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СОВРЕМЕННЫЕ ЛЕТАТЕЛЬНЫЕ АППАРАТЫ

(Modern Aircraft)

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UNIT 1

An - 70 - New Step in the Development of Transport Aviation.

Preparing to read.

1. Here is the title of the text "An-70 New Step in the Development of Transport Aviation". Try to predict how the text begins. The two first sentences will be displayed on the blackboard.

2. Write down three important facts related to the topic 'An -70-New Step in the Development of Transport Aviation'. Share the information and discuss it.

3. Match the keywords with their translations.

1) to be intended for	a)географическая широта
2) long-haul	b) короткий пробег
3) short take-off run	c) тельфер
4) latitude	d) дальнемагистральный
5) multiplexed data exchange channel	e) лебедка
	f) высаживать десант
6) telpher	g) уплотнённый канал обмена данными
7) winch	
8) to airdrop the paratroops	h) соосные вентиляторы
	i) предназначаться
9) coaxial fans	j) хитроумное приспособление
10) contraption	k) годность к полёту
11) container handling	l) погрузка и разгрузка контейнеров
12) airworthiness	

Reading

1. Read the text and check if your answers in ex. 2 p.1 are correct.

2. Read the text and complete the table below.

	Data on aircraft An-70	Advantages (in comparison with other types of aircraft)
Types of engines		
Cargo capacity		
Range		
Speed		
Runways		
Avionics		
Control systems		

An - 70 - New Step in the Development of Transport Aviation

A. An - 70 is a long - haul short take - off military transport plane intended for airlifting military cargo of total mass of up to 47t.

B. The plane can airlift 20 - 35t of cargo on 3800 - 7400km distance at 750kmph cruising speed , airdrop the paratroops and hardware, including single pieces weighing up to 20t**,**from either high or low altitude, bring in 300 troops with their small arms, evacuate 206 sick and wounded.

C. Depending on the operational mode and cargo mass, An –70 can take off from the average - strength concrete runways 1800m long, or the loosely - bound ground airstrips 600 - 900m long. In the latter case it carries 20-35t of cargo on 1450 - 3000km distance.

D. Four D - 27 engines with coaxial fans ensure high cruising speed at 20 - 30% lower fuel consumption, comparing with other modern turbojets.

E. The integrated digital avionics provide for steady operation of the plane by day or night, at every latitude in any weather, flights over the blank terrain, air-defence penetration, formation flights, take-offs from and landings on the unprepared ground airstrips. The use of multiplexed data exchange channels makes for an easy adaptation of avionics to any mission profile.

F. In-built load - carrying contraptions enable the plane to load and unload the cargo, as well as airdrop it. They include four electric telphers of total carrying capacity of 12t, two electric winches having the pull of 1.5 t each. On customers demand the plane can be equipped with the second easily demountable deck or roll-ways for container-handling.

G. On - board control & diagnostic systems allow An -70 to operate autonomously without any special ground infrastructure. All maintenance is done when the conditions so require.

H. An – 70's high technical and operational potential makes it possible to built upon its base a whole range of models, both military and civil : early warning aircraft , flying command post, patrol aircraft, refuel aircraft and many various An-70T commercial transports.

I. In 1998 the International Consortium of Medium Transport Aircraft has been set up which founders, beside Antonov Aeronautical Scientific Technical Complex , include the Russian and Ukrainian aviation factories, scientific Consortium conducts joint R & D , production , export. Its prime objective is the long- term pooling of the financial, industrial and human resources for the successful certification, production, sale, and leasing and after-sale support of An-70. Consortium is the sole legal entity having the right to built An-70 and alter its design. At present An - 70 is undergoing

flight and certification tests for its compliance with the Air force's requirements and AP-25 (FAR-25, JAR-25) airworthiness criteria.

Comprehension Check

1. Divide the text into logical parts and entitle them.

2. Answer the questions below.

1) What is An-70 intended for?
2) How many people can it evacuate?
3) What runways can the aircraft take off?
4) What ensures high cruising speed?
5) What provides for steady operation of the plane by day or night, at every latitude in any weather?
6) What enables the plane to load and unload the cargo?
7) What systems allow An-70 to operate autonomously without any special ground infrastructure?

3. Define the main idea of paragraphs *E* and *F*. Find the supporting details that help to develop the main idea.

4. Explain why:

a) An-70 can take of and land on the unprepared ground airstrips.
b) The avionics can be easily adapted to any mission profile.
c) An-70 has a lower (20-30%) fuel consumption comparing with other modern turbojets.
d) It is possible to build upon An-70's base a whole range of models, both military and civil.
e) An-70 can operate autonomously without any special ground infrastructure.

Vocabulary Focus

1. Fill in the gaps with the words & expressions from the box.

consortium multiplexed sick special ground infrastructure ground airstrips mission profile concrete runways wounded channels hardware.

1) An-70 can airdrop the paratroops and ____; it can evacuate 206 ____ and ____.

2) An-70 can take off from the average-strength _____ 1800 long, or the loosely-bound ____600-900m long.

3) The use of ____ data exchange ____makes for an easy adoption of the avionics to any ____.

4) On-board control and diagnostic systems allow An-70 to operate autonomously without any _____.

5) ____ is the sole legal entity the right to built An-70 and alter its design.

2. Explain the following words and word combinations in other words or give synonyms where it is possible.

A long haul aircraft, to be intended for(A), to airdrop the paratroops (B); formation flights , unprepared airstrips (E); contraption, a demountable deck (F); in compliance with, airworthiness criteria, customer (I).

3. Translate from Russian into English.

1) Ан-70 дальнемагистральный военный транспортный самолёт с коротким пробегом, предназначенный для перевозки военного груза общей массой до 47 тонн.

2) В зависимости от эксплуатационного режима и массы груза, Ан-70 может взлетать с бетонных взлётно-посадочных полос средней прочности, длинной 1800 метров.
3) Четыре двигателя D-27 с соосными вентиляторами обеспечивают высокую крейсерскую скорость при более низком потреблении топлива на 20-30%, по сравнению с другими современными турбореактивными самолётами.
4) Бортовые системы управления и диагностики позволяют Ан-70 работать автономно без какой-либо специальной наземной инфраструктуры.
5) Высокий технический и эксплуатационный потенциал Ан-70 делает возможным строить на его основе целый ряд моделей и военных, и гражданских: самолёт авиации раннего предупреждения, летающий командный пост, самолёт патрулирования, самолёт-заправщик и многие другие.
6) Консорциум является единственным юридическим лицом, имеющим право сроить Ан-70 и вносить изменения в его конструкцию.

Focus on writing

1. Rearrange the following words to form meaningful sentences. Work in groups.

1) cargo / An-70 / intended for / up to 47t / of / total mass / of / a/ military / long haul/ plane / transport / short take-off / military / airlifting / is.

2) speed / SV-27 coaxial fans / turbojets / with / high / consumption / at 20-30% lower / four D-27 engines / with / modern / fuel / ensure / other / cruising / comparing.

3) weather / every / in / latitude / any / at / for / avionics / operation / the / plane / integrated / of / digital / the / night / by / day / or / provide.

4) enable / load-carrying / to load / in-built / as / contraptions / the / unload / the cargo/ it / plane / airdrop / well / as / and.

5) requirements / at / is / certification / with / its / present / the Air force's / and / undergoing / AP-25 / criteria / An-70 / flight / airworthiness / compliance / tests.

2**. Use the prepositions in the box to complete the sentences.**

in	on	for	over	without	by
up to	with	at	of	from	

1) An-70 can take off _____ the average-strength concrete runways 1800m long.

2) It carries 20 - 35t ____ cargo ____ 1450 - 3000km distance.

3) An - 70 is intended ____ airlifting military cargo of ____ 47t.

4) Four D - 27 engines ensure high cruising speed ____ 20 - 30% lower fuel consumption, comparing ____ other modern turbojets.

5) The integrated digital avionics provide ____ steady operation of the plane ____ day or night ____ every latitude ____ any weather, flights ____ the bank terrain .

6) ____ customers demand the plane can be equipped ____ the second easily demountable deck or roll - ways ____ container - handling.

7) On-board control and diagnostic systems allow An-70 to operate autonomously ____ any special ground infrastructure.

3. Write a summary of the text.

<u>Speaking</u>

1. a) Read the text again. Find the details and fill in the table.

Load-carrying contraptions	
Maintenance	
Integrated digital avionics	
International Consortium (founders and activity)	

b) Speak on the points from the table. Work in pairs.

c) Research any new transport aircraft and compare its performances with An - 70.

2. Work in groups. You are involved in developing of different systems or parts of the aircraft. Today you are to make a report to your boss. You are responsible for one of the following topics:

- engines
- avionics
- loading and unloading
- control systems
- flight performances
- ICMTA (Consortium)

3. Choose the topic to speak on. Invent and develop your own ideas for aircraft improvements.

UNIT 2

American Eagles

Preparing to Read

1. Look at the title of the text "American Eagles ". Write down 10 words that may be related to the topic. Then work in pairs, share the words and give your prediction about the contents of the text.

2. Look at the following list and try to guess what type of aircraft it is. Work in groups and share the information.

extremely maneuverable
air superiority
unprecedented avionics
high engine thrust-to-weight ratio
tactical electronic-warfare system
air-to-air weaponry
advanced radars
turn without loosing airspeed
electronic countermeasure set
weapon control stick

3. Match the English words with their Russian counterparts.

1) throttle	a) засветка от земли (помехи)
2) interdiction	b) избыточный, дублированный
3) ground clutter	c) воспрещение, затруднение действий противника
4) redundant	d) авиац. электронное оборудование
5) avionics	e) проекционно-бортовой индикатор
6) air intake trunk	f) многоцелевой

7) thrust-to-weight ratio	g) точность
8) precision	h) коэффициент тяговооружённости
9) versatile	k) рукоятка управления
10) control stick	l) дроссель
11) dogfight	m) обнаружить вражеский самолёт
12) adverse weather	n) воздухозаборники
13) to acquire enemy aircraft	o) сражение в воздухе
	p) плохая погода
14) head-up display	

American Eagles

A. The F-15 Eagle is an all-weather, extremely maneuverable, tactical fighter designed to permit the Air Force to gain and maintain air superiority in aerial combat.

B. The Eagle's air superiority is achieved through a mixture of unprecedented maneuverability and acceleration, range, weapons, and avionics. The F-15 has electronics systems and weaponry to detect, acquire, track and attack enemy aircraft while operating in friendly or enemy-controlled airspace.

C. The weapons and flight control systems are designed so one person can safely and effectively perform air-to-air combat. The F-15 superior maneuverability and acceleration are achieved through high engine thrust-to-weight ratio and low wing loading. Low wing-loading (the ratio of aircraft weight to its wing area) is vital factor in maneuverability and, combined with the high thrust-to-weight ratio, enables the aircraft to turn tightly without losing airspeed.

D. A multimission avionics system sets the F-15 apart from other fighter aircraft. It includes a head-up display, advanced radar, inertial navigation system, flight instruments, ultrahigh frequency communications, tactical navigation system and instrument landing system. It also has an internally mounted tactical electronic-warfare system, identification "friend or foe" system, electronic countermeasures set and a central digital computer.

The head-up display projects on the windscreen all essential flight information gathered by the integrated avionics system. This display, visible in any flight condition, provides the pilot information necessary to track and destroy an enemy aircraft without having to look down at cockpit instruments.

E. The F-15`s versatile pulse-Doppler radar system can look up at highflying targets and down at low flying targets without being confused by ground clutter. It can detect and track aircraft and small high-speed targets at distances beyond visual range down to close range, and at altitudes down to treetop level. The radar feeds target information into the central computer for effective weapons delivery. For close-dogfights, the radar automatically acquires enemy aircraft, and this information is projected on the head-up display. The F-15`electronic warfare system provides both threat warning and automatic countermeasures against selected threats.

F. A variety of air-to-air weaponry can be carried by the F-15. An automated weapon system enables the pilot to perform aerial combat safely and effectively, using the head-up display and the avionics and weapons control stick. When the pilot changes from one weapon system to another, visual guidance for the required weapon automatically appears on the head-up display.

