ASTB Study Supplement

The Sections of this Guide are as follows:

1. Test overview and section explanations.
2. Section 1: Math Skills Section
3. Section 2: Reading Comprehension Section
4. Section 3: Mechanical Comprehension Section
5. Section 4: Spatial Apperception Section
6. Section 5: Aviation and Nautical Information Section
7. Section 6: Aviation Supplemental Section
8. Recommended study plans and supplemental Information (Websites, Gouge, and Commercial Prep Guides.)

Section One: Test Overview and Section Explanation

The difficulty of the ASTB lies in its varied subject matter not in the difficulty of its questions. Also, under the time constraints and pressure of this test you may make the mistake of getting bogged down on a single question at the expense of answering easier questions in the time remaining. Just as much as this is a test of knowledge, it is also a balancing act between accuracy and time management. You should keep the following advice in mind when working through the different sections.

- Each question has equal weight and answering a question incorrectly does not subtract from your score. Therefore, there is no excuse for not answering every single question in a section.
- The difficulty of each question remains at approximately the same level as you progress through the individual sections. Therefore, do not get wrapped around the prop trying to figure out a question in which you are unfamiliar. Swallow your pride and skip difficult questions and return to them if time permits.
- It pays to use a systematic approach to maintain the pace required to adequately tackle each question within a section. The sample test questions in Chapter 8 will give you an opportunity to apply these time management concepts.
- There is no excuse for not answering each and every question on this test.

Ensure you are well rested and hydrated prior to the test day. The longest section is only 30 minutes long, so you have the opportunity to take a bathroom break in between sections. You will want to ensure that you have a timer (watch with standard chrono-functions is adequate) on test day. Also, when completing the sample problems provided in Ch. 8, you should use a timer to pace yourself as if it were game day.

Section Two: Math Skills

       This section has 30 questions and allows 25 minutes to complete the section. That provides 50 seconds for each question. Each question is multiple-choice with 4 choices to choose among.

Sample ASTB question:

> How many seconds per question does one have to complete all questions in the Math Section of the ASTB?
> A. 75
> B. 60
> C. 50—25mins X 60 seconds/min = 1500secs/30 questions = 50 seconds/problem
> D. 40

The ASTB math section is subdivided into the following two types of questions:
1. Word problems: (50%)
2. Basic Calculations (50%)

The following areas are emphasized in the math section:

1. Algebra
2. Rates
3. Exponents/Roots
4. Basic Geometry
5. Averages, Probability, Functions
6. Basic Arithmetic

We will examine each of these areas in greater detail.

Algebra-

Simplification and substitution are the keys to solving algebr problems:

Easy:

> Example: $4x + 2y- 7x+2y=$
> Solved: Combine like terms X, Y to simplify to $4y-3x$

> Example: Given equation $3x + 4y = 24$, if $x=4$ then $y=$
> Solved: Substitute 4 for x. Subtract this number from 24 then solve for Y.

> More difficult:
> Example: If $X=4z$ and $Y=6z$ then $Y=$
>   Simplify Z in terms of X and then solve for Y.
> $Z=X/4$ so $Y=6(X/4)$ or $Y=3/2\ X$

> Example: Simplify the following $\dfrac{4X^2 -2xy+1}{(x-1)}$ factors to $\dfrac{(4x-1)\ (x-1)}{(x-1)} = 4x-1$

A shortcut to algebra problems involves plugging in simple numbers into the original equation and then plugging in the same number into the answer choices to find which answer supplies the same solution.

Example: Simplify $\dfrac{N + 6n^2}{6N+1}$

Answers: A) N+ 1
                           B) N+6
                           C) N^2
                           D) N

This problem can be factored to find the solution or you can simply "plug-in" a common number into both the original equation and the answer choices. When you plug the same number into the answer choices only one answer should derive the same solution as the one from the question stem. If you get more than one answer that supplies the same solution then eliminate the other answers and pick another number to select between the two.

So, plug 1 into the formula above and the result is "1". So you look for the same result when you plug-in 1 in all the answer choices. Both answers C and D result in 1 when you plug in 1. So try another number, plug 2 into the original formula to get the answer "2". Now only answer D results in the same number.

You may find it easier to simplify to find the correct answer, but by plugging in numbers you can verify that your answer is correct.

Rates: Most test takers will find rate problems to be the most difficult math problems on the ASTB. For one, they take the longest amount of time to calculate, as they are almost always apart of a word problem. Secondly, rates require you to apply basic units of measurement, i.e.: 1 ft. – 12inches, 1 hour=60 minutes=3600 seconds.

Most rate problems involve the basic time-distant formula below:

Distance= Rate x Time ,

         Example: An aircraft flies 250 mph for 30 minutes, then 300 mph for 10 minutes, and flies at 240 mph the 40 minutes of the flight. How far did you fly (assuming you can hold your heading and fly along a straight line, Ace)?

         1st 30 minutes (250 x .5hrs)= 125 miles
         2nd 10 minutes (300 x .1/6hr)=50
         3rd 40 minutes (240 x 2/3hr)= 160 miles

Total miles --------------------335 miles

Two trains are 100 miles apart traveling at 40 mph and 30 mph. How far apart are they after 30 minutes. First method: Combined rate is 40+30 for 70mph. Time = 30 minute or ½ hour. So D=RT or 70 x ½ = 35 miles. 100-35=65

Second method: Plot the individual rates: Train #1 - 40 mph X 1/2hour = 20 miles
                                    Train #2 - 30 mph x ½= 15

Thus, if the trains are 100 miles apart and move forward combined 35 miles then they are 65 miles apart.

Example:
If a car travels 42 miles per/hr then how far does it travel in 1200 seconds?
Solve convert seconds to hrs. 1200/3600 =1/3 hours so 1/3 of 42 mph = 14 miles.

Exponents: Exponents and roots make up approximately 5 questions and putting the basic roots and exponent tables to memory will help you shave a lot of time when dealing with these types of questions.

Know 1-15 to the power of 2
Know 1-10 to the power of 3
Know 1-4 to the 4th power

When adding bases containing exponents you <u>can not</u> add the exponents even if the bases are the same.
$5^2 + 5^3$ does not $= 5^5$

When multiplying exponents you <u>can</u> add the exponents when the base is the same.
When dividing exponents with the same base you simply subtract the exponents
$5^2 \times 5^3 = 5^5$
5^5 divided by $5^2 = 5^3$ (remember the bases must be equal to subtract the exponents)
Roots:
Perfect squares in order: 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, 169.......
Perfect cubes in order: 1, 8, 27, 64, 125, 196, ...

Example: $5^{n+1} = 125$ what is n?
Solved: $5^3 = 125$, so n=2

Note: 64's 5th root is 2
        64's 3rd root of 4
        64's square root is 8.

Example: $4n = 64$ what is n?
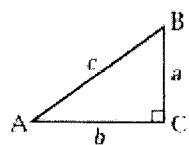Solved 64/4=16 and the 4th root of 16= 2
N=2.

Geometry:
Formulas to know:

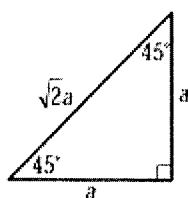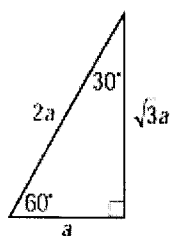| Shape	Formulas for Area *(A)* and Circumference *(C)*
Triangle	$A = \frac{1}{2}bh = \frac{1}{2} \times \text{base} \times \text{height}$
Rectangle	$A = lw = \text{length} \times \text{width}$
Trapezoid	$A = \frac{1}{2}(b_1 + b_2)h = \frac{1}{2} \times \text{sum of bases} \times \text{height}$
Parallelogram	$A = bh = \text{base} \times \text{height}$
Circle	$A = \pi r^2 = \pi \times \text{square of radius}$ $C = 2\pi r = 2 \times \pi \times \text{radius}$ $C = \pi d = \pi \times \text{diameter}$

Formulas for Right Triangles

Pythagorean Theorem:
$$a^2 + b^2 = c^2$$

$$\sin A = \frac{a}{c} = \left(\frac{\text{opposite}}{\text{hypotenuse}} \right)$$

$$\cos A = \frac{b}{c} = \left(\frac{\text{adjacent}}{\text{hypotenuse}} \right)$$

$$\tan A = \frac{a}{b} = \left(\frac{\text{opposite}}{\text{adjacent}} \right)$$

Given a triangle with the interior angles of 30-60-90 or 45-45-90 all you need to know is one side in order to solve for the two other sides.
Note: An equilateral triangle (triangle with all interior angles equal to 60 degrees) if split into two equal halves, forms a 30-60-90 triangle

Example: An equilateral triangle has side of 4. What is the length of the blue line.
Solution: The blue line cuts the equilateral into 2 30-60-90 trinagles (a & b)
Side 1=2
So using the 30-60-90 rules above: the blue line is equal to side 1 x the squre root of three
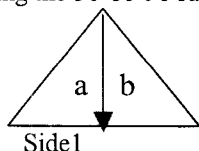
Interest:
Simple interest involves multiplying a lump sum by an the interest rate.

Example: How much does a $1000 lump sum at 10% compute to over a year?

Answer: $100
6-months (Semi annual): $50
3-months (Quarterly): $25

Compound interest combines the interest accrued during periods.
Example: How much interest is accrued on $1000 lump sum at 10% compounded over:
1 year: $100

2 years 1000+100(yr1) x 10% = $111 (yr2) + 100 (yr1)=221

Average formula: <u>sum of totals</u> = average
               # of items

     Example: John shoots 75, 82, 83 his first three rounds of golf what score must he post on his last round to average 80 over the four rounds.
     Answer 80 x 4 rounds = combined score of 320 shots. 320-75-82-83= 80 for the 4th round.

Probability:
The probability of an event occurring is equal to the number of events you want to occur divided by the number of events possible.

     Example: In a 52 card deck (assume a full deck has 52 cards unless told otherwise) what is the probability of selecting a face card.
     The number of ways to get a face card are: king, queen, jack in 4 separate suits or 12 ways. So, 12/52 is the probability

Order of operations: Use the following pneumonic to attack the order of computing long equations

Parenthesis
Exponents
Multiply
Divide
Add
Subtract

$$2$$
Example: 4 x 3 –(6-4) =
Parenthesis (6-4)=2
Exponent 2 squared =4
Multiply 4x3=12
Subtract 12-4 =8

Plug-ins: As explained before it may be easier to derive the answer to a word problem that involves variables by plugging in values to the equation and finding the same solution in the answers.

Example: If a cars cost b dollars the c cars cost how many dollars.

