cube edge (a) and the atomic radius (R) is
(A) $a = R$ (B) $a = 2R$ (C) $a = R/2$ (D) $a = \pi R$
- 7- For a body centered cubic lattice, the number of lattice points related to one unit cell is
(A) 1 point (B) 2 points (C) 3 points (D) 4 points
- 8- For a face centered cubic lattice, the number of lattice points related to one unit cell is
(A) 1 point (B) 2 points (C) 3 points (D) 4 points
- 9- For a simple cubic lattice, the number of lattice points related to one unit cell equals to
(A) 1 point (B) 2 points (C) 3 points (D) 4 points
- 10- For a simple cubic lattice, the nearest neighbors are equal to
(A) 4 point (B) 6 points (C) 8 points (D) 12 points

- 11- For a body centered cubic lattice, the nearest neighbors are equal to
(A) 4 point (B) 6 points (C) 8 points (D) 12 points
- 12- For a face centered cubic lattice, the nearest neighbors are equal to
(A) 4 point (B) 6 points (C) 8 points (D) 12 points
- 13- The energy required to remove one electron from a neutral atom is called the energy.
(A) Electron affinity (B) Ionization (C) Thermal (D) Cohesive
- 14- When a neutral atom gains one extra electron, the energy released is called the energy.
(A) Electron affinity (B) Ionization (C) Thermal (D) Cohesive
- 15- Energy gained from the chemical reaction $Na^+ + Cl^- \rightarrow NaCl$ is called the energy.
(A) Electron affinity (B) Ionization (C) Thermal (D) Cohesive
- 16- The chemical bonds between two silicon atoms inside silicon crystal is called
(A) Ionic bonds (B) Covalent bonds (C) Metallic bonds (D) van der Waals
- 17- The chemical bonds between two copper atoms inside copper crystal is called
(A) Ionic bonds (B) Covalent bonds (C) Metallic bonds (D) van der Waals
- 18- The chemical bonds between two water molecules inside ice crystal is called
(A) Ionic bonds (B) Covalent bonds (C) Metallic bonds (D) van der Waals
- 19- The chemical bonds between two hydrogen atoms in a gas state is called the Bonds.
(A) Ionic (B) Covalent (C) Metallic (D) van der Waals
- 20- The chemical bonds between one hydrogen atom and carbon atom in CH_4 gas is the bonds.
(A) Ionic (B) Covalent (C) Metallic (D) van der Waals
- 21- When you have a neutral sodium (Na_{23}^{11}) atom, the neutral atom has electrons.
(A) 11 (B) 12 (C) 13 (D) 0
- 22- When you have a neutral sodium (Na_{23}^{11}) atom, the neutral atom has neutrons.
(A) 11 (B) 12 (C) 13 (D) 0

- 23- When you have a neutral sodium (Na_{23}^{11}) atom, its atomic weight is equal to
 (A) 11 (B) 12 (C) 23 (D) 0
- 24- The electronic configuration of the neutral sodium atom is
 (A) $1s^2 2s^1 2p^6 3s^1$ (B) $1s^2 2s^2 2p^5 3s^1$ (C) $1s^2 2s^2 2p^6 3s^1$ (D) $1s^2 2s^2 2p^6 3s^2$
- 25- In the free electrons theory, the Fermi velocity of the electrons (v_F) equals to
 (A) $\hbar k_F$ (B) $\hbar k_F/m$ (C) $\hbar k_F/2$ (D) $2\hbar k_F$
- 26- In the free electrons theory, the Fermi energy of the electrons (E_F) equals to
 (A) $\hbar k_F^2$ (B) $(\hbar k_F)^2/m$ (C) $(\hbar k_F)^2$ (D) $(\hbar k_F)^2/2m$
- 27- Elements which have a very large resistance to the electric currents are called
 (A) conductors (B) diamagnetics (C) insulators (D) paramagnetics
- 28- Elements in which the electrons move as gas molecules are called
 (A) metals (B) diamagnetics (C) insulators (D) paramagnetics
- 29- When a free electron moves with velocity (v) into a magnetic field (B), the magnetic force will be zero if the angle (θ) between v and B equals
 (A) π (B) $\pi/2$ (C) $\pi/3$ (D) $\pi/4$
- 30- When a free electron moves with velocity (v) into a magnetic field (B), the magnetic force will have a maximum value if the angle (θ) between v and B equals
 (A) π (B) $\pi/2$ (C) $\pi/3$ (D) $\pi/4$
- 31- The electrical conductivity (σ) of the metal is given by
 (A) $\sigma = n \tau / m$ (B) $\sigma = n \tau / e^2 m$ (C) $\sigma = e^2 n \tau / m$ (D) $\sigma = e^2 / n \tau m$
- 32- The relation between the current density (J) and the electric field (E) inside a metal is
 (A) $J = \sigma^2 / E$ (B) $J = \sigma / E$ (C) $J = \sigma \cdot E^2$ (D) $J = \sigma \cdot E$
- 33- The volume of atoms belong to one unit cell divided by volume of the cell means
 (A) Fermi factor (B) Hall ratio (C) packing fraction (D) Avogadro number

