



General Certificate of Education
Advanced Subsidiary Examination
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General Studies (Specification A)

GENA2

Unit 2 AS Science and Society

Insert

Source Booklet

Source for use with **Questions 1.1 to 1.30**

Section A

Source for Questions 1.1 to 1.30

Space exploration – is it worth all the taxes we spend on it?

Introduction and proposal

- (1) We want to solve problems today, such as homelessness, poverty and street crime. However, this is a long and complicated process, because we just do not have the resources to do everything. The near solar system has resources in abundance. The energy released from the Sun in a day is more than humanity has ever used; the metal in one or two of the medium sized asteroids in the asteroid belt is more than in every skyscraper in the US. There are resources in abundance, and if we can utilise even a fraction of them, we will find ourselves in a better position to deal with issues at home. This discounts all the spin-off technological improvements we will see as well. To this end, we should put a massive public investment into space exploration.

Arguments against

- (2) Historically, western civilisation has always been short of resources. We have always attempted to solve the problem by finding more resources elsewhere, rather than trying to conserve what is available at home. There is a clear pattern: as soon as new sources of materials and energy were found, prices dropped, the population exploded, consumption increased, leading to a new shortage within a short amount of time.
- (3) It is naïve to assume that finding new resources in space will eliminate our shortages and solve all our problems. Consumption would simply adapt to the new abundance and soon we would be back where we started.
- (4) It is time to solve this problem on the demand side, rather than the supply side. If we reduce the world's population to a tenth of what it is today, and if we use technology to conserve energy, land and materials, we will not need to continue this unsustainable cycle into space. A reduction in population is possible in the long term without coercion. Some of the most highly developed and educated regions in the world, such as Europe and Japan, are already experiencing fertility rates well below 2.0 (in some countries as low as 1.2) without coercive one-child policies. A combination of education, higher standards of living and contraception could lead to a worldwide population reduction.
- (5) If you throw one trillion dollars at any pioneering project, it will produce some useful spin-off technologies. For example, the World Wide Web was initially developed to manage data at CERN (European Organisation for Nuclear Research). Spin-off technologies alone are not an argument in favour of space exploration; rather they are an argument in favour of funding any technological advancement. It is asserted that space exploration and war produce the highest returns of social benefits per dollar spent, but these are simply two areas that have historically attracted a lot of funding, so it is obvious that a lot of spin-off technologies have emerged. However, many exciting projects on Earth, such as the development of nuclear fusion, solar energy, and particle accelerators, would prove better value for money as
 - they are not limited in scale by the tiny size of launch payloads;
 - they could discover fundamental knowledge about the universe, not just the solar system;
 - they would produce spin-off technologies in addition to an economically exploitable outcome, such as clean energy.

- (6) In the US, the public often thinks NASA (National Aeronautics and Space Administration) is the one and only company to work in outer space. This makes it quite hard for new firms to actually become involved. In the US, the laws that apply can be very complicated, and it takes companies years to satisfy the conditions. This must be changed.
- (7) How do we expect to build a privately-funded space industry with entrepreneurship and risk taking when there is a large, government-funded organisation whose primary purpose is to protect its own jobs? NASA has been risk averse for decades now, and this has reduced both the safety and the amount of exploration the US gained for its tax dollars. Private entrepreneurship seems more likely to produce the 'right' level of safety and economic exploitation, while NASA should focus on 'far out' exploration.
- (8) Most space programmes are conducted for prestige reasons more than anything else, and the purpose is often nothing more than boosting a politician's popularity. Their practical purpose is rarely analysed by policy makers, and their benefits to the economy are questionable. While space programmes do produce some useful spin-offs, the billions of taxpayers' money (see **Figure 1**) would be much better spent on more effective research, such as finding a cure for cancer.

Figure 1: US Federal budget for expenditure 2010

Spending area	Amount (\$ billions)
Social security	695
Welfare	571
Medicare	453
Medicaid	290
Interest	164
Defence	664
NASA	19
Other	695
Total	3 551

NB. Funds available to the National Cancer Institute: \$5 billion

Arguments in favour

- (9) The assertion of 'western civilisation' as constantly running out of resources is misleading; all human civilisations run out of resources as they grow. Insisting that the limitations of the Earth must be applied to a species which has the capacity to go beyond the Earth is arbitrary. The resources available within our solar system are literally hundreds of times those available on the Earth, and – far more importantly – they do not require the destruction of the biosphere to get to them. Only an enormous reduction in terrestrial human population would permit us to persist for many thousands of years using no resources beyond the Earth.
- (10) Space programmes are well known to produce spin-off technologies that benefit humanity (see **Figure 2**). Other pioneering projects do too, but that is not an argument for ending space development. Space presents challenges that you will not find on Earth, and is probably better than any other human endeavour at producing new technologies, with the possible exception of fighting wars.