Solve a=5, b= 100 and c=4 so 8 (c cars) x 10 (b dollars)= 400
Now go to the answers and find which formula yields 400
A.   ab/c 5 x 10 / 4= 125 (no)
B.   bc   100 x 4 = 400 (yes)
C.   a+b+c 5+100+4 = 109 (hell no)

Sample Problems:

1. If $5x + 3y = 29$ and $x - y = 1$, then x equals?
   - (A) 1
   - (B) 2
   - (C) 3
   - (D) 4
   - (E) 5

   Solved: substitute for X=1 + y

2. Solve for x: $2x/7 = 2x^2$
   - (A) 1/7
   - (B) 2/7
   - (C) 2
   - (D) 7
   - (E) 14

   Solved: divide both sides by 2x

3. If x is an odd integer, which one of the following is an even integer?
   - (A) $2x + 1$
   - (B) $2x - 1$
   - (C) $x^2 - x$
   - (D) $x^2 + x - 1$
   - (E) None of the above

   Plug in an odd integer (3) and see which answer makes the question true

4. 10^x divided by 10^y equals

   - (A) $10^{x/y}$
   - (B) 10^{xy}
   - (C) 10^{x+y}
   - (D) 10^{x-y}
   - (E) None of the above

   Use the rules of exponents

5. $\dfrac{x - 2}{x^2 - 6x + 8}$ can be reduced to:

   (A) $\dfrac{1}{x - 4}$

   (B) $\dfrac{1}{x - 2}$

   (C) $\dfrac{x - 2}{x + 2}$

   (D) $\dfrac{1}{x + 2}$

   (E) $\dfrac{1}{x + 4}$

   Solved: Factor the denominator to (X-2)(X-4) and then cancel (X-2). Solve #2: Plug-in a number in the question(2) and see which answer choice produces the same result.

6. If $3^n = 27$, what is the value of $4^n + 1$

   - (A) 24
   - (B) 48
   - (C) 65
   - (D) 108
   - (E) None of the above

   Solve for n. N=3

7. The expression $\sqrt{28} - \sqrt{7}$ reduces to

   - (A) $\sqrt{4}$
   - (B) $\sqrt{7}$
   - (C) $3\sqrt{7}$
   - (D) $\sqrt{21}$
   - (E) $-\sqrt{35}$

Section 3: Reading Comprehension

The ASTB section has 27 questions and with 25 minutes in order to answer them all. That leaves you with roughly a minute for each question. Each question is multiple-choice with 4 choices. Each question asks you to select the best answer that is inferred from the paragraph given. This requires you to actively read the passage for logic, sequence, and comprehension. Simply trying to find an answer that mirrors the passage is not the idea.

Below are some sample questions. Read carefully and select the choice that best completes the statements or answers to the question.

1. Rates of vibration perceived by the ears as musical tones lie between fairly well-defined limits. In the ear, as in the eye, there are individual variations. However, variations are more marked in the ear, since its range of perception is greater.

   The paragraph best supports the statement that the ear
   - (A) is limited by the nature of its variations
   - (B) is the most sensitive of the auditory organs
   - (C) differs from the eye in its broader range of perception
   - (D) is sensitive to a great range of musical tones
   - (E) depends for its sense on the rate of vibration of a limited range of sound waves

   The correct answer is (C).

2. The propaganda of a nation at war is designed to stimulate the energy of its citizens and their will to win, and to imbue them with an overwhelming sense of the justice of their cause. Directed abroad, its purpose is to create precisely contrary effects among citizens of enemy nations and to assure to nationals of allied or subjugated countries full and unwavering assistance.

   The title below that best expresses the ideas of this passage is
   - (A) "Propaganda's Failure"
   - (B) "Designs for Waging War."
   - (C) "Influencing Opinion in Wartime"
   - (D) "The Propaganda of Other Nations"
   - (E) "Citizens of Enemy Nations and Their Allies"

   The correct answer is (C).

   I have heard it suggested that the "upper class" English accent has been value in maintaining the British Empire and Commonwealth. The argument runs that all manner of folk in distant places, understating that the English language tradition, pride, and authority and so will be suitably impressed. This might have been the case some 9 or 10 decades ago but it is certainly not true not. The accent is more likely is more likely to be a liability than an asset.

3. The title below that best express the ideas of this passage is:
   - (A) "Changed Effects of a 'British Accent'."
   - (B) "Prevention of the Spread of Cockney."
   - (C) "The Affected Language of Royalty."
   - (D) "The Decline of the British Empire."
   - (E) "The 'King's English'."

   Answer is: **A**

4. According to author, the "upper class" English accent
   - (A) Has been imitated all over the world.
   - (B) Has been inspired by British royalty
   - (C) Has brought about the destruction of the British Commonwealth
   - (D) May have caused arguments among the folk in distant corners of the Empire
   - (E) May have helped to perpetuate the British Empire before 1900

   Answer is: **E**

5. The view is widely held that butter is more digestible and better absorbed than other fats because of its low melting point. There is little scientific authority for such a view. As margarine is made today, its melting point is close to that of butter, and tests show only the slightest degree of difference in digestibility of fats of equally low melting points.

The paragraph best supports the statement that:
- (A) butter is more easily digested than margarine
- (B) the concept that butter has a lower melting point than other fats is a common misconception, disproved by scientists.
- (C) There is not much difference in the digestibility of butter and margarine
- (D) most people prefer butter to margarine ·

Answer is: **C**

Science made its first great contribution to war with gun powder. But since gunpowder can be used effectively only in suitable firearms, science also had to develop the iron and steel that were required to manufacture muskets and cannons on a huge scale. To this day, metallurgy receives much inspiration from war. Bessemer steel was the direct outcome of the deficiencies of artillery as they were revealed by the Crimean War. Concern with the expansion and pressure of gases in guns and combustibility of powder aroused interest in the laws of gases and other matters that seemingly have no relation whatever to war.

6. The title below that best expresses the ideas of this passage is
- (A) "Gunpowder, the First Great Invention."
- (B) "How War Stimulates Science."
- (C) "Improvement of Artillery."
- (D) "The Crimean War and Science."

Answer is: **B**

7. An outcome of the Crimean War was the
- (A) invention of gunpowder
- (B) origin of metallurgy
- (C) study of the laws of gases
- (D) use of muskets and cannons

Answer is: **C**

8. We find many instances in early science of "a priori" scientific reasoning. Scientists thought it proper to carry generalization from one field to another. It was assumed that the planets revolved in circles because of the geometrical simplicity of the circle. Even Newton assumed that there must be seven primary colors corresponding to the seven tones of the musical scale.

The paragraph best supports the statement that:
- (A) Newton sometimes used the "a priori" method of investigation
- (B) Scientists no longer consider it proper to uncritically carry over generalizations from the field to another
- (C) The planets revolve about the earth in ellipses rather than in circles
- (D) Even great men like Newton sometimes make mistakes

Answer is: **B**

Section 4: Mechanical Comprehension

Chapter III: Mechanical Comprehension

The mechanical comprehension (MC) section consists of 30 questions in 15 minutes. MC tests an applicant's basic knowledge of physics, mechanics, and aerodynamics. Most of the questions on this section have a common-sense aspect to them. This section is best described as "physics for truckers". Therefore, the basic concepts can be learned without an extensive science background. The review questions in Chapter 8 will provide a practical application of the concepts presented in this chapter.

Once again, time management is critical in the MC section. Pace yourself at roughly 30 seconds per question in order to answer all the questions in this section. Like I said before, many of these questions are common sense and can be answered quickly with basic intuition. Do not get wrapped up on a question in which you are completely unfamiliar- just try to eliminate the "sucker" answers and guess intelligently. The good thing about the MC section is that there are only 3 answer possibilities instead of 4.

Newton's Laws:
$1^{st:}$ Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it.

$2^{nd:}$ The relationship between an object's mass m, its acceleration a, and the applied force F is $F = ma$. Acceleration and force are vectors (as indicated by their symbols being displayed in slant bold font); in this law the direction of the force vector is the same as the direction of the acceleration vector.

3rd: Force exists only in pairs. Force acting on a body always elicits an equal, opposite force acting against it. This concept is illustrated below.

A 150-pound man jumps off a 600-pound raft to a point in the water 12 feet away. Theoretically, the raft would move
    (A)   12 feet in the opposite direction
    (B)   9 feet in the opposite direction
    (C)   6 feet in the opposite direction
    (D)   3 feet in the opposite direction
    (E)   1 foot in the opposite direction
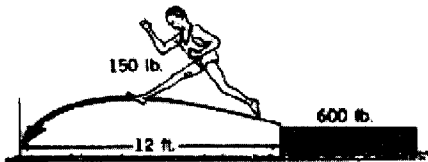
Levers:

1. Mechanical advantage (leverage) is increased by lengthening the lever arm or by placement of the fulcrum (base).

A.) The longer the lever arm the greater the mechanical advantage.

B.) The close the fulcrum is placed to the object being lifted the more mechanical advantage provided by the lever.

C.) A lever arm is in balance (think of a level see-saw) when the force x length of one side of fulcrum is equal to the force x length on the other side of the fulcrum.
Example: The following question tests this concept.

The force F needed to balance the lever is, in lbs., most nearly

(F) 20
(G) 17.5
(H) 15
(I) 12.5
(J) 10
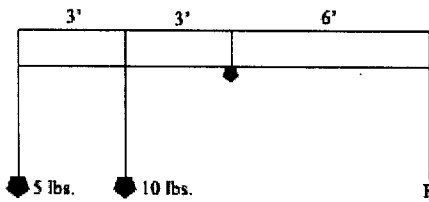
Solved: Position A is the 5lb weight
Position B is the 10lb weight
Position F is the unknown.

Position A is 6 feet from the fulcrum and exerts a force of 5lbs so 6x5=30
Postion B is 3 feet from the fulcrum and exerts a force of 10bls or 3x10=30
Combined forces of A and B = 30+30 or 60
So Position F must balance the force of 60 with and arm of 6 feet. So 60/6=10lbs of force

Spring Tension: The tension of a single spring in Figure A is greater than the tension of a single spring in Figure B. The spring tension of springs supporting an object individually (diagram B) spreads the load between the individual springs.

Ten-pound weights are each suspended from a ceiling by three identical springs. In A, the extension of each spring is

(K) Nine times greater than in B
(L) Three times greater than in B
(M) The same as in B
(N) One-third less than in B
(O) One-ninth less than in B
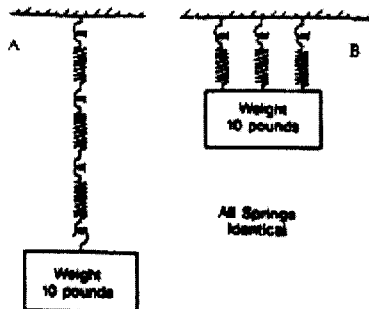
Pulleys:
A. A pulley system will reduce the force required to lift an object (mechanical advantage). The mechanical advantage is proportional to the number of movable and immovable pulleys in the system. In the diagrams below MA=mechanical advantage

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(a)   (b)   (c)
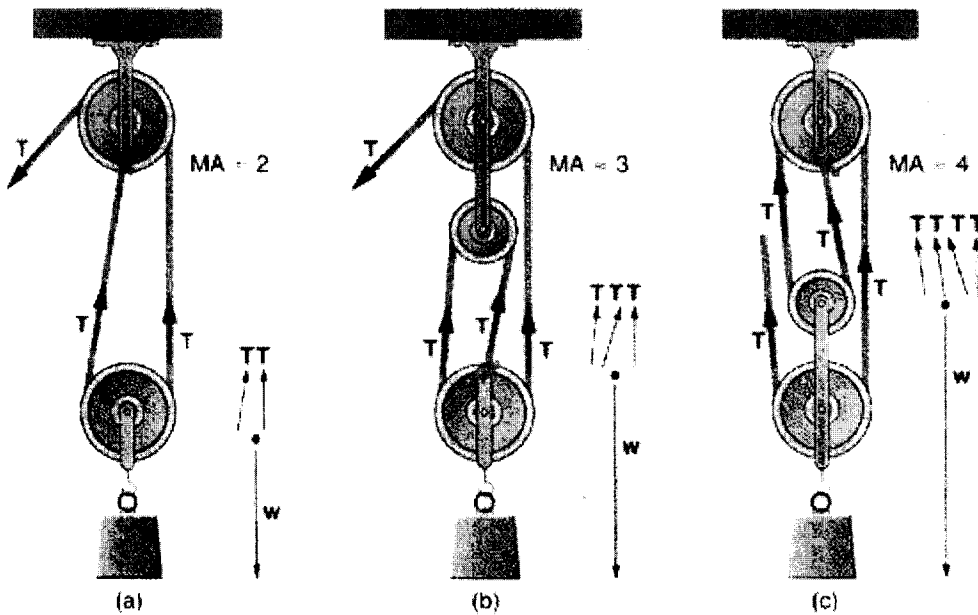
What amount of force is required to move the weights (assume the supported objects all weigh exactly 100lbs.)in the pulley systems above.

