

96 學年度材料科學工程學系碩士班入學考試

科目 理工測驗三 科目代碼 0603

- 1.物理冶金共 06 頁
- 2.工程力學共 11 頁
- 3.近代物理共 08 頁
- 4.有機化學共 08 頁
- 5.應用電子學共 10 頁

注意事項：

- 1.本測驗共有 5 子科，考生可任選二科作答，並在答案卡上勾選作答之科目。
- 2.每一子科各有 40 題，皆為 5 選 1 的單選題；答對一題得 2.5 分，答錯一題倒扣 0.625 分，未答者不計分。
- 3.作答時，請以 2B 鉛筆在【答案卡】上畫卡。
- 4.考試時間為 100 分鐘。

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- The degree of freedom for a two-component system with only one phase is
(a) 0 (b) 1 (c) 2 (d) 3 (e) none of above
- Eutectic reaction occurs
(a) when a single liquid phase is transformed into two solid phases.
(b) when a single liquid phase is transformed into a solid phase.
(c) when two liquid phases are transformed into two solid phases.
(d) when two liquid phases are transformed into a solid phase.
(e) None of above
- The Miller indices of the basal plane in hcp are
(a) 0001 (b) 1001 (c) $10\bar{1}0$ (d) $10\bar{1}2$ (e) 1101
- Choose the close-packed hexagonal metal
(a) Magnesium (b) Gold (c) Molybdenum (d) Tungsten (e) Alkali metal
- The angle for X-ray diffraction from $\{110\}$ planes with a lattice parameter of 0.1 nm in cubic crystal, assuming the wavelength of the X-ray beam is 0.04 nm.
(a) $11^\circ30'$ (b) $16^\circ28'$ (c) $20^\circ30'$ (d) $24^\circ15'$ (e) $36^\circ24'$
- The vibration frequency of an atom in a crystal
(a) 10^{10} Hz (b) 10^{11} Hz (c) 10^{13} Hz (d) 3×10^5 Hz (e) 6.618×10^8 Hz
- Real crystal deform
(a) at their theoretical strength
(b) at small fraction ($10^{-3} \sim 10^{-5}$) of their theoretical strength.
(c) at higher stresses (3 ~ 5 times) than theoretical strength.
(d) at smaller fraction ($10^{-1} \sim 10^{-2}$) of their theoretical strength.
(e) at small fraction ($10^{-5} \sim 10^{-8}$) of their theoretical strength.
- Choose the wrong statement
(a) An edge dislocation lies perpendicular to its Burgers vector.
(b) An edge dislocation moves in its slip plane in the direction of Burger vector.
(c) A screw dislocation lies parallel to its Burger vector.
(d) A screw dislocation move in a direction paralld to the Burgers vector.
(e) The slip plane of a screw dislocation can be any plane containing the dislocation.

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9. The c/a ratio of the hcp zinc crystal is 1.866. The ratio of the strain energy in zinc of a dislocation with a $\frac{1}{3}\langle 11\bar{2}3 \rangle$ Burgers vector to that of a basal slip dislocation is
(a) 0.1 (b) 0.2 (c) 10 (d) 20 (e) none of above
10. Angle between $[121]$ and $[30\bar{1}]$ directions in cubic structure
(a) 75° (b) 56° (c) 67° (d) 34° (e) 45°
11. Which statement is wrong?
(a) crystal boundaries are regions of misfit or disorder between crystals.
(b) atom movements across and along boundaries should occur quite easily.
(c) The speed with which crystal boundaries move depends on temperature.
(d) A metal can approach a more stable state by reducing its grain-boundary area.
(e) none of above.
12. Evaluate the number of atom jumps per second into a vacancy for Cu at temperature just below its melting point.
(a) 2×10^{10} jumps/sec (b) 5×10^{15} (c) 3.14×10^5 (d) 6.2×10^{-2} (e) 10^{-5}
13. What is the jumps/sec for Cu similar to Prob. 12 at room temperature?
(a) 10^{10} jumps/sec (b) 10^{-6} (c) 10^{-2} (d) 10^7 (e) 10^4
14. The activation energy Q for recovery of the yield point in metal A is 83 KJ/mole. If a strained A crystal recovers one-fourth of its original yield point in 5 min at 0°C . The same amount of recovery at -50°C would take
(a) 0.1 min (b) 1.205 hr (c) 3 days (d) 17 days (e) 3.4 months
15. Which statement is wrong?
(a) The driving force for recrystallization comes from the stored energy of cold work.
(b) In those cases where polygonization is essentially completed before the start of recrystallization, the stored energy can be assumed to be confined to the dislocation in polygon walls.
(c) The elimination of the subboundaries is a basic part of the recrystallization process.
(d) In those cases where polygonization is essentially completed before the start of recrystallization, the stored energy can be assumed to be confined to the vacancy in polygon walls.
(e) none of above.

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16. Choose the wrong statement.

- (a) If geometrical coalescence occurs to any extent, it should have a strong effect on grain growth kinetics.
- (b) In a metal containing random set of crystal orientations, geometrical coalescence should probably occur infrequently.
- (c) Geometrical coalescence may be an important phenomenon in a highly textured metal.
- (d) The chances of two grains of nearly identical orientation encountering each other during grain growth is much greater.
- (e) none of above.

17. For strain-induced boundary movements

- (a) no new crystal are formed.
- (b) the boundary leaves behind a crystalline which is higher in its strain energy.
- (c) the boundary usually moves toward its center of curvature.
- (d) the boundary moves faster into the regions where the distortion has been small.
- (e) none of above.

18. Which has the lowest atomic packing density?

- (a) fcc (b) bcc (c) hcp (d) diamond structure (e) simple cubic

19. In the sodium chloride lattice, the coordination number is

- (a) 4 (b) 6 (c) 8 (d) 12 (e) 3

20. The Cesium Chloride lattice has the structure of

- (a) fcc (b) bcc (c) simple cubic (d) hcp (e) diamond structure

21. 二元系統固定壓力下，有一成份 C 的合金，平衡時在某一溫度下為固液相共存，且其固相成份為 S，液相成份為 L，則液相含量為

- (a) $(L-S)/(L-C)$ (b) $(L-S)/(C-S)$ (c) $(L-C)/(C-S)$ (d) $(C-S)/(L-S)$ (e) $(L-C)/(L-S)$

22. 二元相圖中的兩相共存區(miscibility gap)是指

- (a) 兩種原子的固溶體是負偏差(negative deviation)
- (b) 同類原子的鍵結比異類原子鍵結來得弱
- (c) 高溫具短程有序規律(short-range ordering)，低溫則分為雙相結構
- (d) 高溫具短程有序規律，低溫則有長程(long-range)有序規律
- (e) 以上皆非

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23. 哪一效應可證明合金之置換擴散(substitutional diffusion)是空位機制(vacancy mechanism)所造成？
(a)克肯岱爾效應(Kirkendall effect)
(b)達肯效應(Darken effect)
(c)麻他諾效應(Matano effect)
(d)斯諾伊克效應(Snoek effect)
(e)以上皆非
24. 鐵原子在 bcc 鐵、鐵原子在 fcc 鐵、碳原子在 bcc 鐵、碳原子在 fcc 鐵中發生擴散(diffusion)的活化能分別以 A, B, C, D 來表示，則四者之大小關係為
(a) $A > B > C > D$ (b) $C > D > A > B$ (c) $D > C > B > A$ (d) $C > D > B > A$ (e) $B > A > D > C$
25. 碳原子在 fcc 鐵中的擴散係數 $D = \alpha a^2 / \tau_\sigma$ ， α 為幾何因子， a 為晶格常數， τ_σ 為定應力遲緩時間。其中的 α 為多少？
(a) 1/6 (b) 1/12 (c) 1/18 (d) 1/24 (e) 1/36
26. 關於大型鑄錠微結構相關的描述，下列何者有誤？
(a) 靠近模壁的晶粒最小
(b) 靠近模壁的晶粒形狀是等軸
(c) 合金鑄錠中心區有等軸晶
(d) 中心區等軸晶是由於組成過冷所造成
(e) 柱狀區是重新孕核所造成
27. 擴散(diffusion)控制的第二相顆粒尺寸與成長時間(t)關係通常為
(a) $t^{1/3}$ (b) $t^{1/2}$ (c) t (d) t^2 (e) t^3
28. 在液相中產生固相，其孕核(nucleation)速率最快的溫度是在低於熔點一些的地方；高於此溫度，其孕核速率變慢，主要原因是
(a) 原子不容易躍過界面
(b) 原子容易躍過界面
(c) 臨界胚核(embryo)的能障太小
(d) 臨界胚核的能障太大
(e) 以上皆非

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29. 關於析出(precipitation)現象的描述，下列何者有誤？
- (a) 固溶濃度必須隨溫度上升而增加
 - (b) 析出強化必須先做固溶處理
 - (c) 析出物顆粒最多時硬度最高
 - (d) 時效溫度愈高則尖峰時效時間愈短
 - (e) 時效溫度愈高則尖峰時效硬度愈低
30. 高強度低合金鋼(high-strength low-alloy steel)的強化，主要是來自
- (a) 細晶強化
 - (b) 析出強化
 - (c) 加工強化
 - (d) 固溶強化
 - (e) 複合強化
31. 下列何者不是變形雙晶化(mechanical twinning)與麻田相變化(martensitic transformation)共有的特徵？
- (a) 透鏡狀外型
 - (b) 有晶癖面(habit plane)
 - (c) 剪移應變
 - (d) 晶格結構不變
 - (e) 成份不變
32. 下列何者不是麻田相變化(martensitic transformation)必有的特徵？
- (a) 硬度變大
 - (b) 無理數晶癖面(habit plane)
 - (c) 非恆溫(athermal)相變化
 - (d) 剪移應變
 - (e) 應變促進相變化
33. 關於形狀記憶合金的描述，下列何者有誤？
- (a) 形狀記憶合金是一種熱彈性(thermoelastic)合金
 - (b) 形狀記憶是指記得母相形狀
 - (c) 形狀記憶合金的變形是在 M_f (完全變成麻田相的溫度)以下實施
 - (d) 超彈性(superelasticity)現象是指具有很大彈性變形能力
 - (e) 超彈性現象需在 A_f (完全變成母相的溫度)以上發生
34. 平衡狀況下在 727°C 附近，肥粒鐵(ferrite)可溶 0.02% 碳，沃斯田鐵(austenite)可溶 0.77% 碳，雪明碳鐵(cementite)的碳含量為 6.67%，則 Fe-0.45%C 的合金，冷卻下來的波來鐵(pearlite)含量為
- (a) 89%
 - (b) 71%
 - (c) 57%
 - (d) 43%
 - (e) 29%
35. 下列哪一特性是屬於變韌鐵(bainite)相變化與波來鐵(pearlite)相變化所共有
- (a) 針狀外形
 - (b) 層狀雙相結構
 - (c) 置換型合金元素重新分配
 - (d) 碳元素重新分配
 - (e) 無理數晶癖面(habit plane)