- 34- The packing fraction of the face centered cubic lattice equals
(A) 26 % (B) 52 % (C) 68 % (D) 74 %
- 35- The packing fraction of the simple cubic lattice equals
(A) 26 % (B) 52 % (C) 68 % (D) 74 %
- 36- The energy stored in a spring is called the energy.
(A) kinetic (B) potential (C) chemical (D) nuclear
- 37- When atoms stay at equilibrium position, the attractive force will equal to the force.
(A) repulsive (B) spring (C) friction (D) chemical
- 38- Elements move away from regions of high magnetic fields are called
(A) conductors (B) diamagnetics (C) insulators (D) paramagnetics
- 39- Elements move towards regions of high magnetic fields are called
(A) conductors (B) diamagnetics (C) insulators (D) paramagnetics
- 40- Elements in which the electric currents can go through very easily are called
(A) conductors (B) diamagnetics (C) insulators (D) paramagnetics
- 41- When an electric charge ($+q$) moves with velocity (v) into an electric field (E), the electric force increases if
(A) v decreases (B) v increases (C) E increases (D) q decreases
- 42- When two resistors (3 & 6 ohm) are connected in parallel, the equivalent resistance equals
(A) 2 ohm (B) 3 ohm (C) 6 ohm (D) 9 ohm
- 43- To measure the Hall coefficient in the element, the angle between the electric current and the applied magnetic field should be
(A) π (B) $\pi/2$ (C) $\pi/3$ (D) $\pi/4$
- 44- When a system looks the same when $x \rightarrow x + a$, then in k -space the dispersion looks the same if the change in k equals
(A) $2\pi/a$ (B) π/a (C) $\pi/2a$ (D) $\pi/4a$

- 45- "Electrons try to maximize their total orbital angular momentum". This rule is the
- (A) 1st Hunds (B) 2nd Hunds (C) 3rd Hunds (D) Madelung
- 46- "Electrons try to align their spins". This rule is the
- (A) 1st Hunds (B) 2nd Hunds (C) 3rd Hunds (D) Madelung
- 47- "The energy ordering is from lowest values of $(n + l)$ to the largest, and when two shells have the same value of $(n + l)$, fill the one with the smaller n first". This rule is the
- (A) 1st Hunds (B) 2nd Hunds (C) 3rd Hunds (D) Madelung
- 48- "The orbital and spin angular momentum either align or antialign , so that the total angular momentum is $J = [L \pm S]$ ". This rule is the
- (A) 1st Hunds (B) 2nd Hunds (C) 3rd Hunds (D) Madelung
- 49- Given a direct lattice point R . a point G is a point in the reciprocal lattice if and only if
- (A) $e^{i(G+R)}$ (B) $e^{i(G-R)}$ (C) $e^{i(G.R)}$ (D) $e^{(iG/R)}$
- 50- In one-dimensional case, the compressibility (β) depends on the spring constant (κ) and on the spacing between the atoms (a) as follows
- (A) $\beta = \kappa . a$ (B) $\beta = (\kappa . a)^{-1}$ (C) $\beta = \kappa / a$ (D) $\beta = \sqrt{\kappa . a}$

Answer the following questions:

“50Marks”

ملاحظة هامة: يقوم الطالب بطمس (تسويد) الاجابة المختارة باستخدام القلم الجاف فقط في نموذج الاجابة

(bible sheet)

Q.1: {Choose True (T) or False (F) for each sentences and put your answer in the bible sheet:

(25 Marks)