A. 50 lbs, (MA=2) so weight/MA= 50lbs
B. 33.33 lbs
C. 25 lbs

If the pulley below is immovable, what is the minimum force that must be applied to position 1 in order to raise the 20lb weight at position 2 upwards 3 feet.?

A.) 20 lbs over 2 feet
B.) 10.1 lbs over 3 feet
C.) 7.5 lbs over 3 feet
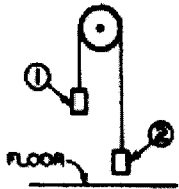
Solution: This immovable one pulley system provides ½ the force to lift the object and will have a movement ratio of 1:1. i.e: To lift a 20 lb object three feet requires a 10+lbs of force applied over three feet.

When a small pulley drives a large pulley with a belt, the smaller pulley turns faster.

Pressure, temperature, volume of gases:

Boyle's law (temperature held constant): If a gas (air) remains at a constant temperature, the volume is inversely proportional to the pressure. Thus, compressing a gas to ½ its' volume doubles the pressure.
Example:

Charles'Law: (pressure constant)If gas is held at a constant pressure, the volume is directly proportional to the absolute temperature. Thus heating a gas to double its original temperature doubles its volume.

Bernoulli's Principle:

Bernoulli's principle states that **as the velocity of a fluid increases, its pressure decreases**. This theory is shown in the venture tube pictured below. When the fluid passing through the tube reaches the narrow part, it speeds up. According to Bernoulli's principle, it then should exert less pressure on the side walls of the narrow section of this tube. The application of Bernoulli's principle is most prevalent in the lift that is exerted on an aircraft wing (airfoil). The lift theory is discussed further, in Chapter 7.
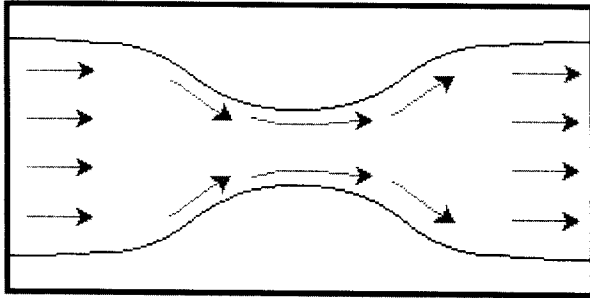
Figure 3-2 Venturi tube

Altitude affects on pressure:

1.The higher the altitude the less dense the air (i.e. less atmospheric pressure).
2. The deeper an object is submerged the more pressure is exerted upon it. Conversely, as an object rises through water the less pressure is exerted upon that object.

Mass/Weight/Gravity:

All of the following statements about weight are true:
- Weight increases closer to earth surface
- Weight is greater on planets with greater mass
- Weight varies from location to location

All the following statements about mass are true
- The mass of an object is not affected by gravity, i.e: the mass of an object on the moon is the same as the mass of an object on the earth's surface.
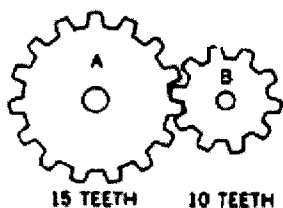
If Gear R is the driver, at the moment shown, gear S is

|	
(P)	Not moving
(Q)	Jammed
(R)	Moving at its highest speed
(S)	Moving in the same direction as gear R
(T)	Moving in the opposite direction as gear R
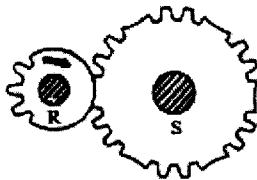
If gear A makes 14 revolutions, gear B will make
(A)	9 revolutions
(B)	14 revolutions
(C)	17 revolutions
(D)	21 revolutions
(E)	25 revolutions

15 TEETH   10 TEETH

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# Section 5: Spatial Apperception

This section has 25 questions and gives you 10 minutes in order to answer them all. That leaves you with roughly 30 seconds for each question. Each question is multiple-choice with 5 choices to choose between.

Directions: The two pictures below show an aerial view and a picture of a plane from which the view would be seen. Notice that the view is out to sea and that the horizon appears to be tilted. Notice also that the plane is shown flying out to sea and that it is banked. You can determine the attitude (bank, pitch, and heading) of a plane by the view that the pilot has when he or she looks directly ahead from the cockpit
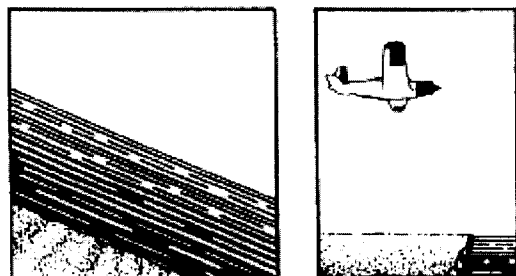
Each problem in the ASTB test will consist of a row of six pictures: An aerial view at the extreme left and five possible answers to chose from. Each answer picture shows a plane in flight. The picture at the extreme left shows the view that the pilot would have looking directly ahead from the cockpit of one of the five pictured planes. You will have to determine from which plane the view would be seen and select the answer.

Example:
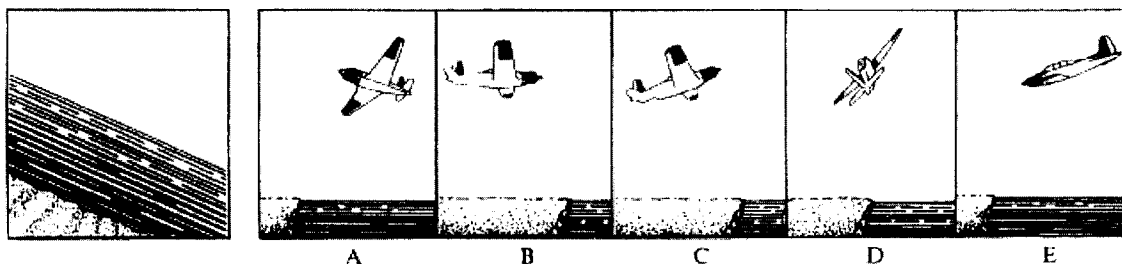
The answer in this particular example is B because picture B shows the plane in the attitude that would give the pilot the view shown on the left.

In all the problems in the ASTB test the answer pictures will show the plane flying at the same height near the same point of the shore, but the plane is shown in many different attitudes: not banked or banking left or right: climbing, diving, or flying level; and headed in one of several directions. The pictures immediately below show four different aerial views and the corresponding headings for the plane. In each of the pictures the plane is flying level and is not banked. Note: When the plane is flying level, the horizon appears in the middle of the aerial view.
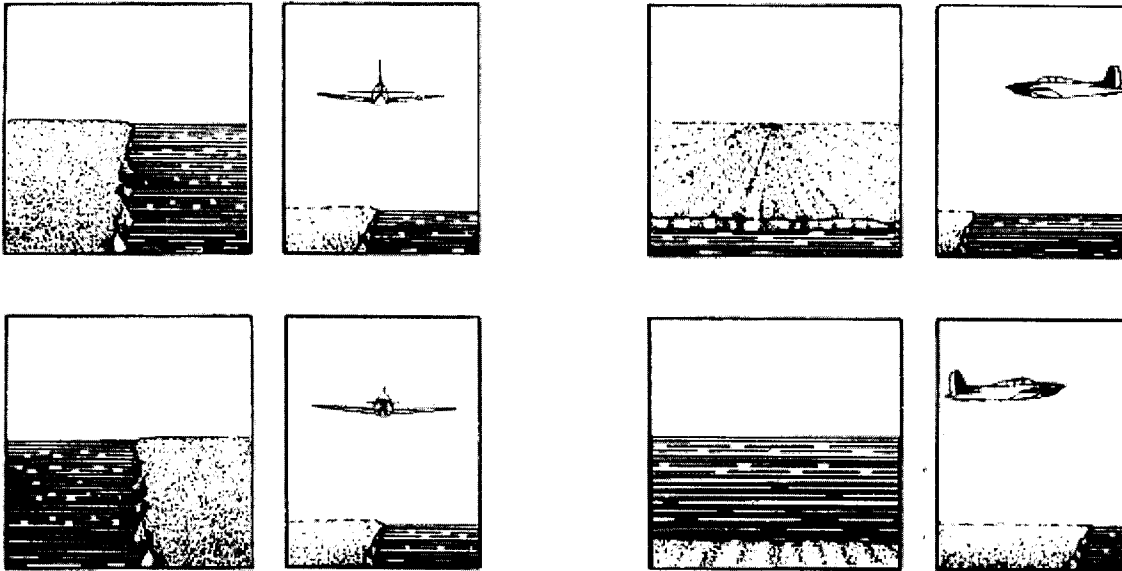
The pictures shown below are three different aerial views and the corresponding bank of the plane. The degree of the bank is either slight or extreme.
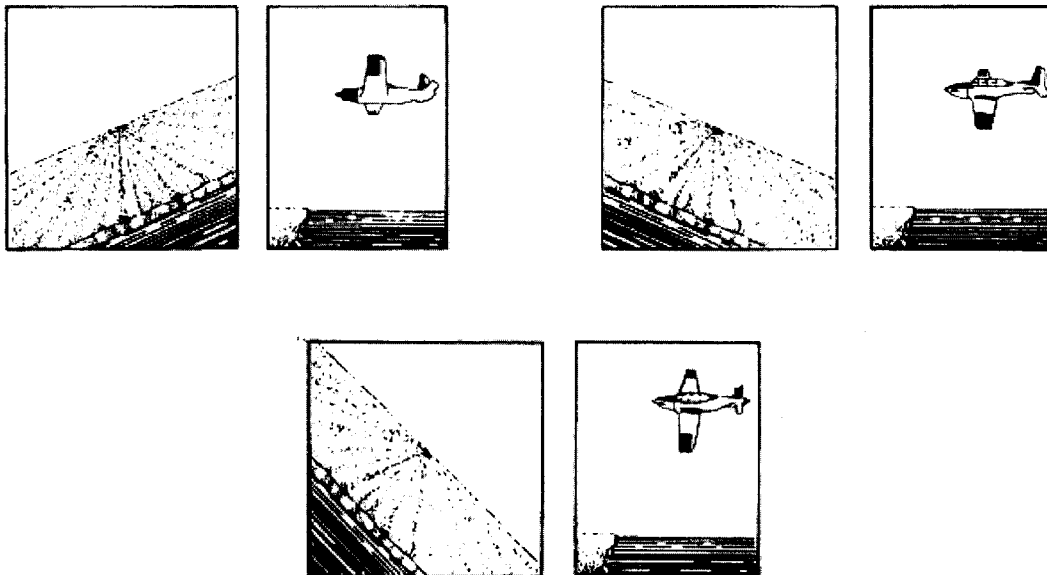
In the pictures the plane is flying level and is headed toward land. Notice that as the plane banks severely to the left.