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36. 碳鋼之麻田鐵(martensite)晶格常數(nm)為 $c = 0.2866 + 0.0116x$, $a = 0.2866 - 0.0013x$; 沃斯田鐵(austenite)則為 $a = 0.3555 + 0.0044x$; 其中 x 為碳原子的含量(%)。則 Fe-1.0%C 合金由沃斯田鐵變成麻田鐵的長度變化為
(a)減少 1.3 % (b)增加 1.3 % (c)減少 4 % (d)增加 4 % (e)以上皆非
37. 下列哪一碳鋼可形成最多的針狀麻田鐵(lenticular martensite) ?
(a)Fe-0.20%C (b)Fe-0.30%C (c)Fe-0.40%C (d)Fe-0.50%C (e) Fe-0.60%C
38. 下列哪一回火(tempering)現象是低碳鋼(如 Fe-0.15%C)與高碳鋼(如 Fe-1.13%C)所共有 ?
(a)碳原子重新分佈
(b)雪明碳鐵(cementite)的形成
(c)中間碳化物(ϵ/η)的形成
(d)殘留沃斯田鐵(austenite)變成麻田鐵(martensite)
(e)以上皆非
39. 黃銅中的鋅含量在 20%以下時, 下列哪一性質隨鋅含量增加而變小 ?
(a)伸長率 (b)抗拉強度 (c)硬度 (d)導電率 (e)以上皆非
40. 三種合金的強度與比重分別是 A: 607 MPa, 2.7 ; T: 1170 MPa, 4.5 ; S: 1660 MPa, 7.8。則三者之比強度(specific strength)大小為
(a) A>T>S (b) A>S>T (c) T>A>S (d) T>S>A (e) S>T>A

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1-2. Several materials were subjected to mechanical tests and the results are plotted in the following:

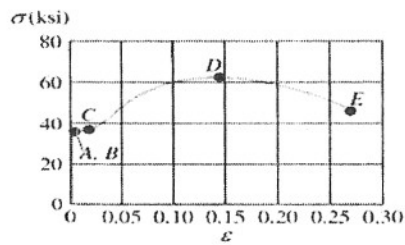


Figure 1.1

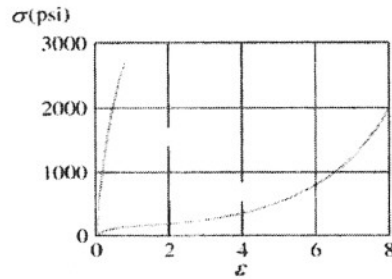


Figure 1.2

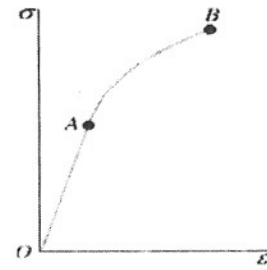


Figure 1.3

Statements:

- A. Figure 1.1 is the results for a typical mild steel in tension
- B. Figure 1.2 is the results for rubber materials in tension
- C. Figure 1.3 is the results for a brittle material in tension
- D. Stress at point A in Figure 1.1 is called the proportional limit
- E. In the region from B to C, as shown in Figure 1.1, the material becomes perfectly plastic

1. Which statement listed in the following is true:
 - (a) All the statements are true
 - (b) Statement B is not true
 - (c) Statement C is not true
 - (d) Statement D is not true
 - (e) Statement E is not true
2. For a materials subjected to tension and the results is plotted in Figure 1.1. Which of the statement listed in the following is not true.
 - (a) Stress at point D is called ultimate stress
 - (b) Strain hardening begins at point C
 - (c) The slope of the straight line from O to A is called the modulus of elasticity
 - (d) Necking occurs at point C
 - (e) Lateral contraction occurs at point C

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3-4. A bar AB, fixed at both ends, is subjected to a load P at point C, L is the length of the bar, a and b are the distances from C to ends A and B, respectively. δ denoted the displacement. In this problem, $b > a$.



3. Which statement listed in the following is not true

- (a) Segment A C is subjected to tension
- (b) Segment BC is subjected to compression
- (c) $\delta_{AC} > \delta_{BC}$
- (d) $\delta_{AC} + \delta_{BC} = 0$
- (e) Reaction at point A > reaction at point B

4. Which statement listed in the following is true

- (a) The bar is called statically determinate bar
- (b) In order to calculate the displacement at C, we have to know modulus of the bar
- (c) The reactions at points A and B are the same when $a = b$
- (d) Point C will move upward
- (e) All the statements from (a) to (d) are not true

5~6. A solid bar with length $L = 1.0$ m, diameter $d = 20$ mm, and shear modulus of elasticity $G = 60$ GPa is subjected to torque T. The allowable shear stress in the bar is 60 MPa.



5. What is the maximum permissible value of the torque T

- (a) 20π N·m
- (b) 30π N·m
- (c) 40π N·m
- (d) 50π N·m
- (e) none of the above

6. What is the angle of twist when the bar is subjected to the maximum permissible torque

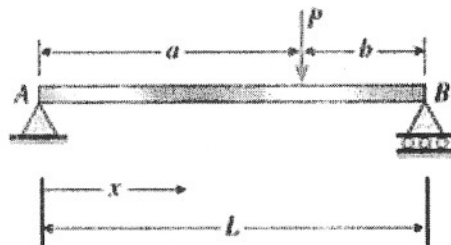
- (a) $\frac{1}{15}$ rad
- (b) $\frac{1}{20}$ rad
- (c) $\frac{1}{25}$ rad
- (d) $\frac{1}{30}$ rad
- (e) none of the above

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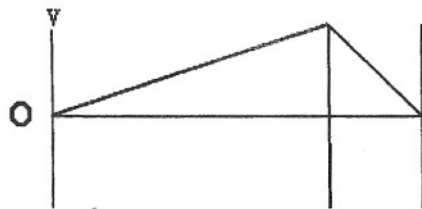
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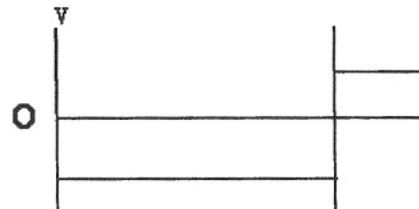
7-8. A simple beam AB supporting a concentrated load P is shown in the following:



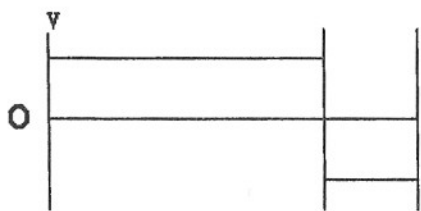
7. Which plot listed in the following is best fit of shear-force diagram of the beam



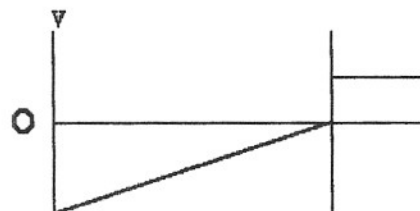
(a)



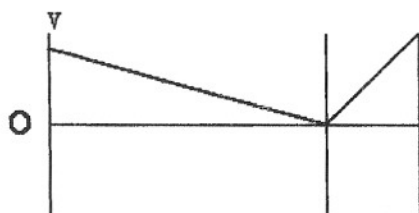
(b)



(c)



(d)



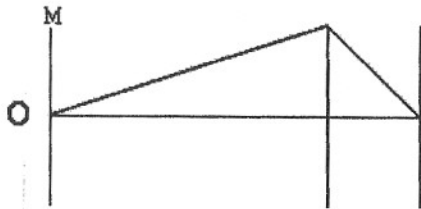
(e)

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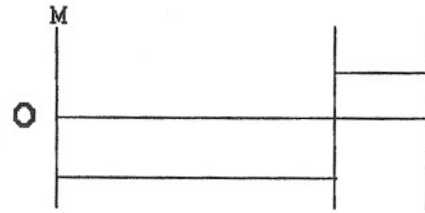
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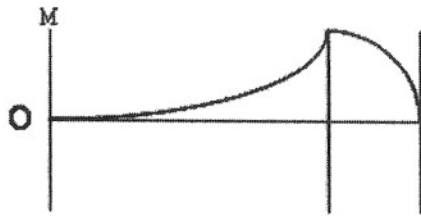
8. Which plot listed in the following is the best fit of bending-moment diagram for the beam



(a)



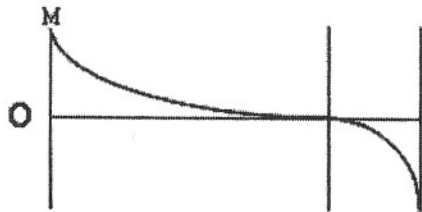
(b)



(c)



(d)



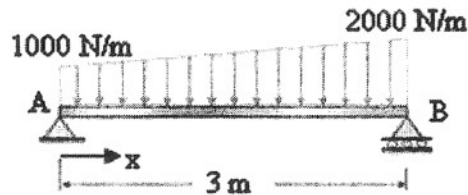
(e)

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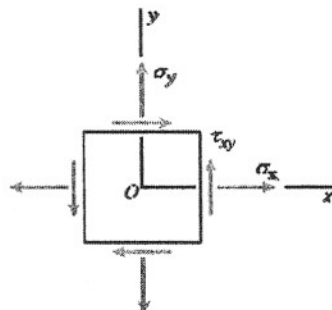
96 學年度 材料科學工程學 系(所) _____ 組碩士班入學考試

科目 理工測測三一工程力學 科目代碼 0603 共 11 頁第 05 頁 *請在【答案卷卡】內作答

9-12 A beam with simple supports is subjected to a distributed load as shown in the figure.



9. The reaction at point A is
 (a) 3500 N (b) 3000 N (c) 1500 N (d) 2500 N (e) 2000 N
10. The maximum shear-force of the beam is
 (a) 3500 N (b) 3000 N (c) 1500 N (d) 2500 N (e) 2000 N
11. The maximum bending-moment of the beam is located at the position x
 (a) $0.6 \text{ m} < x < 1.0 \text{ m}$ (b) $1.0 \text{ m} < x < 1.4 \text{ m}$ (c) $1.4 \text{ m} < x < 1.8 \text{ m}$
 (d) $1.8 \text{ m} < x < 2.2 \text{ m}$ (e) $2.2 \text{ m} < x < 2.6 \text{ m}$
12. The maximum tensile stress σ of the beam is
 (a) less than 50 MPa (b) $75 \text{ MPa} < \sigma < 100 \text{ MPa}$ (c) $175 \text{ MPa} < \sigma < 200 \text{ MPa}$
 (d) can be solved (e) none of the above
- 13-16. An element in plane stress is subjected to stresses as shown in the figure



$\sigma_x = 20 \text{ MPa}$, $\sigma_y = 10 \text{ MPa}$, and $\tau_{xy} = 5 \text{ MPa}$

Using Mohr circle, answer the following questions

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13. The coordinates of the center C of the circle in a set of coordinate axes with σ_{x1} as abscissa (positive to the right) and τ_{x1y1} as ordinate (positive downward) are

- (a) (15 MPa, 0) (b) (5 MPa, 0) (c) (0, 15 MPa) (d) (0, 5 MPa) (e) none of the above

14. The stress condition on the x face of the element are

- (a) (30 MPa, 10 MPa) (b) (20 MPa, 10 MPa) (c) (10 MPa, 5 MPa)
 (d) (10 MPa, 10 MPa) (e) (20 MPa, 5 MPa)

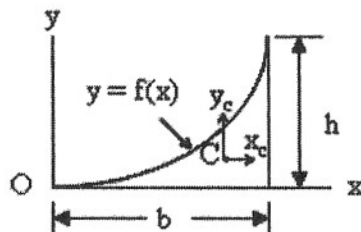
15. The radius of the circle is

- (a) $3\sqrt{2}$ MPa (b) $5\sqrt{2}$ MPa (c) $5\sqrt{3}$ MPa (d) $10\sqrt{3}$ MPa (e) none of the above

16. The principal stress is located at the angle of (count counterclockwise from x axis)

- (a) $\theta = 15^\circ$ (b) $\theta = 17.5^\circ$ (c) $\theta = 20^\circ$ (d) $\theta = 22.5^\circ$ (e) none of the above

17-18. A parabolic spandrel with the origin of axes at vertex as shown in the figure.