- 1- The enthalpy (H) of the solid materials reaches its maximum value at the () melting temperature.
- 2- The physical properties of amorphous Si is the same in all directions. ()
- 3- If r_C/r_A ratio for some oxides lies between (0.22-0.42) , then the () tetrahedral glass formation is possible.
- 4- The glass network modifiers usually enhance the chemical resistance of () the glass due to formation of NBO_s.
- 5- The glass transition temperature T_g of a glassy material is not heating () rate dependent.
- 6- The glass modifier cations for oxide glasses are generally of high valance () and form covalent bonds with oxygen.
- 7- Metallic glasses can be easily prepared using melt quench technique. ()
- 8- Chalcogenide glasses are generally brittle and have a low softening () temperature.
- 9- The crystalline solids generally have a definite heat of fusion. ()
- 10- The enthalpy (H) of a supercooled melt of a crystalline material () decreases exponentially during cooling tell to solidification point.
- 11- The degree of crystallization for a supercooled melt in equilibrium is () governed by the nucleation and growth rates.
- 12- High vacuum is not necessary during thin film preparation by electron () beam technique.
- 13- Urbach formula can be used to determine the band gap energy (E_g) for () a semiconductor thin film.
- 14- The constants A,B in Lasocka empirical formula for thermal analysis of () glass are heating rate dependent.
- 15- The optical loss in glasses used for fiber optics reaches its minimum at () wavelength in med IR range (1.5-1.6 μm).
- 16- Rayleigh scattering in a multi component glasses is mainly due to () composition fluctuations only.

- 17-The extended state conduction for amorphous chalcogenide glasses () generally takes place during measurement at high temperatures.
- 18-The band tail energy for amorphous semiconducting thin films can be () determined using the Tauc relation.
- 19-Thin films of high melting point materials can be easily prepared using () plasma sputtering technique.
- 20-The phenomena of electrochromic can be used to change the color of () transparent glasses.
- 21-Soda Ash and Lima stone are added to silicate glasses to increase the () network connectivity of this glass.
- 22-Flout processing technique is generally used to produce window glasses. ()
- 23-B₂O₃ glasses are the most suitable glass types for glass recycling. ()
- 24- Normal dispersion ($dn/d\lambda < 0$) for glasses takes place generally at UV () range of the spectrum.
- 25-Hand blown technique is generally used to prepare decorative glasses. ()

Q.2:Choose the correct answer for these statements and put your answer (A,B,C,D) in the bible sheet: (25 Marks)

26- The volume of the solid materials when transforms from solid to liquid state undergoes:

- A)- strong decrease B)-strong increase C)- slight increase D)- remain constant

27- At the crystallization transition region of amorphous solids, the temperature of the sample generally :

- A)- decreases B)- increases C)-remain the same D) None of the above

28-Addition of Alkali oxides to silicate glass resulted in:

- A)-increase network connectivity B) increases viscosity
C)- decreases diffusion coefficient D)- reducing chemical resistance

29- The most easy and popular technique generally used to prepare amorphous thin films is:

- A)- melt quench B)- CVD C)- Thermal evaporation D) sputtering

30- The refractive index of amorphous thin films depends on :

- A)-materials type B)-wavelength of incident photons

D) all the above

A)_ IR region

C)- VIS region

D)- FIR region

A)-convent bonds

B)- ionic bonds

C)- metallic bonds

D)- a,b

A)- between nearest neighbor atoms

B)- between dopant atoms at low temperature

C)-between localized states at fermi level

D)- inside conduction band

A)-glass transition region

B)- crystallization region

C) melting region

D)- All the above

A)- its unit cell parameters

B) the chemical composition

C)- the average coordination number

D)-the bond energy

A)- decrease sample temperature

B)- decrease the surrounding temperature

C)- $H = 0$

D)- $H < 0$

A)- electronic absorption

B) vibrational absorption

C)- a and b

D)- None of the above.

A)- 4

B)- between 2 and 3

C) - >4

D)- 0.22-0.42

3

A)-increase network connectivity

B)- decrease chemical resistance

A)- increasing softening point

D)- All of the above

40- The addition of Al_2O_3 to B_2O_3 glass results to :

A)- it acts as glass modifier

B)- it acts as glass former

C)- increase glass stability

D)- None of the above

41-The addition of alkaline earth oxide to silicate glass results to :

A)- creation of one NBO

B)- poor chemical durability

C)- increasing softening point

D)- all of the above

42-The amorphous solids soften at :

A)- definite temperature

B)- over a range of temperatures

C)- at the onset crystallization temperature

D)- None of the above

43- Chalcogenide glasses have many properties such as:

A)- electrically semiconducting material

B)- very strength

C)- soften at very high temperature

D)- b and c

44-Tetrahedral glassy thin films (α -Si, α -Ge) can be easily prepared by:

A)- melt quench technique

B)- splat cooling

C)- sputtering

D)-a and b

45-Free carrier absorption takes place in amorphous semiconducting thin films when the incident photon energy $h\nu$ is:

A)- $< E_g$

B)- $= E_g$

C)- $> E_g$

D)- b and c

46-Si single crystal can be easily prepared using technique of :

A)- thermal evaporation

B)- sputtering

C)- The Czochralski method

D)- melt quench

47- The Pauling's rule for glass formation states that the Octahedral glasses can be formed when the r_c/r_A ratio is :

A)- 0.115-0.225

B)- 0.414-0.732

C)-=1

D)- 0.732-1

48-Zachariasen theory for glass formation states that the number of oxygen atoms surround the cations must be small, specifically:

A)-6

B) 2

C) 3 or 4

D) >4

49- The advantageous of sputtering deposition are those except:

A)-low substrate temperature

B)- good adhesion

C)- low cost

D)- uniform coating

50-Both the refractive index (n) and the absorption coefficient (α) for the same amorphous thin film are:

A)- dependent parameters

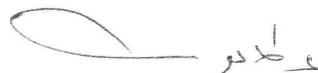
B) independent parameters

C) constant for the same film

D) All of the above

With my best wishes

Prof. Dr. Atta Yousef Abdel-latif





Exam in 4 pages

Use the following physical constants when you need:

Electron charge $e = 1.6 \times 10^{-19}$ Coulomb, Electron mass $m_e = 9.11 \times 10^{-31}$ kg,
Proton mass $m_p = 1.673 \times 10^{-27}$ kg, Planck's constant $h = 6.626 \times 10^{-34}$ J.s
The gyromagnetic ratio of H^1 , $g = 5.586$ Boltzmann Constant $k = 1.38 \times 10^{-23}$ J/K

Section (A): (26 marks)

A1. Mark (/) for the correct sentence and (x) for the wrong one (6 marks)

1. The Larmor frequency of a magnetic moment around a magnetic field is proportional to the applied magnetic field
2. When a magnetic field is applied to electrons at room temperature, all the electron spins will have direction parallel to the applied magnetic field.
3. In a magnetic resonance experiment, a static magnetic field is applied for the splitting of the energy levels
4. The energy required for the NMR of the hydrogen nucleus in a magnetic field is usually in the microwave range.
5. Zeeman effect states that electrons with different values of l will experience a shift in their energy levels in the presence of a static magnetic field
6. The magnetic hyperfine coupling refers to the coupling between the orbital magnetic moment and the spin magnetic moment.

A2. Circle the correct answer (10 points - 20 marks):

1. The free precession of a magnetic moment around a magnetic field is defined by
(a) The Bohr magneton (b) The Larmor frequency (c) The angular momentum
2. The L-S coupling splits the d -electrons levels ($l=2$) to
(a) six energy levels with $j=5/2$ (b) two groups with $j=5/2$, $j=3/2$
(c) four energy levels with $j=3/2$
3. The number of resonance frequencies in the ESR experiment in the case of $l=2$ and $s=1/2$ is
(a) one transition frequency (b) two transition frequencies
(c) five transition frequencies

4. The Larmor frequency of the electron spin in a magnetic field of 0.1 Tesla
 (a) 42.6 MHz (b) 2.8 GHz (c) 100 MHz
5. The magnetic moment of an electron spin μ_z is
 (a) $1/2 \mu_B$ (b) μ_B (c) $3/2 \mu_B$
6. For a magnetic field of 2.348 T, H^1 resonates at:
 (a) 100 GHz (b) 65.744 MHz (c) 100 MHz
7. The ratio of the nuclear magneton to the Bohr magneton μ_N / μ_B is equal to
 (a) m_p / m_N (b) m_e / m_p (c) m_p / m_e
8. In an ESR experiment, the resonance transition between the energy levels is maintained by
 (a) an applied magnetic field (b) exciting microwaves (c) exciting radiowaves
9. In an ESR experiment under constant excitation energy, the resonant magnetic field is
 (a) directly proportional to the g-factor (b) inversely proportional to the g-factor
 (c) doesn't depend on the g-factor
10. The total energy angular momentum state (J) is lower in energy due to
 (a) spin-spin interactions (b) orbit-orbit interactions
 (c) spin-orbit interactions

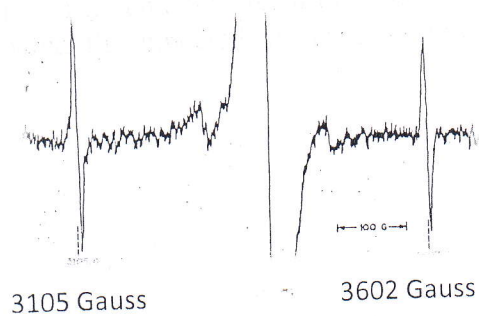
Section B (24 marks):