G. The Eagle can be armed with combinations of four different air-to-air weapons: Aim-7F/M Sparrow missiles or AIM-120 advanced medium range air-to-air missiles on its lower fuselage corners, AIM-9L/M Sidewinder or AIM-120 missiles on two pylons under the wings, and an internal 20mm Gatling gun in the right wing root. Low-drag conformal fuel tanks were especially developed for the F-15C and D models. Conformal fuel tanks can be attached to the sides of the engine air intake trunks under each wing and are designed to the same load factors and airspeed limits as the basic aircraft. Each conformal fuel tank contains about 114 cubic feet of usable space. These tanks reduce the need for in-flight refueling on global missions and increase time in the combat area. All external stations for munitions remain available with the tanks in use. AIM -7 F/M Sparrow missiles, moreover, can be attached to the corners of the conformal fuel tanks.

H. The F-15E is a two-seat, dual-role, totally integrated fighter for all- weather, air-to-air and deep interdiction missions. The rear cockpit is upgraded to include four

multi-purpose CRT displays for aircraft systems and weapons management. The digital, triple-redundant flight control system permits coupled automatic terrain following, enhanced by a ring-laser gyro inertial navigation system. For low altitude high-speed penetration and precision attack on tactical targets at night or in adverse weather, the F-15E carries a high-resolution APG-70 radar and low attitude navigation and targeting infrared for night pods.

Reading

1. Read the text and write out the words and word combinations you don`t know, try to guess their meaning from the context. Compare your notes with your partners.

to penetrate	identification friend or foe
conformal fuel tank	electronic warfare system
threat warning system	engine throttle
a head-up display	deep interdiction mission
ground clutter	redundant
air intake trunk	control stick
dogfight	to acquire the aircraft

2. Read the text while reading find out the necessary information and fill in the following table.

Systems the aircraft equipped with	Aircraft performances	Types of weapons

Comprehension Check

1. Read the following statements. Say weather they are true; if not, correct them.

1) The weapons and flight control systems are designed so five pilots can safely and effectively perform air-to-air combat.

2) The F-15 Eagle is an all-weather, extremely maneuverable, tactical fighter.

3) Its maneuverability and acceleration are achieved through aspect ratio and low wing loading.

4) The head-up display projects on the windscreen only a small amount of information gathered by the integrated avionics system.

5) The radar feeds target information into central computer for effective weapons delivery.

6) The F-15`s electronic warfare system provides only threat warning and doesn`t provide automatic countermeasures against selected threats.

7) The Eagle can be armed with combinations of one air-to-air weapon - AIM-7F/M Sparrow missiles.

8) Low-drag conformal fuel tanks were especially developed for the F-15C and models.

9) Conformal fuel tanks reduce the need for in-flight refueling on global missions and increase time in the combat area.

10) The F-15E is a two-seat, dual-role, totally integrated fighter for all-weather, air-to-air and deep interdiction missions.

2. Ask questions to which the following sentences are the answers. Remember to use "wh" words: why, what, where, when. Work in groups.

1. ____designed to permit the Air Force to gain and maintain air superiority in aerial combat.

2. ____through a mixture of unprecedented maneuverability and acceleration, range, weapons and avionics.

3. ____ the weapons and flight control systems.

4. ____ it sets-the F-15 apart from other fighter aircraft.

5. ____ projects on the windscreen all essential flight information gathered by the integrated avionics system.

6. ____The F-15`s versatile pulse - Doppler radar system.

7. ____ enemy aircraft.

8. ____both threat warning and automatic countermeasures against selected threats.

9. ____ enables the pilot to perform aerial combat safely and effectively.

10. ____ when the pilot changes one weapon system to another.

11. ____ with combinations of four different air-to-air weapons.

12. ____ low-drag, conformal fuel tanks.

13. ____ about 114 cubic feet of usable space.

14. ____ the digital, triple redundant flight control system.

15. ____ a high resolution APG-70 radar and low altitude navigation and targeting infrared for night pods.

Vocabulary Focus

1. Find in the text the synonyms to the given words and expressions.

a battle in the air	multifunctional
distance	menace (danger) warning
aviation electronic equipment	
to do smth. better than others	upgraded
to win in the battle	accuracy
to fulfill	bad weather
essential	to collect information
to be fitted	
to crash, to defeat the enemy	

2. Match the words with their definitions.

1. aircraft acquisition	a) the armament intended for battles in the air
2. wing-loading	b) danger

3. multimission avionics	c) a special channel for sucking in the air for ventilation
4. air-to-air weaponry	d) the detection of the aircraft
5. ground clutter	e) the ratio of aircraft weight to its wing area
6. threat	f) ground interference
7. air intake tranks	g) a versatile radio electronic on-board equipment

3. Express the same in English.

Беспрецедентная маневренность и ускорение; авиационное электронное оборудование; проникать; оборона противника; делать лучше, чем другой; побеждать в воздушном бою; система распознавания «свой - чужой»; местные помехи (засветка) от земли; воздушный бои; дроссель двигателя; рукоятка управления; быть вооруженным чем-либо; современные ракеты класса воздух-воздух среднего радиуса действия; конформные топливные баки; гироскопическая инерциальная навигационная лазерная система; точное поражение тактических целей; плохие погодные условия; ночные разведывательные полёты; резервный.

Focus on Writing

1. Match the beginnings and the endings of the sentences.

1) The air's superiority is achieved …	**a)** about 114 cubic feet of usable space
2) The weapons and flight control systems are designed so …	**b)** four different air-to-air weapons
3) The F-15 superior maneuverability and acceleration are achieved…	**c)** visual range down to close range, and at altitudes down to treetop level
4) A multimission avionics system sets the F-15…	**d)**four multi-purpose CRT displays for aircraft systems weapons management
5) The head-up display projects on	**e)** through a mixture of unprecedented maneuverability and acceleration,

the windscreen all essential flight information…

6) The F-15 pulse-Doppler radar system can detect and track aircraft and small high-speed targets at distances beyond…

7) The Eagle can be armed with combinations of…

8) Each conformal fuel tank contains…

9) The rear cockpit is upgrated to include

10) For low altitude, high-speed penetration and precision attack on tactical targets at night or in adverse weather…

range, weapons, and avionics

f) the F-15E carries a high-resolution APG-70 radar and low attitude navigation and targeting infrared for night pods

g) one person can safely and effectively perform air-to-air combat

h) apart from other fighter aircraft

i) gathered by the integrated avionics system

j) through high engine thrust-to-weight ratio and low wing loading

2. Make up your own sentences using the words and word combinations of exercise 1 p. 17

3. Write a summary of the text.

<u>Speaking</u>

1. You are going to introduce your aircraft at Farnborough Air Show in the United Kingdom. Describe the performances of American Eagles and persuade the potential customers to purchase the aircraft from your company. Split into groups. Everyone should take part in presentation
(remember to use the table ex.2 p.12) .

Speak about: 1- radar systems of the aircraft
2- fuel system
3- weapons
4- the head-up display
5- flight performances

UNIT 3

Sukhoi S-37 ``Berkut`` 5th Generation Russian Fighter

Preparing to read

1. Write 3 important factors related to the topic.

2. The beginning of the sentence is displayed on the blackboard. Can you predict how the text begins? Share your ideas with your group mates.

Reading

1. Skim the text and try to guess the meaning of the underlined words from the contents of the text.

Sukhoi S-37 ``Berkut`` 5th Generation Russian Fighter

A. Sukhoi S-37 "Berkut", Russian's 5th generation fighter. New in Sukhoi fighters forward-swept wing design integrated into the tandem triplane configuration. Visible in the tail section of the aircraft are two "stringers". A rather interesting element: the "stringers" are of different length. At first it might appear that this is an optical illusion, however, after a closer examination the difference in length of the "stringers" is obvious. It is reasonable to conclude that the longer "stringer" contains a spin-recovery parachute. However, the difference in size of the "stringers" can also be explained by a possibility of an aft facing radar.

B. The S-37 fighter is designed to use the thrust-vectoring AL-37FU engines, however, during the first test flights it was used the more powerful D-30F6 engines from MiG-31, Russia's most advanced high-speed interceptor aircraft. The original, 1991 S-37 project was a smaller aircraft with a delta wing design and a single AL-41F engine. This apparently was not the case with the 1997 S-37 "Berkut" : the new aircraft is significantly larger, it is equipped with two engines, and employs a forward-swept wing design. The combined thrust of S-37's engines is 25 tons.

C. The basic dimensions and weight of the S-37 "Berkut" are similar to those of Su-37. While the main advantage of the forward-swept wing design is the improved maneuverability at subsonic speeds and high angles of attack, its primary drawbacks are the reduced lift and handling problems at supersonic speeds. A natural way to counter such problems is by using more powerful engines and advanced thrust-vectoring controls. The 1991 S-37 project was designed with very powerful AL-41F engines in mind. The AL-441F would be able to satisfy the power requirements of the S-37.

D. The S-37 has large canards mounted on the intake side, close to the leading edge of the forward-swept wing. It is also apparent that the vertical stabilizers are canted slightly outward, and not inward. Two large auxiliary intake doors are located on the centre fuselage section. It previously suggested that the nose section of the S-37 was similar to the one of Su-27 family. However, later it became clear that it is rather similar to the original S-37 design announced in 1991 and later canceled. It is now clear that the S-37 fighter is intended to become Russia's fifth generation fighter.

Main characteristics:

- 75 feet long
- inverted-arrow wing design
- two thrust-vectoring engines
- tandem triplane configuration
- reduced RCS airframe
- airframe is covered with radio wave absorbent.

Dimensions:

Wingspan 15.65m

Length 22.2m

Height 6.36m

Powerplant:

Two afterburning, thrust-vectoring Saturn/Lulka AL-37FU with digital controls;

Thrust (each): 83.35kN dry;142.2kN with afterburning;

Thrust-vectoring in pitch -20* to 20* at 30* per second.

Weight:

Normal take-off 26000kg

MTOW 34000kg

Performance:

Max level speed at sea level 760kt (1400km/h)

Max rate of climb at sea level 230m/sec

Service ceiling 18800m

Range (armed, internal fuel) 3880km

Required runway length 1200m

Armament:

One GSh-30 30mm cannon with 150 rounds;

Two R-73 and two R-27 missiles carried under the fuselage on special conformal suspensions. There are no armaments under the wing, but as need be it can be placed on underwing pylons.

2. Read the text and find the meaning of the following equivalents. Consult a dictionary.

- spin-recovery
- forward-swept wing
- thrust-vectoring controls
- conformal
- suspension
- canards
- tandem triplane configuration

3. Read the text and search for the detailed information on the following:

-wing configuration (its advantages and disadvantages)

-engines

-armaments

-performance

-powerplant

Comprehension Check

1. **Divide the text into logical parts and entitle them.**
2. **Answer the questions:**
   1) What kind of aircraft is the Sukhoi S-37 “Berkut”?
   2) What new is in the wing design of the aircraft?
   3) What is visible in the tail section of the aircraft?
   4) Are the “stringers” of different length?
   5) How can the difference in size of the “stringers” be explained?
   6) What kind of engines is it powered by?
   7) What are the basic dimensions and weight of the S-37 “Berkut”?
   8) What is the main advantage of the forward-swept wing design? What are the drawbacks?
   9) What kind of engine would be able to satisfy the power requirements of the S-37?
   10) Are the vertical stabilizers canted slightly outward and not inward?
   11) Are two large auxiliary doors visible on the center fuselage section?
   12) The airframe is covered with radio wave absorbent, isn’t it?
   13) What thrust can each engine develop?
   14) What range can it fly?
3. **Make up a summary of the text.**

Vocabulary Focus

1. **Find the words in the text that mean:**
   - push
   - improved
   - decreased
   - advanced
   - outside

- inside
- ban
- to be alike
- obvious

2. Explain the meaning of the following words:

- triplane
- interceptor
- maneuverability
- canards
- armament
- afterburning

3. a) Find the equivalents in the text:

- хвостовая штанга
- отклонение вектора тяги
- противоштопорный парашют
- переднее горизонтальное оперение
- оружие
- воздухозаборник
- дожигание топлива
- рабочий потолок

b) Make up 4-5 sentences with these words.

4. Fill in the gaps.

1) The difference in size of the stringers can be also explained by …… .
2) One of the most interesting and confusing technical issue about the new Russian fighter is its …… .
3) The basic dimensions and weight of the S-37 "Berkut' are similar to those of ……. .
4) The S-37 fighter has large …… mounted on the intake side, close to the leading edge of the ….. .
5) Its primary drawbacks are …… lift and handling problems at ….. speeds.

Engines; reduced; SU-37; radar; supersonic; canards; forward-swept wing.

Focus on writing

1. Complete the sentences.

1) New in Sukhoi fighters forward-swept wing design integrated into the ……. .

2) It is reasonable to conclude that the longer "stringer" contains a ……. .

3) The S-37 fighter is designed to use the …… .