The equation of the curve is $y = f(x) = \frac{hx^2}{b^2}$ in which b is the base and h is the height of the

spandrel. The coordinates of the centroid C is located at $(\frac{3b}{4}, \frac{3h}{10})$, the moment of inertia I_x with

respect to the x-axis is $\frac{bh^3}{21}$, the product of inertia with respect to the x and y axes is $\frac{b^2h^2}{12}$.

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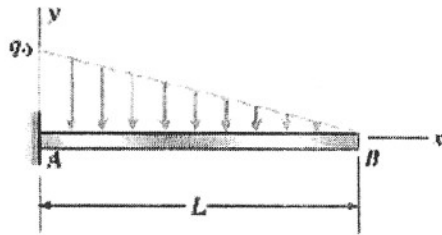
17. Find the moment of inertia I_{x_c} with respect to x_c axis.

- (a) $\frac{53}{2100}bh^3$ (b) $\frac{37}{2100}bh^3$ (c) $\frac{29}{2100}bh^3$ (d) $\frac{21}{2100}bh^3$ (e) none of the above

18. Find the products of inertia $I_{x_c y_c}$ with respect to the centroid axes.

- (a) $\frac{b^2 h^2}{100}$ (b) $\frac{b^2 h^2}{120}$ (c) $\frac{b^2 h^2}{150}$ (d) $\frac{b^2 h^2}{180}$ (e) none of the above

19-20. A cantilever beam AB supporting a triangularly distributed load $q = q_0 \frac{(L-x)}{L}$, as shown in the figure.



19. The shear force in the beam is

- (a) $\frac{q_0}{6L}(L-x)^2$ (b) $\frac{q_0}{2L}(L+x)^2$ (c) $\frac{q_0}{3L}(L-x)^2$ (d) $\frac{q_0}{3L}(L+x)^2$ (e) $\frac{q_0}{2L}(L-x)^2$

20. The bending moment in the beam is

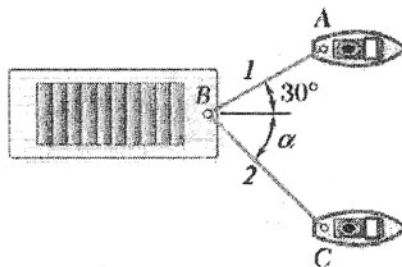
- (a) $-\frac{q_0}{6L}(L-x)^3$ (b) $-\frac{q_0}{6L}(L+x)^3$ (c) $-\frac{q_0}{3L}(L-x)^3$ (d) $-\frac{q_0}{3L}(L+x)^3$ (e) $\frac{q_0}{6L}(L-x)^2$

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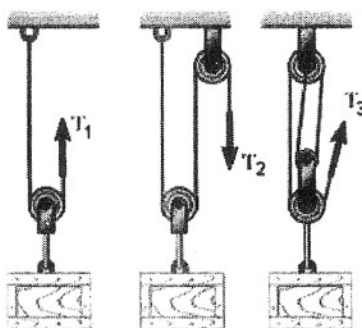
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Problems 21 ~23. A barge is pulled by two tugboats, as shown below. The resultant of the forces exerted by the tugboats is a 10 kN force directed along the axis of the barge. The angle $\alpha=60^\circ$.



21. The tension in rope 1 is
 (a) 8.66 kN (b) 17.32 kN (c) 34.64 kN (d) 5 kN (e) 10 kN
22. The tension in rope 2 is
 (a) 17.32 kN (b) 8.66 kN (c) 34.64 kN (d) 5 kN (e) 10 kN
23. The value of α for which the tension in rope 2 is minimum.
 (a) 15° (b) 30° (c) 45° (d) 60° (e) 75°

Problems 24~26. A 100-kg crate is supported by the following rope-and-pulley arrangements as shown. Determine the tensions T_1 , T_2 and T_3 in the rope.



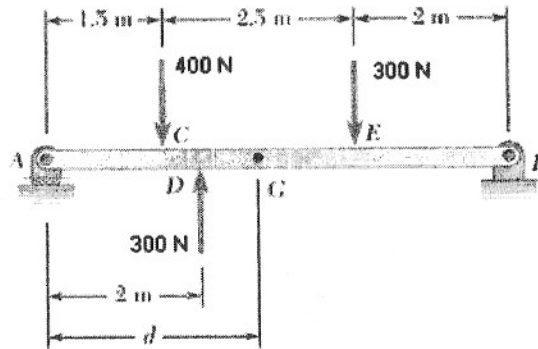
24. The tension T_1 is
 (a) 50 N (b) 100 N (c) 245 N (d) 490 N (e) 980 N
25. The tension T_2 is
 (a) 50 N (b) 100 N (c) 245 N (d) 490 N (e) 980 N
26. The tension T_3 is
 (a) 50 N (b) 100 N (c) 245 N (d) 490 N (e) 980 N

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Problems 27~30. A force and a couple are applied to a beam. Replace this system with a single force F applied at point G and determine the distance d .

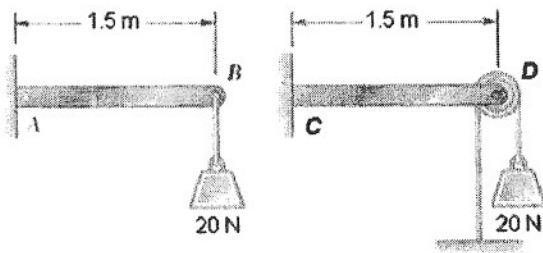


27. The force F is
 (a) $200\text{ N}\uparrow$ (b) $200\text{ N}\downarrow$ (c) $400\text{ N}\uparrow$ (d) $400\text{ N}\downarrow$ (e) $600\text{ N}\uparrow$
28. The distance d is
 (a) 0 m (b) 1 m (c) 2 m (d) 3 m (e) 4 m

If the directions of the two 300-N forces are reversed, replace this system with a single force F applied at point G and determine the distance d .

29. The force F is
 (a) $200\text{ N}\uparrow$ (b) $200\text{ N}\downarrow$ (c) $400\text{ N}\uparrow$ (d) $400\text{ N}\downarrow$ (e) $600\text{ N}\uparrow$
30. The distance d is
 (a) 0 m (b) 1 m (c) 2 m (d) 3 m (e) 4 m

Problems 31~34. A 20-N weight can be supported in the two different ways shown. Knowing that the pulley has a radius of 0.2 m , determine the reaction at A and C in each case.



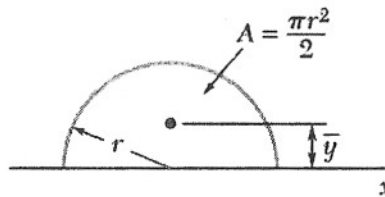
31. The reaction force at A is
 (a) $20\text{ N}\uparrow$ (b) $20\text{ N}\downarrow$ (c) $30\text{ N}\uparrow$ (d) $30\text{ N}\downarrow$ (e) $40\text{ N}\uparrow$

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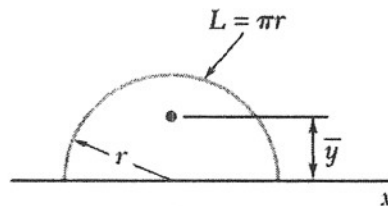
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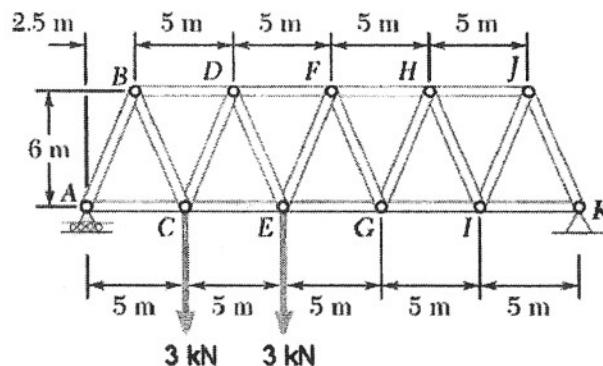
32. The reaction moment at A is
 (a) 20 Nm clockwise (b) 20 Nm counterclockwise (c) 30 Nm clockwise
 (d) 30 Nm counterclockwise (e) 40 Nm clockwise
33. The reaction force at C is
 (a) 20 N↑ (b) 20 N↓ (c) 30 N↑ (d) 30 N↓ (e) 40 N↑
34. The reaction moment at C is
 (a) 30 Nm clockwise (b) 40 Nm counterclockwise (c) 40 Nm clockwise
 (d) 60 Nm counterclockwise (e) 60 Nm clockwise
35. The centroid of a semicircular area \bar{y} is
 (a) $\frac{r}{\pi}$ (b) $\frac{2r}{\pi}$ (c) $\frac{2r}{3\pi}$ (d) $\frac{3r}{2\pi}$ (e) $\frac{4r}{3\pi}$



36. The centroid of a semicircular arc \bar{y} is
 (a) $\frac{r}{\pi}$ (b) $\frac{2r}{\pi}$ (c) $\frac{2r}{3\pi}$ (d) $\frac{3r}{2\pi}$ (e) $\frac{4r}{3\pi}$



Problems 37~38. A Warren bridge truss is loaded as shown. Determine the forces in member CE and DF .



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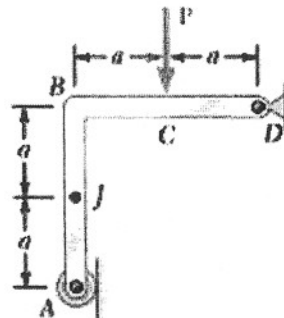
37. The force in member CE is

- (a) 3.0 kN Tension (b) 3.0 kN Compression (c) 4.0 kN Tension
 (d) 4.5 kN Tension (e) 4.5 kN Compression

38. The force in member DF is

- (a) 3.0 kN Tension (b) 3.0 kN Compression (c) 4.0 kN Tension
 (d) 4.5 kN Tension (e) 4.5 kN Compression

Problems 39~40. A force P is applied to a bent rod which is supported by a roller and a pin and bracket. Determine the internal force in the axial direction and internal moment at point J .