Cracking the Code on Spacial Apperception:

A proven method for attacking the spacial apperception is detailed in the three-step process below:

1. First, determine from the reference picture whether the aircraft is climbing or descending. This should be apparent from the relationship of the horizon to the picture. If the sky is small and the ground/water is large then you are climbing. The opposite is true for a dive. The horizon will cut the picture into two equal rectangles if the aircraft is level. The horizon will cut the picture into two equal triangles if the aircraft is banking and level. Immediately check the answers to eliminate the pictures that don't have the same climb, descent, or level representation.

2. Next, determine if the aircraft is banked left/right and to what degree (either slightly or severely banked). Use the samples provided to get a feel for the 5 possibilities of bank: 1. Level, slightly left, slightly right, severely left, severely right. Once, go to the pictures and eliminate the wrong answers. Nine times out of ten you will only have one option remaining at this point and the answer will be clear.

3. Finally, determine whether the aircraft is heading to sea, heading to land, or parallel to the shoreline. After using the elimination process from steps 1 and 2, it should be easy to determine from the remaining options the correct answer.

Here are more samples problems:
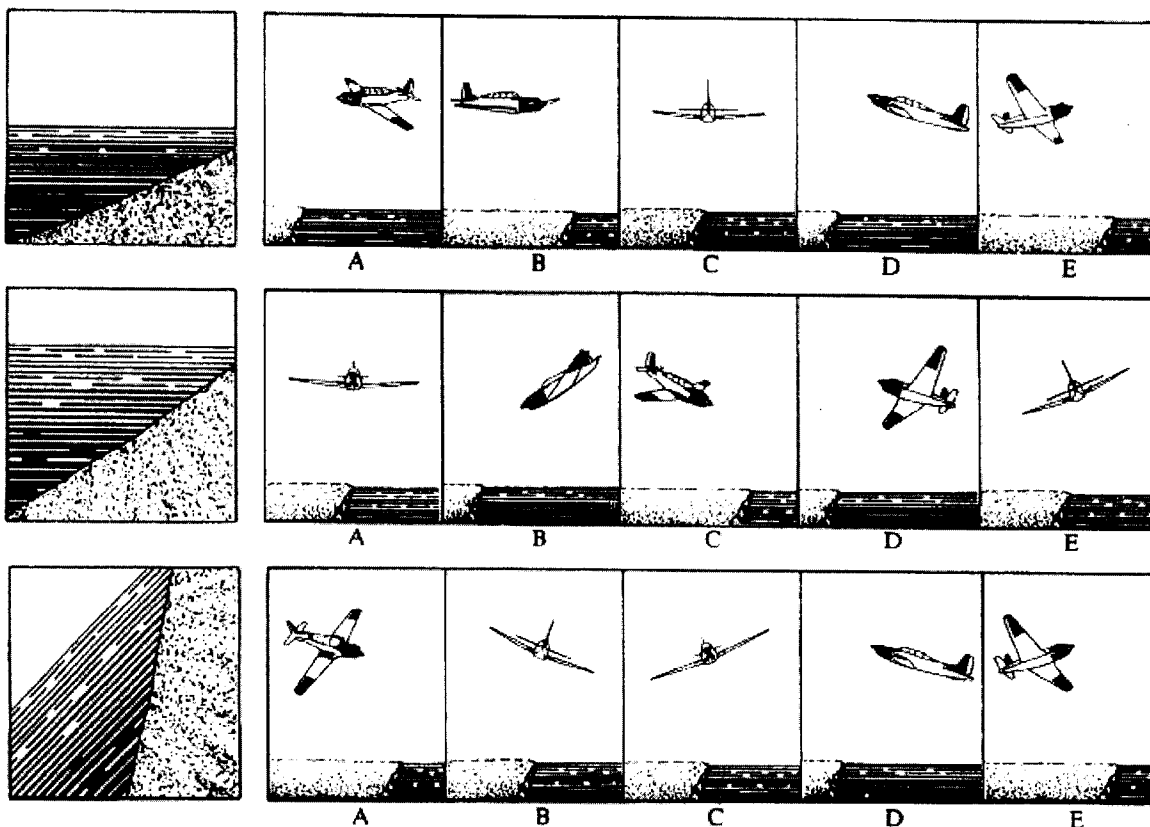
The answer to the sample problems are:

Sample 2:
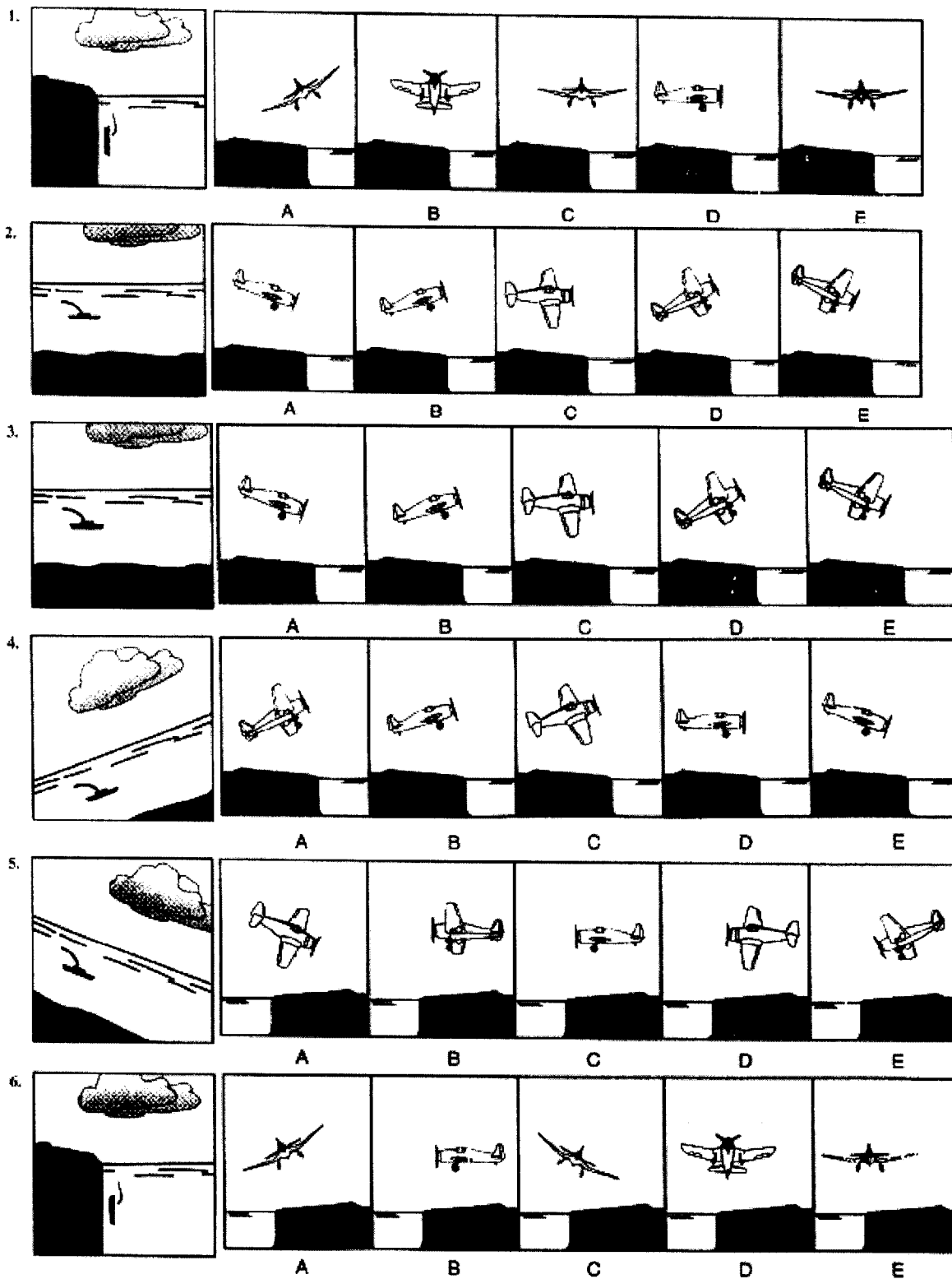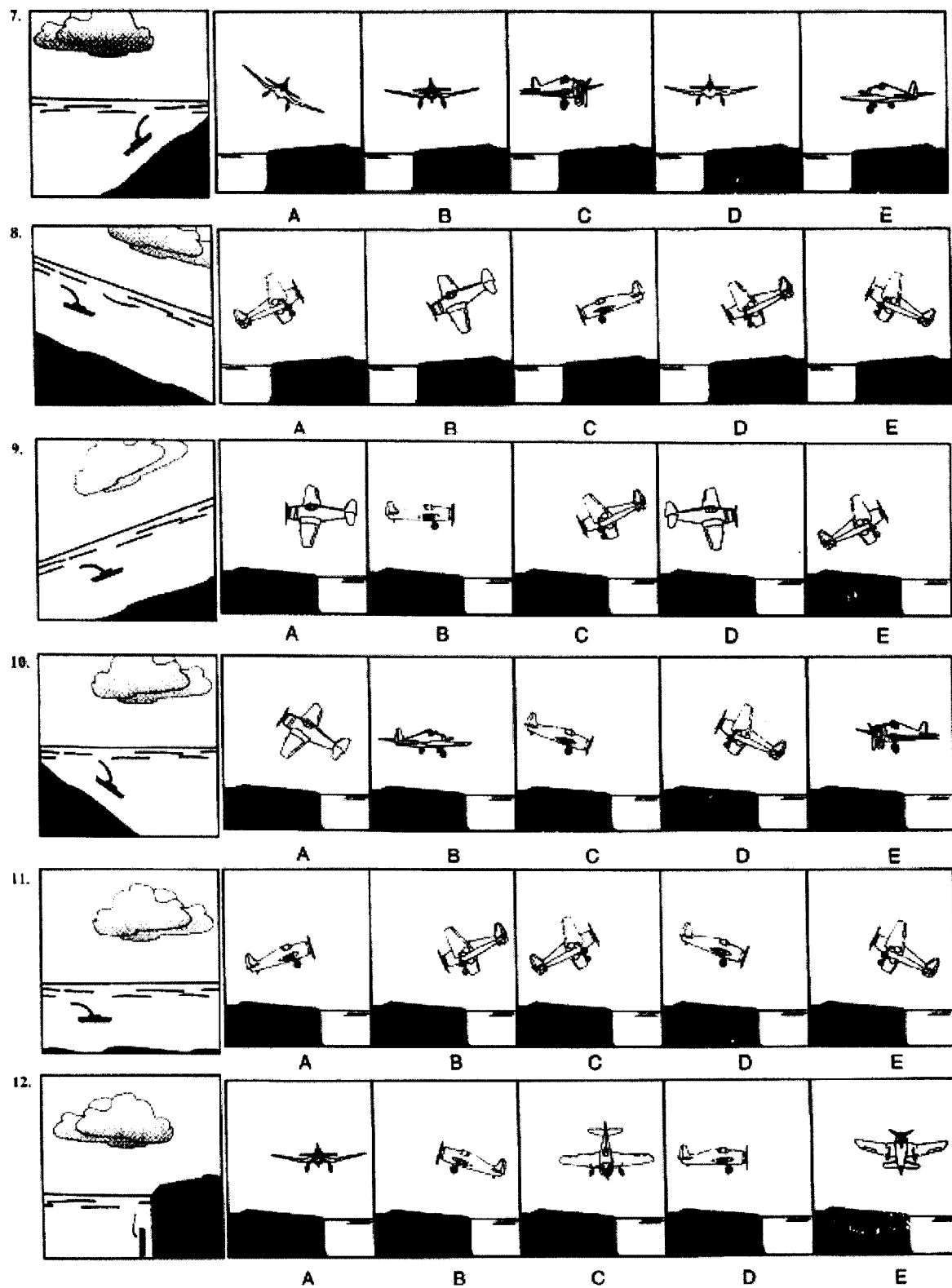B—the plane is flying level and diagonally out to sea.