4) During the first test flights it was used the more powerful D-30F6 engines from …… , Russia's most advanced high-speed ….. ….. .

5) The original, 1991 S-37 project was a smaller aircraft with a ….. wing design and a ….. AI-41F engine.

6) This apparently wasn't the case with the 1997 S-37 "Berkut": the new aircraft is significantly larger, it is equipped with two engines and employs a …. …. …. design.

7) The basic dimensions and weight of the S-37 "Berkut" are similar to those of ……. .

8) The main advantage of the forward-swept wing design is the …. ….. ….. ….. .

9) The drawbacks are the …. ….. and ….. ….. at supersonic speeds.

10) It previously suggested that the nose section of the S-37 was similar to the one of …. family.

2. Make up meaningful sentences from the following words:

1. is/ engines/ fighter/ to use/ the thrust-vectoring/ the S-37/ designed
2. intake/ section/ large/ are located/ two/ fuselage/ auxiliary/ centre/doors/ on the
3. canards/ side/ the Su-37/ intake/ has/ on the/ large/ mounted
4. wave/ the airframe/ with/ absorbent/ is/ radio/ with
5. the S-37 fighterussia`s/ it/ that/ to become/ fighter/ clear/ fifth/ now/ is/ is intended/ generation

Speaking

1. Work in pairs. Your authorities give you the task to introduce some improvements of aircraft Su-37. Cooperate and prove your point of view speaking on your improvements.

UNIT 4

Vertical Horizons

Preparing to read

1. Read the title of the text and think of all possible terms that may relate to the topic.

2. Work in pairs. Share the words and give your prediction about the content of the text.

Reading

1. Skim the text and try to guess and explain the meaning of the underlined words or word – combinations.

Vertical Horizons

A. People have dreamed of taking off and landing vertically for as long as they have dreamed about flying. But today the two classes of air vehicle remain fundamentally fixed-wing distinct: those that hover efficiently and those that fly efficiently. Closing the gap between rotary-wing and fixed-wing aircraft is the dream of vertical flight proponents, and designers are pursuing two paths: improving the efficiency of helicopters and perfecting new configurations.

B. The first "free" vertical flight was made by Frenchman Paul Cornu in 1907, barely four years after the Wright brother's first flight, but the machine was impractical. Autogyros became quite sophisticated between the wars, but they were not true vertical take-off and landing (VTOL) machines. The first practical helicopters were the German side-by-side rotor Focke-Angelis Fa61 of 1936 and intermeshing-rotor Flettner Fl282 of 1941. But Igor Sikorsky's VS300 defined the modern single-rotor helicopter when it first flew in 1939.

C. Despite all the technological progress since then, helicopters remain niche players in aviation. Compared with equivalent fixed-wing aircraft, they are still more expensive to buy and costly to operate; they are too noisy inside and out; and they vibrate too much for the comfort of their occupants or the longevity of their components. Yet helicopters are arguably the most versatile and useful of air vehicles.

Room for improvement

D. There is still considerable development potential in conventional helicopter, albeit incremental. Higher speeds, heavier payloads, less noise and vibration, and lower production and operating costs are possible. Typical industry goals for a 2020-timeframe helicopter include a 200kt (370km/h) cruise speed; 30% reductions in empty weight and fuel consumption; 60%lower external noise; fixed-wing levels of vibration and safety; 30-50% lower development, production, operation and maintenance costs; and all-weather operability.

E. The latest helicopters can cruise at up to 160kt, but this is an economical, rather than physical barrier. At 160kt the power required in forward flight is close to the power required in hover; to increase speed the power required in level flight has to be reduced. This will require lower-drag airframes, active rotor control and antitorque concepts. Eurocopter's Dauphin-based DGV200 demonstrator has cruised at 195kt, and exceeded 200kt, proving that faster helicopters are possible.

F. More important than higher speed are lower noise and vibration, as both are barriers to the wider acceptance of helicopters. External noise is being tackled with rotor designs and operating procedures. The latest high-thrust blades allow the main rotor to be slowed in the cruise, reducing fly-over noise, and both passive and active means to reduce approach noise are being evaluated.

G. The main source of noise on the descent is blade vortex interaction (BVI) – the main rotor blades hitting the air shed by preceding blades. Among the mitigating technologies NASA has evaluated is the low-noise planform rotor. This has a "wavy"

blade that distributes the shed air and reduces BVI noise. Another is the modulated rotor, in which the blades are spaced unevenly to generate a more random, less annoying noise.

H. A third concept for reducing BVI noise is the active twist rotor, in which the load distribution and spatial position of each blade is controlled individually. This reduces the strength of the wake and allows the blade to be "flown" away from the air shed by the preceding blade. The active twist rotor has shown substantial reduction in noise and vibration in NASA windtunnel testing.

I. Active rotor control is a feature of most advanced low-noise, high-speed helicopter designs, with advances in materials and electronics making individual blade control practical. Manufacturers are testing main rotor blades with active servo flaps driven by piezo-electric actuators. These are precursors to smart-material "morphing" blades that would allow elimination of the mechanical swashplate used to control blade pitch.

J. Smart, or active, structures also promise to reduce internal noise, as well as vibration. Passive vibration reduction has reached its limits, with the trend towards variable rotor RPM to reduce external noise requiring an adaptive antivibration system. Approaches being tested include acoustically active gearbox struts and cabin ceiling panels fitted with piezo-electric actuators that oscillate to cancel out noise and vibration.

K. Pushing helicopter speeds higher may require a new approach. One concept receiving attention is the reverse velocity rotor. This tackles the fundamental limit on the forward speed of a conventional helicopter, which is a result of the rotor flying sideways. As forward speed increases, airflow over the advancing blade gets faster while that over the retracting blade gets slower. Eventually the retreating blade begins to stall, setting the speed limit.

L. The reverse-velocity rotor (RVR) has a double-ended aerofoil that generates lift whichever way the air is flowing over the blade. As forward speed increases, the

rotor is slowed until the retreating blade is immersed in reverse flow, but still producing lift. This requires a variable-speed transmission and auxiliary propulsion, as at high speed the rotor is autorotating and pitch and yaw control is provided by thrust vectoring.

M. Windtunnel testing indicates the reverse-velocity rotor is capable of cruise speeds exceeding 300kt, but it retains the simplicity of a helicopter with no reconfiguration required to transition from vertical to forward flight. Under NASA contract, Sikorsky has studied an 80-passenger RVR runway-independent aircraft, with three engines, an eight-blade rotor and ducted-fan propulsor on the tail. The baseline RVR has a 340kt cruise and 1,000km range. Compounding – adding a wing to offload the rotor in the cruise – results in a smaller aircraft for the same mission, but increases empty weight and hover download.

Tilting forward

N. The RVR rivals the speed of a tiltrotor, widely regarded as the next step in rotorcraft evolution. The tiltrotor combines the hover capability of a helicopter with the cruise efficiency of a turboprop. The first example flew in 1954, and the first conversion from helicopter to aeroplane mode was accomplished in 1958, but the first production tiltrotor has yet to enter service.

O. Today's tiltrotors, the Bell Boeing V-22 military transport and Bell/Augusta BA609, are designed to cruise at 275kt, while NASA's 2020 timeframe technology goals call for a 350-400kt cruise to make the tiltrotor competitive with short-haul jets.

P. The tiltrotor has speed and range advantages, but the configuration presents challenges. Weight is one: an airliner can carry 120% of its empty weight and a helicopter 80% , but today's tiltrotors can lift only 40% . Hover capability is reduced by the compromise proprotor design – thrust in the hover is 10 times that needed in the cruise – and by the download on the airframe, which can equal 10% of aircraft weight.

Q. Led by Augusta Westland, Europe is working on a second-generation tiltrotor to address some of these issues. Key innovations in the Erica – a 350kt-cruise, 1,100km-range, 20-passenger tiltrotor – are the reduced-diameter rotors and tiltable wing. Smaller proportions improve cruise performance, while a tilting wing offsets the loss in hover efficiency by reducing download to around 1% of aircraft weight. The smaller rotors allow for take-off and landing in aeroplane mode, enhancing safety, while tilting the wing independently of the nacelles widens the conversion corridors.

Future tiltrotors

R. Bell and Boeing independently are looking at future tiltrotors and improvements to the current generation. The latter include a variable-geometry rotor with slotted blade providing higher lift in the hover without incurring a power penalty in forward flight. Others address the download issue, and include movable overwing vanes to deflect the rotor downwash and active synthetic jets to delay flow separation over the wing.

S. Bell is studying a larger quad tiltrotor (QTR) with four proprotors. The military version has a C-130-size fuselage, 20t payload and uses V-22-size dynamics. A 120-passenger civil QTR would cruise at 340kt. Boeing's advanced tiltrotor concept – designed to meet the same NASA runway-independent aircraft needs as Bell's civil QTR and Sikorsky's RVR – is a canard configuration with two large-diameter, five-blade proprotors at the tips of a W-planform wing designed to minimize download.

T. Faster rotorcraft have yet to be flight tested even experimentally, but Boeing hopes to fly the unmanned X-50 canard rotor/wing (CRW) demonstrator this year. Previous stoppable rotor/wing rotor/wing designs had problems with conversion between rotor- and wing-borne flights, but CRW is different. Earlier designs used the rotor/wing to provide lift in all modes, whereas the CRW unloads the rotor/wing during conversion, with lift being provided by the foreplane and tailplane.

U. Boeing believes this will ease the transition between the helicopter mode, where the rotor/wing acts as a two-blade reaction-drive rotor, and aeroplane mode, where the rotor/wing is locked perpendicular to the fuselage. The concept simplifies the

powerplant design, with warm turbofan exhaust gases ducted to nozzles in the rotor tips for vertical flight, and then redirected rearwards to provide jet propulsion for forward flight.

V. Although it promises to be the first concept to combine the best attributes of rotary- and fixed-wing aircraft, the canard rotor/wing will have to fly successfully to be taken seriously. Until it does, the gap between helicopters and jets will remain.

2. Consult a dictionary and find the meaning of the following words and word combinations:

1. high-thrust blades

2. blade vortex interaction (BVI)

3. the mitigating technologies

4. random noise

5. the airshed

6. windtunnel

7. piezo-electric actuators

8. mechanical swashplate

9. to cancel out noise and vibration

10. the reverse velocity rotor (RVR)

11. tilting forward

12. to enhance safety

13. shed air

14. precursors

15 gearbox struts

16. blade pitch

3. Read the text attentively. While reading it, search for the necessary information and fill in the table.

Advantages of rotary-wing aircraft	Advantages of the latest helicopters

4. Ask questions on the points below and answer them. Rely upon sentences from the text.

- … those that hover efficiently and those that fly efficiently;
- … is the dream of vertical flight proponents;
- … by Frenchman Paul Cornu in 1907;
- … the German side-by-side rotor Focke-Angelis Fa61 of 1936 and intermeshing-rotor Flettner FI282 of 1941;

… they are too noisy inside and out; and they vibrate too much;

- … higher speeds, heavier payloads, less noise and vibration, and lower production and operating costs;
- … include a 200kt (370rm/h) cruise speed; 30% reductions in empty weight and fuel consumption; 605 lower external noise;
- is blade vortex interaction(BVI) – the main rotor blades hitting the air shed by preceding blades

<u>Vocabulary Focus</u>

1. **Find the words in the text, which are similar to the meaning of the following words:**

- complicated
- to enhance
- horizontal flight
- to be decreased
- on landing
- to demand
- common
- transformation

2. Make up the right choice: *between, off, of, in, with, since, by, in, despite, after.*

The first "free" vertical flight was made …. Frenchman Paul Cornu ….. 1907, barely four years …. the Wright brother's first flight, but the machine was impractical. Autogyros became quite sophisticated …. the wars, but they were not true vertical take-… and landing (VTOL) machines. ….. all the technological progress … then, helicopters remain niche players … aviation. Compared … equivalent fixed-wing aircraft, they are still more expensive to buy and costly to operate. Helicopters are arguably the most versatile and useful … air vehicles.

3. Express the same in English:

Зависать, усовершенствование новых конфигураций, вертолет с одним несущим винтом, универсальный, увеличивающийся постепенно, способность работать при любых погодных условиях, снижение, вихрь, неравномерно, технологии смягчения (удара), существенное уменьшение шума, аэродинамическая труба, повышенная безопасность, задержать разделение потока над крылом, отклонять несущий поток по направлению вниз.