39. The internal force in the axial direction at point J is

- (a) 0 N (b) $0.5 P \leftarrow$ (c) $0.5 P \uparrow$ (d) $1 P \leftarrow$ (e) $1 P \uparrow$

40. The internal moment at J is

- (a) 0 (b) $0.5aP$ counterclockwise (c) $0.5 aP$ clockwise
 (d) $1 aP$ counterclockwise (e) $1 aP$ clockwise

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科目 理工測驗三一近代物理 科目代碼 0603 共 08 頁第 01 頁 *請在【答案卷卡】內作答

- Who received Nobel Prize for his work on special relativity.
(a) Bohr, (b) Einstein, (c) Planck, (d) Rutherford, (e) None of the above.
- A particle's rest mass is m_0 . When it is accelerated to the speed of v , its mass becomes m . What is the kinetic energy of this particle?
(a) $(1/2)mv^2$, (b) m_0c^2 , (c) mc^2 , (d) $(m-m_0)c^2$, (e) $mc^2 (1-v^2/c^2)^{-1/2}$.
- Two very long electrically conductive wires are parallel to each other and each carries an electric current of I in the same direction. Two graduate students are observing the system and doing measurements on the force(s) between the wires. One graduate student is sitting in the lab while the other is moving along the wire at the same velocity of the average velocity of the conducting electrons in the wire. (Note: electrons carry negative charges.) Which of the following statement is INCORRECT.
(a) The static student observes no electrostatic force between the wire.
(b) The moving student measures only the electrostatic force.
(c) The static student measures the electromagnetic Lorentz force.
(d) The moving student observes the electromagnetic Lorentz force, and it is equal to what the static student has measured.
(e) The moving student observes no electrostatic force between the wire.
- An electron microscope utilizes the electron beam at 300 keV energy. This means that the electrons move at about 60% of the speed of light. The electrons travel about 2.0 m from its generator (called the electron gun) through the lens system and the specimen until they reach the detector, which is either the photographic film or a charge coupled device (CCD). If you could fly with the electrons at the same speed, what would be the length of trip as you see it?
(a) 3.3 m, (b) 2.5 m, (c) 2.0 m, (d) 1.6 m, (e) 1.2 m
- Quantum theory was initiated by
(a) Einstein's explanation of photoelectrons.
(b) Heisenberg's uncertainty principle.
(c) Schroedinger's wave equation.
(d) Planck's interpretation of blackbody radiation.
(e) Bohr's model of atoms.

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科目 理工測驗三—近代物理 科目代碼 0603 共 08 頁第 02 頁 *請在【答案卷卡】內作答

6. In the experiment of x-rays scattered by free electrons at rest, which of the following statement is CORRECT?
- (a) The electron gains the maximum energy if the x-ray photon is scattered in the direction opposite to its incident direction, i.e., the scattering angle is 180° .
 - (b) It is possible for the photon to transfer its entire energy to the electron.
 - (c) The electron gains the maximum energy if the x-ray photons' scattering angle is 90° .
 - (d) The photon loses the maximum energy if its scattering angle is 90° .
 - (e) None of the above.
7. A photon strikes the surface of a metal specimen from the normal direction, ejecting one photoelectron, flying away from the surface also in the normal direction. Which of the following statements is CORRECT?
- (a) The energy of the photon must be at least equal to the kinetic energy of the photoelectron.
 - (b) Statement (a) is incorrect because there are other energies involved in this process.
 - (c) The momentum of the photon is equal to that of the photoelectron, but in opposite directions.
 - (d) The problem is wrong: It is not possible to have the photon and the induced photoelectron in the opposite directions. This would have violated the conservation of momentum.
 - (e) If the incident photons are of the same energy, then the kinetic energy of a photoelectron emitted from the sodium surface is lower than that from a copper surface.
8. When the peak frequency from an ideal blackbody is doubled, what happens to the power output (assuming constant area)?
- (a) 2 times greater, (b) 4 times greater, (c) 8 times greater, (d) 16 times greater,
 - (e) 4 times smaller.
9. Who proposed that particles had the properties of waves.
- (a) Bohr, (b) Heisenberg, (c) Planck, (d) Rutherford, (e) deBroglie.
10. The wavelength of a 1 eV electron is 1.2 nm. What is the wavelength of a 2 eV electron?
- (a) 2.4 nm, (b) 1.7 nm, (c) 0.85 nm, (d) 0.6 nm,
 - (e) Cannot be calculated without values of some physical constants.

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11. Which of the following statement is INCORRECT?

- (a) The wave packet is a superposition of many sinusoidal waves of various wavelengths and propagation velocities.
- (b) The group velocity of a wave packet is equal to the velocity of the particle associated with the wave packet.
- (c) The phase velocity cannot be defined for the wave packet..
- (d) If a particle is moving at a constant velocity, then it can be represented by a single sinusoidal wave of a certain wavelength.
- (e) The phase velocity is the product of frequency and wavelength.

12. A laser beam of 500 nm wavelength is chopped to 1 picosecond pulses. What is the uncertainty of wavelength? (Speed of light is approximately 3×10^8 m/s.)

- (a) 0.88 nm, (b) 0.14 nm, (c) 0.02 nm, (d) Cannot be calculated without values of other physical constants,
- (e) There is no uncertainty in photons. The wavelength is still 500 nm.

13. In the one dimensional time-independent Schroedinger equation $-\frac{\hbar^2}{2m} \frac{d^2\psi}{dx^2} + V\psi = E\psi$

which statement is INCORRECT?

- (a) V represents the potential distribution, which is a function of x .
 - (b) ψ is a function of x . It is the probability of finding the particle at position x .
 - (c) The symbol m is the mass of the particle.
 - (d) When $V=0$, the solution of Schroedinger equation represents a free particle which may have any kinetic energy.
 - (e) The equation is applicable only to non-relativistic cases.
14. A one dimensional potential barrier is located between $x=0$ and $x=a$. The height of the barrier is V_0 , that is, the potential is zero for $x<0$ and $x>a$, and is V_0 for $0 \leq x \leq a$. A particle of energy E is initially located in the region $x<0$. Which of the following statement is CORRECT.
- (a) If $E < V_0$, then the particle can never go over the barrier and reach the $x>a$ region.
 - (b) If $E > V_0$, then the particle has a chance of reaching region $x>a$, and the particle will have less energy.
 - (c) If $E < V_0$, then there is a probability for the wave of the particle to tunnel through the potential barrier. The wave exiting the barrier will have a longer wavelength.
 - (d) If $E < V_0$, then there is a probability for the wave of the particle to tunnel through the potential barrier. The wave exiting the barrier will have a smaller amplitude.
 - (e) It is possible to find the particle INSIDE the barrier, that is, in region $0 \leq x \leq a$.

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15. A particle is confined in a two dimensional square potential well of infinite depth. The length of the side of the potential well is L . The energy state of this particle is described by a pair of quantum numbers (n_x, n_y) . Which of the following statement is INCORRECT? (E_0 is the ground state energy for the same particle in a one dimensional trap of the length L .)
- (a) States (1,4) and (4,1) have the same energy.
 - (b) State (2,2) has energy $8E_0$.
 - (c) The ground state energy is $2E_0$.
 - (d) Level $50E_0$ has two-fold degeneracy.
 - (e) There is no state corresponding to $15E_0$.
16. The ground state energy of hydrogen atom is -13.6 eV. What is the energy of the emitted photon when an electron jumps from the $n=2$ state to the $n=1$ state of hydrogen?
- (a) 6.8, (b) -10.2 eV, (c) 10.2 eV, (d) 13.6 eV, (e) -13.6 eV
17. When alpha particles are scattered by a metal foil, which of the following statements is INCORRECT:
- (a) Alpha particles are mainly scattered by the atomic nuclei.
 - (b) The interaction between alpha particle and the atomic nuclei is Coulomb force.
 - (c) Thomson's model of atom cannot explain the angular distribution of scattered alpha particles.
 - (d) For the same material and thickness of foil, the higher the kinetic energy of the alpha particles, the more they are scattered.
 - (e) When thicknesses are the same, a copper foil scatters more alpha particle to larger angle than an aluminum foil does.
18. The scattering experiment that discovered the atomic nucleus was done with the alpha-particles. What other waves/particles can be scattered by atoms and provide the similar evidence of atomic nuclei?
- (a) neutrons, (b) electrons, (c) X-rays, (d) protons, (e) positrons.
19. What element was first discovered not on earth, but on the sun due to the absorption lines the element produced in the continuous spectrum of solar radiation?
- (a) hydrogen, (b) helium, (c) carbon, (d) oxygen, (e) nitrogen.

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20. Bohr's correspondence principle is about which of the following phenomena?
- (a) When the object of mass m is moving at a velocity v much smaller than the speed of light, its relativistic kinetic energy equals to the classical kinetic energy or $(1/2)mv^2$.
 - (b) An atom emits a photon of energy E when the atom's electron jumps from state n to state $n-1$. The same energy E must be absorbed by the atom for its electron to jump from state $n-1$ to state n .
 - (c) A moving meter stick appears shorter to a stationary observer A holding a meter stick; another observer B, moving along with the moving meter stick, finds observer A's meter stick shorter.
 - (d) All particles have their corresponding waves; all electromagnetic waves have their corresponding corpuscles.
 - (e) If the radius of the orbit of the atomic electron is made very large, then the radiation due to the quantum transition from the state n (a very large number) to $n-1$ is the same as the radiation of a charged particle moving along the orbit of the same radius, calculated from the classical electrodynamics.
21. A normalized wavefunction of an electron state in a hydrogen atom is $[2/(\pi^{1/2}a^{3/2})]e^{-r/a}$, where r is the length of radius vector and $a = 5.292 \times 10^{-11}$ m is equal to the radius of the innermost Bohr orbit. Which electron has the normalized wavefunction?
- (a) 1s (b) 2s (c) 2p (d) 3s (e) 3p
22. Not all the transitions between two electron states in a hydrogen atom are allowed to occur. What is an allowed transition below?
- (a) 4s to 3s (b) 4s to 2s (c) 4s to 1s (d) 4s to 3p (e) 4s to 3d
23. Consider the normal Zeeman effect. How many spectral lines are expected to obtain for a transition between two states of different orbital angular momentum l when the radiating atoms are placed in a magnetic field of magnitude B ?
- (a) 1 (b) 2 (c) 3 (d) 4 (e) 5
24. Which element exhibits the electron configuration $[\text{Ne}]3s^23p^1$?
- (a) Na (b) Ar (c) Al (d) Si (e) Ge
25. A Cu K_β characteristic X-ray peak can be produced by accelerating electrons to a Cu target. What is the electron transition to produce the X-ray peak Cu K_β ?
- (a) $n=2$ to $n=1$ (b) $n=3$ to $n=1$ (c) $n=3$ to $n=2$ (d) $n=4$ to $n=1$ (e) $n=4$ to $n=2$

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科目 理工測驗三一近代物理 科目代碼 0603 共 08 頁第 06 頁 *請在【答案卷卡】內作答

26. A continuous spectrum called the bremsstrahlung radiation can be produced by 30 KeV electrons striking a silver target. What is the cause to produce the continuous spectrum?
- (a) deceleration of incident electrons
 - (b) acceleration of incident electrons
 - (c) many transitions occurred simultaneously
 - (d) many electrons in each silver atom
 - (e) incident electrons with energy higher than 10 KeV
27. Which state is impossible to exist in a many-electron atom?
- (a) $3^2S_{1/2}$
 - (b) $3^2P_{1/2}$
 - (c) $3^2P_{3/2}$
 - (d) $4^2D_{3/2}$
 - (e) $4^2P_{5/2}$
28. Which diatomic molecule exhibits the highest dissociation energy?
- (a) NaCl
 - (b) NaF
 - (c) KCl
 - (d) LiCl
 - (e) LiF
29. The energy of a simple harmonic oscillator is characterized by the equation $E = h \nu (N + 1/2)$ where ν is the oscillation frequency. Which number is not allowed for N below?
- (a) 0
 - (b) 1/2
 - (c) 1
 - (d) 2
 - (e) 3
30. The Bose-Einstein function is always higher than the Fermi-Dirac function. At which energy below Bose-Einstein is closer to Fermi-Dirac probability?
- (a) 0
 - (b) 1 KT
 - (c) 3 KT
 - (d) 4KT
 - (e) 5 KT
31. What is square of the root-mean-square speed of an ideal-gas molecule?
- (a) $8KT/m$
 - (b) $3KT/m$
 - (c) $8KT/(\pi m)$
 - (d) $3KT/(\pi m)$
 - (e) $3KT/2$
32. In the Debye theory of heat capacity, which assumption is considered in the calculation such that the heat capacity C is proportional to T^3 at low temperature?
- (a) phonon obeys Bose-Einstein statistics
 - (b) phonon obeys Bose-Maxwell statistics
 - (c) all the phonons have the same frequency
 - (d) the density state of phonon is constant
 - (e) the density state of phonon is not constant