Sample 3:

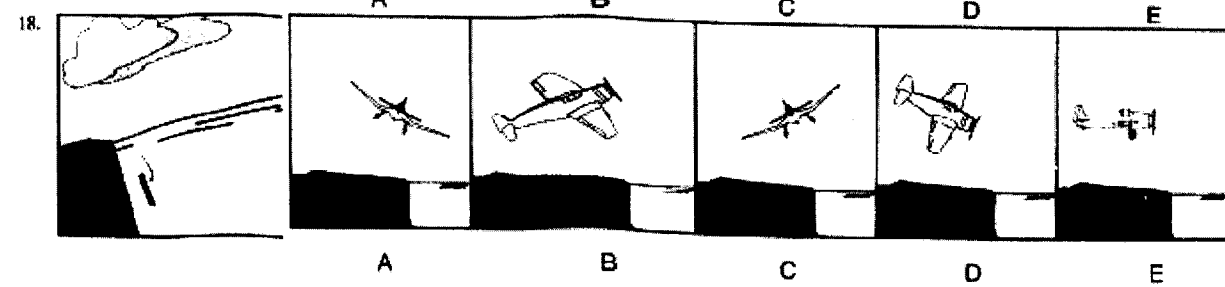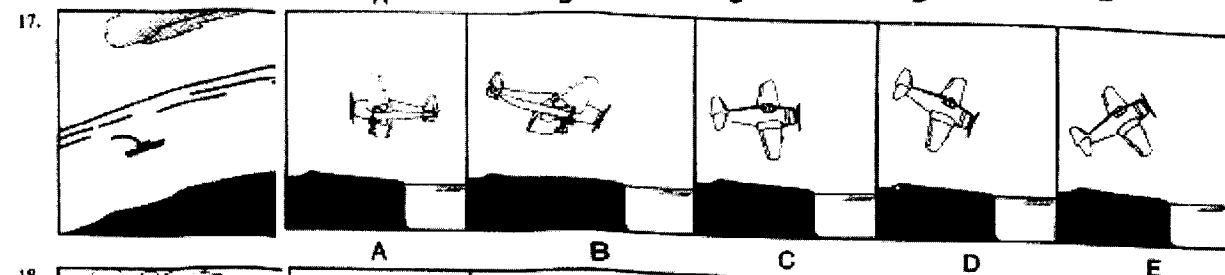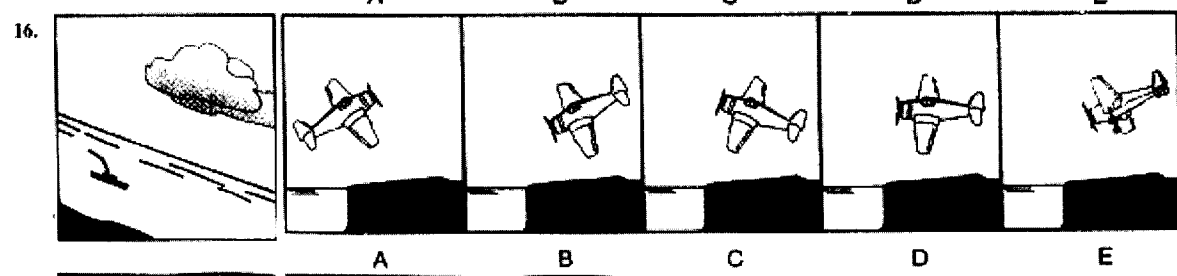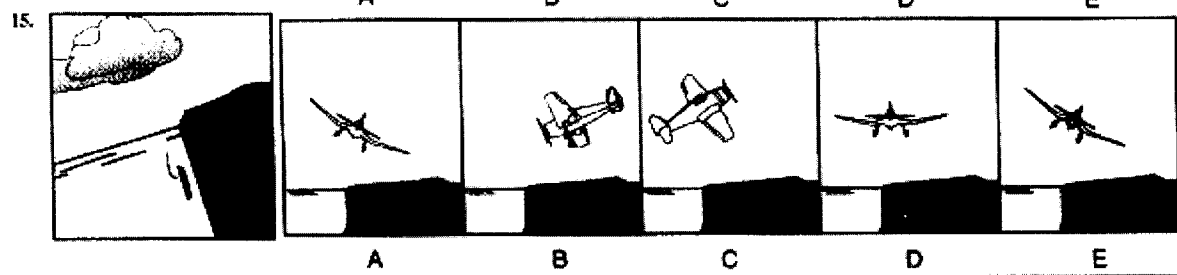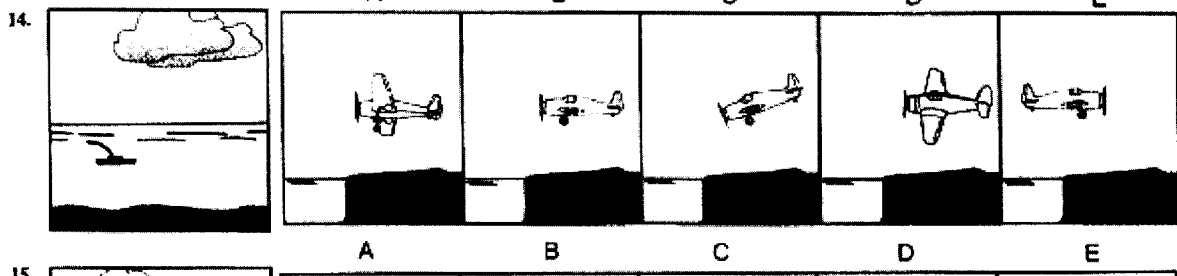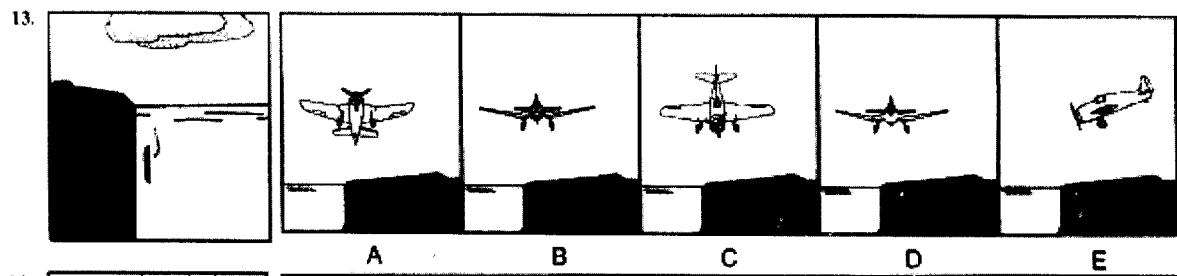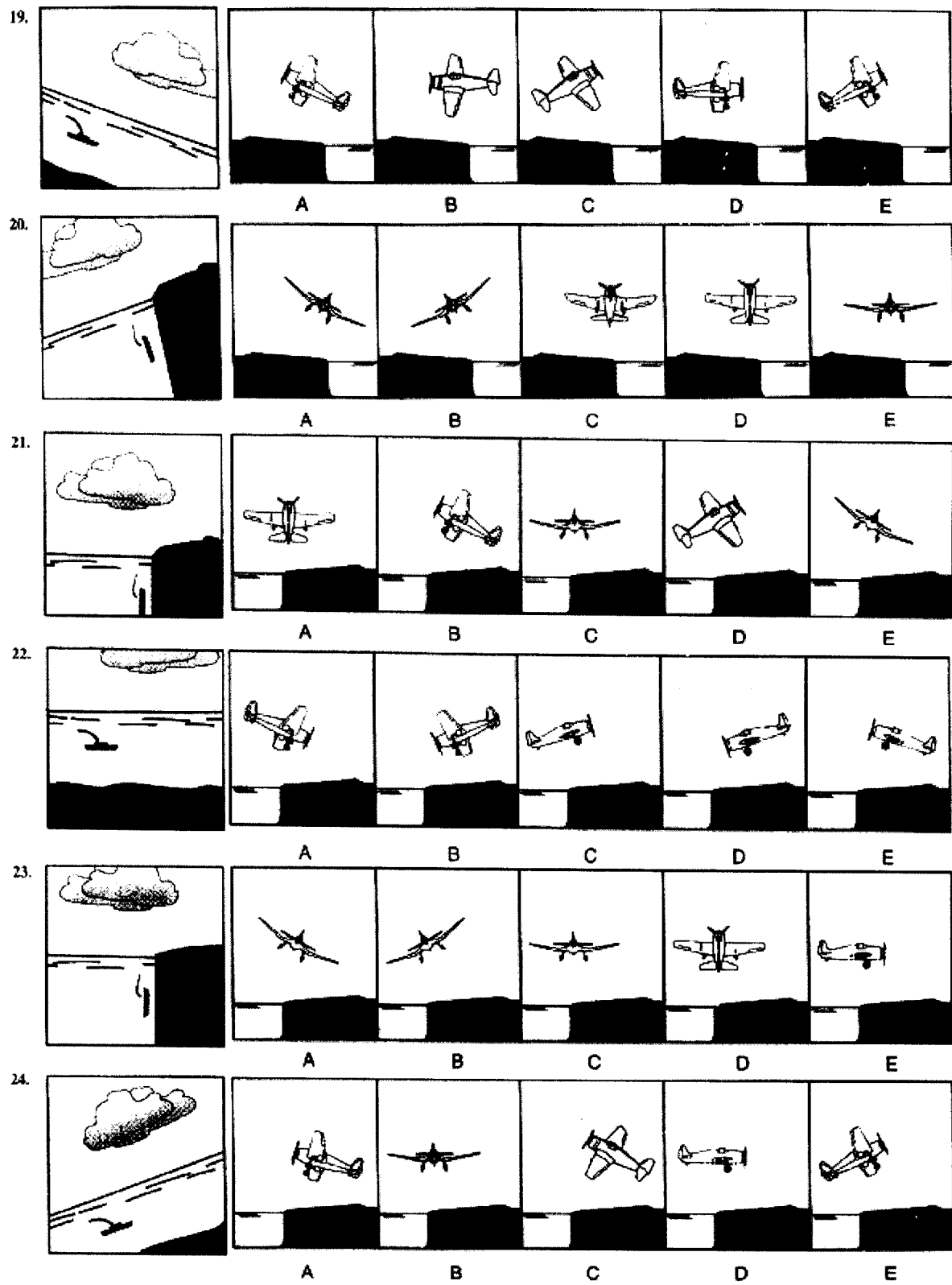C—the plane is still flying diagonally out to sea, but is in a slight dive.

