Neap:

Trial Examination 2011

VCE Physics Unit 1

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Number of marks
A Core – Area of study			
1. Nuclear physics and radioactivity	16	16	38
2. Electricity	14	14	28
B Detailed studies			
1. Astronomy **OR**	12	12	24
2. Astrophysics **OR**	12	12	24
3. Energy from the nucleus **OR**	12	12	24
4. Investigations: Flight **OR**	12	12	24
5. Investigations: Sustainable energy sources **OR**	12	12	24
6. Medical physics	12	12	24
			Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, up to two pages (one A4 sheet) of pre-written notes (typed or handwritten) and one scientific calculator.
Students are NOT permitted to bring into the examination room: blank pieces of paper and/or white out liquid/tape.

Materials supplied

Question and answer booklet of 43 pages including formulae, data and a periodic table at the front.

Answer sheet for multiple-choice questions.

Instructions

Please ensure that you write your **name** and your **teacher's name** in the space provided on this booklet and on the answer sheet for multiple-choice questions.

Always show your working where space is provided.

Where an answer box has a unit printed in it, give your answer in that unit.

All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

FORMULAE

absorbed dose	$\text{absorbed dose} = \frac{E}{m}$
mass–energy equation	$E = mc^2$
torque	$\tau = Fr$
power	$P = \frac{E}{t}$ or $P = Fv$
Bernoulli's equation	$\frac{1}{2}\rho v^2 + \rho gh + P = \text{constant}$
electrical charge	$Q = It$
electrical work	$W = QV$
charge on the electron	$e = -1.6 \times 10^{-19}$ C
voltage	$V = IR$
power	$P = VI$
resistors in series	$R_T = R_1 + R_2 \ldots$
resistors in parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \ldots$
efficiency	$\text{efficiency (\%)} = \frac{\text{useful energy output}}{\text{energy input}} \times 100$
speed	$\text{speed} = \frac{\text{distance}}{\text{time}}$
Glide ratio (lift-to-drag ratio)	$\frac{\text{glide distance}}{\text{loss of altitude}}$

DATA

$$\text{speed of light in vacuum} = 3.0 \times 10^8 \text{ m s}^{-1}$$

$$1 \text{ MeV} = 1.6 \times 10^{-13} \text{ J}$$

PREFIXES

Prefix	Abbreviation	Value
giga	G	10^9
mega	M	10^6
kilo	k	10^3
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}

THE PERIODIC TABLE OF THE ELEMENTS

Key: atomic number 79; symbol of element Au; relative atomic mass 197.0; name of element gold

1 H 1.0 hydrogen																	2 He 4.0 helium
3 Li 6.9 lithium	4 Be 9.0 beryllium											5 B 10.8 boron	6 C 12.0 carbon	7 N 14.0 nitrogen	8 O 16.0 oxygen	9 F 19.0 fluorine	10 Ne 20.2 neon
11 Na 23.0 sodium	12 Mg 24.3 magnesium											13 Al 27.0 aluminium	14 Si 28.1 silicon	15 P 31.0 phosphorus	16 S 32.1 sulfur	17 Cl 35.5 chlorine	18 Ar 39.9 argon
19 K 39.1 potassium	20 Ca 40.1 calcium	21 Sc 44.9 scandium	22 Ti 47.9 titanium	23 V 50.9 vanadium	24 Cr 52.0 chromium	25 Mn 54.9 manganese	26 Fe 55.8 iron	27 Co 58.9 cobalt	28 Ni 58.7 nickel	29 Cu 63.5 copper	30 Zn 65.4 zinc	31 Ga 69.7 gallium	32 Ge 72.6 germanium	33 As 74.9 arsenic	34 Se 79.0 selenium	35 Br 79.9 bromine	36 Kr 83.8 krypton
37 Rb 85.5 rubidium	38 Sr 87.6 strontium	39 Y 88.9 yttrium	40 Zr 91.2 zirconium	41 Nb 92.9 niobium	42 Mo 95.9 molybdenum	43 Tc 98.1 technetium	44 Ru 101.1 ruthenium	45 Rh 102.9 rhodium	46 Pd 106.4 palladium	47 Ag 107.9 silver	48 Cd 112.4 cadmium	49 In 114.8 indium	50 Sn 118.7 tin	51 Sb 121.8 antimony	52 Te 127.6 tellurium	53 I 126.9 iodine	54 Xe 131.3 xenon
55 Cs 132.9 casesium	56 Ba 137.3 barium	57 La 138.9 lanthanum	72 Hf 178.5 hafnium	73 Ta 180.9 tantalum	74 W 183.8 tungsten	75 Re 186.2 rhenium	76 Os 190.2 osmium	77 Ir 192.2 iridium	78 Pt 195.1 platinum	79 Au 197.0 gold	80 Hg 200.6 mercury	81 Tl 204.4 thallium	82 Pb 207.2 lead	83 Bi 209.0 bismuth	84 Po (209) polonium	85 At (210) astatine	86 Rn (222) radon
87 Fr (223) francium	88 Ra (226) radium	89 Ac (227) actinium	104 Rf (261) rutherfordium	105 Db (262) dubnium	106 Sg (263) seaborgium	107 Bh (264) bohrium	108 Hs (265) hassium	109 Mt (268) meitnerium	110 Ds (271) darmstadtium	111 Rg (272) roentgenium	112 Uub		114 Uuq		116 Uuh		118 Uuo