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96 學年度 材料科學工程學 系 (所) 組碩士班入學考試

科目 理工測驗三—近代物理 科目代碼 0603 共 08 頁第 07 頁 *請在【答案卷卡】內作答

33. In a buckyball, 60 carbon atoms are arranged in a cage structure of 12 pentagons and 20 hexagons whose geometry is like that of a soccer ball . What is the coordination number of each carbon atom in the buckyball?
(a) 2 (b) 3 (c) 4 (d) 5 (e) 6
34. The occupation probability of electrons at an energy state in an intrinsic semiconductor obeys the Fermi-Dirac statistics. The energy band gap of the intrinsic semiconductor is E_g and the electron density in the conduction band is 10^{11} cm^{-3} at room temperature. How many electrons per cm^3 occupy at its Fermi level?
(a) 10^{11} (b) 5×10^{10} (c) 0 (d) $5 \times 10^{10} \times e^{-E_g/2}$ (e) $10^{11} \times e^{-E_g/2}$
35. An external voltage V is applied across a pn junction diode with the p end positive and the n end negative. Which statement describing this condition is incorrect?
(a) Forward bias
(b) electron injection from the n end
(c) increase of depletion width
(d) reduction of depletion width
(e) increase of diode current
36. A blue light can be emitted from a diode laser made of GaN. Which statement is incorrect regarding the GaN diode laser?
(a) the wavelength of the diode can be fine tuned by the doping
(b) the blue light is emitted from a GaN active layer
(c) the laser diode is operated at forward bias
(d) the blue light is coherent
(e) the laser diode can be powered by batteries
37. The electric potential energy of NaCl is the coulomb energy of the Na^+ and Cl^- ions, which is part of the cohesive energy. Let us consider a Na^+ ion in NaCl. Which statement is incorrect below?
(a) the first nearest neighbors are 6 Cl^- ions
(b) The second nearest neighbors are 8 Na^+ ions
(c) Its Madelung constant is 1.748
(d) The electric potential energy is negative
(e) It has the same Madelung value for all crystal of the same structure.

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38. Which one has the highest critical temperature among the following superconductors?
(a) Hg (b) Pb (c) Nb₃Ge (d) YBa₂Cu₃O₇ (e) La_xBa_{2-x}CuO₄
39. Si atoms are bonded by the sp³ hybrids in a Si crystal. Which statement is incorrect in the sp³ hybridization?
(a) The bond angle is 109.5°
(b) The bond angle is smaller than that of sp² hybrids
(c) The bond angle is the same as that in CCl₄
(d) one of the sp³ hybrids points to [111]
(e) The total energy decreases after hybridization
40. The melting points of molecular solids depend approximately on the number of electrons per molecules. Which one has the highest melting temperature in the following molecular solids?
(a) CH₄ (b) SiF₄ (c) C₄F₈ (d) UF₆ (e) HgBr₂

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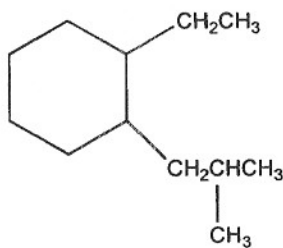
科目 理工測驗三—有機化學 科目代碼 0603 共 08 頁第 01 頁 *請在【答案卷卡】內作答

1. Which of the following statements is false?
- (a) Increasing solvent polarity decreases the reaction rate if any reactants in the rate-determining step are charged.
 - (b) Increasing solvent polarity increases the reaction if none of the reactants in the rate-determining step is charged.
 - (c) An S_N2 reaction is favored by a high concentration of a good nucleophile in an aprotic polar solvent.
 - (d) An S_N1 reaction is favored by a poor nucleophile in a protic polar solvent.
 - (e) If an alkyl halide can undergo both S_N2 and S_N1 reactions, the S_N1 pathway will be favored by a good nucleophile.

2. Which compound is a Lewis base?

- (a) CH_3NH_4^+
- (b) CH_3COOH
- (c) CH_3OCH_3
- (d) AlCl_3
- (e) c and d.

3. How many secondary carbons does the following compound have?



- (a) 3, (b) 4, (c) 5, (d) 6, (e) 7

4. How many degrees of unsaturation are in the formula $\text{C}_{23}\text{H}_{38}$?

- (a) 3, (b) 4, (c) 5, (d) 6, (e) 7

5. Alkynes are less reactive toward electrophilic addition because

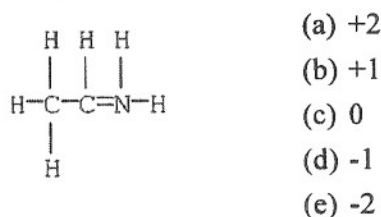
- (a) triple bonds are stronger than double bonds.
- (b) only one pi bond must be broken in the addition of an electrophile to an alkene.
- (c) the intermediate that is formed from an alkyne is a vinylic cation, whereas the intermediate that is formed from an alkene is an alkyl cation.
- (d) alkynes are less stable than alkenes.
- (e) hyperconjugation stabilizes the intermediate from an alkyne more so than from an alkene.

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科目 理工測驗三—有機化學 科目代碼 0603 共 08 頁第 02 頁 *請在【答案卷卡】內作答

6. The formal charge on nitrogen in the compound below is _____.



7. Which set of reagents would be the *best* choice to accomplish the transformation shown below?

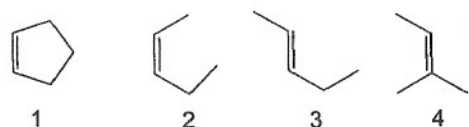


- (a) 1. H_2SO_4 2. CH_3OH
 (b) CH_3OH , cat. H^+
 (c) 1. $\text{Hg}(\text{OAc})_2$, CH_3OH 2. NaBH_4
 (d) 1. BH_3 , CH_3OH , 2. H_2O_2 , CH_3O^-
 (e) either (a) or (b)

8. Buffering is used to maintain the pH of human blood in the relatively narrow 7.3 - 7.4 range. What acid/base pair serves to buffer the blood?

- (a) $\text{H}_2\text{O} / \text{HO}^-$
 (b) $\text{H}_3\text{O}^+ / \text{H}_2\text{O}$
 (c) $\text{H}_2\text{CO}_3 / \text{HCO}_3^-$
 (d) $\text{NH}_4^+ / \text{NH}_3$
 (e) HCl / Cl^-

9. Rank the following compounds in order of decreasing stability (i.e. first choice is *most* stable).



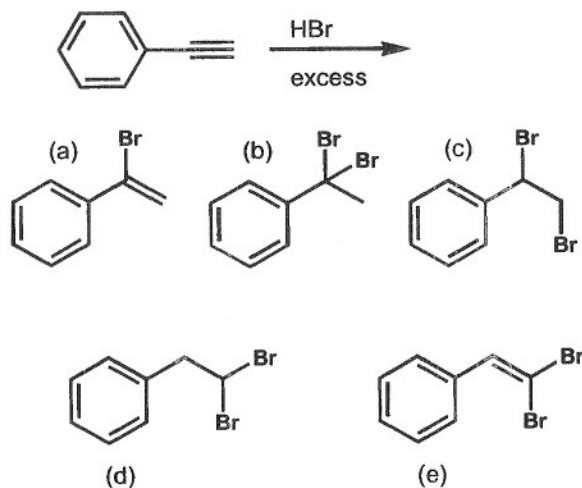
- (a) $1 > 2 > 3 > 4$
 (b) $4 > 3 > 1 > 2$
 (c) $4 > 1 > 2 > 3$
 (d) $4 > 3 > 2 > 1$
 (e) $2 > 4 > 1 > 3$

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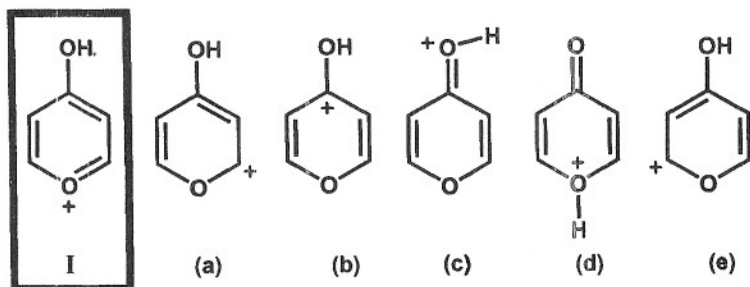
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科目 理工測驗三一有機化學 科目代碼 0603 共 08 頁第 03 頁 *請在【答案卷卡】內作答

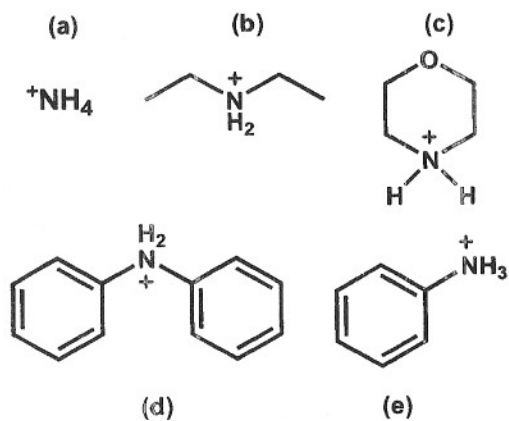
10. Which product is expected from the reaction below ?



11. Which of the following is *not* an acceptable resonance structure of I?



12. Which of the following compounds is the strongest acid?

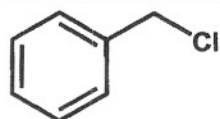


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科目 理工測驗三—有機化學 科目代碼 0603 共 08 頁第 04 頁 *請在【答案卷卡】內作答

13. Which of the following compounds reacts *slowest* under S_N1 reaction conditions?



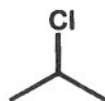
(a)



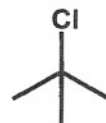
(b)



(c)



(d)



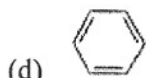
(e)

14. Which of the following is not a nucleophile?

(a) $FeBr_3$

(b) Br^-

(c) NH_3



(e) AlH_4^-

15. What configurations are found in the product(s) of the reaction below?



(a) 1*R*,2*R* only

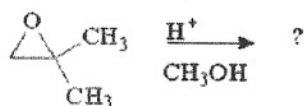
(b) 1*S*,2*S* only

(c) 1*R*,2*S* only

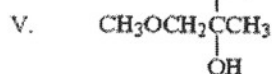
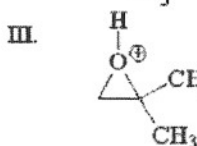
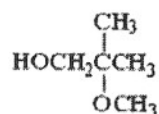
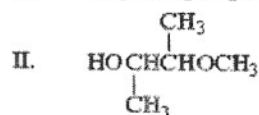
(d) an equal mixture of 1*R*,2*R* and 1*S*,2*S*

(e) an equal mixture of 1*R*,2*R* and 1*R*,2*S*

16. What is the major product for the following reaction?



I. $CH_3OCH_2CH_2CH_2CH_2OH$ IV.



(a) I, (b) II, (c) III, (d) IV, (e) V

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科目 理工測驗三一有機化學 科目代碼 0603 共 08 頁第 05 頁 *請在【答案卷卡】內作答

17. An increase in which of the following results in a decrease in the rate of the chemical reaction?
- (a) temperature
 - (b) concentration
 - (c) collision frequency
 - (d) energy of activation
 - (e) fraction of collisions with proper orientation
18. Which of the following compounds contains the longest carbon-carbon single bond?
- (a) Allene
 - (b) 1,3-butadiyne
 - (c) 1,3-butadiene
 - (d) 1-butene
 - (e) Propyne
19. Which of the following does not provide evidence that there are two different mechanisms for nucleophilic substitution?
- (a) reaction products when CH_3I is used as the substrate
 - (b) reaction products when $(\text{CH}_3)_3\text{CCH}_2\text{I}$ is used as substrate
 - (c) the stereochemistry of nucleophilic substitutions
 - (d) the polarity of the solvents
 - (e) the effect of nucleophile concentration on rate
20. Which of the following is chiral?
- (a) *cis*-1-bromo-3-chlorocyclobutane
 - (b) *trans*-1-bromo-3-chlorocyclobutane
 - (c) *cis*-1,4-dimethylcyclohexane
 - (d) *cis*-1,3-dimethylcyclohexane
 - (e) *trans*-1,3-dimethylcyclohexane

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96 學年度 材料科學工程學 系(所) 組碩士班入學考試

科目 理工測驗三—有機化學 科目代碼 0603 共 08 頁第 06 頁 *請在【答案卷卡】內作答

Choose the one alternative that best completes the statement or answers the question.

