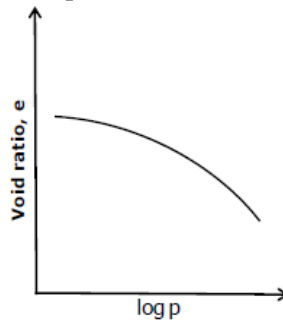




6. The major and minor principal stresses at a point are 3MPa and -3MPa respectively. The maximum shear stress at the point is
- (A) Zero (C) 6MPa  
(B) 3MPa (D) 9MPa
7. The number of independent elastic constants for a linear elastic isotropic and homogeneous material is
- (A) 4 (C) 2  
(B) 3 (D) 1
8. The effective length of a column of length L fixed against rotation and translation at one end and free at the other end is
- (A) 0.5 L (C) 1.414 L  
(B) 0.7 L (D) 2L
9. As per India standard code of practice for pre stressed concrete (IS:1343-1980) the minimum grades of concrete to be used for post-tensioned and pre-tensioned structural elements are respectively
- (A) M20 for both (C) M15 and M20  
(B) M40 and M30 (D) M30 and M40
10. A solid circular shaft of diameter d and length L is fixed at one end and free at the other end. A torque t is applied at the free end. The shear modulus of the material is G. The angle of twist at three free ends is
- (A)  $\frac{16 TL}{\pi d^4 G}$  (C)  $\frac{64 TL}{\pi d^4 G}$   
(B)  $\frac{32 TL}{\pi d^4 G}$  (D)  $\frac{128 TL}{\pi d^4 G}$
11. In a compaction test, G, w, S and e represent the specific gravity, water content, degree of saturation and void ratio of the soil sample, respectively. If  $\gamma_w$  represents the unit weight of water and  $\gamma_d$  represents the dry unit weight of the soil, the equation for zero air voids line is
- (A)  $\gamma_d \frac{G\gamma_w}{1+Se}$  (C)  $\gamma_d \frac{G\gamma_w}{e+\gamma_w S}$   
(B)  $\gamma_d \frac{G\gamma_w}{1+Gw}$  (D)  $\gamma_d \frac{Gw}{1+Se}$
12. A fine grained soil has liquid limit of 60 and plastic limit of 20. As per the plasticity chart, according to IS classification, the soil is represented by the letter symbols
- (A) CL (C) CH  
(B) CI (D) CL - ML

13. Quick sand condition occurs when  
 (A) The void ratio of the soil becomes 1.0  
 (B) The upward seepage pressure in soil becomes zero  
 (C) The upward seepage pressure in soil becomes equal to the saturated unit weight of the soil  
 (D) The upward seepage pressure in soil becomes equal to the submerged unit weight of the soil
14. The  $e$ - $\log p$  curve shown in the figure is representative of



- (A) Normally consolidated clay  
 (B) Over consolidated clay  
 (C) Under consolidated clay  
 (D) Normally consolidated clayey sand
15. If  $\sigma_h$ ,  $\sigma_v$ ,  $\sigma'_h$  and  $\sigma'_v$  represent the total horizontal stress, total vertical stress, effective horizontal stress and effective vertical stress on a soil element, respectively, the coefficient of earth pressure at rest is given by  
 (A)  $\frac{\sigma_h}{\sigma_v}$   
 (B)  $\frac{\sigma'_h}{\sigma'_v}$   
 (C)  $\frac{\sigma_v}{\sigma_h}$   
 (D)  $\frac{\sigma'_v}{\sigma'_h}$
16. A mild-sloped channel is followed by a steep-sloped channel. The profiles of gradually varied flow in the channel are  
 (A)  $M_3, S_2$   
 (B)  $M_3, S_3$   
 (C)  $M_2, S_1$   
 (D)  $M_2, S_2$
17. The flow in a rectangular channel is subcritical. If width of the channel is reduced at a certain section, the water surface under no-choke condition will  
 (A) Drop at a downstream section  
 (B) Rise at a downstream section  
 (C) Rise at an downstream section  
 (D) Not undergo any change
18. The correct match of **Group-I** with **Group-II** is

Group – I

P. Evapotranspiration

Group - II

1. Penman method

- |                              |                     |
|------------------------------|---------------------|
| Q. Infiltration              | 2. Snyder's method  |
| R. Synthetic unit hydrograph | 3. Muskingum method |
| S. Channel Routing           | 4. Horton's method  |