58 Ce 140.1 cerium	59 Pr 140.9 praseodymium	60 Nd 144.2 neodymium	61 Pm (145) promethium	62 Sm 150.3 samarium	63 Eu 152.0 europium	64 Gd 157.2 gadolinium	65 Tb 158.9 terbium	66 Dy 162.5 dysprosium	67 Ho 164.9 holmium	68 Er 167.3 erbium	69 Tm 168.9 thulium	70 Yb 173.0 ytterbium	71 Lu 175.0 lutetium
90 Th 232.0 thorium	91 Pa 231.0 protactinium	92 U 238.0 uranium	93 Np 237.1 neptunium	94 Pu (244) plutonium	95 Am (243) americium	96 Cm (251) curium	97 Bk (247) berkelium	98 Cf (251) californium	99 Es (252) einsteinium	100 Fm (257) fermium	101 Md (258) mendelevium	102 No (259) nobelium	103 Lr (260) lawrencium

SECTION A – CORE

Instructions for Section A

Answer **all** questions **for both** Areas of study in this section of the paper.

Where an answer box has a unit printed in it, give your answer in that unit.

In questions where more than one mark is available, appropriate working should be shown.

Areas of study **Page**

Area of study 1 – Nuclear physics and radioactivity

The following information relates to Questions 1 to 3.

Below are the reactants and products of three different nuclear reactions.

	Reactant	Product
Example *A*	$^{131}_{53}\text{I}$	$^{131}_{54}\text{Xe}$
Example *B*	$^{59}_{27}\text{Co}$	$^{59}_{27}\text{Co}$
Example *C*	$^{218}_{86}\text{Rn}$	$^{214}_{84}\text{Po}$

Question 1

For each example, *A* to *C*, determine what kind of decay was occurring: α, β or γ. Provide one reason for your choice in each case.

Example *A* is _____ decay because:

_____

Example *B* is _____ decay because:

_____

Example *C* is _____ decay because:

_____

3 marks

A student in your class states that: "The reactant and product in example *B* are different isotopes of Cobalt."

Question 2

Using your definition of the term isotope, explain why the student's statement is not correct.

_____

_____

_____

_____

2 marks

Question 3

Write a complete decay equation for example *A*.

1 mark

The following information relates to Questions 4 to 9.

Iodine-131 is an isotope that has application in nuclear medicine. It is usually produced by bombarding Tellurium-130 ($^{130}_{52}$Te) with neutron radiation in a nuclear reactor.

Question 4

Explain how this process can be used to produce atoms of Iodine-131. Use at least one nuclear equation to support your argument.

_____

_____

_____

3 marks

One hospital keeps a sample of I-131 for use in radiation therapy. It is noted that the activity of the sample has reduced by 75% in 17 days.

Question 5

What is the half-life of I-131? Show your working.

2 marks

Andrea, a patient with a Thyroid disorder, has taken 30 mg of I-131 as part of a treatment for the disorder. The radiologist needs to calculate the dose equivalent for Andrea over a period of one hour.

Question 6

List the four pieces of information or data that the radiologist needs to do the calculation. Assume that the activity of the sample is constant during one hour.