21. Which of the following compounds will undergo an S_N2 reaction most readily?

- (a) $(CH_3)_3CCH_2I$ (b) $(CH_3)_3CCl$ (c) $(CH_3)_2CHI$ (d) $(CH_3)_2CHCH_2CH_2CH_2Cl$
(e) $(CH_3)_2CHCH_2CH_2CH_2I$

22. What product results from the S_N2 reaction between (R)-2-chloropentane and hydroxide?

- (a) (R)-2-pentanol (b) (S)-2-pentanol (c) racemic pentanol (d) 1-pentanol (e) 3-pentanol

23. Which of the following is the strongest nucleophile in an aqueous solution?

- (a) HO^- (b) F^- (c) Cl^- (d) Br^- (e) I^-

24. Which of the following factors has no effect on the rate of S_N1 reactions?

- (a) the nature of the alkyl halide
(b) the nature of the leaving group
(c) the concentration of the alkyl halide
(d) the concentration of the nucleophile
(e) the value of the rate constant

25. In the S_N1 hydrolysis mechanism of $(CH_3)_3CBr$, there are _____ elementary steps, _____ distinct transition states, and _____ distinct intermediates.

- (a) 2,2,2 (b) 2,2,3 (c) 2,3,2 (d) 3,2,3 (e) 3,3,2

26. Which of the following alkyl bromides undergoes solvolysis in methanol without rearrangement?

- (a) (R)-2-bromo-3-ethylpentane
(b) (S)-2-bromo-3-ethylpentane
(c) (R)-3-bromo-2-methylpentane
(d) (S)-3-bromo-2-methylpentane
(e) 3-bromo-3-ethylpentane

27. Which of the alkyl chlorides listed below undergoes dehydrohalogenation in the presence of a strong base to give 2-pentene as the only alkene product?

- (a) 1-chloropentane
(b) 2-chloropentane
(c) 3-chloropentane
(d) 1-chloro-2-methylbutane
(e) 1-chloro-3-methylbutane

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96 學年度 材料科學工程學 系 (所) 組碩士班入學考試

科目 理工測驗三一有機化學 科目代碼 0603 共 08 頁第 07 頁 *請在【答案卷卡】內作答

28. Which of the following correctly reflects relative stabilities of carbocations?

- (a) 3° allylic $> 2^\circ > 1^\circ$ benzylic
- (b) methyl $> 2^\circ$ benzylic $> 3^\circ$
- (c) 3° benzylic $>$ vinyl $> 1^\circ$
- (d) 2° allylic $> 2^\circ >$ vinyl
- (e) 1° benzylic $> 3^\circ > 3^\circ$ allylic

29. Which of the following is the strongest acid?

- (a) CH_3NH (b) CH_3OH (c) CH_3SH (d) CH_3OCH_3 (e) CH_3Cl

30. Which of the following is the strongest base?

- (a) HOMgBr (b) H_2O (c) CH_4 (d) CH_3OH (e) CH_3MgBr

31. What m/z value would you predict for the most stable fragment peak in the mass spectrum of 4-ethylheptane?

- (a) 128 (b) 127 (c) 113 (d) 99 (e) 85

32. In the electromagnetic spectrum, _____ frequencies, _____ wavenumbers, and _____ wavelengths are associated with high energy.

- (a) high, small, long (b) low, large, short (c) low, small, short
- (d) high, large, short (e) high, small, short

33. Which of the following are considered to be bending (in-plane) vibrations?

- (a) scissoring and wagging (b) scissoring and twisting (c) rocking and wagging
- (d) rocking and twisting (e) scissoring and rocking

34. Which of the following functional groups typically exhibits a carbonyl stretch at the lowest frequency?

- (a) amide (b) ester (c) ketone (d) aldehyde (e) ether

35. What type of 2-D NMR spectrum which carbon atoms are coupled to which hydrogen atoms?

- (a) DEPT (b) APT (c) COSY (d) HETCOR (e) MRI

36. Which of the following is aromatic?

- (a) cyclopentadienyl cation (b) 1,3-cyclohexadiene (c) cyclobutenyl anion
- (d) 1,3,5-hexatriene (e) cycloheptatrienyl cation

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37. Benzene can be reduced to cyclohexane when it is treated with hydrogen in the presence of a nickel catalyst under conditions of high temperature and pressure. Predict the signs of ΔH° and ΔS° for this process.

- (a) $\Delta H^\circ > 0, \Delta S^\circ > 0$ (b) $\Delta H^\circ > 0, \Delta S^\circ < 0$ (c) $\Delta H^\circ > 0, \Delta S^\circ = 0$
(d) $\Delta H^\circ < 0, \Delta S^\circ > 0$ (e) $\Delta H^\circ < 0, \Delta S^\circ < 0$

38. Which of the following substituents acts as a moderate activator and o/p director in electrophilic aromatic substitution reactions?

- (a)-Br (b)-SO₃H (c)-CO₂H (d)-NHCOR (e)-CHO

39. Which of the following compounds has the lowest boiling point?

- (a) 1-butanol (b) butanoic acid (c) butanenitrile
(d) methyl propanoate (e) butanamide

40. Esters and amides are most easily made by nucleophilic acyl substitution reactions on:

- (a) alcohols. (b) acid anhydrides. (c) carboxylates.
(d) carboxylic acids. (e) acid chlorides.

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96學年度 材料科學工程學 系(所) _____ 組碩士班入學考試

科目理工測驗三一應用電子學 科目代碼 0603 共 10 頁第 01 頁*請在【答案卷卡】內作答

- Which of the following also can represent 24_{10} ?
 (a) 11101_2 (binary form) (b) 32_8 (octal form) (c) 16_{16} (hexadecimal form)
 (d) $0010\ 0100_{BCD}$ (binary-coded decimal format) (e) None of above is correct.
- Based on the following truth table in Fig.E2, with three inputs A, B, C, and the output D, please use Sum-of-Products (SOP) or Karnaugh map to find the Boolean expression of D.
 (a) $D = \bar{B}\bar{C} + A\bar{B}C$ (b) $D = \bar{A}\bar{B} + \bar{B}C$ (c) $D = A\bar{B}C$
 (d) $D = BC + \bar{A}\bar{B}\bar{C}$ (e) $D = BC + \bar{B}\bar{C}$

A	B	C	D
0	0	0	1
1	0	0	1
0	1	0	0
0	0	1	0
1	1	0	0
1	0	1	0
0	1	1	0
1	1	1	1

Fig.E2

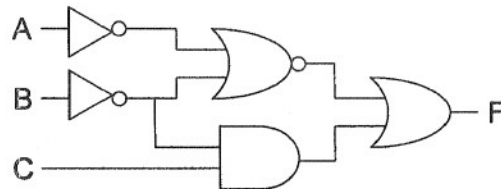


Fig.E3

- Based on the logic circuit as above in Fig.E3, with three inputs A, B, C, and the output F, please find the Boolean expression of F.
 (a) $F = \bar{A} + \bar{B} + \bar{B}C$ (b) $F = A + B + \bar{B}C$ (c) $F = A + C$
 (d) $F = (A + B)(\bar{B}C)$ (e) $F = AB + \bar{B}C$
- Assuming that the initial state of the shift-register shown in Fig.E4 as below is 100 (i.e., $Q_0 = 1, Q_1 = 0,$ and $Q_2 = 0$), please find after how many shifts does the register return to the starting state.
 (a) 4 (b) 5 (c) 6 (d) 7 (e) None of above is correct

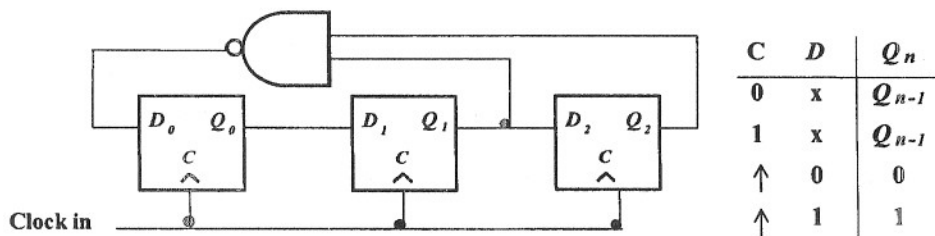


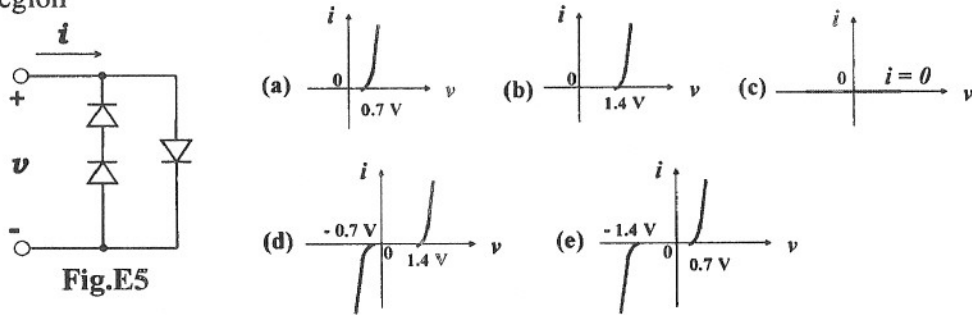
Fig.E4

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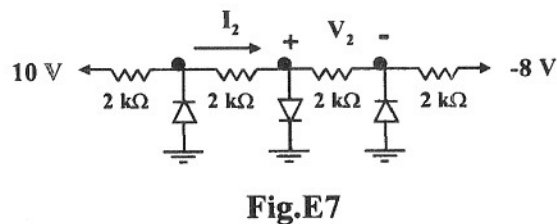
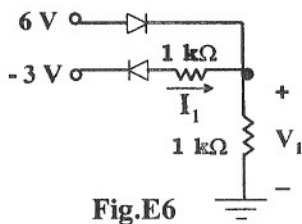
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5. Please find the i versus v to scale for the circuit as shown below in Fig.E5. The diodes are typical small-signal silicon devices at 300K. Assume 0.7V for all diodes in the forward-bias region



6. Please find the I_1 and V_1 for the circuit as shown below in Fig.E6, assuming that the diodes are ideal.
- (a) $I_1 = 0 \text{ mA}$, $V_1 = 6 \text{ V}$ (b) $I_1 = 0 \text{ mA}$, $V_1 = -6 \text{ V}$ (c) $I_1 = -9 \text{ mA}$, $V_1 = 6 \text{ V}$
 (d) $I_1 = 9 \text{ mA}$, $V_1 = -6 \text{ V}$ (e) None of above is correct.