<u>Writing Focus</u>

1. Make meaningful sentences from the following words:

1) the most/ yet/ air/ are/ versatile/ helicopters/ and/ arguably/ of/ useful/ vehicles

2) can/ 160 kt/ the latest/ up to/ cruise at/ economical/ but/ is/ than/ barrier/ this/ physical/ rather/ helicopters/ an

3. are/ vibration/ more/ and/ speed/ important/ than/ higher/ noise/ lower

4. procedures/ noise/ with/ being/ tackled/ external/ with/ designs/ rotor

5. interaction/ the main/ is/ on the/ source/ vortex/ noise/ blade/ of/ descent

6. a helicopter/ the tiltrotor/ the cruise/ a turboprop/ capability/ combines/ of/ efficiency/ the hover/ with/ of

2. Complete the sentences according to the sense. Match the beginning and the end of the sentence.

1) The latest high-thrust blades allow the main rotor…

2) The active twist rotor has shown substantial reduction in noise…

3) Manufactures are testing main rotor blades with active servo flaps…

4) Smart, or active, structures also promise…

5) As forward speed increases, airflow over the advancing blade gets faster…

6) Windtunnel testing indicates the reverse-velocity rotor is capable…

7. the tiltrotor has speed and range advantages…

… to reduce internal noise as well as vibration, …but the configuration present

challenges, … and vibration in NASA windtunnel testing, …while that over the

retracting blade gets slower, … to be slowed in the cruise, …driven by piezo-

electric actuators, …of cruise speeds exceeding 300 kt.

Speaking

1. Make up false statements and let your group mates correct them.

Example:

S1: Compared with equivalent fixed-wing aircraft, helicopters are still much cheaper to buy and to operate.

S2: False. Compared with equivalent fixed-wing aircraft, helicopters are still more expensive to buy and costly to operate.

2. You are a designer of a helicopter and are going to make a report at the conference. Speak on the following topics:

- advantages of helicopters
- disadvantages of helicopters;
- helicopter improvement;
- future tiltrotors
- a problem of noise reduction

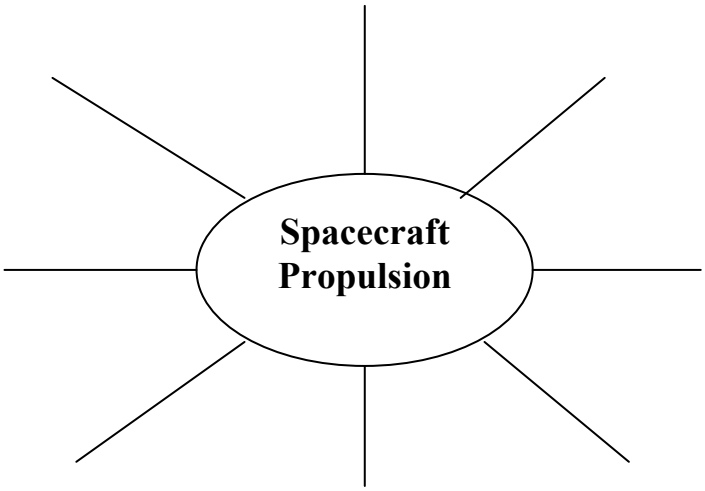
3. Make up a summary of the text "Vertical Horizons".

UNIT 5

Spacecraft Propulsion

Preparing to Read

1. Brainstorm all possible terms related to the topic.



2. Work in pairs, share the words and give your prediction about the content of the text.

3. Read the statements and agree or disagree with them and explain your viewpoint.

1. When in space, the purpose of a propulsion system is to change the velocity of a spacecraft.
2. When launching a spacecraft from the Earth, a power plant must overcome the Earth's gravitational pull.
3. Any rocket engine is air-breathing engine.
4. The rocket engine must provide impulse to overcome Earth gravitation.
5. Rocket engines provide 100% efficiency.

Reading

1. Scan the text and try to explain what underlined terms mean according to the content of the text.

2. Read the text and match the English words with their Russian counterparts.

1. delta-v	a. рабочее тело
2. reaction mass	b. межзвёздный полёт
3. resistojet	c. солнечный парус
4. ion thruster	d. ионный ракетный двигатель
5. tangential	e. омический ракетный двигатель
6. aerobraking	f. аэродинамическое торможение
7. solar sail	j. касательный, направленный по касательной
8. interstellar travel	h. характеристическая скорость

Spacecraft Propulsion

A. Spacecraft propulsion is used to change the velocity of spacecraft and artificial satellites, or in short, to provide delta-v. There are many different methods. Each method has drawbacks and advantages, and spacecraft propulsion is an active area of research. Most spacecraft today are propelled by heating the reaction mass and allowing it to flow out the back of the vehicle. This sort of engine is called a rocket engine.

B. All current spacecraft use chemical rocket engines (bipropellant or solid-fuel) for launch, though some have used air-breathing engines on their first stage. Most satellites have simple reliable chemical engines (often monopropellant rockets) or resistojet rockets to keep their station. Newer geo-orbiting spacecraft are starting to use electric propulsion for stationkeeping. Interplanetary vehicles mostly use chemical rockets as well, although a few have experimentally used ion thrusters with some success (a form of electric propulsion).

C. Artificial satellites must be launched into orbit, and once there they must accelerate to circle their orbit. Once in the desired orbit, they often need some form of attitude control so that they are correctly pointed with respect to the Earth, the Sun, and possibly some astronomical object of interest. They are also subjected to drag from the thin atmosphere, so that to stay in orbit for a long period of time some form of propulsion is occasionally necessary to make small corrections. Many satellites need to be moved from one orbit to another from time to time, and this also requires propulsion. When a satellite has exhausted its ability to adjust its orbit, its useful life is over.

D. Spacecraft designed to travel further also need propulsion methods. They need to be launched out of the Earth's atmosphere just as do satellites. Once there, they need to leave orbit and move around.

E. For interplanetary travel, a spacecraft must use its engines to leave Earth orbit. Once it has done so, it must somehow make its way to its destination. Current interplanetary spacecraft do this with a series of short-term orbital adjustments. In between these adjustments, the spacecraft simply falls freely along its orbit. The simplest fuel-efficient means to move from one circular orbit to another is with a Hohmann transfer orbit: the spacecraft begins in a circular orbit around the Sun. A short period of thrust in the direction of motion accelerates or decelerates the spacecraft into an elliptical orbit around the Sun which is tangential to its previous orbit and also to the orbit of its destination. The spacecraft falls freely along this elliptical orbit until it reaches its destination, where another short period of thrust accelerates or decelerates it to match the orbit of its destination. Special methods such as aerobraking are sometimes used for this final orbital adjustment.

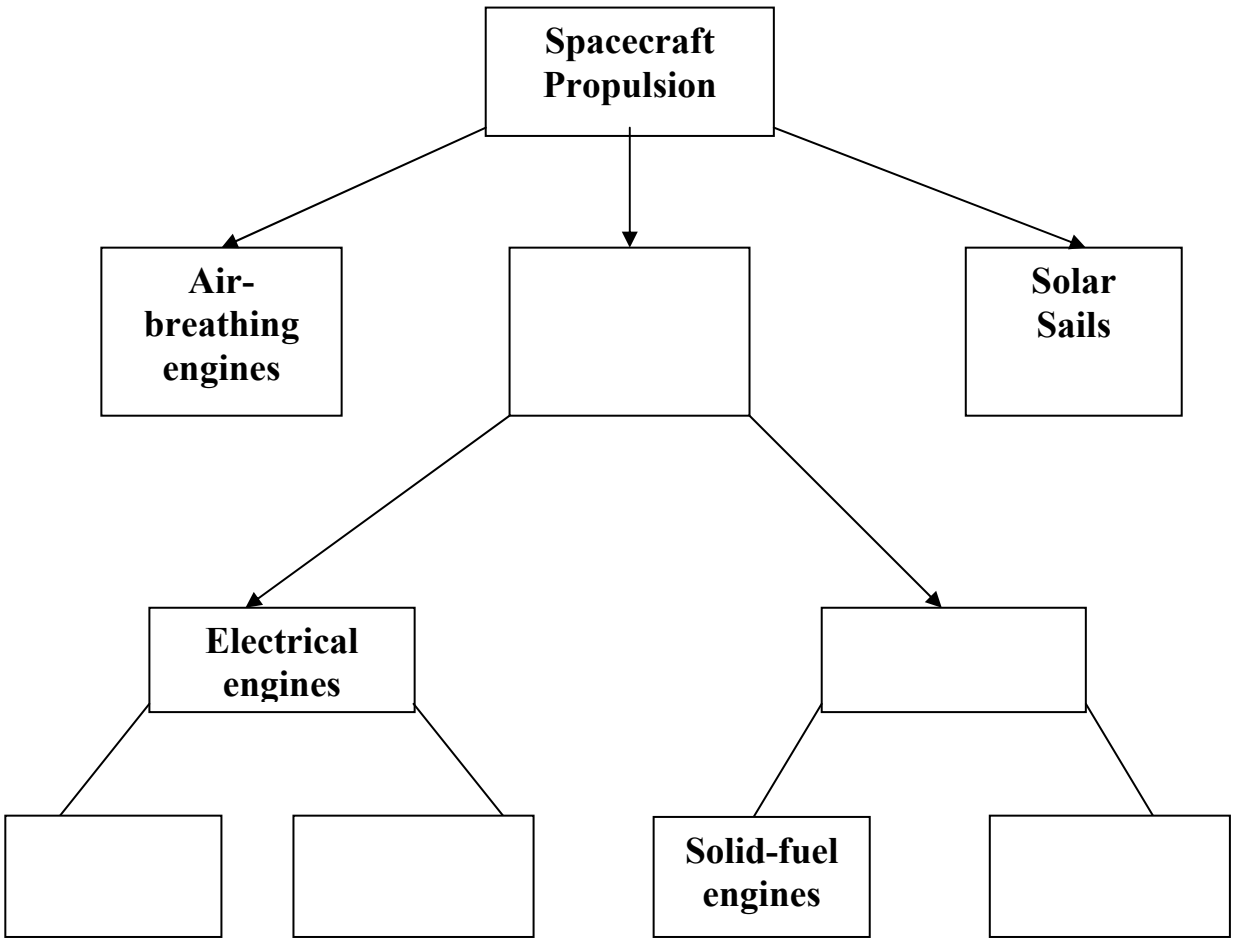
F. Some spacecraft propulsion methods such as solar sails provide very low but inexhaustible thrust; an interplanetary vehicle using one of these methods would follow a rather different trajectory, either constantly thrusting against its direction of motion in order to decrease its distance from the Sun or constantly thrusting along its direction of motion to increase its distance from the Sun.

G. Spacecraft for interstellar travel also need propulsion methods. No such spacecraft has yet been built, but many designs have been discussed. Since interstellar distances are very great, a tremendous velocity is needed to get a spacecraft to its destination in a reasonable amount of time. Acquiring such a velocity on launch and getting rid of it on arrival will be a formidable challenge for spacecraft designers.

Comprehension Check

1. Divide the text into logical parts. State the topic of each part and entitle it.

2. Complete the scheme according to the content of the text.



3. Choose the right answer.

1. To reach the desired orbit the spacecraft propulsion must provide ___ .

a) final orbital adjustment b) delta-v c) short-term thrusting

2. Current spacecraft use ____ on their first stage.

a) ion thrusters b) air-breathing engines c) chemical rocket engines

3. Special methods such as ____ are sometimes used for final orbital adjustment.

a) accelerating b) decelerating c) aerobraking

4. Spacecraft for interstellar travel need ____ .

a) low inexhaustible thrust b) short-term thrusting c) tremendous velocity

5. Most satellites have simple reliable chemical rockets or ____ to keep their station.

a) aerobraking b) air-breathing engines c) resistojet rockets

4. Match the words with their definitions.

1. This device propels the vehicle by heating the reaction mass and allowing it to flow out the back of the vehicle.	a) air-breating eng engine
2. This type of engine consumes outboard air to operate.	b) solar sail
3. These vehicles are launched into orbits and circle them.	c) rocket engine
4. This device uses solar energy to propel an aircraft.	d) Hohman transfer orbit
5. It's a means of transferring from one orbit to another.	e)artificial satellite

5. Answer the questions below.

1. What purpose is spacecraft propulsion used for?
2. What is the main operational principle of a rocket engine?
3. Are the spacecraft propulsions used in the orbits?
4. What is the useful life of artificial satellites limited by?
5. Do the engines work continuously on interplanetary travel?
6. What provides inexhaustible thrust in space?

7. Interstellar travel- is it a reality nowadays?
8. What makes interstellar travel formidable challenge for spacecraft designers?