Answer the following four questions

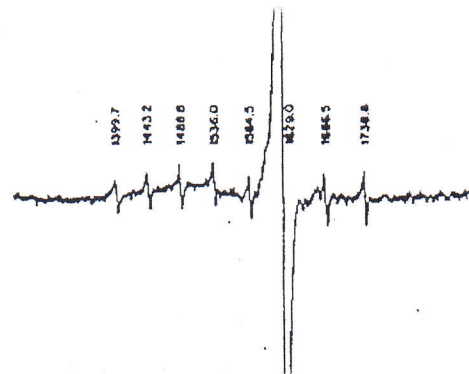
- 1) Draw a diagram of the electron magnetic resonance setup showing its main components.

- 2) Draw the energy level diagram of the deuterium atom $S(1/2)$ and $I(1)$ resulting from the hyperfine coupling in a constant magnetic field and show that the expected spectrum is triplet

- 3) The following figure shows the ESR spectrum of hydrogen atoms in an x-rayed human tooth at room temperature. Calculate the hyperfine coupling of the hydrogen atom and the exciting photon energy.



- 4) In an ESR spectrum of Fe^+ and Co^{++} , The Fe^+ spectrum consists of a single intense line while the Co^{++} spectrum is a hyperfine octet due ^{59}Co with $I = \frac{1}{2}$. If the exciting photon energy is 9.4175 GHz and for the magnetic field at the center of the intense line (Fe^+) is 1629.06 G, calculate the g factor of Fe^+ .



Best wishes

Examiner: Prof. Dr. Mohamed Almokhtar

<i>Date : / / 2021</i> <i>Time: 3 hours</i>	<i>First Semester Exam 2020-2021.</i> <i>Semiconductor Physics and Thin</i> <i>Film Applications</i> <i>(451Phy.)</i>	<i>Assiut university</i> <i>Faculty of Science</i> <i>Physics Department</i>
	<i>Max. degree (50)</i>	

Answer the following questions:

Section (A): Choose the correct answer from the following:

1- Einstein showed that the relation between diffusion coefficient (D) and mobility (μ) of the charge carriers (holes) can be expressed as: (A) $D_p = \mu_p \frac{K_B}{T^2 e}$ (B) $D_p = \mu_p \frac{K_B T}{e}$ (C) $D_p = \mu_p \frac{K_B T^2}{e}$	
2- Temperature dependence of charge carrier mobility in semiconductor is: (A) $\mu \propto T^{-3/2}$ (B) $\mu \propto 1/T^2$ (C) $\mu \propto T^{3/2}$	
3-The general expression for Fermi energy level in an intrinsic semiconductor is: (A) $E_f = \frac{E_c + E_v}{2} + \frac{4}{3K_B T} \ln \left[\frac{m_p^*}{m_e^*} \right]$ (B) $E_f = \frac{E_c + E_v}{2} + \frac{3K_B T}{4} \ln \left[\frac{m_p^*}{m_e^*} \right]$	
4- When the complex refractive index of a semiconductor is given by a relation $n^* = n + ik$ at a certain wavelength λ , hence the absorption coefficient α is: (a) $\alpha = \frac{2\pi k}{\lambda}$ (b) $\alpha = \frac{4\pi k}{\lambda}$ (c) $\alpha = \frac{4\pi}{\lambda k}$	
5- The general expression for the density electrons in an intrinsic semiconductor with an energy gap E_g and $C = 4.83 \times 10^{21}$ is: (A) $n_i = CT^{2/3} \exp \left[-\frac{E_g}{2K_B T} \right]$ (B) $n_i = CT^{2/3} \exp \left[+\frac{2E_g}{K_B T} \right]$	
6- When the intrinsic charge carrier concentration (n_i) is $2.5 \times 10^{19}/m^3$, at room temperature 300oC, where $K_B T = 0.026$ eV and $C = 4.83 \times 10^{21}$, hence the estimated forbidden energy gap is: (A) $E_g = 1.44$ eV (B) $E_g = 0.72$ e	
7- If the complex dielectric constant of nano-semiconductor compound of particle size 3 nm is given by $\epsilon^* = \epsilon_1 + i\epsilon_2$, then real refractive index n is: (a) $n = \frac{1}{\sqrt{2}} \left[\left\{ \epsilon_1 + (\epsilon_1^2 + \epsilon_2^2)^{1/2} \right\} \right]^{1/2}$ (b) $n = \frac{1}{\sqrt{2}} \left[\left\{ \epsilon_1 + (\epsilon_1^2 - \epsilon_2^2)^{1/2} \right\} \right]^{1/2}$	

