Unit 11 COOLING ISSUES

LEAD-IN

1. What methods of cooling electronic components do you know?
2. Which of them is the most efficient and why?

1. Here are the symbols of the most common thermal conductors.
Write down their Polish and English names.

Symbol	Polish	English
Cu		
Al		
Au		
Ag		

2. Match the terms with their definitions

1. Thermal conductivity	a. is an important physical property, which refers to the amount of energy it takes to heat a substance by one degree.
2. Specific heat capacity	b. is the most often used measure of airflow available to cool power supplies and other electronic components and devices
3. Cubic Feet per Minute	c. is a physical property that describes how well a substance transfers heat
4. Linear Feet per Minute	d. is the volume of air passing through a specific cross sectional area. Power supply designers often prefer LFM because it describes where the air flows and its potential to remove heat.
5. Thermal resistance	e. a heat property and a measure of a temperature difference by which an object or material resist a heat flow

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3. ***What methods of cooling are described below?***

FORCED AIR ***CONVECTION*** ***CONDUCTION***

________________________**:** Most commercial and industrial grade switching power supplies over 100 watts require this method of cooling. Manufacturers typically specify the amount of (...) required in CFM. (...) can be provided by system fans or by the power supply manufacturer in the form of fan(s) on-board the power supply.

________________________**:** In certain telephony, telecommunications, and military requirements fan cooling is not acceptable. In these applications, (...) power supplies have become widely used. Internal components conduct their heat into aluminum extrusions and base plates and require no forced air. Watt for watt, (...) power supplies are generally more costly than forced-air cooled supplies.

________________________: Heat dissipating from the power supply's components into the surrounding air with little or no air movement is sometimes the main vehicle for heat removal. Fixing the power supply to a metal surface is highly desirable in these cases to benefit from some amount of cooling via conduction. Employing the most effective natural (...) techniques is important. Plan to keep the power supplies away from other heat generating or heat sensitive components to the greatest extent possible. Orient the power supply so that its heat will rise above it and not stay trapped. Vertical mounting may be best. Lying the supply flat is the least effective mounting to get the heat to rise out. Deration of the power supply is usually required when convection cooling. This, unless the supply was specifically designed for (...) cooling. Here the power supply designer will implement internal deration, select higher temperature components, and use more heat sinking. In any case, (...) supplies are more costly than forced-air cooled supplies.

Which method is...

a. the most widely used
b. the cheapest
c. is sometimes used is the army

4. Fill in the gaps with words from the box

Convection; cubic; waste; absorbed; generated; fan; dissipated; currents; thermal; heating; anticipated; achieving

All power supplies generate waste heat that needs to be 1. ____________________ . As more components are squeezed into smaller spaces the 2. ________________ effect becomes greater. Miniaturization results in higher levels of heat per 3. ________________ volume of space. The heat 4. ___________________ by components not only passes into the air around the components but is 5. _________________ by adjacent parts, by the PCB and by the equipment case. As a result, various parts of the system operate at higher temperatures than originally 6. __________________ and adversely affect the reliability and service life. Predictive techniques such as fluid dynamic analysis can help anticipate potential problems caused by 7. __________________ heat but there is no substitute for a combination of

experience and practical evaluation to achieve the optimum 8. ________________ performance.
The two most common ways of cooling a power supply are 9. _______________ cooling and forced air cooling. Data sheets for a power supply will specify either convection cooled ratings or forced air cooled ratings, or both. Where the power supply has a convection cooled rating, it is intended for use in an environment where there is free air. You must ensure that there is adequate space around and above the unit for free air convection 10.________________ to cool the unit and must also ensure that the ambient temperature local to the power supply is controlled to a level within its maximum ratings.
Power supplies with forced air cooled ratings may incorporate a cooling 11.________________ , or the manufacturer may specify the external fan cooling required to operate the unit at maximum load and ambient temperature. Power supply data sheets should be studied carefully early on in the design to decide if cooling is needed.
The main difference between convection and force-cooled products is in the power density delivered for a given efficiency. Convection cooled products typically offer a lower power density than force cooled products, meaning that they occupy a larger volume. For example, a power supply on a 3 x 5in industry standard footprint may have a convection rating of 100W while the force cooled version may have a rating as high as 200W. The use of fans is growing, as more applications put increasing emphasis on 12. ____________________ the best possible power density.

5. Reading

What is nanotechnology?
Do you think it could be used in cooling systems?

Read the text and answer the questions

1. What are the main advantages of using nanoparticles for cooling?
2. In what way can they improve the cooling systems?
3. What are the three main problems associated with nanoparticles?

The coolness of tiny things

NANO-THIS. Nano-that. Nano-the-other. The idea that making things so small you measure their dimensions in nanometres will unlock advantages denied to larger objects has been around for well over a decade. Long enough, in other words, for sceptics to wonder when something useful will actually come of it. It looks possible, though, that something useful is indeed about to happen. The evidence suggests that adding a sprinkle of nanoparticles to water can improve its thermal conductivity, and thus its ability to remove heat from something that it is in contact with, by as much as 60%. In a world where the cost of coolth is a significant economic drain (industrial cooling consumes 7% of the electricity generated within the European Union) that offers a worthwhile gain. It would, for instance, allow the huge computer-filled warehouses that drive the Internet to fit in more servers per square metre of floor space.
Nanofluid cooling, as the phenomenon is known, was discovered almost two decades ago, but is only now coming out of the laboratory. According to Mamoun Muhammed of Sweden's

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Royal Institute of Technology, one of the field's leading researchers, three problems have stood in its way.

The first was stopping the particles sticking together and thus ceasing to be nano. That has been overcome by adding emulsifying agents such as cetrimonium bromide (originally developed as an antiseptic) to the mix.