Vocabulary Focus

1. Find the following word combinations in the text and explain their meaning in your own words.

Current spacecraft, bipropellant engine, geo-orbiting spacecraft (paragraph **B**); attitude control, drag (paragraph **C**); short-term orbital adjustments, to fall freely along the orbit, to accelerate or decelerate spacecraft (paragraph **E**) , inexhaustible thrust, interplanetary vehicle (paragraph **F**).

2. a) Match the words from *A* and *B*. Make as many combinations as possible. Translate them into Russian.

A	***B***
1. spacecraft	a) travel
2. artificial	b) engine
3. interstellar	c) propulsion
4. reliable	d) orbit
5. attitude	e) control
6. elliptical	f) satellite
7. interplanetary	g) vehicle

b) Complete the sentences below with the expressions from a)

1. _____ mostly use chemical rockets.

2. _____ is used to provide delta-v.

3. Artificial satellites need some form of _____ so that they are correctly pointed with respect to the Earth.

4. Most satellites have ____ to keep their station.

5. The spacecraft follows along the ____ around the Sun.

3. a) In a dictionary, find words of similar meaning to the ones in the box.

adjustment	artificial	velocity	drawback	inexhaustible

b) Make up sentences with the words you have found for your group mates to guess the original word.

4. Translate the sentences into English using your active vocabulary.

1. Твёрдо-топливные двигатели развивают достаточную характеристическую скорость, чтобы вывести космический аппарат на орбиту.

2. Современные космические корабли приводятся в движение нагретым рабочим телом, истекающим из сопла.

3. Чтобы скорректировать положение спутника на орбите, иногда применяется аэродинамическое торможение.

4. В настоящее время омические и ионные двигатели используются экспериментально.

5. Солнечный парус является источником неиссякаемой тяги.

6. Искусственный спутник движется вокруг Солнца по эллиптической орбите.

7. Инженерам придётся разработать новые источники энергии для межзвёздных полётов.

Focus on Writing

1. State the main topic of each paragraph and make a summary of the text.

2. Write a letter inviting your colleague to collaborate with your team in carrying out joint research on engine for long interstellar travel. Here are some phrases used in letters of invitation:

We would like to invite you as a ....

We are pleased to inform you …

We hope that you will be able to …

We look forward to seeing you …

If you accept our invitation …

Speaking

1. Make a graphic of the Hohmann transfer orbit mentioned in the text. Explain to your partners how orbital adjustments are performed.

2. Divide into groups. Each team is to investigate the most suitable engine for long interstellar travel. Report the main characteristics of chosen engine, speak about its advantages and drawbacks and persuade your colleagues to choose it. You might need the following phrases:

During the past decade there has been increasing research into ….

… is an important and common problem.

The object of this study …

Accordingly, we suggest …

There is still lack of knowledge of …

Space Shuttle Programme

Preparing to Read

1. a) Predict which of these topics might be mentioned in the text about Space Shuttle Programme.

a reliability
b artificial satellite
c animal
d robot
e payload
f computer
g astrology
h airframe
i communication

b) Compare your list with your partner and explain the reasons why you chose these topics.

Reading

1. Scan the text and try to guess the meaning of underlined words from the content of the text.

2. Read the text and match the English words with their Russian counterparts.

1. liftoff	a. манипулятор
2. ditch	b. стыковочная система
3. robot arm	c. переходной шлюз
4. space probe	d. момент отрыва
5. lifespan	e. орбитальная ступень
6. orbiter vehicle	f . кварцевая керамическая плитка
7. O-ring seal	g. космическая научно-исследовательская ракета
8. silica-based ceramic tile	h. кольцевое уплотнение

9. airlock	i. аварийная посадка на воду
10. docking system	j. эксплуатационный ресурс
11. rocket booster	k. ракета-носитель

Space Shuttle Programme

A. A spacecraft is a vehicle that travels through space. Spacecraft include robotic or unmanned space probes as well as manned vehicles. The term is sometimes also used to describe artificial satellites, which have similar design criteria. The term spaceship is generally applied only to spacecraft capable of transporting people.

B. A spacesuit has at times been called a miniature spacecraft or spaceship, emphasizing its purpose of keeping its wearer alive while traveling in the vacuum of outer space.

C. NASA's Space Shuttle, officially called Space Transportation System **(STS)**, is the United States' manned launch vehicle. It is partly reusable, and is the world's first spacecraft to be designed with this capacity. It is used to carry large payload to various orbits, for crew rotation of the International Space Station (ISS), and to carry out servicing missions. Each shuttle was designed for a projected lifespan of 100 launches.

D. The program started in the late 1960s and has totally dominated NASA's manned operations since the mid 1970s. Use of the Space Shuttle will be focused on completing the assembly of the International Space Station in 2010, and it will then be retired.

E. The Space Shuttle consists of four main components:

- the reusable Orbiter Vehicle (**OV**), with a large payload bay and three main engines (used while the external fuel tank is attached) and an orbital maneuvering system with two smaller engines (used after the external tank has been disposed of);
- a large expendable external fuel tank (**ET**) containing liquid oxygen and liquid hydrogen for the three main engines of the orbiter; it is jettisoned 8.5 minutes after

launch at an altitude of 109 kilometers and breaks up in the atmosphere upon reentry; the pieces fall in the ocean and are not recovered;

- a pair of reusable solid-fuel rocket boosters (**SRB**); the propellant consists mainly of ammonium perchlorate (oxidizer, 70 % by weight) and aluminum (fuel, 16 %); they are separated in two minutes after launch at a height of 66 km and are recovered after landing in the ocean, their fall slowed by parachutes.

F. The Shuttle has a large payload bay taking up much of its length. The payload bay doors have heat radiators mounted on their inner surfaces, and so are kept open while the Shuttle is in orbit for thermal control. Thermal control is also maintained by adjusting the orientation of the Shuttle relative to Earth and Sun. Inside the payload bay is the Remote Manipulator System, a robot arm used to retrieve and deploy payloads. Since the arm is a crucial part of the Thermal Protection Inspection procedures now required for shuttle flights, it will likely be included on all future flights.

G. The Space Shuttle system has had numerous improvements over the years. The Orbiter has changed its thermal protection system several times in order to save weight and ease workload. The original silica-based ceramic tiles need to be inspected for damage after every flight, and they also soak up water and thus need to be protected from the rain. Later many of the tiles on the cooler portions of the Shuttle were replaced by large blankets of insulating felt-like material, which means huge areas no longer have to be inspected as much.

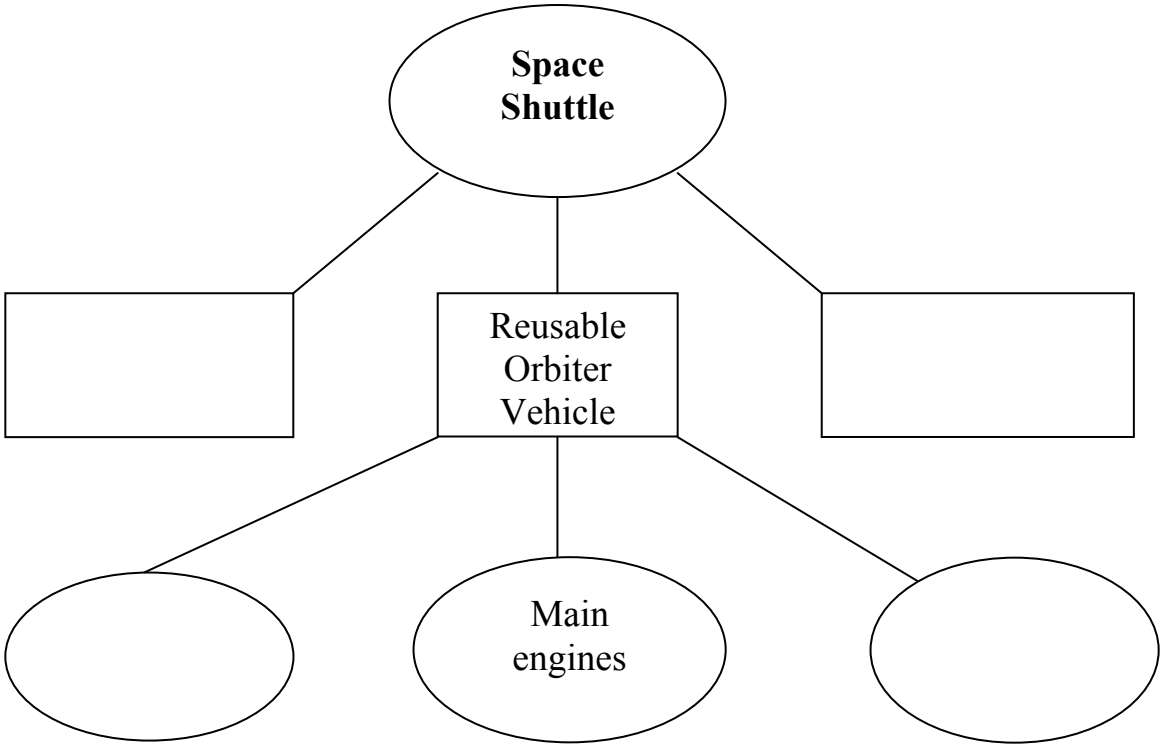
H. Internally the Shuttle remains largely similar to the original design, with the exception that the avionics continues to be improved. The original systems were "hardened" IBM 360 computers connected to analog displays in the cockpit . The computers use the HAL/S programming language. In addition to the "glass cockpit" several improvements have been made for safety reasons after the Challenger explosion, including a crew escape system for use in situation that require the Orbiter to ditch. With the coming of the Space Station, the Orbiter's internal airlocks are

being replaced with external docking systems to allow for a greater amount of cargo to be stored on the shuttle mid-deck during Station resupply missions.

I. For STS-1 and STS-2 the external tank was not painted. This saved considerable weight, and thereby increases the payload the orbiter can carry into orbit. Additional weight was saved by removing some of the internal "stringers" in the hydrogen tank which proved to be unneeded in flight. The resulting "light weight external tank" has been used on the vast majority of shuttle missions. STS-91 saw the first flight of the "super light weight external tank". This version of the tank is made of the Aluminum-Lithium alloy. It weighs 7,500 lb (3.4 t) less than the last run of light-weight tanks. As the Shuttle cannot fly unmanned, each of these improvements has been "tested" on operational flights. And, of course, the SRBs have undergone improvements as well. Notable is the adding of a third O-ring seal to the joints between the segments, which occurred after the Challenger accident.

Comprehension Check

1. Complete the scheme according to the content of the text:



2. Complete the table according to the content of the text.

	Space Shuttle Programme
Purposes	
Components	
Improvements	
Saving of the weight	

3. Divide the text into logical parts and entitle them.

4. Answer the following questions.

1. Why is NASA's Space Shuttle used?
2. What is a projected lifespan of each shuttle?
3. What will the use of Space Shuttle be focused on?
4. What components does the Space Shuttle consist of?
5. Why is the payload bay doors kept open while the Shuttle is in orbit?
6. How else is thermal control maintained in orbit?
7. What improvements have been made in thermal protection system?
8. What has been done to store greater amount of cargo on the shuttle mid-deck?
9. When is the orbital maneuvering system used?
10. What is the external fuel tank made of?

5. Make up a summary of the text.

<u>Vocabulary Focus</u>

1. Work in groups. Find the following word combinations in the text and explain their meaning to your partners in your own words.

Manned vehicle (A), artificial satellite (A), spacesuit (B), reusable orbiter vehicle (E), heat radiator (F), expendable fuel tank (E), termal protection system (G), crew escape system (H), internal stringer (I).

2. a) Find words in the text that mean:

a enhancement (paragraph G)

b spacecraft (paragraph B)

c used many times (paragraph C)

d to concentrate (paragraph D)

e to jettison (paragraph E)

f to start (paragraph E)

g to shield (paragraph G)

h standard (paragraph A)

b) Make up your own sentences with these words.

3. a) Match the words from *A* and *B* opposite in meaning .

A	***B***
needed	reusable
external	landing
assembly	waste
jettisoned	unneeded
launch	external
unmanned	internal
expendable	adding

save	manned
removing	joined
internal	disassembly

b) Complete the sentences with the words from the columns A and B.