8- 3- When the complex refractive index of a semiconductor is given by the relation $n^* = n + ik$ at a certain wavelength λ , hence the reflectivity (R) is given by:

(A) $R = \frac{(n-1)^2 + (k+1)^2}{(n+1)^2 + (k+1)^2}$ (B) $R = \frac{(n-1)^2 + (k)^2}{(n+1)^2 + (k)^2}$ (C) $\frac{(n+1)^2 + (k+1)^2}{(n-1)^2 + (k+1)^2}$

9- The injected excess carriers into a semiconductor, diffuse away from the metal-semiconductor point contact at $x = 0$ and their density decreases exponentially with a distance x by the equation:

(A) $(\Delta n)_x = (\Delta n)_{x0} \exp \left[-\frac{x}{\sqrt{D_n \tau_n}} \right]$ (B) $(\Delta n)_x = (\Delta n)_{x0} \exp \left[-\frac{\sqrt{D_n \tau_n}}{x} \right]$

Where, $L_n = \sqrt{D_n \tau_n}$ is the electron diffusion length. τ_n the lifetime and D_n is the electron diffusion coefficient

10- If the band gap of CdS photoconductor is 2.4eV, hence wavelength (λ) of the emitted photons due to a direct recombination process of electrons from the conduction band with holes in the valence is:

(A) $\lambda = 526 \text{ nm}$ (B) $\lambda = 625 \text{ nm}$ (C) $\lambda = 517 \text{ nm}$

11- The diffusion current in semiconductor at room temperature is directly proportional to:

(A) Square of the electric field (E^2). (B) The electric field intensity (E).
(C) $\sqrt{E}$ of the electric field .

12- Donor impurities in n-type semiconductor introduce localized defect states within the energy band gap:

- (A) Near the conduction band edge.
(B) At the midpoint of the band gap
(C) Near the valence band edge

13- In **n-type** semiconductor the optical absorption process at photon energy $h\nu < E_g$ is ascribed to:

- (A) Optical excitation of electron from a donor level to the conduction band.
(B) Optical excitation of electron from the valence band to a donor levels

14- Incorporation of impurities into the crystal lattice sites of semiconductor at constant temperature results in:

- (A) A decrease in electrical conductivity due to the decrease in the concentration of free charge carrier.
(B) An increase in electrical conductivity due to the increase in the concentration of free charge carrier.
(C) No change in electrical conductivity.

15-Enhancement of the optical and optoelectronic properties in nanosemiconductor materials can be attributed to:	
(A) Increase in the nanoparticle size and a decrease in the surface area of atoms at the nanoparticle surface.	
(B) Decrease in the nanoparticle size (i.e., quantum size effect) and increase in surface area (i.e., Surface to volume ratio (S/V) of atoms at the nanoparticle surface	
16- Indirect optical transition in solids occurs:	
(A).When a minimum of the conduction band and a maximum of the valence band exist at different points in k-space (i.e., $k_i \neq k_f$).	
(B) When minimum of the conduction band and maximum of the valence band exist at the same points in k-space (i.e., $k_i = k_f$).	
17- Optical and electrical properties of $Zn_xCd_{1-x}S$, alloyed semiconductor nanoparticles:	
(A) Are dependent significantly on the molar ratio (x) of zinc content.	
(B) Are independent on the molar ratio (x) of zinc content	
18- The broadening, reduction and red shift of the excitonic absorption peak in GaAs due to increasing in the temperature can be attributed to:	
(A) Exciton-Electron interaction.	(B) Exciton-Phonon scattering.
(C) both (A) and (B)	
19- Increase in the nanoparticle size due to improvement in the degree of crystallization via thermal annealing process of the polycrystalline nanosemiconductor results in:	
(A) An increase in the optical band gap and enhancement in the PL intensity.	
(B) A decrease (i.e., red shift) in the optical band gap associated with a decrease in the PL intensity.	
20- Free Exciton (Van-Mott Exciton) is characterized by:	
(A) Small radius and strong binding energy.	
(B) Large radius and weak binding energy.	
(C) It is usually occur at room temperature.	
21- The optical band gap of direct band gap semiconductors such as CdS, ZnO and GaAs can be determined from the extrapolation of straight line portion of:	
(A) Tauc's plot $[(\alpha h\nu)^2 \text{ vs } h\nu]$ to $(\alpha h\nu)^2 = 0$, and the intercept with $h\nu$ -axis gives $h\nu = E_g$.	
(B) The plot of $(\alpha h\nu)^{1/2} \text{ vs } h\nu$, and the intercept with $h\nu$ -axis gives $h\nu = E_g$	
22- One of the most important properties of semiconducting material is:	
(A) The positive temperature coefficient of its electrical conductivity (i.e., $\sigma \propto T$).	