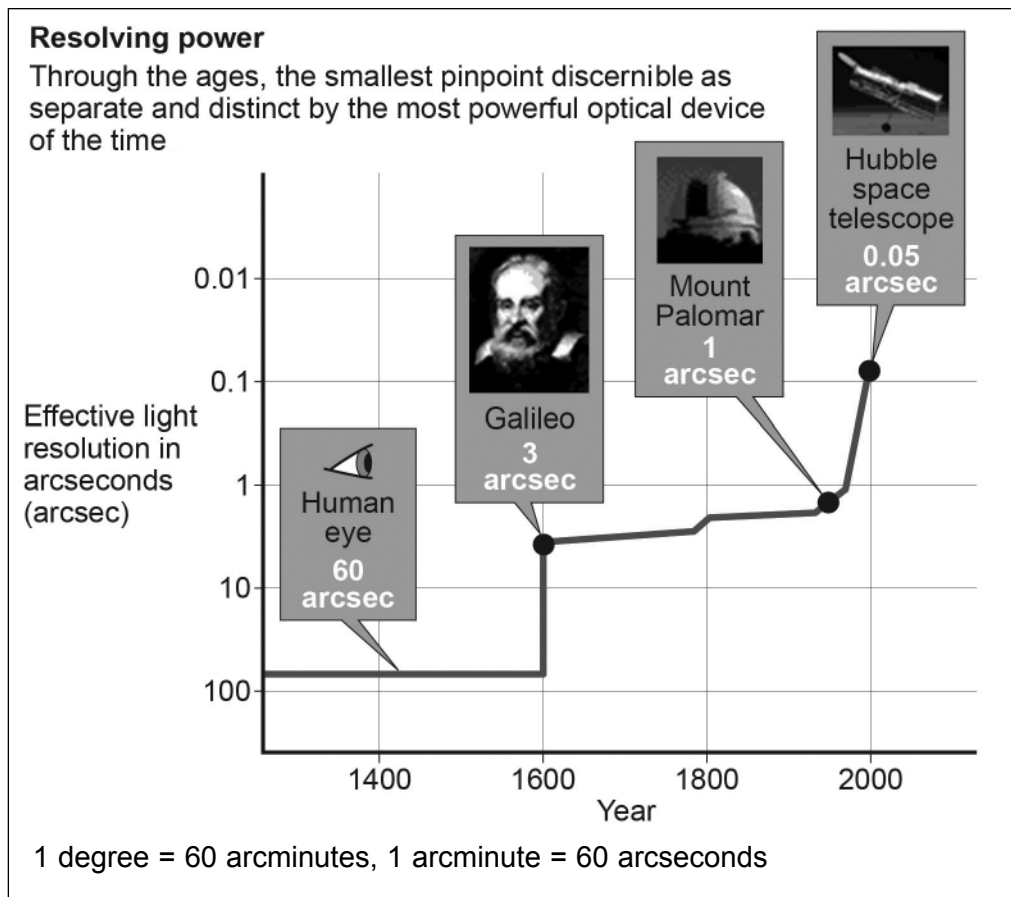
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- (11) Fusion research, solar power research, and many other kinds of 'pioneering' research are actually the same as the research needed for many long-term space development projects, so there is no conflict here.

Figure 2: Some spin-offs from space research

- It has been conservatively estimated by US space experts that for every dollar the US spends on Research and Development in the space programme, it receives \$7 back as corporate and personal income taxes from increased jobs and economic growth.
- The Hubble space telescope has led to the development of charge-coupled devices used in breast scans. The images allow the detection of minute differences between malignant and benign tumours without the need for a surgical biopsy.
- Water purification systems, using iodine rather than chlorine to kill bacteria.
- Moon boot materials have led to athletics shoes with improved shock-protection and motion control.
- Robot technology has led to the development of a voice-controlled wheelchair.
- Self-righting life rafts have been developed from the Apollo programme.
- Improved aircraft engines, with reduced fuel consumption and lower noise levels.

- (12) It is easy to argue against the bullet points in paragraph 5. On the issue of tiny payload limitation, projects in space are limited by payload only to the degree that they rely on resources from Earth. That phase of development is temporary, and payload limits have always been subject to revision and incrementally increased by improved technologies.
- (13) 'They could discover fundamental knowledge about the universe, not just the solar system.' What does that mean? If an Earth civilisation is not limited to Earth in its understanding, what makes you think a solar one is limited to the solar system? Rather, the solar system provides a far more effective place to do much of this research.
- (14) It is possible to build an accelerator many times larger if you can do it on the Moon. Space telescopes see much further and more clearly simply by benefit of being above the atmosphere (see **Figure 3**). Larger telescopes, made possible by increased space infrastructure, would do even more. High-energy research, which might represent a threat to human populations or to the environment if conducted on Earth, could be done on the Moon without fear.

Figure 3: Resolutions possible over time

- (15) The only truly clean and sustainable energy supply would be from solar powered satellites in Earth orbit, beaming power to the surface, rather than nuclear fusion (as any practical fusion reactor is going to produce some radioactive waste, and unlike fission reactors, fusion reactors are likely to explode if they fail).
- (16) Much, even most, space exploration in the past has been publicly funded. An argument for space exploration to continue to be funded from taxes does not exclude private industry from also becoming more involved. Regulations to allow privately and publicly funded exploration must be drafted, and on the understanding that Space is an inherently dangerous environment. The only way to achieve 100% safety is not to go. That did not stop us previously, and it should not stop us now. Public investment will ensure that such exploration continues, with benefits for all of us in the future.

Source: passage adapted from various Space Exploration articles

Figure 1: data from US Government Printing Office, Archive 2010

Figure 3: image redrawn by AQA, original from Space Telescope Science Institute (STScI)

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