1. _____

2. _____

3. _____

4. _____

4 marks

Question 7

Explain how the radiologist would use the above data to calculate the Effective Dose (in Sieverts) for the patient. (There is no need to do an actual calculation.)

_____

_____

_____

_____

2 marks

The patient is told by the radiologist not to go into places where she will be close to other people, such as public transport, for two weeks directly after the I-131 treatment. Apart from β-radiation , I-131 also emits γ-rays.

Question 8

With reference to the type of decay that emerges from I-131, explain why it is best for Andrea to keep away from other people.

_____

_____

_____

2 marks

Question 9

Discuss why two weeks would be a sensible safety margin.

_____

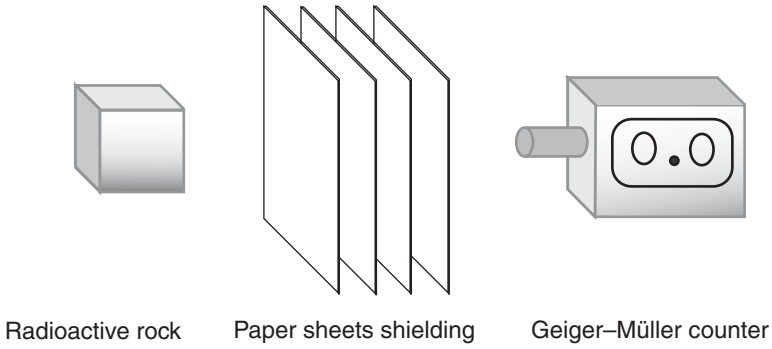
_____

_____

2 marks

The following information relates to Questions 10 to 12.

A sample of radioactive rock of mass 0.01 kg is analysed by measuring its radiation using varying amounts of shielding by sheets of normal writing paper. The experimental setup is shown below.



The results of the analysis are shown in the graph below:

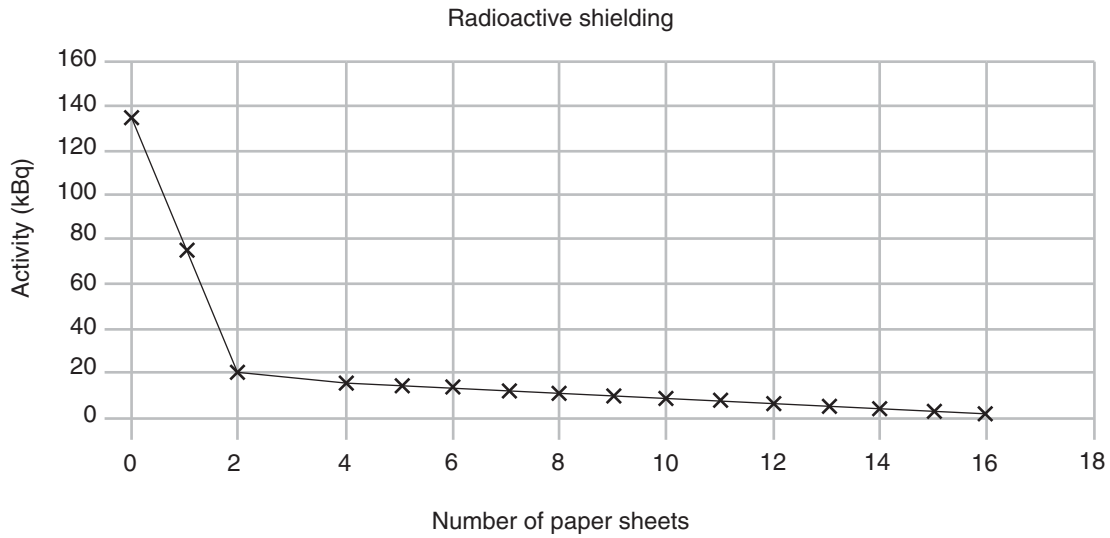


Figure 1

Question 10

Using the information provided by the graph, determine what kind(s) of radiation is produced by the rock. Explain your choice using data from the graph.

_____

_____

_____

_____

4 marks

As a result of her work on the radioactive rock, a Scientist inhales a small amount of the radioactive dust made from the same material as the rock.

Question 11

Explain why this type of exposure is a cause for concern, and suggest what safety measure could have prevented this exposure.