- |                        |                        |
|------------------------|------------------------|
| (A) P-1, Q-3, R-4, S-2 | (C) P-3, Q-4, R-1, S-2 |
| (B) P-1, Q-4, R-2, S-3 | (D) P-4, Q-2, R-1, S-3 |

19. **Group-I** gives a list of devices and **Group-II** gives the list of uses

- |                 |   |
|-----------------|---|
| P. Pitot tube   | 1. Measuring pressure in a pipe         |
| Q. Manometer    | 2. Measuring velocity of flow in a pipe |
| R. Venturimeter | 3. Measuring air and gas velocity       |
| S. Anemometer   | 4. Measuring discharge in a pipe        |

The correct match of **Group-I** with **Group-II** is

- |                        |                        |
|------------------------|------------------------|
| (A) P-1, Q-2, R-4, S-3 | (C) P-2, Q-1, R-4, S-3 |
| (B) P-2, Q-1, R-3, S-4 | (D) P-4, Q-1, R-3, S-2 |

20. A coastal city produces municipal solid waste (MSW) with high moisture content, high organic materials, low calorific value and low inorganic materials. The most effective and sustainable option for MSW management in that city is

- |                    |                  |
|--------------------|------------------|
| (A) Composting     | (C) Incineration |
| (B) Dumping in sea | (D) Landfill     |

21. According to the Noise Pollution (Regulation and control) Rules, 2000, of the Ministry of Environment and Forests, India, the day time and night time noise level limits in ambient air for residential areas expressed in dB(A) are

- |               |               |
|---------------|---------------|
| (A) 50 and 40 | (C) 65 and 55 |
| (B) 55 and 45 | (D) 75 and 70 |

22. An air parcel having 40°C temperature moves from ground level to 500 m elevation in dry air following the "adiabatic lapse rate". The resulting temperature of air parcel at 500 m elevation will be

- |          |          |
|----------|----------|
| (A) 35°C | (C) 41°C |
| (B) 38°C | (D) 44°C |

23. Aggregate impact value indicates the following property of aggregates

- |                |              |
|----------------|--------------|
| (A) Durability | (C) Hardness |
| (B) Toughness  | (D) Strength |

24. As per IRC: 67-2001, a traffic sign indicating the Speed Limit on a road should be of  
 (A) Circular Shape with White Background and Red Border  
 (B) Triangular Shape with White Background and Red Border  
 (C) Triangular Shape with Red Background and White Border  
 (D) Circular Shape with Red Background and White Border
25. The local mean time at a place located in longitude  $90^{\circ} 40'E$  when the standard time is 6 hours and 30 minutes and the standard meridian is  $82^{\circ} 30'E$  is  
 (A) 5 hours, 2 minutes and 40 seconds (C) 6 hours, and 30 minutes  
 (B) 5 hours, 57 minutes and 20 seconds (D) 7 hours, 02 minutes and 40 seconds

**Q. No. 26 – 51 Carry Two Marks Each**

26. The solution to the ordinary differential equation  $\frac{d^2y}{dx^2} + \frac{dy}{dx} - 6y = 0$  is  
 (A)  $y = c_1 e^{3x} + c_2 e^{-2x}$  (C)  $y = c_1 e^{-3x} + c_2 e^{2x}$   
 (B)  $y = c_1 e^{3x} + c_2 e^{2x}$  (D)  $y = c_1 e^{-3x} + c_2 e^{-2x}$
27. The inverse of the matrix  $\begin{bmatrix} 3 + 2i & i \\ -i & 3 - 2i \end{bmatrix}$  is  
 (A)  $\frac{1}{12} \begin{bmatrix} 3 + 2i & -i \\ i & 3 - 2i \end{bmatrix}$  (C)  $\frac{1}{14} \begin{bmatrix} 3 + 2i & -i \\ i & 3 - 2i \end{bmatrix}$   
 (B)  $\frac{1}{12} \begin{bmatrix} 3 - 2i & -i \\ i & 3 + 2i \end{bmatrix}$  (D)  $\frac{1}{14} \begin{bmatrix} 3 - 2i & -i \\ i & 3 + 2i \end{bmatrix}$
28. The table below gives values of a function  $F(x)$  obtained for values of  $x$  at intervals of 0.25.