1. Spacecraft include ____ space probes.

2. The Space Shuttle includes a large ____ fuel tank that is ____ in 8.5 minutes after ____.

3. The ____ fuel tank was not painted to ____ considerable weight.

4. Use of the Space Shuttle is focused on completing the ____ of the International Space Station in 2010.

5. Some weight was saved by ____ some of the internal stringers in the hydrogen tank ____ in flight.

4. Match the words and expressions from the text to the definitions.

1. expendable unit	it provides joining of spacecraft in the orbit
2. thermal protection system	it keeps a cosmonaut alive while traveling in outer space
3. robot arm	it is an unmanned orbiter carrying out research missions
4. docking system	it adjusts the orientation of the Shuttle
5. external fuel tank	it retrieves and deploys payload
6. space probe	it is jettisoned in some minutes after launch
7. spacesuit	it maintains specified temperature in a spacecraft
8. orbital maneuvering system	it can't be used repeatedly

5. Fill in the gaps with the words from the box.

external fuel tank	jettisoned	felt-like
computers	blankets	thermal
protection	ascent	

1. The fuel tank and booster rockets are ____ during ____ .
2. _____ control is maintained by adjusting the orientation of the Shuttle relative to Earth and Sun.
3. Shuttle's thermal _____ system includes large _____ of insulating _____ material.
4. The _____ use the HAL/S programming language.
5. A large expendable _____ contains liquid oxygen and liquid hydrogen

6. Complete the missing parts of the table.

Verb	**Nouns**		**Adjective or Participle**
	Person	**Thing**	
apply	applicant		
operate		operation	
create			creative
transport		transportation	
adjust			adjusting
protect	protector		protective

Focus on Writing

1. Read the following words to form meaningful sentences.

1. length/ the Shuttle/ has/ a/ much/ of/ bay/ taking up/ payload/ large/ its.

_____ .

2. language/ the computers/ programming/ the HAL/S use.

_____ .

3. IBM 360/ in/ the original systems/ hardened/ connected/ were/ to / displays/ the cockpit/ analog/computers.

_____.

4. Changed/ and/ workload/ the orbiter/ has/ its/ in order to/ times/ thermal/ ease/ save/ system/ weight/ protection/several.

_____.

5. The term/ of/capable/is/ generally/ spaceship/ to/ spacecraft/ only/ people/ applied/ transporting/ only.

_____.

2. Match the beginnings and the endings of the sentences.

1. The program started in the late 1960s and	a) a robot arm used to retrieve and deploy payloads.
2. Thermal control is also maintained by	b) removing some of the internal stringers in the hydrogen tank.
3. Later many of the tiles on the cooler portions of the Shuttle	c) with the exception that the avionics continues to be improved.
4. Additional weight was saved by	d) adjusting the orientation of the Shuttle relative to Earth and Sun.
5. Inside the payload bay is the	e) has totally dominated NASA's manned

Remote Manipulator System, operations since the mid 1970s.

6. Internally The Shuttle remains largely similar to the original design,

f) were replaced by a large blankets of insulating felt-like material.

Speaking

1. Divide into groups. Your design team is going to introduce some new improvements in Space Shuttle design. Speak about the advantages of your improvements. You might need some speech patterns:

I have a great pleasure to …

The object of this presentation is to show…

Let me give my explanation of …

Let me now turn to …

In conclusion, let me say …

Any questions or comments?

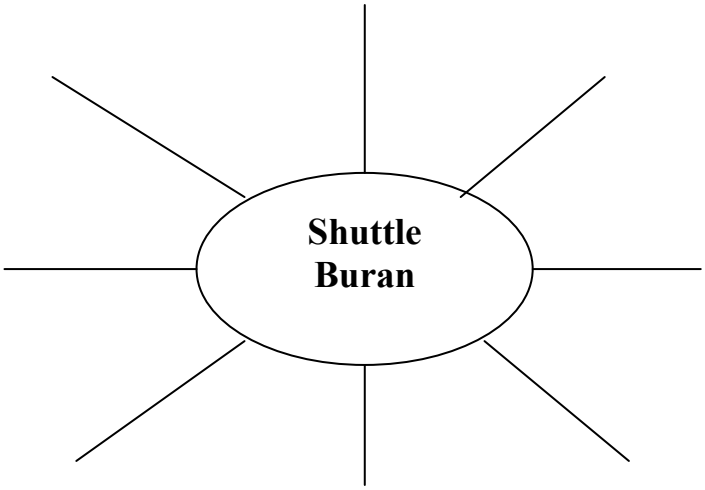
I'd like to thank you all for …

UNIT 7

Shuttle Buran

Preparing to Read

1. a) Brainstorm all possible terms related to the topic.



b) Compare your list with your partner and explain the reasons why you chose these terms.

c) Work in pairs and discuss whether it is important for the people to develop reusable space vehicles.

Reading 1

1. Scan the text and highlight all the adjectives defining Shuttle Buran.

2. Read the text and write a brief heading for each paragraph.

3. Read the text and match the English words with their Russian counterparts.

1. reusable spacecraft	a) планирующее снижение
2. booster rocket	b) углерод-углеродный
3. software	c) элевон
4. to orbit	d) КА однократного использования
5. expendable space vehicle	e) ракетный ускоритель

6. gliding descent	f) программное обеспечение
7. carbon-carbonic	g) рулевой аэродинамический стопор
8. elevon	h) КА многократного использования
9. rudder-aerodynamic brake	i) вращаться на орбите

Shuttle Buran

A. The Soviet reusable spacecraft program Buran began in 1976 at TsAGI as a response to the United States Space Shuttle program. Soviet politicians were convinced that the Space Shuttle could be used for military purposes, hence posing a potential threat to the balance of power during the Cold War. The project was the largest and the most expensive in the history of Soviet space exploration.

B. Because Buran's debut followed Space Shuttle Columbia's and there were visual similarities between the two shuttle systems, during the Cold War many speculated that espionage played a role in the development of the Soviet shuttle. However, it is now known that while externally it was an aerodynamic copy of the Space Shuttle, internally it was all engineered and developed domestically.

C. The first and only orbital launch of the unmanned shuttle Buran was on 15 November 1988. It was lifted into orbit by the specially designed Energiya booster rocket. The life support system was not installed and no software was installed on the CRT displays. The shuttle orbited the Earth twice before returning, performing an impressive automated landing on the shuttle runway at Baikonur Cosmodrome. This is a capability that the U.S. shuttle system does not have.

D. The Buran orbiter is the first reusable manned space vehicle in our country. The Buran orbiter is the space airplane which may descent from an orbit and land to an airdrome. The Buran is our first vehicle capable not only to put pay-loads into Space, but also to provide their orbit maintenance and repair as well as return to the Earth.

E. The Buran orbiter is able to put up to 30 tons into Space and to return up to 20 tons of payload to the Earth. The availability of a cargo compartment of impressive sizes on the vehicle permits to transport orbital station modules or large structures up to 17 m long and 4,5 m in diameter and not only 2-4 crew members but up to 6 passengers can be accommodated in a crew cabin.

F. Expendable space vehicles perform a ballistic or sliding descent in the atmosphere and parachute landing. The necessity to provide a space vehicle return from the Space and to bring it to the airdrome forced the designers to decide many complex problems. The gliding descent from the orbit through dense layers of atmosphere has stipulated the necessity to use a principally new reusable thermal protection system designed to sustain 100 flights.

G. For the Buran orbiter three kinds of thermal protection have been developed:

- "carbon-carbonic" material with maximum operating temperature up to 1650 degrees C for the components with the highest thermal load -the fuselage nose and wing leading edge;
- ceramic tiles for parts heating up to 1250 degrees C;
- flexible material for surface parts with the temperature not higher than 379 degrees C.

All of them surpassed by strength the materials used in the USA Space Shuttle construction.

H. Each of almost forty thousand tiles of ceramic thermal protection had its original geometry differing from the others by plane form, side surfaces view and inside and outside surfaces curvature, availability of cuts and notches. The measurements of a real frame surface geometry under each tile in more than 100 points were made to ensure the tiles fitting closely. To execute all this manually was impossible. The special software was developed and as a result manufacturing and installation of tiles were carried out completely on paperless technology without drawings, using the data bank . The bank data is based on the interface between a design office and plants. The

data bank information describes the geometry, technology parameters and materials. More than one billion manufacturing control and testing programmes are automatically generated on the plant.

I. The Buran descending from a space orbit passes all possible for an airplane flight performances in the atmosphere starting with large hypersonic (M-25) up to landing (M=0,2) speeds. In this connection the aerodynamic scheme without a horizontal tail with a double swept wing, with elevons, rudder-aerodynamic brake and balance flap as control surfaces has been chosen. This assembly was worked up during wind tunnel tests and evaluated in the BOR-5 suborbital flying model flights.

J. For working up the most responsible flight phase - landing approach and landing - the Buran flying prototype was constructed. In general it distinguished from the orbital vehicle by installation of four turbojet engines and accordingly by capability of an independent takeoff from the airfield. 24 flights were executed on the prototype, in 15 of them completely automatic mode landing was made. There was no pilot onboard the orbiter but it having made two turns around the Earth completely automatically controlled touched the runway with the accuracy which experienced pilots could envy. It was the first in the world automatic landing of a spaceplane.

K. The main differences between the space aeroplane Buran and the Space Suttle-orbiter are :

- the automatic landing of Buran from orbit onto airdrome;
- the absence of the main rocket engine on the orbital space aeroplane. The main engine was placed onto a central block of a carrier-rocket Energia which is able to launch into an orbit 120 tonns of payload against 30 tonns for the Space Shuttle;
- the high lift/drag ratio of the space aeroplane Buran is 6.5 against 5.5 for the Space Shuttle;
- the space aeroplane Buran returned 20 tonns of payloads against 15 tonns for the Space Shuttle orbiter from an orbit to an aerodrome;
- the cutting lay-out pattern of thermoprotection tiles of Buran is optimal and longitudinal slits of tile belts are orthogonal to the flow line. Sharp angles of tiles are absent. The tile belts of the Buran fuselage and fin have an optimal position.

L. The Buran orbiter flight was a necessary step in the space engineering progress but it has left its trace not only in this field. Born in the course of work on the Buran project new materials, technologies, computer designing methods and equipment components find an application in far, at first sight, from space branches of economy.

Comprehension Check

1. Choose the best option for each of the following sentences. The text is not allowed to look at.

1. It is known that the Shuttle Buran was an aerodynamic copy of the Space Shuttle, internally it was …..

a) an exact copy of the Vostok space vehicle developed domestically.

b) all engineered and developed domestically.

c) an improved copy of the Space Shuttle.

2. The Shuttle Buran was lifted into orbit by …

a) high-power rocket engine .

b) a pair of reusable solid-fuel rocket boosters.

c) specially designed Energia booster rocket.

3. The Buran orbiter is able to put up ….

a) to 30 tons into space and to return up to 20 tons of payload to the Earth.

b) to 20 tons into space and to return up to 15 tons of payload to the Earth.

c) to 6.5 tons into space and to return up to 5.5 tons of payload to the Earth.

4. It was necessary to develop a principally new reusable thermal protection system because of …

a) severe weight restrictions of the Shuttle Buran.

b) the gliding descent from the orbit through dense atmosphere.

c) safety consideration.

5. The special software was developed …..

a) to carry out measurement, manufacturing and installation of thermal protection tiles.

b) to cut down expenses .

c) to simplify the assembly of thermal protection.

2. Choose the best alternative to fill the gaps in theses sentences.

1. The first and only orbital launch of the ____ Shuttle Buran was on 15 November 1988.

a) unmanned b) manned c) improved

2. The shuttle orbited the Earth twice before returning, performing an impressive automated _____ on the shuttle runway at Baikonur Cosmodrome.

a) takeoff b) manoeuvre c) landing

3. The _____ from the orbit through dense atmosphere forced the designers to develop a principally new reusable thermal protection system.

a) ballistic descent b) liftoff c) parachute landing d) gliding descent

4. Special _____ was developed and as a result measurement, manufacturing and installation of tiles were carried out completely on paperless technology.

a) equipment b) technology c) hardware d) software

5. It was impossible to measure a real frame surface geometry under each tile in more than 100 points _____ .

a) by means of computer b) theoretically c) manually d) on paperless technology

6. The aerodynamic scheme was worked up during_____.

a) automated landing b) wind tunnel tests c) gliding descent d) designing

7. The high _____ of Buran is 6.5 against 5.5 for the Space Shuttle.

a) lift/drag ratio b) thrust/weight ratio c) aspect ratio d) pressure ratio

3. The text has twelve paragraphs A-L. Which paragraph mentions aerodynamic configuration of Buran? Find the supporting details that help to understand it.