_____

_____

_____

3 marks

Further measurements reveal that no matter how much shielding is put between the rock and the G–M counter, there is a constant, but small, amount of radiation detected, even if we replace the paper shielding by lead sheets.

Question 12

How could you explain the above observation?

_____

_____

1 mark

The following information relates to Questions 13 to 16.

Several natural decay chains occur in the Earth's crust.

Question 13

Explain what is meant by the term 'decay chain'.

_____

_____

2 marks

One particular decay chain involves the radioactive gas Radon-218. This isotope of Radon (Rn) undergoes alpha decay. Radon and neighbouring elements on the Periodic Table are shown below. Decay modes for radioactive isotopes are given in brackets.

Pb-210 (β) Pb-206 (stable)	Bi-210 (β)	Po-210 (α, γ) Po-214 (α, γ)	At-218 (α)	Rn-218 (α, γ) Rn-220 (α, γ)	Fr-223 (α, γ)

Table 1

Question 14

Explain why, in many cases, alpha and gamma decay occur in the same isotope.

_____

_____

2 marks

Question 15

Using the section of the Periodic Table shown above, show how Rn-218 can decay into a stable isotope of lead (Pb-206) in five steps.

3 marks

In cartoons and films superheroes often acquire their superpowers by being exposed to some form of 'radiation'. In such stories the person involved becomes a 'mutant' as a result of radioactivity.

Question 16

Using your knowledge of radioactivity, explain why such stories are both wrong from a scientific point of view and also believable because they contain a small amount of correct science.

It is wrong because:

_____

_____

It is believable because:

_____

_____

2 marks

END OF AREA OF STUDY 1

Area of study 2 – Electricity

The following information relates to Questions 1 to 2.

A single positively charged particle is placed midway between two charged plates as shown in Figure 2.

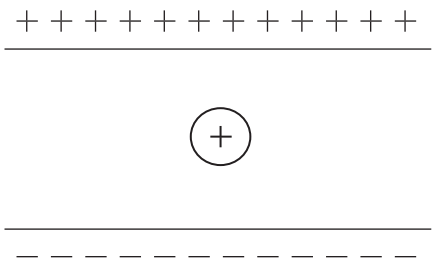


Figure 1

Question 1

The charged particle is most likely to

A. move towards the positive plate.
B. move towards the negative plate.
C. not move at all.
D. move back and forth around its midway position.

2 marks

Question 2

The movement of charged particles over time is generally known as

A. current.
B. voltage.
C. power.
D. resistance.

2 marks

The following information relates to Questions 3 to 6.

An electric heater has two identical heating elements, each with a constant resistance of 75 Ω. It is connected to the 240 V AC mains supply. The elements can be connected three ways, either singly or in combination, to provide three settings of approximately:

1. 385 W
2. 770 W
3. 1.5 kW

Question 3

What is meant by the term AC?

_____

_____

_____

2 marks

Question 4

Complete the circuit in Figure 2 to show which wiring provides the highest power output.

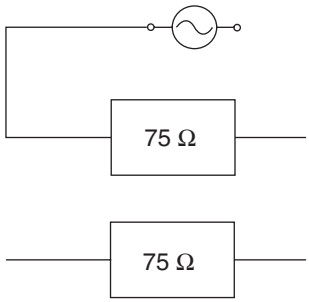


Figure 2

2 marks

Question 5

Explain if either a parallel or series circuit will give the maximum power output.

_____

_____

_____

2 marks

Question 6

Show, with calculations, how the highest power setting is obtained.

2 marks

Emily-Rose and Liz are discussing wiring and they notice that a plastic kettle has only two wires, an active and a neutral, while a metal kettle has an earth wire as well.

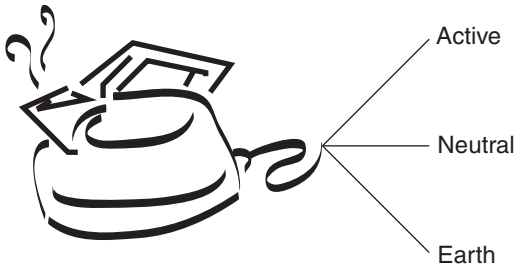


Figure 3: Metal kettle

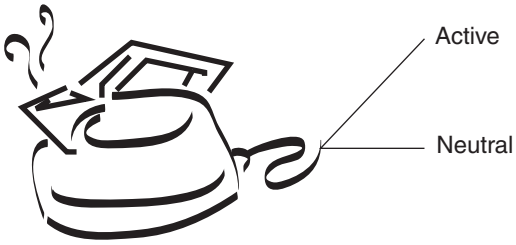


Figure 4: Plastic kettle

Question 7

Explain why a metal kettle requires an earth wire while a plastic one does not.