x	0	0.25	0.5	0.75	1.0
F(x)	1	0.9412	0.8	0.64	0.50

The value of the integral of the function between the limits 0 to 1 using Simpson's rule is

- (A) 0.7854 (C) 3.1416  
 (B) 2.3562 (D) 7.5000
29. The partial differential equation that can be formed from  
 $z = ax + by + ab$  has the form (with  $p = \frac{\partial z}{\partial x}$  and  $q = \frac{\partial z}{\partial y}$ )  
 (A)  $z = px + qy$  (C)  $z = px + qy + pq$   
 (B)  $z = px + pq$  (D)  $z = qy + pq$

30. A parabolic cable is held between two supports at the same level. They horizontal span between the supports is  $L$ . The sag at the mid-span is  $h$ . The equation of the parabola is  $y = 4h \frac{x^2}{L^2}$ , where  $x$  is the horizontal coordinate and  $y$  is the vertical coordinate with the origin at the centre of the cable. The expression for the total length of the cable is

(A)  $\int_0^L \sqrt{1 + 64 \frac{h^2 x^2}{L^4}} dx$

(C)  $\int_0^{L/2} \sqrt{1 + 64 \frac{h^2 x^2}{L^4}} dx$

(B)  $2 \int_0^{L/2} \sqrt{1 + 64 \frac{h^3 x^2}{L^4}} dx$

(D)  $2 \int_0^{L/2} \sqrt{1 + 64 \frac{h^2 x^2}{L^4}} dx$

31. Given a function

$$f(x, y) = 4x^2 + 6y^2 - 8x - 4y + 8$$

The optimal value of  $f(x, y)$

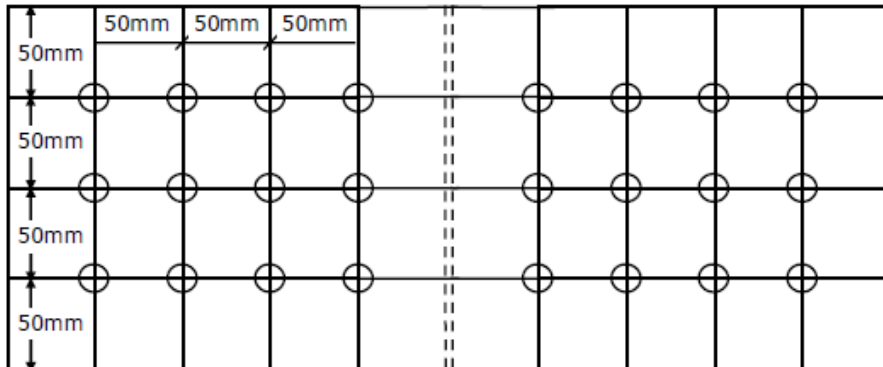
(A) Is a minimum equal to  $10/3$

(C) Is a minimum equal to  $8/3$

(B) Is a maximum equal to  $10/3$

(D) Is a maximum equal to  $8/3$

32. A double cover butt riveted joint is used to connect two flat plates of 200 mm width and 14 mm thickness as show in the figure. There are twelve power driven rivets of 20 mm diameter at a pitch of 50 mm in both directions on either side of the plate. Two cover plates of 10 mm thickness are used. The capacity of the joint in tension considering bearing and shear ONLY, with permissible bearing and shear stresses as 300 MPa respectively is



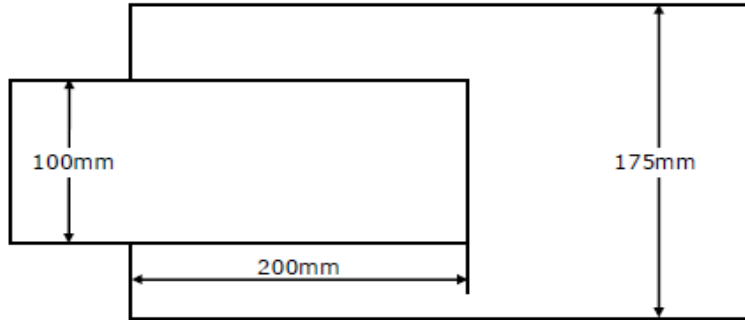
(A) 1083.6kN

(C) 541.18kN

(B) 871.32kN

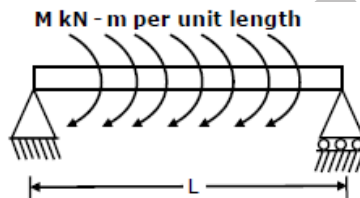
(D) 433.7kN

33. Two plates, subjected to direct tension, each of 10mm thickness and having widths of 100 mm and 175 mm, respectively are to be fillet welded with an overlap of 200 mm. Given that the permissible weld stress is 110 MPa and the permissible stress in steel is 150 MPa, then length of the weld required using the maximum permissible weld size as per IS: 800-1984 is