The second problem is which particles to use. At the moment oxides of metals such as zinc and copper seem to be the favourites, but tiny tubes made of carbon are also being explored. This, in turn, raises the question of how the phenomenon actually works. It is not simply a matter of the added ingredient (6-8% of the total volume seems to be the optimum mix) being a good conductor in its own right, though this helps. Nanofluids are better conductors than the sum of their parts. That suggests the particles are changing the structure of the water itself in ways that improve its conductivity. Water, despite its protean appearance, has a lot of internal structure, particularly when it is cool. The molecules are organised, albeit more loosely, in ways that resemble the material's solid form, ice. Nanoparticles inevitably alter this arrangement, and that may make the mix better able to transmit heat. If the changes involved were understood, picking the right size and composition of nanoparticle would be less a matter of guesswork.

The biggest problem about moving from laboratory to industry, though, is the question of scale. As the quantities increase, the way the constituents mix and react alters significantly. That makes it hard to predict from small-scale experiments what will happen in a commercial setting.

If these problems can be overcome, though, a bright future beckons, and some of the nano - hype that has been swirling around might actually get translated into a useful product.

Match words from the text with their definitions

1. To change
2. Often changing and becoming very different
3 . A substance having a definite shape and volume; one that is neither liquid nor gaseous.
4. A substance that stabilizes an emulsion by increasing its kinetic stability. One class of (...) is known as surface active substances, or surfactants.
5. A small amount of a substance
6. To stop happening or continuing
7. To use a lot of advertisements and other publicity to interest people

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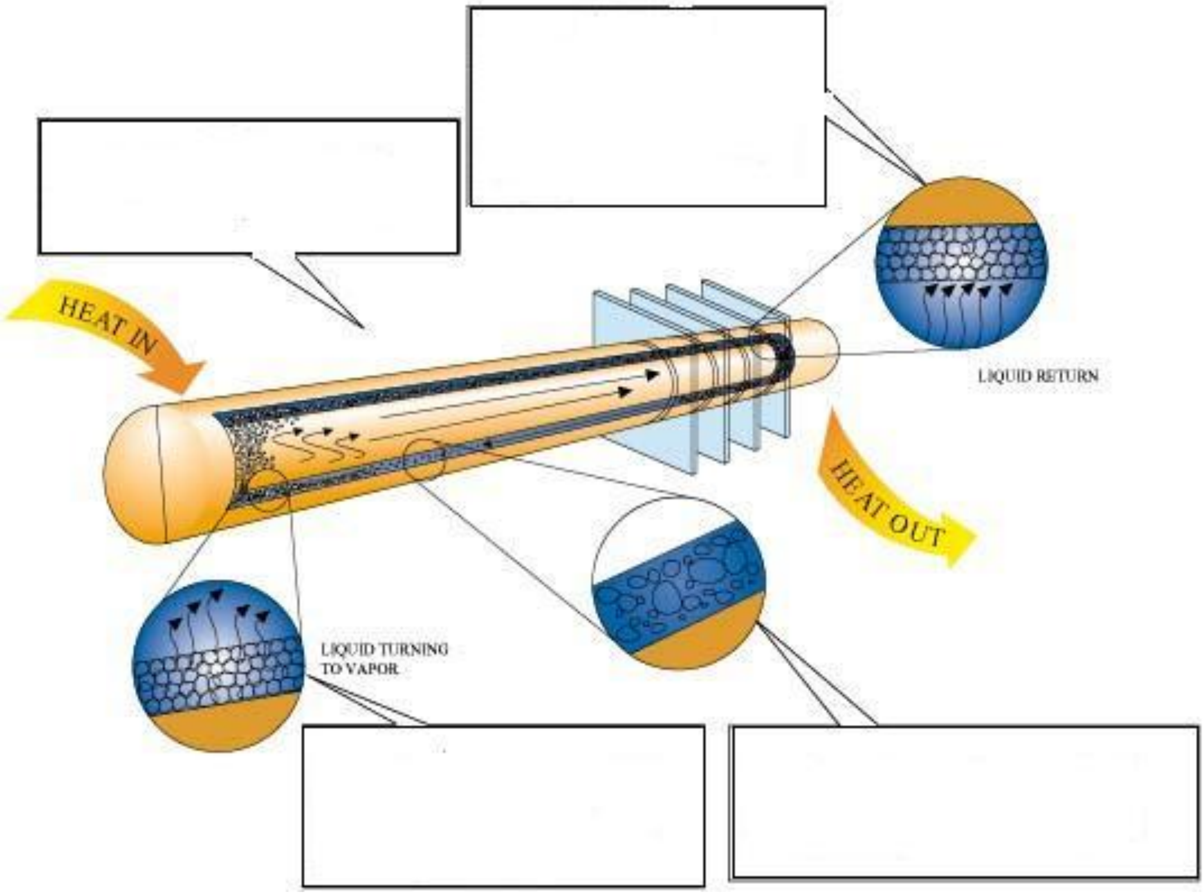
6. Can you say what the picture represents? What are its applications? Label the picture

a. WICK serves as a pump using capillary pressure to return the fluid from the condenser to the evaporator. The wick also serves as an extended surface to allow higher heat fluxes
b. CONDENSER: Heat exits the heat pipe at the condenser where the working fluid condenses and releases its heat of vaporization.
c. EVAPORATOR Heat enters heat pipe at its evaporator, where it causes working fluid to vaporize. The vaporized fluid creates a pressure gradient which forces the vapour towards the condenser.
d. ADIABATIC. Vapour travels from the evaporator to the condenser through the adiabatic section. As the pressure drop is low, there is little temperature change in this area



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