Sample 4:
A—the plane is still flying diagonally out to sea and is in a slight dive, but is now banked.
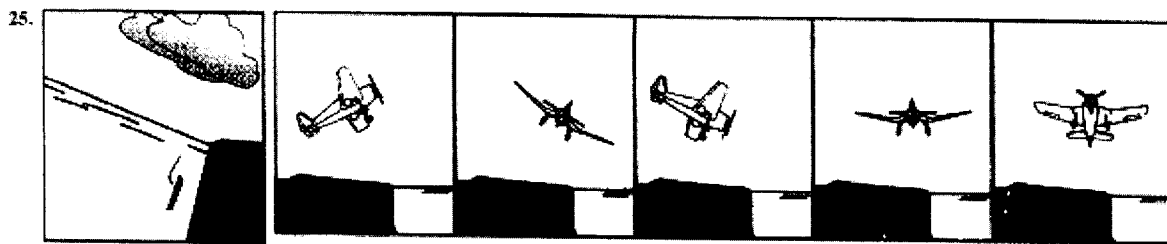
Below are some samples questions that will test your concept of the materials that we've covered. You practice these over and over using the 3-step process mentioned above. You have only 25 seconds per problem so ingrain this process to gain speed in your solutions.
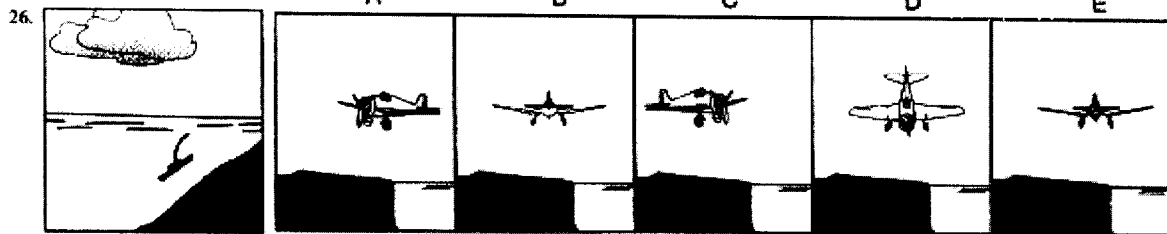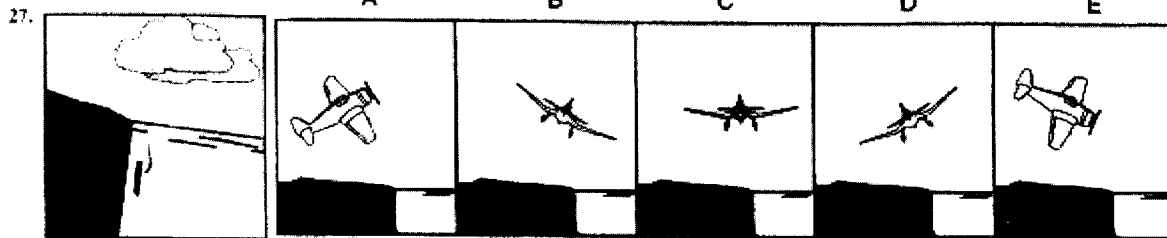
7.

A　B　C　D　E

8.

A　B　C　D　E

9.

A　B　C　D　E

10.

A　B　C　D　E

11.

A　B　C　D　E

12.

A　B　C　D　E

13.

    A   B   C   D   E

14.

    A   B   C   D   E

15.

    A   B   C   D   E

16.
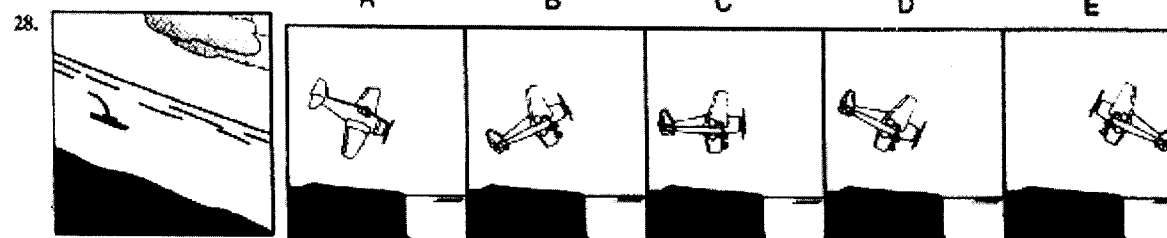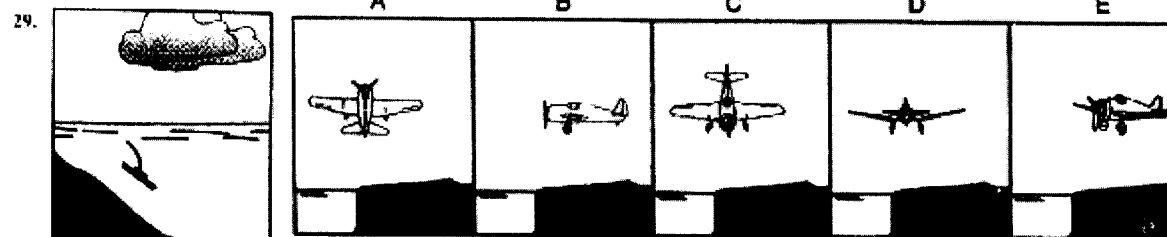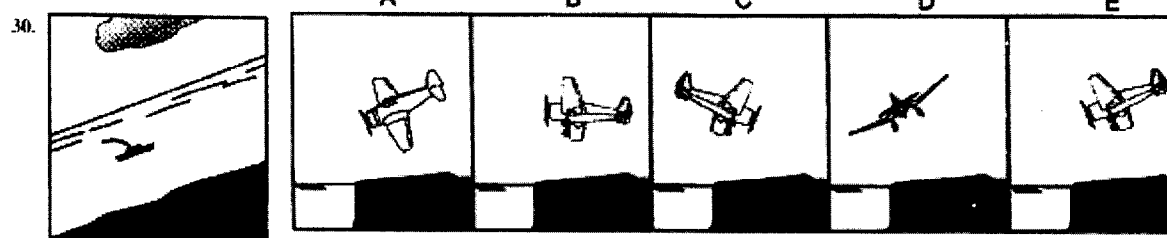
    A   B   C   D   E

17.

    A   B   C   D   E

18.

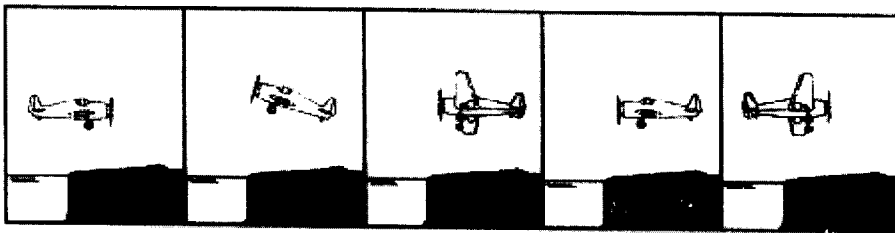   A   B   C   D   E

19.

A   B   C   D   E

20.

A   B   C   D   E

21.

A   B   C   D   E
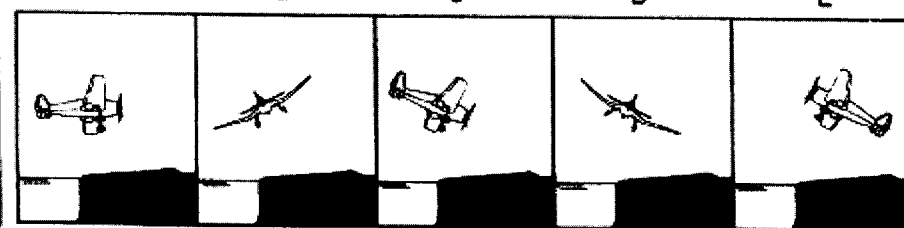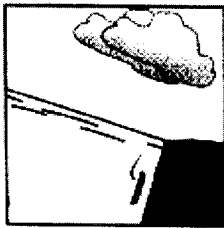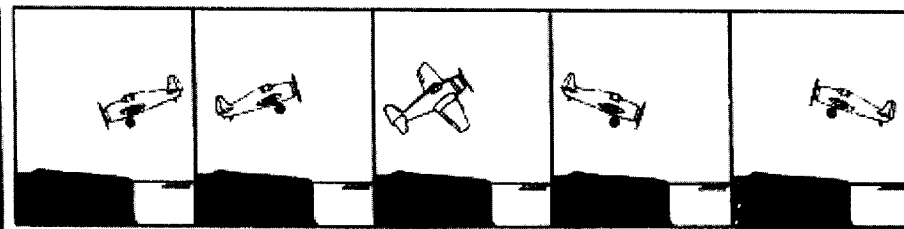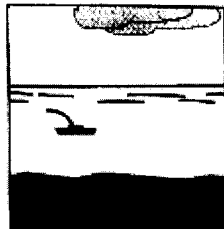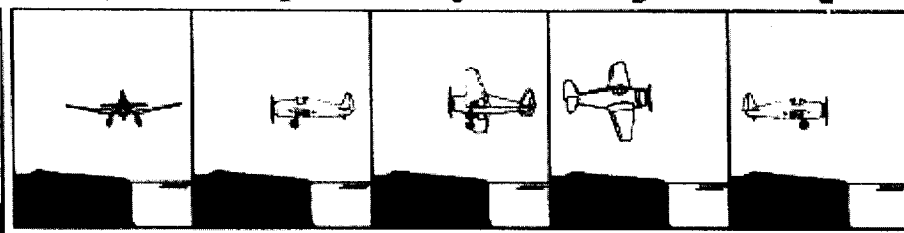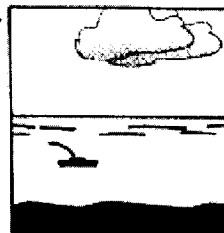
22.