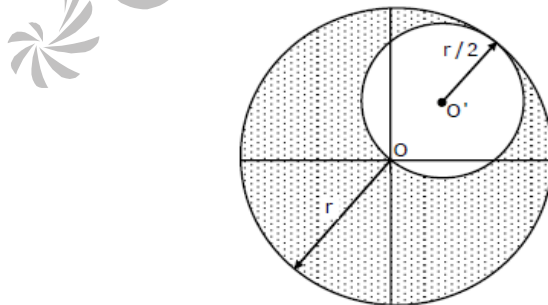
- (A) 245.3mm
- (B) 229.2mm
- (C) 205.5mm
- (D) 194.8mm

34. For the simply supported beam of length  $L$ , subjected to a uniformly distributed moment  $M$  kN-m per unit length as shown in the figure, the bending moment (in kN-m) at the mid-span of the beam is



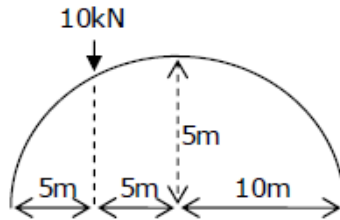
- (A) Zero
- (B)  $M$
- (C)  $ML$
- (D)  $M/L$

35. A disc of radius  $r$  has a hole of radius  $r/2$  cut-out as shown. The centroid of the remaining disc (shaded portion) at a radial distance from the centre "O" is

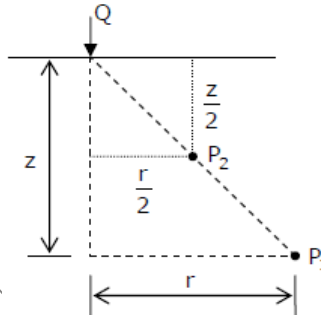


- (A)  $\frac{r}{2}$
- (B)  $\frac{r}{3}$
- (C)  $\frac{r}{6}$
- (D)  $\frac{r}{8}$

36. A three hinged parabolic arch having a span of 20 m and a rise of 5m carries a point load of 10kN at quarter span from the left end as shown in the figure. The resultant reaction at the left support and its inclination with the horizontal are respectively



- (A) 9.01kN and 56.31°  
 (B) 9.01kN and 33.69°  
 (C) 7.50kN and 56.31°  
 (D) 2.50kN and 33.69°
37. The vertical stress at point  $P_1$  due to the point load  $Q$  on the ground surface as shown in figure is  $\sigma_z$ . According to Boussinesq's equation, the vertical stress at point  $P_2$  shown in figure will be



- (A)  $\frac{\sigma_z}{2}$   
 (B)  $\sigma_z$   
 (C)  $2\sigma_z$   
 (D)  $4\sigma_z$
38. An open ended steel barrel of 1m height and 1m diameter is filled with saturated fine sand having coefficient of permeability of  $10^{-2}$  m/s. The barrel stands on a saturated bed of gravel. The time required for the water level in the barrel to drop by 0.75m is
- (A) 58.9s  
 (B) 75s  
 (C) 100s  
 (D) 150s
39. The ultimate load capacity of a 10m long concrete pile of square cross section 500 mm  $\times$  500 mm driven into a homogeneous clay layer having undrained cohesion value of 40 kPa is 700kN. If the cross section of the pile is reduced to 250 mm  $\times$  250 mm and the length of the pile is increased to 20 m, the ultimate load capacity will be
- (A) 350 kN  
 (B) 632.5 kN  
 (C) 722.5 kN  
 (D) 1400 kN

40. For a rectangular channel section, Group I lists geometrical elements and Group II gives proportions for hydraulically efficient section.