4. Define the main idea of paragraph H. Highlight the topic words of the part.

5. Answer the following questions.

1. When did the Soviet reusable spacecraft program begin?

2. When did the first orbital launch of the Shuttle Buran take place?

3. How many tons can Buran orbiter put into space and return to the Earth?

4. How many crew members and passengers can be accommodated in the cabin?

5. What kinds of thermal protection have been developed for Buran?

6. What technology was used to measure a real frame surface geometry?

7. What aerodynamic scheme has been chosen for Buran?

8. Why was the flying prototype constructed?

9. Are Buran and the Space Shuttle Columbia absolutely similar?

10. What are the main differences between them?

5. Make up a summary of the text.

<u>Vocabulary Focus</u>

1. Work in pairs. Give the definitions of the following words and expressions.

Similarity (B); booster rocket , life-support system , software, automated landing (C); orbit maintenance (D); parachute landing (F); paperless technology, data bank (H); double swept wing, wind tunnel (I).

2. a) In the text, find the words with the meaning opposite to these ones.

Cheap (A), difference (B), manned (C), climb (D), reusable, simple (F), rigid (G), automatically (H), subsonic (I), inaccuracy (J), transverse (K).

b) Make up your own sentences with these words.

3. Choose the English equivalents in the text:

Конфигурация поверхности каркаса, ракетный ускоритель, керамическая термозащита, модуль орбитальной станции, шаблон, потенциальная угроза, автоматическая посадка, посадка с парашютом, аэродинамическое качество, балансировочный закрылок, аэродинамическая труба, выводить на орбиту.

4. Match the words and expressions from the text to the definitions.

1. software	a) ground facilities for airplane operation, parking, maintenance
2. life support system	b) it allows the engineer to design something without drawing, using the data bank
3. airdrome	c) facilities for aerodynamic testing of vehicles and their components
4. booster rocket	d) information in the form of data and programs
5. paperless technology	e) it provides cosmonauts with air, food, water, and comfortable environment
6. data bank	f) it is an accelerating engine which lifts the spacecraft into orbit
7. wind tunnel	g) information which is used by several computer users

<u>Focus on Writing</u>

1. Match the beginning and the end of the sentences:

1. The shuttle Buran was lifted …	a) to ensure the tiles fitting closely.
2. Expendable space vehicles perform…	b) ballistic or sliding descent in the atmosphere.
3. The measurements of a real frame surface geometry were made…..	c) onto a central block of carrier-rocket Energia.
4. The main engine was placed….	d) into orbit by specially designed Energia booster rocket.

2. Imagine, that you were a journalist and an eye-witness of the first launch of Buran in 1988. Make up a short newspaper article describing this great event. Don't forget to mention :

- the purposes ;
- the amount of payload;
- the main features of Buran;
- method of designing.

Reading 2

1. a) Read the advertisement below.

Traveling into Space!

Space Travel Agency
offers you
unique opportunity!
To glance admiringly at the Earth
from Space!
Safety, Comfort, Reasonable Prices!
Tel.: 21 (45) 2467678

b) What kind of service do you think the agency provides? Imagine that you are interested in this information. Ask the manager of the agency as many questions as possible to get more data on the traveling and the spacecraft.

2. Now read the text and get some answers.

Kliper

A. For many years, Russian engineers think over possible configurations of a new spacecraft, which could replace the venerable but small Soyuz.

B. The Kliper would be launched on the top of Onega booster - a heavily modified Soyuz rocket - with no payload fairing but with the emergency escape rocket attached to the nose section of the reentry capsule. The emergency escape system, resembling that of the Soyuz spacecraft, would be capable of pulling the crew capsule away from the launch vehicle at every stage of the launch and orbit insertion.

C. While in orbit, the Kliper is capable of delivering crew and cargo to the space station or carrying two pilots and four passengers, including tourists, on an autonomous flight. A special detachable habitation module partially borrowed from the Soyuz spacecraft would be mounted behind the reentry capsule, rather then in front of it, as in the Soyuz spacecraft. The habitation module contains docking system, toilet and other life-support systems. In turn, the habitation module, will be surrounded by a service module, containing orbital maneuvering and attitude-control systems and power-supply systems with solar panels. The habitation module/service module combination would be jettisoned from the reentry capsule after the braking maneuver to return to Earth, as it now done onboard the Soyuz spacecraft.

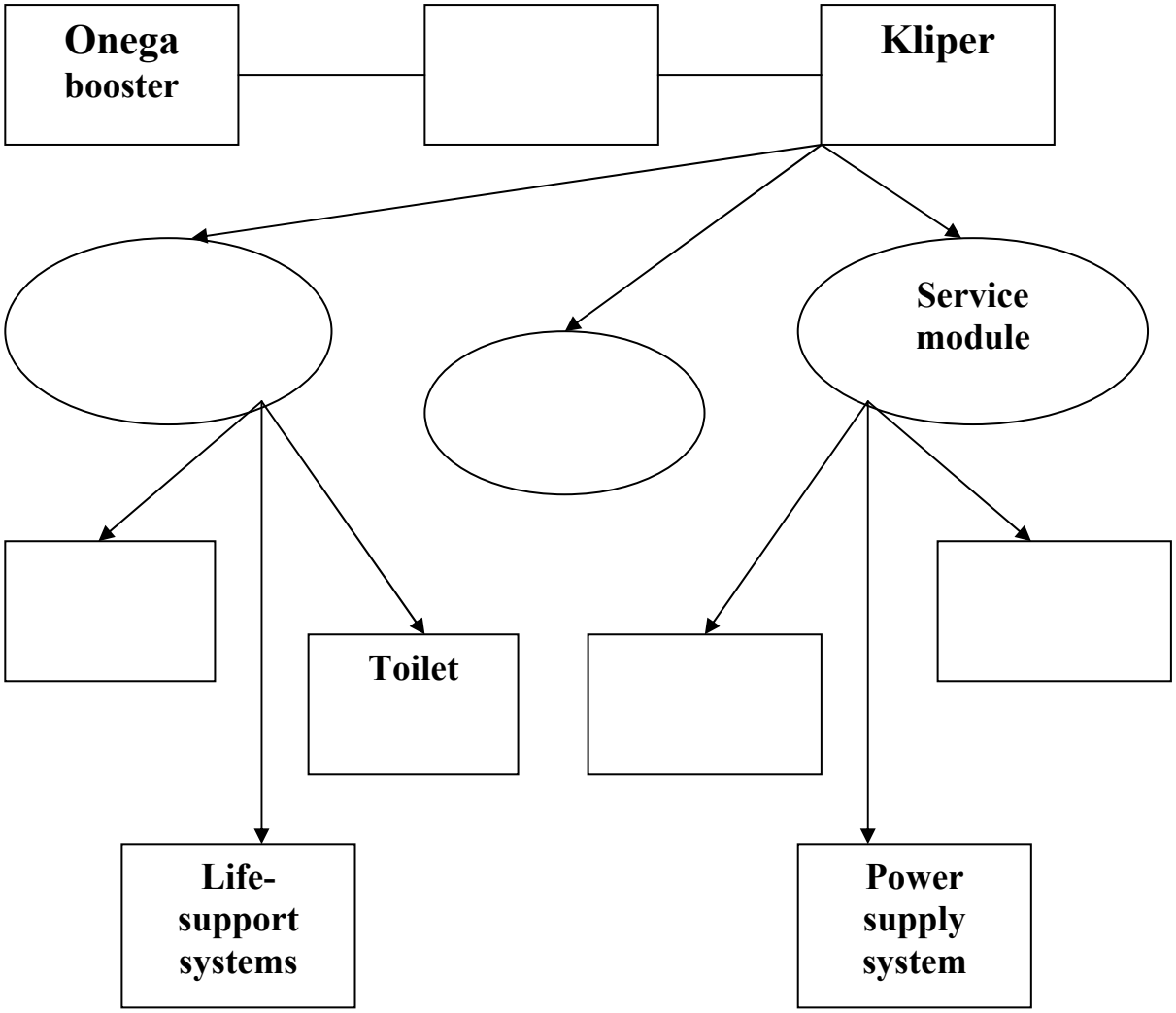
D. The aerodynamic body of the Kliper arranging two vertical and one horizontal movable rudders on its tail would allow the vehicle to glide as far as 500 kilometers left and right from the ground track of its orbit, with g -loads not exceeding 2 and the skin temperature in the most critical area of the nose not exceeding 3,000K.

E. The spacecraft will feature combination of thermal protection systems borrowed from the Buran program and from the Soyuz spacecraft. Some sections of the thermal protection system, such as nose section would not be reusable.

F. The Kliper will land with the help of three main uncontrolled parachutes and several solid-propellant engines, which would be fired shortly before the touchdown. The engineers are still debating a choice between special landing legs and an inflatable cushioning device to soften the landing. The latter would probably enable the spacecraft to splashdown safely in the water.

G. There will be a winged version of the Kliper spacecraft. The new configuration would enable Kliper to increase range of its side maneuver from 500 to 2,000 kilometers and to terminate its flight at virtually any orbit with subsequent landing on a regular runway. However, an emergency escape during the launch accident would now require a controlled landing at the airport rather than a relatively simple descent under parachutes into a random location along the flight path.

3. Fill in the diagram with the missing information from the text.



Comprehension Check

1. Match the given titles with the corresponding paragraph. Watch out! There is an extra title.

1. Landing system.
2. New Idea.
3. Life support system.
4. Launch system.
5. Winged version.
6. Kliper structure.
7. Thermal protection system.
8. Aerodynamic features.

2. Fill in the gaps with the words from the box.

solid propellant engines top the thermal protection system
movable rudders the habitation module
parachutes emergency escape rocket

1. The Kliper would be launched on the _____ of Onega booster with no payload fairing but with the _____ attached to the nose section of the reentry capsule.
2. _____ contains docking system toilet and other life-support systems.
3. The aerodynamic body of the Kliper arranges two vertical and one horizontal _____ on its tail.
4. Some sections of _____ would not be reusable.
5. The Kliper will land with the help of three main uncontrolled _____ and several _____ , which would be fired shortly before the touchdown.

3. Read the text again and decide if these statements are true or false. Correct the false ones.

1. The Kliper would be launched inside the payload fairing.
2. The emergency escape system would be capable of pulling the crew capsule away from the launch vehicle at the initial stage of launch.
3. The Kliper is intended for delivering two pilots and four passengers and cargo to the space station.
4. The service module will surround the habitation module.
5. The thermal protection system will be absolutely new.
6. Two vertical and one horizontal movable rudders provide gliding as far as 500 km left and right from the ground track of its orbit.
7. The Kliper will land with the help of controllable parachutes and several liquid-propellant engines.
8. The winged version would enable the Kliper to increase range of its side maneuver from 500 to 2000km.

4. Make up a summary of the text.

Vocabulary Focus

1. Work in pairs. Give the definitions of the following words and expressions.

To attach, reentry (A); detachable, solar panel, autonomous (C); rudder (D); inflatable (F); runway, flight path (G).

2. Match the words and expressions from the text to the definitions.

1. solid-propellant engine	a) this device provides safe splashdown on the water;
2. inflatable cushioning device	b) this compartment houses crew and passengers of the spacecraft;
3. attitude-control system	c) it provides electric power using sunlight;
4. habitation module	d) it uses solid propellant to provide thrust;

5. solar panel — e) system controlling orientation of a spacecraft on the orbit.

3. a) Match the words from *A* and *B*. Make as many combinations as possible. Translate them into Russian.

A	*B*
1. controlled	a) panel
2. payload	b) landing
3. space	c) vehicle
4. solar	d) module
5. habitation	e) escape
6. reentry	f) fairing
7. emergency	g) device
8. autonomous	h) station
9. launch	i) flight
10. inflatable	j) capsule

b) Make up some sentences with your word combinations.

Focus on Writing

1. Read the following words to form meaningful sentences.

1. A/the/capsule/behind/be/special/ module/ habitation/would/detachable/reentry/mounted.

2. Body/ the Kliper/one/of/aerodynamic/rudders/ and/features/two/ movable/vertical/horizontal.

3. Will/ and/service/attitude-control/contain/module/systems/maneuvering/orbital.

4. A/be/spacecraft/the Kliper/there/ winged/will/ version/of.

5. Module/ the/a/habitation/module/be/ service/by/will/surrounded.

Speaking

1. Imagine that you have to prepare a report for the Scientific and Technical Conference of Students. The topic of your report is " Reusable Spacecraft". You may need to read the texts "Space Shuttle Program" "Shuttle Buran" and "Kliper" again. The following expressions might be helpful:

- In my opinion ….
- I really think that ….
- I am sure …
- For example …
- In comparison with …
- Similarly

UNIT 8

The International Space Station

Preparing to Read

1. Look at the picture and write down some facts that you know about the International Space Station. Compare them with your partner. Try to answer the following questions:

1. What purpose is the International Space Station intended for?

2. How is it constructed?

3. What difficulties are the designers of the International Space Station faced with?

Reading

1. Skim the text and highlight all the adjectives describing the International Space Station.

2. Read the text and write out the words and word combinations you don't know, try to guess their meaning from the context. Compare your notes with your partners.