(B) The negative temperature coefficient of its electrical conductivity (i.e., $\sigma \propto \frac{1}{T}$).	
23- Presence of non radiative structural defect states in nano semiconductor materials results in: (A) Improvement of the PL emission intensity and blue shift of the forbidden energy gap. (B) Quenching/reduction in the PL emission intensity and red shift of the forbidden energy gap.	
24-- At steady state value of a photo-conductivity the rise curve of the photocurrent is described by: (A) $\Delta\sigma = \Delta\sigma_{st} \left[\exp\left(-\frac{t}{\tau}\right) \right]$. (B) $\Delta\sigma = \Delta\sigma_{st} [1 - \exp(-t/\tau)]$.	
25- The light-emitting diode (LED), is a p-n junction, which emits light, when electrons from the conduction band of n-region recombine with holes in the valence band of p-region within the energy gap and operate: (A) Under the forward bias of an external electric field. (B) Under the reverse bias of an external electric field.	

SECTION B: Put a sing ($\checkmark$) in the front of the right sentence and a sing (x) for the wrong sentence:

26- Electrical conductivity of semiconductor increases exponentially with temperature according to the Arrhenius equation: $\sigma_i = \sigma_0 \exp\left[+\frac{E_g}{2K_B T}\right]$.	
27- To have high efficient photovoltaic cells and photodiodes, it is preferable to use direct band gap semiconductor materials.	
28- Increasing in the degree of crystallization and nanoparticle size of polycrystalline semiconductor via thermal annealing process leads to increase in the optical energy gap and enhancement in photoluminescence (PL) intensity.	
29- Photovoltaic energy conversion depends on the number of photons striking earth surface with energy larger than the band gap of the semiconductor, these photons promote an electron from the valence band to the conduction band.	
30- n-type semiconductor reveals extrinsic photoconductivity due to optical absorption by localized donor atom, accompanied by the creation of free electrons in the valence band and positive ion bounded to the donor atom.	

31- Under the influence of applied electric field, the intrinsic photoconductivity in CdS is ascribed to the optical absorption by host atoms, accompanied by photo generation of a free electrons and holes in conduction and valence band respectively.	
32-The optical band gap of pure semiconductor increases with increasing temperature due to electron-electron and electron -phonon interaction (i.e., scattering process).	
33- The efficiency of amorphous silicon solar cell is higher than that of defect free (pure) single crystalline silicon cell.	
34- Under the forward-biased of light-emitting diode (LED), the light emission takes place when electrons from the conduction band of n-region recombine with holes in the valence band of p-region.	
35. Free carrier life time can be defined as the time that an excited electron or hole spends in the conduction or the valence band respectively, before its recombination with a carrier of opposite sign.	
36- When an electron is captured by an excited center in the band gap containing a hole, or a hole being captured by an excited center containing electron. Then PL emission can be assigned as defect related- PL emission	
37- The optical and optoelectronic properties of the semiconductors are not affected by the structural native defects such as vacancies and interstitial in the crystal lattice.	
38- After optical excitation of direct band gap semiconductor with photon energy $h\nu > E_g$, the band edge PL emission occurs after relaxation process of photo generated electrons to the bottom of the conduction and holes to the top of valence band before recombination process.	
39- <i>One of the most fascinating and useful aspects of nanomaterials is their applications such as optical detector, laser, sensor, imaging, phosphor, display, solar cell, photo catalysis, photo-electrochemistry and biomedicine.</i>	
40- In Group II-IV nanosemiconductor such as $Zn_xCd_{1-x}S$ alloys, the optical absorption edge red shifted toward the long wavelength region, with increasing zinc content (molar ratio (x)).	
41- <i>According to Franck-Condon principle, PL emission spectrum is usually blue-shifted with respect to the optical absorption spectrum, i.e. appearing at longer wavelength.</i>	