Group I		Group II	
P	Top width	1	$\frac{y_e}{2}$
Q	Perimeter	2	$y_e$
R	Hydraulic Radius	3	$2 y_e$
S	Hydraulic Depth	4	$4 y_e$

$y_e$  is the follow depth corresponding to hydraulically efficient section. The correct match of Group I with Group II is

- (A) P-2, Q-4, R-1, S-3  
 (B) P-3, Q-1, R-4, S-2  
 (C) P-3, Q-4, R-1, S-2  
 (D) P-3, Q-4, R-2, S-1
41. The Froude number of flown in a rectangular channel is 0.8. If the depth of flow is 1.5m, the critical depth is  
 (A) 1.80m  
 (B) 1.56m  
 (C) 1.36m  
 (D) 1.29m
42. A wall of diameter 20 cm fully penetrates a confined aquifer. After a long period of pumping at a rate of 2720 litres per minute, the observations of drawdown taken at 10 m and 100 m distances from the center of the wall are found to be 3m and 0.5 m respectively. The transmissivity of the aquifer is  
 (A) 676 m<sup>2</sup>/day  
 (B) 576 m<sup>2</sup>/day  
 (C) 526 m<sup>2</sup>/day  
 (D) 249 m<sup>2</sup>/day
43. If the BOD<sub>3</sub> of a wastewater sample is 75 mg/L and reaction rate constant k (base e) is 0.345 per day, the amount of BOD remaining in the given sample after 10days is  
 (A) 3.21 mg/L  
 (B) 3.45 mg/L  
 (C) 3.69 mg/L  
 (D) 3.92 mg/L
44. Consider the following statements in the context of geometric design of roads.  
 I: A simple parabolic curve is an acceptable shape for summit curves.  
 II: Comfort to passengers is an important consideration in the design of summit curves.  
 The correct option evaluating the above statements and their relationship is  
 (A) I is true, II is false  
 (B) I is true, II is true, and II is the correct reason for I  
 (C) I is true, II is true, and II is NOT the correct reason for I

- (D) I is false, II is true
45. The design speed for a two-lane road is 80 kmph. When a design vehicle with a wheelbase of 6.6 m is negotiating a horizontal curve on that road, the off-tracking is measured as 0.096 m. The required widening of carriageway of the two-lane road on the curve is approximately
- (A) 0.55m (C) 0.75m  
(B) 0.65m (D) 0.85m
46. Consider the following statements in the context of cement concrete pavements.
- I. Warping stresses in cement concrete pavements are caused by the seasonal variation in temperature.
- II. Tie bars are generally provided across transverse joints of cement concrete pavements
- The correct option evaluating the above statements is
- (A) I: True II: False (C) I: True II: True  
(B) I: False II: True (D) I: False II: False
47. A bench mark has been established at the soffit of an ornamental arch at the known elevation of 100.0 m above sea level. The back sight used to establish height of instrument is an inverted staff reading of 2.105 m. A forward sight reading with normally held staff of 1.105 m is taken on a recently constructed plinth. The elevation of the plinth is
- (A) 103.210m (C) 99.000m  
(B) 101.000m (D) 96.790m

### Common Data Questions: 48 and 49

Ion concentrations obtained for a groundwater sample (having pH = 8.1) are given below.

Iron	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	Cl <sup>-</sup>
Ion concentration (mg/L)	100	6	15	250	45	39
Atomic Weight	Ca = 40	Mg = 24	Na = 23	H = 1, C = 12, O = 16	S = 32, O = 16	Cl = 35.5

48. Total hardness (mg/L as CaCO<sub>3</sub>) present in the above water sample is
- (A) 205 (C) 275  
(B) 250 (D) 308
49. Carbonate hardness (mg/L as CaCO<sub>3</sub>) present in the above water sample is

- (A) 205 (C) 275  
(B) 250 (D) 289

**Common Data Questions: 50 and 51**

The moisture holding capacity of the soil in a 100 hectare farm is 18 cm/m. the field is to be irrigated when 50 percent of the available moisture in the root zone is depleted. The irrigation water is to be supplied by a pump working for 10 hours a day, and water application efficiency is 75%. Details of crops planned for cultivation are as follows:

Crop	Root zone depth (m)	Peak rate of moisture use (mm/day)
X	1.0	5.0
Y	0.8	4.0

50. The capacity of irrigation system required to irrigate crop X in 36 hectares is  
(A) 83 litres/sec (C) 57 liters/sec  
(B) 67 liters/sec (D) 53 liters/sec
51. The area of crop Y that can be irrigated when the available capacity of irrigation system is 40 liters/sec is  
(A) 40 hectares (C) 30 hectares  
(B) 36 hectares (D) 27 hectares