The International Space Station

A. The International Space Station (ISS) is the largest and most complex international scientific project in history. The station will represent a move of unprecedented scale off the home planet. The International Space Station draws upon the scientific and technological resources of 16 nations: the Russia, US, Canada, Japan, 11 nations of the European Space Agency and Brazil.

B. More than four times as large as the Russian Mir space station, the completed International Space Station will have a mass of about 1,040,000 pounds. It will measure 356 feet across and 290 feet long, with almost an acre of solar panels to provide electrical power to six state-of-the-art laboratories.

C. The station will be in an orbit at an altitude of 250 statute miles with an inclination of 51.6 degrees. This orbit allows the station to be reached by the launch vehicles of all the international partners to provide a capability for the delivery of crews and supplies. The orbit also provides excellent Earth observations with coverage of 85 percent of the globe and over flight of 95 percent of the population. By the end of this year, about 500,000 pounds of station components will be have been built at factories around the world.

D. The international partners, Canada, Japan, the European Space Agency, and Russia, will contribute the following key elements to the International Space Station:

- Canada is providing a 55-foot-long robotic arm to be used for assembly and maintenance tasks on the International Space Station.
- The European Space Agency is building a pressurized laboratory to be launched on the Space Shuttle and logistics transport vehicles to be launched on the Ariane 5 launch vehicle.
- Japan is building a laboratory with an attached exterior platform for experiments as well as logistics transport vehicles.
- Russia is providing two research modules: an early living section called the Service Module with its own life support and habitation systems; a science power platform of solar arrays that can supply about 20 kilowatts of electrical power; logistics transport vehicles; and Soyuz spacecraft for crew return.

E. The ISS, when completed, will be essentially made of a set of communicating pressurized modules connected to a truss, on which four large pairs of photovoltaic modules are attached. The pressurized modules and the truss will be perpendicular: the truss spanning from starboard to side and the habitable zone extending on the aft-forward axis.

F. The ISS Environmental Control and Life Support System controls atmospheric pressure, oxygen levels, water, and fire extinguishing, among other things. The highest priority for the life support system is the ISS atmosphere, but the system also collects, processes, and stores water and waste used and produced by the crew. For example, the system recycles fluid from the sink, shower, and condensation.

G. Currently the ISS consists of only four main pressurized modules; two Russian modules Zarya and Zvezda and two US modules Destiny and Node 1. Zarya was the first module launched by a Proton rocket in November 1998, followed by a shuttle mission that connected Zarya with Node 1, the first of three Node modules, 2 weeks after Zarya had been launched.

H. The first phase of the International Space Station, the Shuttle-Mir Program, began in 1995 and involved more than two years of continuous stays by astronauts aboard the Russian Mir Space Station and nine Shuttle-Mir docking missions. Knowledge was gained in technology, international space operations and scientific research. Engineers got knowledge and experience through Shuttle-Mir that could not be achieved any other way. That included valuable experience in international crew training activities; the operation of an international space program; and the challenges of long duration spaceflight for astronauts and ground control. Dealing with the real-time challenges experienced during Shuttle-Mir missions also has resulted in an unprecedented cooperation and trust between the U.S. and Russian space programs, and that cooperation and trust has enhanced the development of the International Space Station.

Comprehension Check

1. Divide the text into logical parts. Think of the subtitle to each part. Highlight the key words of each part.

2. Define the main idea of paragraph D. Find the supporting details that help to develop the main idea.

3. In the text find the main function of the life support system.

4. Expand the following statements.

1. The orbit of the ISS provides excellent Earth observation.

2. The international partners will contribute some key elements of the ISS.

3. The ISS will be made of a set of communicating pressurized modules.

4. Engineers got knowledge and experience through Shuttle-Mir.

5. Work in pairs. Take turns answering the questions.

1. How many countries take part in designing and constructing of the ISS?

2. What are the key elements of the ISS?

3. What provides electrical power for the ISS?

4. What are the functions of the life support system?

5. What was the predecessor of the ISS? What experience did it result in?

6. Make up a summary of the text.

Vocabulary focus

1. Find the English equivalents to the words in brackets.

1. Electrical power to six (современный) laboratories is provided by an acre of (панели солнечных батарей).

2. A 55-foot-long (манипулятор) will be used for (сборка) and (техобслуживание) tasks on the ISS.

3. The ISS will be made of a set of (герметический) modules connected to a (ферма), on which four large pairs of (фотоэлектрический) modules are attached.

4. Engineers got valuable (опыт) in international space operation, ground control and (продолжительный космический полёт).

2. Give the definitions of the following words and expressions, compare them with your partners and choose the best ones.

State-of-the-art; truss; solar array; robotic arm; logistics transport vehicle; research module.

3. a) Find in the text the synonyms for the following words.

Means, difficult (A), booster, supply (C), cooperate (D), collaboration (H).

b) Make up your own sentences with these words.

4. Fill in the gaps with the words from the box.

pressurized modules	truss	inclination
atmospheric pressure	solar array	fire extinguishing

1. The pressurized modules and the _____ will be perpendicular.

2. The ISS life support system controls _____ , oxygen level, water and _____.

3. The station will be in an orbit at an altitude of 250 statute miles with an _____ of 51.6 degrees.

4. A science power platform of _____ can supply about 20 kilowatt of electrical power.

5. Currently the ISS consists of four main _____ .

Speaking

Imagine that you have to prepare a report for the student scientific conference. You should outline some aspects and their advantages:

- ISS performances;
- international cooperation;
- modular design of the ISS.

You may need some more information. Conduct an investigation to find it.

UNIT 9

High-size long-time space station

Preparing to Read

1. Give your prediction about the content of the text. Explain your opinion.

2. a) Tick the words which come to your mind when you think of this topic. Add your own words and expressions.

weightlessness	pressure	fairy
artificial	airframe	vacuum
dangerous	tremendous	regeneration
protection	meteorite	astrology

b) Make up sentences on the subject using as many words from the list as possible.

Reading

1. Read the text and write out the words and word combinations you don't know, try to guess their meaning from the context. Compare your notes with your partner.

High-size long-time space station

A. Space has always drawn attention of mankind. But up to now man's flights have been limited to near Earth space. The problem of long-time man's flights is connected with the necessity of complex life-support system for long time of man's existence in space. It needs a big volume of water, air and food. Theoretical calculations of space station with life-support system shows that a very big size and mass station is needed for long time space flight without the Earth support. However, the size and mass of station sent to the Earth orbit are limited by possibility of launch vehicle. So, now and then numerous projects of compound station which could be expanded at any time in free space have come out. All those projects contained rather

complicated constructions with hermetic connections and systems of building which could not be used in real space flight.

B. The problem of making of a high-size frame can be solved by using of technology of the polymerization of fibre-filled composites and a reactionable matrix applied in space or on other space body when space station will be working during a long period of time. In due time the prepreg carries out into free space, unfolds and hence proceeds to the fast polymerization of a matrix.

C. This way of producing the artificial space vehicle airframes has some advantages – no complex mechanical structures are used that require hermetic sealing and other operations. The manufacture of this airframe does not require the permanent human presence. The prepreg may be unfolded automatically from the container under a program which eliminates the extravehicular activity of an operator in free space at all. This technology may be employed, along with Earth orbit, to make space stations on other celestial bodies such as the Moon, the Mars, asteroids, etc. The main advantage of this technology is the absence of restrictions on the frame sizes. Great volume of station can be released in one or some frames connected through transportation junctions. There are no restrictions on the station form.

D. There are some basic specific space factors capable to influence the polymer curing. These are:

-vacuum;

-sharp temperature drops depending on the surface solar radiation;

- erosive effect of different types of space radiation;

- specific atmosphere of a planet able to influence the polymerization on other celestial bodies.

E. For a long time flights space stations must be equipped with the closed self-regulating ecological systems. The closed ecological system must exist during all

time of space flight. Regeneration of air, water, microelement compounds and other must be conducted without human help. But this system must include cosmonauts, as a part of system. Studies of these systems are being carried out for a long time in different countries. As it was shown, the existence of this closed system is possible. Creation of the closed ecological system is possible to be based on our modern knowledge. On the other side, existence of the closed ecological system on modern space ships is not possible today. Stability of ecological system can be observed at a big diversity of plants, animals and microorganisms. So, for stability of this ecological system the space station must have very high volume. Sufficient volume can not be made on modern space ships created on usual technology.

Comprehension check

1. Agree or disagree with these statements:

1. The size and mass of station sent to the Earth orbit are limited by gravity.
2. The problem of making of a high-size frame can be solved by means of cascade welding of superlight titanium alloy.
3. High-size frames could be done by using a reactionable matrix applied in space.
4. The manufacture of this airframe requires the extravehicular activity of an operator.
5. The main advantage of this technology is the absence of restrictions on the frame size.
6. Closed ecological system can exist without cosmonauts on modern spaceships.
7. Vacuum, specific atmosphere of a planet, sharp temperature drops influence the polymer curing.
8. Future flights in far space must be supplied with self-regulating ecological system.

2. Divide the text into logical parts. Think of the subtitle to each part. Highlight the topic words of each part.

3. Which of the following sentences summarize the main idea of the paragraph *A* most accurately?

1. Solving of the problem of long-time space man's flight is impossible without new materials for space construction.
2. To improve the possibility of launch vehicle is the only way out to construct new space stations.
3. Long-time man's space flight is possible only in closed ecological system.
4. Complex life-support system is needed to provide long-time man's existence in space.

4. Work in pairs. Take turns answering the questions.

1. What is the problem of long-time man's flight connected with?
2. What is the size and mass station sent to the Earth orbit limited by?
3. What way can the problem of making of a high-size frame be solved?
4. What are the advantages of this technology?
5. Does it require the permanent human presence?
6. What are the main space factors influencing the polymer curing?
7. Is it possible to maintain closed ecological system on modern space ships?
8. When is the stability of ecological system possible?

5. Make up a summary of the text.

<u>Vocabulary Focus</u>

1. a) Match words in *A* with words *B* to form the word combinations.

A	***B***
life-support	volume
big	technology
theoretical	system
space	connection

launch	calculations
numerous	projects
compound	station
complicated	sealing
hermetic	structure
high-size	vehicle
reactionable	construction
artificial	diversity
mechanical	frame
ecological	matrix

b) Make up 5-6 sentences using your word combinations. Compare them with your partner. Check each other.

2. In the text, highlight the words and phrases which mean the same as these words and word combinations.

Near-Earth environment, capability, pressurized (A); to deploy (B); man-made, half-finished material, limitation, connection (C); to affect (D); self-sustained system (E).

3. Choose the words from the ex.2 which you would like to use. Make up your own sentences with these words.

4. Complete the sentences below with suitable words from the box.

regeneration	stability	matrix	restrictions
near Earth space	unfolded	reactionable matrix	
prepreg	extravehicular activity	fibre-filled composites	

1. For _____ of this ecological system the space station must have very high volume.

2. The main advantage of this technology is absence of _____ on the frame size.

3. The prepreg may be _____ automatically from the container under a program which eliminates the _____ of an operator in free space at all.

4. _____ of air, water, microelement compounds and other must be conducted without human help.

5. Now man's space flights are limited to _____.

6. In due time the _____ carries out into free space , unfolds and hence proceeds to the fast polymerization of a _____.

7. The problem of making a high-size frame can be solved by using of technology of the polymerization of _____ and a _____ applied in space or on other space body.

5. Work in pairs. Give the definitions of the following words and expressions.

Life-support system, launch vehicle, hermetic connection, frame, fibre-filled composite, extravehicular activity, celestial body, vacuum, closed ecological system.

6. Fill in the table with missed word forms:

Verb	**Noun**	**Adjective**
		Connective
		Calculable
State		
		Constructive
Restrict		
		Existent

Speaking

1. **Compare modern International Space Station with this project. Discuss their life-support systems, capacity and other aspects.**

Учебное издание

СОВРЕМЕННЫЕ ЛЕТАТЕЛЬНЫЕ АППАРАТЫ

(Modern Aircraft)

Методические указания

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