A   B   C   D   E

23.

A   B   C   D   E

24.

A   B   C   D   E

25.

| A | B | C | D | E |

26.

| A | B | C | D | E |

27.

| A | B | C | D | E |

28.

| A | B | C | D | E |

29.

| A | B | C | D | E |

30.

| A | B | C | D | E |

22

31.

| A | B | C | D | E |

32.

| A | B | C | D | E |

33.

| A | B | C | D | E |

34.

| A | B | C | D | E |

35.
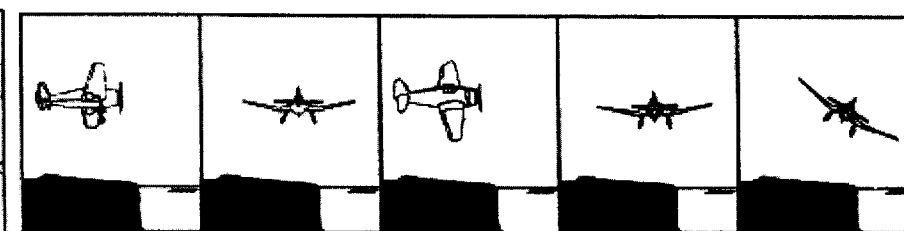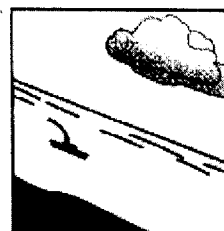
| A | B | C | D | E |

Section 6: Aviation and Nautical Information Test

This section has 30 questions and gives you 15 minutes in order to answer them all. That leaves you with 30 seconds per question. Each question is multiple-choice with 4 choices to choose between. The questions asked here consist mainly of general knowledge and history when it comes with both naval aviation and U.S. Naval terminology/knowledge. Know the two diagrams below and know what the function of the moveable surfaces of an airplane control.

beam

board

aft

propeller Rotates and powers a
vessel forward or backward

kee

Front of ship

Conn-Ships Controls

Green Nav Light

Mast

Funnel

Bridge

Accommodation

Hatches

Stern

Foc'sle

Starboard

Port

Keel

Bow

Deck

Load line

Bulkhead

RED Nav
Light

Cargo
Hold

Horizontal stabilizer

Fin

Left aileron

Wing

Rudder

Left flap

Elevator

Cabin

Fuselage

Propeller
Engine
compartment

Right flap

Right aileron

Landing gear

Wing tip

Ailerons control bank angle around the longitudinal axis.
Elevator controls pitch around the lateral axis.
Elevator up plane climbs, Elevator down plane dives

Normal or Vertical Axis

Lateral Axis

Longitudinal Axis
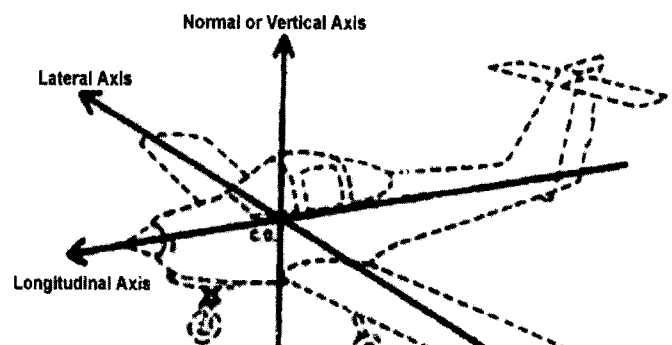
Rudder controls yaw around the vertical axis.

The modern aircraft has five basic structural components: fuselage, wings, empennage (tail structures), power plant (propulsion system) and the undercarriage.

The fuselage is the main body structure to which all other components are attached. Types of fuselage structures are monocoque, semi-monocoques and open-truss.

The fuselage contains the cockpit or flight deck, passenger compartment and cargo compartment. While wings produce most of the lift, the fuselage also produces a little lift. A bulky fuselage can also produce a lot of drag. For this reason, a fuselage is streamlined to decrease the drag. We usually think of a streamlined car as being sleek and compact - it does not present a bulky obstacle to the oncoming wind. A streamlined fuselage has the same attributes. It has a sharp or rounded nose with sleek, tapered body so that the air can flow smoothly around it.
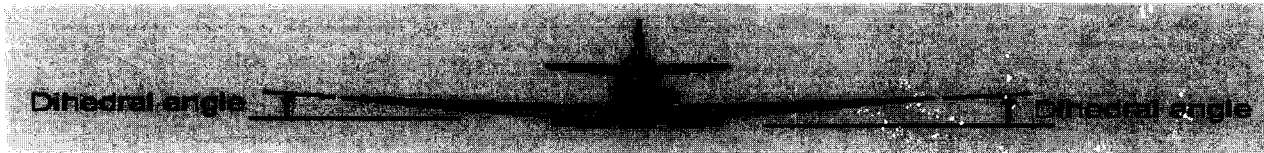
The wings are the most important lift-producing part of the aircraft. Wings vary in design depending upon the aircraft type and its purpose. Most airplanes are designed so that the outer tips of the wings are higher than where the wings are attached to the fuselage. This upward angle is called the dihedral and helps keep the airplane from rolling unexpectedly during flight. Wings also carry the fuel for the airplane.

Four Forces of Flight
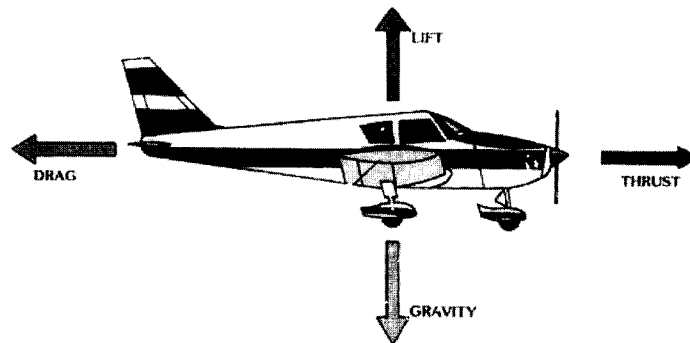
Thrust forward force created by a propeller or jet exhaust. Counters drag.

Drag- Rearward force that counters thrust. Types of drag discussed below. No the type of drag that your OSO dresses up in is not included in this discussion.

Lift- Force opposing gravity. This is what keeps the airplane aloft

Gravity- Force opposing lift.

maximum thickness   maximum camber   mean line

chord line

Lift

Airflow
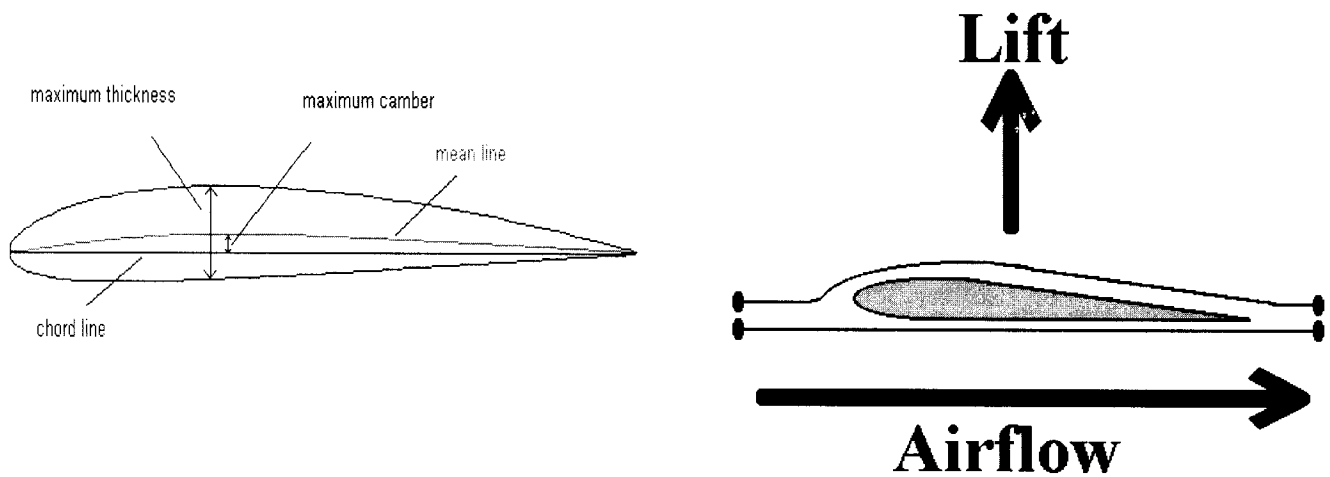
Aerofoil - a device that provides reactive force when in motion relative to the surrounding air; can lift or control a plane in flight.

Aerofoils work using the principle of the **Bernoulli effect.** A faster flowing fluid exerts a lower pressure on its surroundings than a slower flowing fluid. Due to the shape of aerofoils the air that passes above the wing as well as taking a longer path, is accelerated backwards, this means that the air flowing over the top surface of the wing is moving over the aerofoil surface much faster than that flowing over the lower surface. Thus the air below the aerofoil exerts a larger force on the surface of the wing than that flowing over the top, resulting in the aerofoil generating an upwards resultant force, lift.

An airfoil creates more lift at lower altitudes with low humidity due to the density of the air being greater. **Density altitude** is a measure of the combined effects of outside air temperature and air pressure compared to a **normal temperature/pressure day** (defined as 15 celsius and 29.92 inches of mercury) Thus, if taking off at sea-level (0 MSL) on a hot and humid day the density altitude of the airport is much higher than normal. Higher density altitude reduces aircraft performance (airspeed, climb rate, engine efficiency, propeller efficiency).

Form drag and pressure drag are virtually the same type of drag. Form or pressure drag is caused by the air that is flowing over the aircraft or airfoil. The separation of air creates turbulence and results in pockets of low and high pressure that leave a wake behind the airplane or airfoil (thus the name pressure drag). This opposes forward motion and is a component of the total drag. Since this drag is due to the shape, or form of the aircraft, it is also called form drag. Streamlining the aircraft will reduce form drag, and parts of an aircraft that do not lend themselves to streamlining are enclosed in covers called fairings, or a cowling for an engine, that have a streamlined shape. Airplane components that produce form drag include (1) the wing and wing flaps, (2) the fuselage, (3) tail surfaces, (4) nacelles, (5) landing gear, (6) wing tanks and external stores, and (7) engines.

Skin friction drag is caused by the actual contact of the air particles against the surface of the aircraft. This is the same as the friction between any two objects or substances. Because skin friction drag is an interaction between a solid (the airplane surface) and a gas (the air), the magnitude of skin friction drag depends on the properties of both the solid and the gas. For the solid airplane, skin fiction drag can be reduced, and airspeed can be increased somewhat, by keeping an aircraft's surface highly polished and clean. For the gas, the magnitude of the drag depends on the viscosity of the air. Along the solid surface of the airplane, a boundary layer of low energy flow is generated. The magnitude of the skin friction depends on the state of this flow.