7. Please find the I_2 and V_2 for the circuit as shown above in Fig.E7. assuming that the diodes are ideal.
- (a) $I_2 = 2.25 \text{ mA}$, $V_2 = 4.5 \text{ V}$ (b) $I_2 = 2.5 \text{ mA}$, $V_2 = 0 \text{ V}$ (c) $I_2 = 0 \text{ mA}$, $V_2 = 0 \text{ V}$
 (d) $I_2 = 0 \text{ mA}$, $V_2 = 4 \text{ V}$ (e) None of above is correct.
8. Please find V_A and V_B of the steady-state output waveform in Fig.E9b for the circuits shown in Fig.E8a. Assume that RC is much larger than the period of the input voltage and that the diodes are ideal.
- (a) $V_A = -5 \text{ V}$, $V_B = 15 \text{ V}$ (b) $V_A = -10 \text{ V}$, $V_B = 10 \text{ V}$ (c) $V_A = -15 \text{ V}$, $V_B = 5 \text{ V}$
 (d) $V_A = 5 \text{ V}$, $V_B = 25 \text{ V}$ (e) None of above is correct.

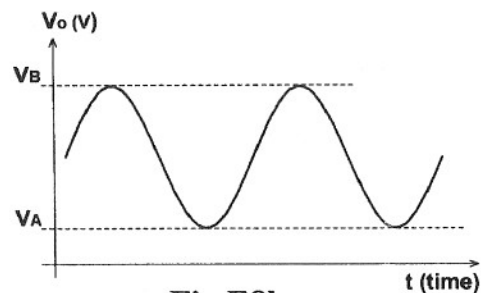
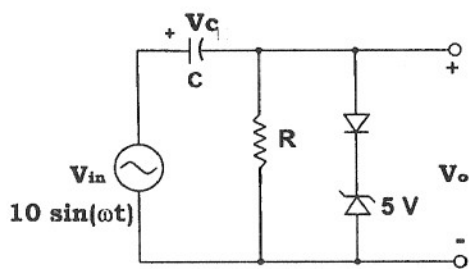


Fig.E8a

Fig.E8b

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9. Please find the V_o versus V_{in} to the scale in the same plot for the following circuit Fig.E9, assuming 0.7 V for all diodes (including Zeners) in the forward-bias region.

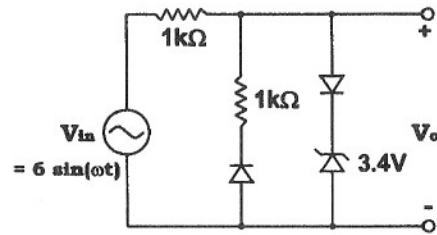
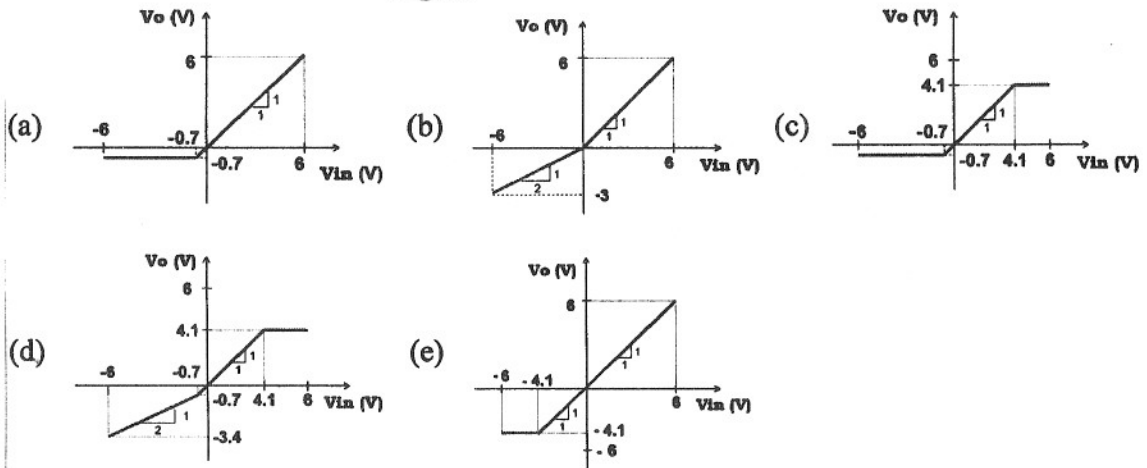


Fig.E9

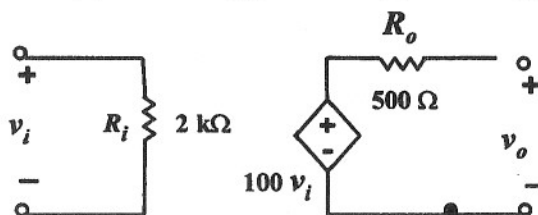


10. Suppose that an input signal is given by $V_i(t) = 2 \sin(1000 \pi t) + \cos(2000 \pi t)$. The gain of an amplifier at 500 Hz is $3 \angle 30^\circ$, please find the output signal $V_o(t)$ with above amplifier if liner waverform distortion is to be avoided.

- (a) $V_o(t) = 6 \sin(1000 \pi t + 30^\circ) + 3 \cos(2000 \pi t + 60^\circ)$
 (b) $V_o(t) = 6 \sin(1000 \pi t + 30^\circ) + 3 \cos(2000 \pi t + 30^\circ)$
 (c) $V_o(t) = 6 \sin(1000 \pi t - 30^\circ) + 3 \cos(2000 \pi t - 60^\circ)$
 (d) $V_o(t) = 6 \sin(1000 \pi t - 30^\circ) + 3 \cos(2000 \pi t - 30^\circ)$
 (e) None of above is correct.

11. If two of the identical amplifiers as shown below in Fig.E11 are cascaded, the overall open circuit voltage gain (A_{voc}) of the cascaded amplifiers is most likely to be

- (a) 400 (b) 800 (c) 6400 (d) 8000 (e) 160000



Input resistance $R_i = 2 \text{ k}\Omega$
 Output resistance $R_o = 500 \Omega$
 Open-circuit gain $A_{voc} = 100$

Fig.E11

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12. Based on the following plot Fig.E12 as below showing an enhancement NMOS transistor, which of the following statements is most **incorrect**?

- (a) The threshold voltage (V_{to}) could be 1V
- (b) The i_D at saturation region will increase as V_{to} increases
- (c) The i_D at saturation region will increase as transistor channel length (L) decreased
- (d) The i_D will increase as v_{GS} increases for $v_{GS} > V_{to}$
- (e) The transistor will be at cutoff region for $v_{GS} \leq V_{to}$

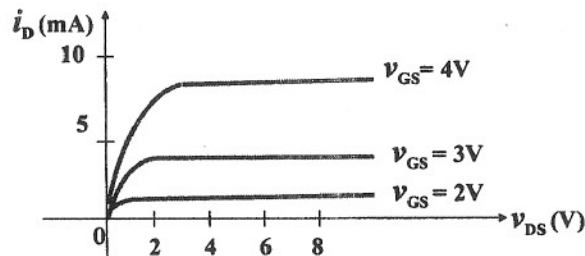


Fig.E12

13. For the enhancement mode transistors as shown below in the circuit of Fig.E13, the transistors have $V_{to} = 2V$ for NMOS and $V_{to} = -2V$ for PMOS, and $K = 2mA/V^2$ for both NMOS and PMOS. The i_D is most likely to be

- (a) 0 mA (b) 2 mA (c) 8 mA (d) 18 mA (e) 72 mA

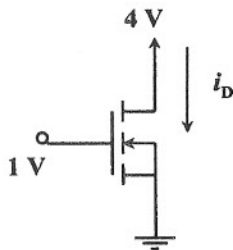


Fig.E13

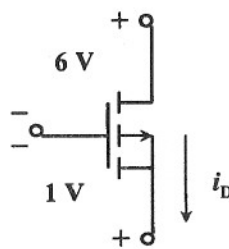


Fig.E14

$K = (1/2) KP (W/L)$
 $KP = 50 \mu A/V^2$ (typical value)
 W : Channel width
 L : Channel length

14. For the enhancement mode transistors as shown above in the circuit of Fig.E14, the transistors have $V_{to} = 2V$ for NMOS and $V_{to} = -2V$ for PMOS, and $K = 2mA/V^2$ for both NMOS and PMOS. The i_D is most likely to be

- (a) 0 mA (b) 2 mA (c) 18 mA (d) 32 mA (e) 128 mA

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15. For the circuit shown in Fig.E15, the MOSEFET has $V_{to} = 1 \text{ V}$ and $K = 0.5 \text{ mA/V}^2$. For DC operation (Q point), the I_{DQ} and V_{GSQ} are most likely to be
- (a) $I_{DQ} = 0.3 \text{ mA}$, $V_{GSQ} = 7 \text{ V}$ (b) $I_{DQ} = 0.3 \text{ mA}$, $V_{GSQ} = 7 \text{ V}$
 (c) $I_{DQ} = 0.4 \text{ mA}$, $V_{GSQ} = 6 \text{ V}$ (d) $I_{DQ} = 0.6 \text{ mA}$, $V_{GSQ} = 4 \text{ V}$
 (e) $I_{DQ} = 0.5 \text{ mA}$, $V_{GSQ} = 5 \text{ V}$

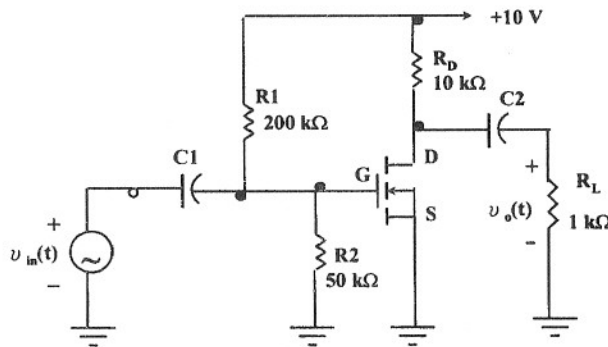


Fig.E15

16. For the following transistors in Fig.E16, the $\beta = 100$, $|V_{CE}| = 0.2 \text{ V}$ in saturation, and $|V_{BE}| = 0.6 \text{ V}$ in the active and saturation regions. Which statement is mostly true about the operation region of transistor, the collector-to-emitter voltage (V_{CE}), and collector current (I_C) values.
- (a) $V_{CE} = 4.6 \text{ V}$ (b) $V_{CE} = 0.2 \text{ V}$ (c) $I_C = 0.02 \text{ mA}$ (d) The transistor is in cutoff region
 (e) None of above

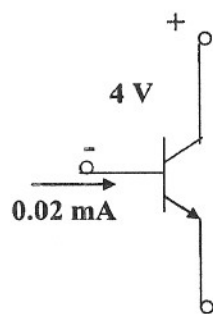


Fig.E16

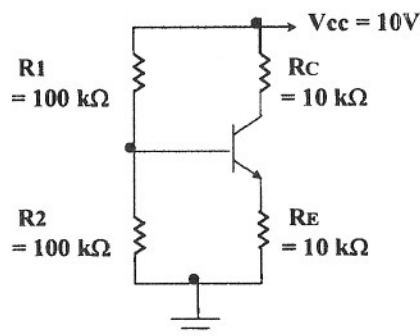


Fig.E17

17. Consider the four-resistor bias network as shown above in Fig.E17, with $R_1 = 100\text{k}\Omega$, $R_2 = 100\text{k}\Omega$, $V_{cc} = 10\text{V}$, $R_C = 10\text{k}\Omega$, $R_E = 10\text{k}\Omega$, and $\beta = 200$, the collector current (I_C) is most likely to be
- (a) 0.10 mA (b) 0.22 mA (c) 0.44 mA (d) 0.88 mA (e) None of above

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18. Which is most likely to be true, assuming ideal operation amplifier (ideal OP-Amp) in Fig.E18 as below.