42- Presence of trapping centers in a photoconductor leads to decrease in the life time of minority charge carriers, while presence of a recombination centers result in increase in the minority carrier life time.	
43- UV irradiation of CdS nanostructure (quantum dots) results in increasing in the optical band gap and enhancement in PL intensity ascribed to reduction in a particle size via photo-corrosion process..	
44- Presence of structural native defects and impurities in CdS nanostructure results in sharpness and symmetric profile and spectral blue shift of the PL emission spectrum	
45- Impurity photoconductivity in p-type semiconductor due to optical absorption at localized acceptors in the crystal, results in photo generated hole in a valence band and an electron bounded at the neighborhood of the acceptors for each absorbed photon.	
46- If the electric field across the depletion-region in a photodiode is increased with increasing sufficiently large reverse bias across the junction, the photo-generated electrons and holes may acquire sufficient energy to liberate more electrons and holes within this layer by a process of impact ionization. The device in which this internal amplification process occurs is known as avalanche photodiodes (APDs)..	
47- The excess kinetic energy of trapped charge carriers can be released either by emission of photons via radiative recombination process or released this energy to another free carrier and host lattice as phonons via non radiative recombination process (i.e., relaxation process).	
48- Trapping levels near conduction band act as electron traps and trapping levels near valence band act as hole traps, meanwhile trapping levels near the center of the energy band gap have a high probability of capturing both an electron and a hole resulting in recombination of the trapped carriers	
49- The semiconductor photodiode detector is a p-n junction structure based on the internal photo effect. Since photons absorbed in the depletion layer generate electrons and holes which are subjected to the local electric field within that layer. The two carriers transport in opposite directions, induces an electric current in the external circuit.	
50- The intensity of band edge emission in indirect band gap semiconductor materials is higher than that of direct band gap semiconductor, because long lifetime of radiative recombination in indirect semiconductor allows non-radiative recombination process to become more significant and effective	

With my best wishes

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Q1. Choose the correct answers (select one or more):

(25 Marks)

- I In statistical mechanics, thermodynamical properties can be obtained via:
- A. Time average.
 - B. Partition function Z .
 - C. Boltzmann distribution.
 - D. None of the above.
- II The ensemble average of a physical quantity is equal of its time average. This is true for:
- A. A microcanonical ensemble
 - B. Canonical ensemble
 - C. Grand canonical ensemble
 - D. None of the above.
- III Molecular dynamics simulation method is a
- A. Deterministic
 - B. Time dependent
 - C. Chaotic
 - D. None of the above.
- IV One of the important applications of periodic boundary condition (PBC) in
- A. Crystalline
 - B. Amorphous.
 - C. Polymers.
 - D. None of the above.
- V In the canonical ensemble:
- A. The energy and temperature are constant.
 - B. Temperature is constant.
 - C. Density is constant.
 - D. Entropy is constant.
- VI In the grand canonical ensemble, a system A fixed volume is in contact with large reservoir B
- A. A can exchange energy with B.
 - B. A can exchange particle with B.
 - C. A cannot exchange anything with B.
 - D. None of the above.
- VII In the equilibrium state, the thermodynamic probability of a system is
- A. Zero
 - B. Maximum
 - C. Minimum but not 1
 - D. one

- VIII. For a microcanonical ensemble, the phase density inside a small energy interval remains constant and outside such a region, it is
- According to the representation of the system
 - We cannot infer about energy outside.
 - Zero
 - Same as inside
- IX. In Ising-Model, and according to Boltzmann distribution, the mean spin of the atom depends on
- Atomic spins
 - Atomic orbital
 - Magnetic moment.
 - None of the above
- X. Temperature and entropy are examples of :
- Extensive and intensive.
 - Intensive and extensive.
 - Extensive only.
 - Intensive only.

Q2. Derive the Maxwell- Boltzmann Probability function for energy distribution. (10 Marks)

$$P_r = \frac{e^{-E_r/k_B T}}{\sum_{j=1}^n e^{-E_j/k_B T}}$$

Q3. A physical System is composed of N distinguishable spins assuming two possible values ± 1 . These two values correspond to the energy levels $\pm \epsilon$, respectively. Compute the total energy E using Boltzmann formula and microcanonical ensemble. Finally, compare the results with those in canonical ensemble. (8 Marks)

Q4. A statistical system is composed of N independent distinguishable particles. Each one of these particles has only two energy levels, E_1 and E_2 , such that $E_2 - E_1 = \epsilon > 0$. Chose a suitable ground state for the energy and write down the total energy as a function of the temperature T. Finally, discuss the limits $T \rightarrow 0$ and $T \rightarrow +\infty$ (7 Marks)

Q5. Write briefly on the following topics: (10 Marks)

- Molecular dynamics
- Ising model
- Neighbor list method