Parasite drag is simply the mathematical sum of form drag and skin friction drag. Also termed

Parasite Drag = Form Drag + Skin Friction Drag

Induced drag is the drag created by the vortices at the tip of an aircraft's wing. *Induced drag* is the drag due to lift. The high pressure underneath the wing causes the airflow at the tips of the wings to curl around from bottom to top in a circular motion. This results in a trailing vortex. Induced drag increases in direct proportion to increases in the angle of attack. The circular motion creates a change in the angle of attack near the wing tip which causes an increase in drag. The greater the angle of attack up to the critical angle (where a stall takes place), the greater the amount of lift developed and the greater the induced drag.

Forces of Thrust
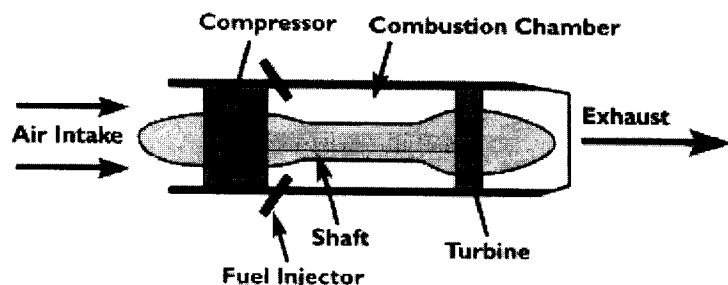
Jet Propulsion and Jet Engines

Jet propulsion is similar to the release of an inflated balloon. The pressure inside the balloon is pushing in all directions. It is also "jetting" out from the mouth of the balloon. The end of the balloon opposite to the mouth is not open. This creates an imbalance and causes the balloon to move in the direction away from the open mouth. Jet engines work in a similar fashion.

There are several types of jet engine: ramjet, turbojet, turbofan. The last two are the most widely used.

The ramjet is as simple a jet engine as can be found. Air enters the inlet and is compressed. This raises the pressure of the air. As the air arrives at the combustion chamber, fuel is added and an electric spark is generated. This causes a controlled explosion that raises the temperature and the pressure of the air tremendously. The hot, high-pressure air "jets" out the nozzle of the engine providing the forward thrust. This seems so simple, why would anyone want a more complex engine? The weakness of this engine is that the air coming in the inlet must be traveling at a very high speed (supersonic) for good efficiency. A ramjet does not work well at low speeds. This is simply not practical for most flying situations.

The turbojet was the first really useful jet engine to be built. The air flows into the engine through the inlet. The design of the inlet makes the air slow down and also raises the pressure. The air then goes through the compressor where sets of blades compress the air even more, greatly raising the pressure. The air then enters the combustion chamber where the fuel is added and ignited. The very hot, high-pressure air rushes past the turbine blades making them spin very fast. The turbine blades are connected back to the compressor blades by a shaft. The turbine blades take some of the energy from the air and returns it to the compressor. The hot, high pressure air that gets past the turbine, "jets" out the exhaust nozzle thrusting the engine forward.

To increase the thrust available, a device called an afterburner is sometimes built into the engine. Fuel is dumped into the hot exhaust gas exiting the nozzle causing another controlled explosion. This makes the air even hotter which adds more energy to it, thereby increasing the thrust. This is not an efficient thing to do however, and is only done for brief periods when extra thrust is needed, for example, on takeoff or when a burst of speed is needed during a dog fight, or when an extra push is needed to reach supersonic speed. You may have seen movies with high performance jets, like the F-14. If you watch one of these jets from the back, and the pilot turns on the afterburners you will hear a burst of noise and see an orange glow around the outlet of the engines. The airplane will then shoot up into the sky.

The turbofan is a refinement to the turbojet that results in a more efficient engine. A large set of fan blades is set right in the front of the inlet. The fan works much like a propeller, thrusting the engine forward, pushing a large amount of air backwards. As the air is pushed back by the fan some of it goes into the engine and some bypasses the engine. The engine that sits behind the fan is basically a turbojet. The air that goes into this engine receives the same treatment as air that goes through the turbojet. The turbine in a turbofan drives the fan as well as the compressor. The air that "jets" out the back of this engine has less thrust than air that exits a turbojet, but that decrease in thrust is made up for by the thrust generated by the fan. A turbofan engine actually is more efficient than a turbojet and is quieter as well. Afterburners can be fitted to a turbofan if required.

The turboprop engine is essentially a turbofan engine where the fan is replaced by a propeller. The propeller is placed outside of the inlet. A gearbox is introduced which controls the spinning of the shaft, enabling speed control for the propeller. This is the most efficient means of propulsion, however it is limited in forward speed. Because the propeller is out in the free stream air, not mounted in the inlet (where the air speed is reduced) the propeller has to rotate at faster speeds. The speed of the propeller approaches the speed of sound well before the airplane itself. As the airplane approaches the speed of sound, drag greatly increases. So the speed of the airplane must be kept well below the speed of sound to prevent the tips of the propeller from going too fast.
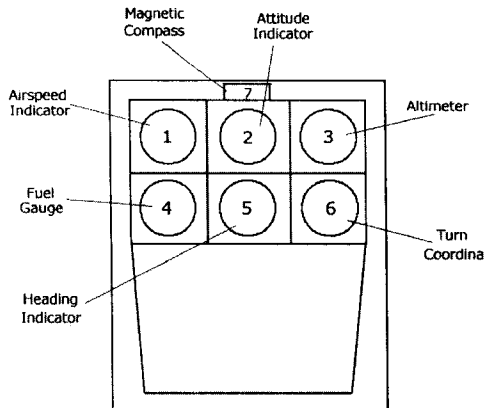
1. Airpeed indicator: Uses pitot tube pressure to indicate airspeed in knots

2. Attitude indicator: Used to maintain wings level in instrument conditions (also turbulence)

3. Altimeter: use static pressure to indicate altitude above Mean Sea Level (MSL)

4. Fuel Guage: Measures fuel flow

5. Heading indicator: couples electronic stabilizing features with magnetic compass to indicate magnetic heading of aircraft

6. Turn coordinator indicates alignment of aircraft along the longitudinal axis.

7. Magnetic heading (whiskey compass): indicates magnetic heading but unstable.

Pilot Guide to Airport Signs and Markings

Airport Signs — Action or Purpose

Sign	Purpose
4-22	RUNWAY HOLD POSITION
	HOLDING POSITION: Direction of intersecting runway
8-APCH	ILS APCH HOLD POSITION: Hold Short for Acft on Approach
ILS	ILS HOLD POSITION: Hold Short of ILS Critical Area
⊖	NO ENTRY: Identifies Paved Areas Where Aircraft Entry is Prohibited
B	TAXIWAY LOCATION: Identifies Taxiway on Which Aircraft is Located
22	RUNWAY LOCATION: Identifies Runway on Which Aircraft is Located
4	RUNWAY DISTANCE REMAINING: Identifies Runway Length Remaining

Sign	Purpose
▭	RUNWAY BOUNDARY: Exit Boundary of Rwy Protected Areas
▭	ILS CRITICAL AREA BOUNDARY: Exit Boundary of ILS Critical Area
L→	RUNWAY EXIT: Defines Direction & Designation of Exit Twy from Rwy
Also ...	TWY DIRECTION: Defines Direction & Designation of Intersecting Taxiway(s)
22↑	OUTBOUND DESTINATION: Defines Directions to Take-Off Runways
↖MIL	INBOUND DESTINATION: Defines Directions for Arriving Aircraft
▨	TAXIWAY ENDING MARKER: Indicates Twy Does Not Continue
↙A G L→	DIRECTION SIGN ARRAY: Identifies Location in Conjunction with Multiple Intersecting Taxiways

If in Doubt Ask!

ATCT Light Gun Signals

Signal	Aircraft on the Ground
STEADY GREEN	Cleared for Takeoff
FLASHING GREEN	Cleared to Taxi
STEADY RED	STOP
FLASHING RED	Taxi Clear of the Runway in Use
FLASHING WHITE	Return to Starting Point on Airport
ALTERNATING RED/GREEN	Exercise Extreme Caution

(CONTINUED ON REVERSE SIDE)

Outer edge taxi lights in blue
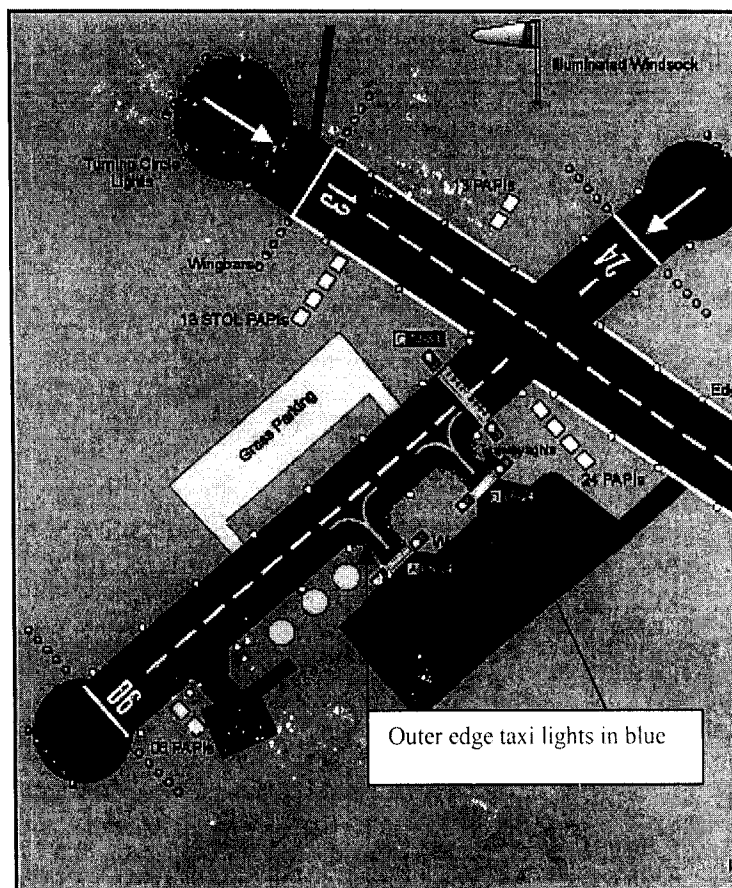
Section 8: Supplemental Information

ASTB sample questions: www.navygouge.com: follow the links to the ASTB gouge.
Air Warriors - www.airwarriors.com: Blog site that contains everything Naval Aviation.
Arco: 6th Edition $18.00 from B&N
Cliffstestprep: $20.00 from B&N
Learning Express: 2nd Edition $20.00 from B&N
Private Pilot Manual – (Jeppesson)

The following movies have tidbits of information that may be helpful on the Aviation/Nautical knowledge section:

The Right Stuff- Remember names, missions, firsts (First to space, first on moon, first to break sound barrier)
Apollo 17- Stay awake on this one and you may find a nugget or two helpful on the A/N section
Top Gun: Industry Standard, but not much substance here to help you on the test. If you haven't heard yet, unless your callsign is Maverick don't be the dork wearing his leather flight jacket to the Seville.
History of Naval and Marine Corps Aviation: www.history.navy.mil/branches/org4-4.htm : understand the different functions and designations of the naval aircraft inventory.