- (a) $I_1 + I_2 = I_3 + I_4$ (b) $I_1 = I_3$ (c) $I_2 = I_4$ (d) $I_1 + I_3 = I_2 + I_4$ (e) None of above

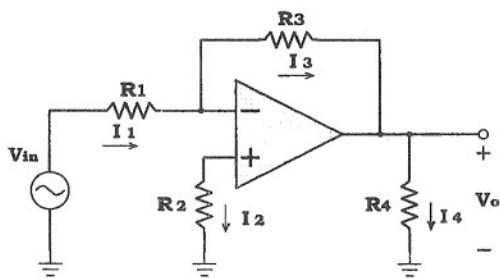


Fig.E18

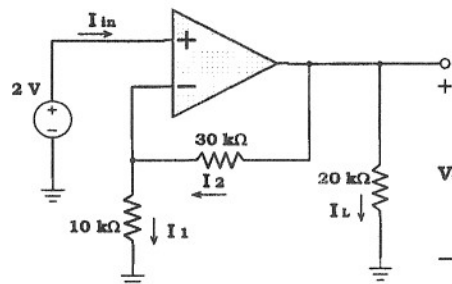


Fig.E19

19. Which is most likely to be true, assuming ideal operation amplifier (ideal OP-Amp) in Fig.E19 as above.

- (a) $V_o = 2\text{ V}$ (b) $V_o = 4\text{ V}$ (c) $V_o = 6\text{ V}$ (d) $V_o = 8\text{ V}$ (e) None of above

20. Which is most likely to be true, assuming ideal operation amplifier (ideal OP-Amp) in Fig.E20 as below.

- (a) $V_o = -1\text{ V}$ (b) $V_o = -3\text{ V}$ (c) $V_o = -6\text{ V}$ (d) $V_o = -9\text{ V}$ (e) None of above

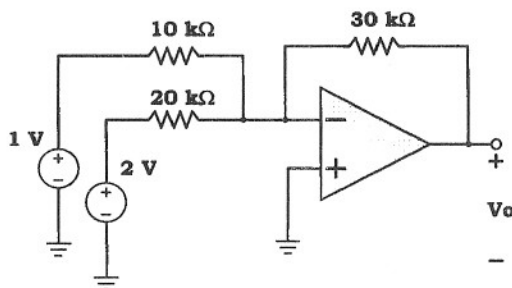


Fig.E20

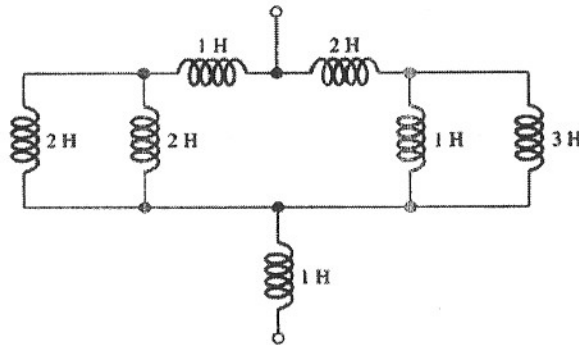
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21. Find the equivalent inductance for the series-parallel combinations shown in below.

- (a) 1.158H (b) 2.158H (c) 3.158H (d) 4.158H (e) 5.158H



22. At the resonant frequency $f_0 = 1\text{MHz}$, a series resonant circuit with $R = 50\ \Omega$ has $|V_R| = 2\text{V}$ and $|V_L| = 20\text{V}$. Determine the value of L .

- (a) $59.58\ \mu\text{H}$ (b) $79.58\ \mu\text{H}$ (c) $99.58\ \mu\text{H}$ (d) $111.58\ \mu\text{H}$ (e) $131.58\ \mu\text{H}$

23. Repeat the problem 22. Find the value of C ?

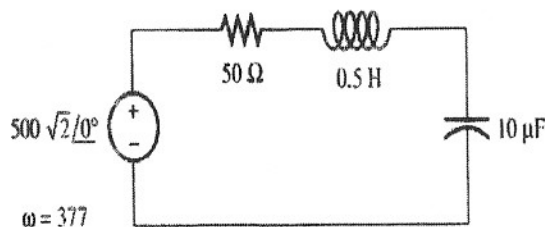
- (a) $318.3\ \text{pF}$ (b) $418.3\ \text{pF}$ (c) $518.3\ \text{pF}$ (d) $618.3\ \text{pF}$ (e) $718.3\ \text{pF}$

24. Repeat the problem 22. What is the value of $|V_C|$?

- (a) 5V (b) 10V (c) 15V (d) 20V (e) 25V

25. Find the reactive power delivered by the source shown in below.

- (a) -1186VAR (b) 1186VAR (c) 2286VAR (d) -2286VAR (e) 3286VAR



26. Repeat the problem 25. Find the apparent power delivered by the source.

- (a) 2628VA (b) 2728VA (c) 2828VA (d) 2928VA (e) 3028VA

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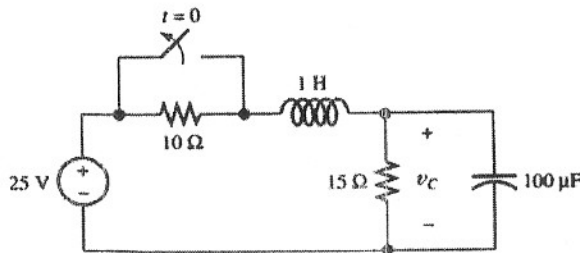
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27. A parallel resonant circuit has $R = 5\text{K}\Omega$, $L = 50\ \mu\text{H}$, and $C = 200\text{pF}$. Determine the resonant frequency.
 (a) $5.592\ \mu\text{Hz}$ (b) $4.592\ \mu\text{Hz}$ (c) $3.592\ \mu\text{Hz}$ (d) $2.592\ \mu\text{Hz}$ (e) $1.592\ \mu\text{Hz}$

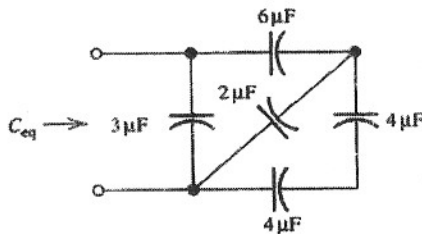
28. A parallel resonant circuit has $R = 5\text{K}\Omega$, $L = 50\ \mu\text{H}$, and $C = 200\text{pF}$. Determine the quality factor.
 (a) 10 (b) 9 (c) 8 (d) 7 (e) 6

29. A 200-turn coil is wound on a core having a reluctance of 5×10^5 ampere-turns/Wb. Determine the inductance of the coil.
 (a) 60mHz (b) 70mHz (c) 80mHz (d) 90mHz (e) 100mHz

30. The circuit shown in below has been set up for a long time prior to $t = 0$ with the switch closed. Find the steady-state value of v_c after the switch has been opened for a long time.
 (a) 15V (b) 20V (c) 25V (d) 30V (e) 35V



31. Find the equivalent capacitance for the circuits shown in below.
 (a) $1.4\ \mu\text{F}$ (b) $2.4\ \mu\text{F}$ (c) $3.4\ \mu\text{F}$ (d) $5.4\ \mu\text{F}$ (e) $7.4\ \mu\text{F}$



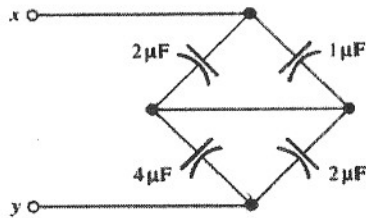
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32. Find the equivalent capacitance between terminals x and y for the circuit shown in below.

- (a) $6 \mu\text{F}$ (b) $5 \mu\text{F}$ (c) $4 \mu\text{F}$ (d) $3 \mu\text{F}$ (e) $2 \mu\text{F}$



33. What is the bandgap of silicon at room temperature?

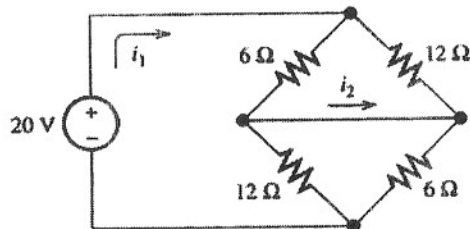
- (a) 0.9eV (b) 1eV (c) 1.1eV (d) 1.3eV (e) 1.4eV

34. What is the dielectric constant of SiO_2 at room temperature?

- (a) 3 (b) 4 (c) 5 (d) 5.5 (e) 6

35. Find the value of i_1 .

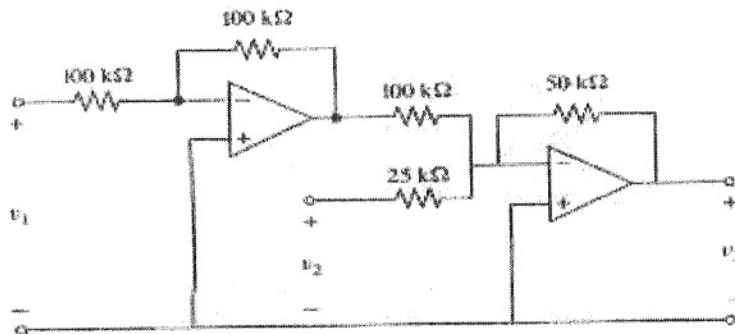
- (a) 2.5A (b) 3A (c) 3.5A (d) 4A (e) 1A



36. Repeat the problem 35, find the value of i_2 .

- (a) 0.533A (b) 0.633A (c) 0.733A (d) 0.833A (e) 0.933A

37. For the voltage transfer function $v_3 = k_1 v_1 + k_2 v_2$, find k_1



- (a) 0.5 (b) 1 (c) 1.5 (d) 2 (e) 2.5

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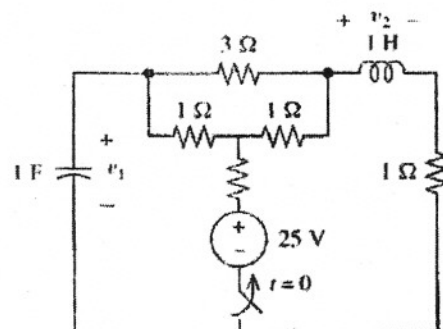
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38. Repeat the problem 37, find the value of k_2

- (a) -0.5 (b) -1 (c) -1.5 (d) -2 (e) -2.5

39. If the circuit is in dc steady state at $t = 0^-$, and find v_1 at $t = 0^-$



- (a) 10/7 (b) 50/7 (c) 100/7 (d) 150/7 (e) 200/7

40. Repeat the problem 39, find the value of v_2 at $t = 0^+$

- (a) -70/14 (b) -75/14 (c) -81/14 (d) -85/14 (e) -87/14