**Linked Answer Questions 52 and 53**

A doubly reinforced rectangular concrete beam has a width of 300 mm and an effective depth of 500 mm. the beam is reinforced with 2200 mm<sup>2</sup> of steel in tension and 628 mm<sup>2</sup> of steel in compression. The effective cover for compression steel is 50 mm. Assume that both tension and compression steel yield. The grades of concrete and steel used are M 20 and Fe250 respectively. The stress lock parameters (rounded off to first two decimal places) for concrete shall be as per IS 456:200.

52. The depth of neutral axis is  
(A) 205.30mm (C) 160.91mm  
(B) 184.56mm (D) 145.30mm
53. The moment of resistance of the section is  
(A) 206.00 kN-m (C) 236.80 kN-m  
(B) 209.20 kN-m (D) 251.90 kN-m,

---

**Statement for Linked Answer Questions: 54 and 55**

The unconfined compressive strength of a saturated clay sample is 54kPa.

54. The value of cohesion for the clay is
- (A) Zero (C) 27 kPa  
(B) 13.5 kPa (D) 54 kPa
55. If a square footing of size 4 m × 4 m is resting on the surface of a deposit of the above clay, the ultimate bearing capacity of the footing (as per Terzaghi's equation) is
- (A) 1600 kPa (C) 27 kPa  
(B) 315 kPa (D) 54 kPa

**Q. No. 56 – 60 Carry One Mark Each**

56. Which of the following options is closest in meaning to the word **Circuitous**.
- (A) Cyclic (C) Confusing  
(B) Indirect (D) Crooked
57. The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.
- Unemployed: Worker**
- (A) fallow: land (C) wit: jester  
(B) unaware: sleeper (D) renovated: house
58. Choose the most appropriate word from the options given below to complete the following sentence:
- If we manage to \_\_\_\_\_ our natural resources, we would leave a better planet for our children.
- (A) Uphold (C) Cherish  
(B) Restrain (D) Conserve
59. Choose the most appropriate word from the options given below to complete the following sentence: His rather casual remarks on politics \_\_\_\_\_ his lack of seriousness about the subject.
- (A) Masked (C) Betrayed  
(B) Belied (D) Suppressed

60. 25 persons are in a room. 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is:
- (A) 2 (C) 13  
(B) 17 (D) 3

**Q. No. 61 – 65 Carry Two Marks Each**

61. Hari (H), Gita (G), Irfan (I) and Saira (S) are siblings (i.e. brothers and sisters). All were born on 1<sup>st</sup> January. The age difference between any two successive siblings (that is born one after another) is less than 3 years. Given the following facts:
- Hari's age + Gita's age > Irfan's age + Saira's age
  - The age difference between Gita and Saira is 1 year. However Gita is not the oldest and Saira is not the youngest.
  - There are no twins.

In what order were they born (oldest first)?

- (A) HSI G (C) IGSH  
(B) SGHI (D) IHSG
62. 5 skilled workers can build a wall in 20 days; 8 semi-skilled workers can build a wall in 25 days; 10 unskilled workers can build a wall in 30 days. If a team has 2 skilled, 6 semi-skilled and 5 unskilled workers, how long will it take to build the wall?
- (A) 20 (C) 16  
(B) 18 (D) 15

63. Modern warfare has changed from large scale clashes of armies to suppression of civilian populations. Chemical agents that do their work silently appear to be suited to such warfare; and regretfully, there exist people in military establishments who think that chemical agents are useful tools for their cause.

Which of the following statements best sums up the meaning of the above passage:

- (A) Modern warfare has resulted in civil strife.  
(B) Chemical agents are useful in modern warfare.  
(C) Use of chemical agents in warfare would be undesirable  
(D) People in military establishments like to use chemical agents in war.
64. Given digits 2,2,3,3,4,4,4,4 how many distinct 4 digit numbers greater than 3000 can be formed?
- (A) 50 (C) 52  
(B) 51 (D) 54

65. If  $137 + 276 = 435$  how much is  $731 + 672$ ?

(A) 534

(C) 1623

(B) 1403

(D) 1513