_____

_____

_____

2 marks

The following information relates to Questions 8 to 9.

A solar light uses a rechargeable battery to store the energy obtained from sunlight to light a series of LED globes. The current is 600 mA. The graph in Figure 5 shows the energy consumption of the lights.

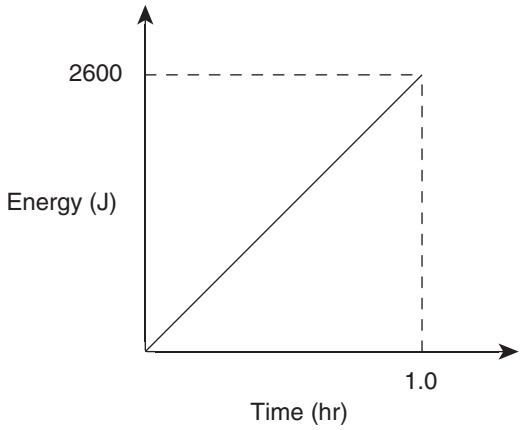


Figure 5

Question 8

How much charge passes through the circuit in one hour?

C	2 marks

Question 9

Work out the EMF (voltage) supplied by the battery over one hour.

V	2 marks

The following information relates to Questions 10 to 11.

Simon, an electrician, explains to Clayton that in most houses the lighting and power are wired on separate circuits, each with a separate fuse. Figure 7 shows part of a lighting circuit with a fuse. Lighting has an 8A fuse and power has 15A fuse. Each globe can be assumed to have a constant resistance of 80 Ω.

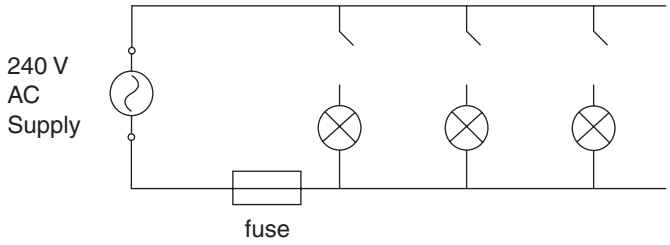


Figure 6

Question 10

Why is it better to wire the light circuit in parallel rather than in series?

_____

_____

_____

2 marks

Question 11

Explain what might happen to the fuse if all circuits are switched on at the same time.

_____

_____

_____

_____

3 marks

The following information relates to Questions 12 to 14.

A solar cell typically has the following current – voltage $(I - V)$ characteristics:

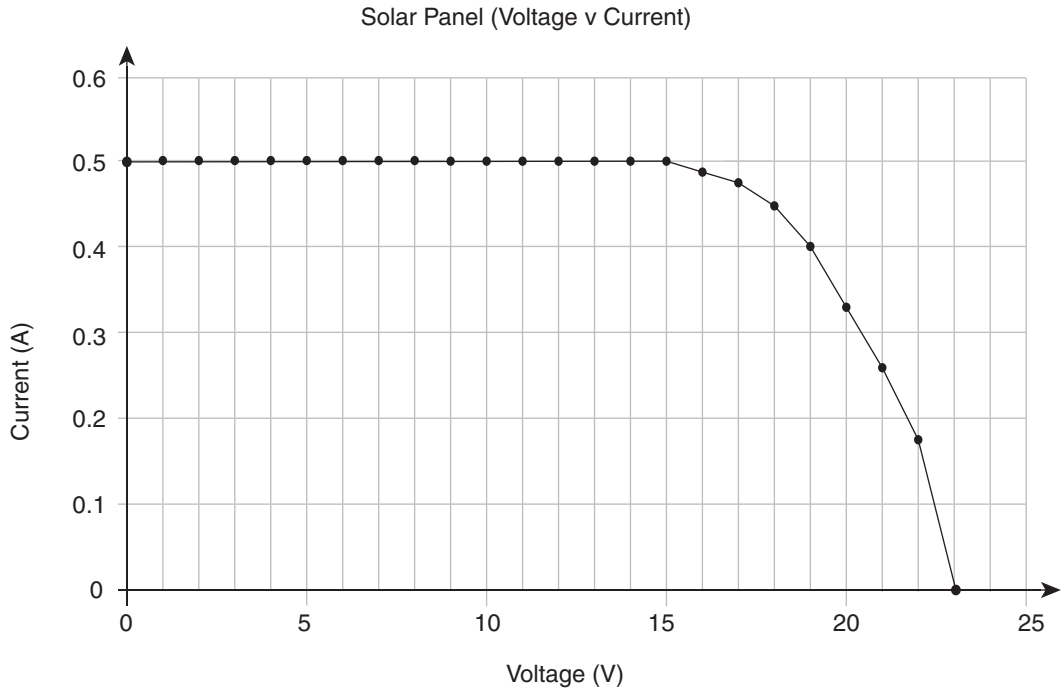


Figure 7

Question 12

Calculate the power output of the solar panel at 19 V.

W

1 mark

Question 13

Explain whether or not the solar panel behaves as a non-ohmic device.

_____

_____

_____

2 marks

Question 14

What is the approximate resistance of the cell at 20 V?

	Ω

2 marks

END OF AREA OF STUDY 2

SECTION B – DETAILED STUDIES

Instructions for Section B

Select **one** Detailed study.

Answer **all** the questions on the Detailed study you have chosen, in pencil, on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 2, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

You should take the value of g to be 10 m s^{-2}

Detailed study **Page**

Detailed study 1 – Astronomy

The following information relates to Questions 1 to 2.

The Voyager 1 spacecraft was launched in 1977 and is now heading out beyond our solar system. It is the furthest man-made object to do so. It sends signals to Earth via radio waves which travel at the speed of light $(3 \times 10^8 \text{ m s}^{-1})$.

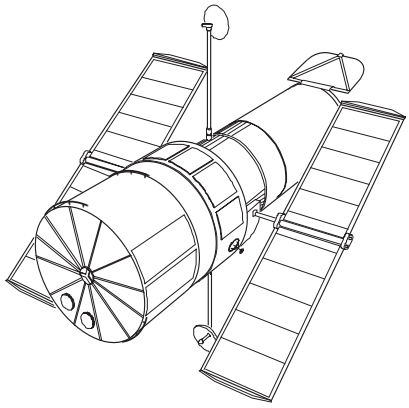


Figure 1

Question 1

Voyager 1 is approximately some 17.4 billion (1.74×10^{10}) kilometres from the Earth.

How long does it roughly take to send a radio signal from Earth to Voyager 1?

A. 58 000 hours
B. 16 hours
C. 58 hours
D. 0.016 hours

Question 2

A parsec is a unit of measurement used in astronomy to measure the distance to stars.

$$1 \text{ Parsec} = 3.1 \times 10^{16} \text{ metres}$$

How far has Voyager travelled in parsecs?

A. 0.56
B. 1.8
C. 5.6×10^{-4}
D. 1800

Question 3

Some communication satellites use a geosynchronous orbit around the equator – in this case the satellite appears stationary to observers on the ground and always at the same point in the sky.

If a person was standing directly underneath the satellite on the equator, the term that best describes its position would be

A. zenith.
B. altitude.
C. azimuth.
D. nadir.

Question 4

Melbourne's position is 38° south of the equator.

This means that the south celestial pole is located at what altitude in the sky?

A. 0°
B. 52°
C. 90°
D. 38°

Question 5

For a person standing in Melbourne, which statement is correct?

A. The person sees both the northern and southern sky equally.
B. The person sees the northern sky more than the southern sky.
C. The person sees the southern sky more than the northern sky.
D. The person cannot see the northern sky at all.

Question 6

For a person standing on the equator, which statement is correct?

A. The person sees both the northern and southern sky equally.
B. The person sees the northern sky more than the southern sky.
C. The person sees the southern sky more than the northern sky.
D. The person cannot see the northern sky at all.

Question 7

A star has a right ascension (RA) of 02:00 hours. Another star has a RA of 12:30 hours.

How long will it take the second star to cross the same point in the sky as the first star?

A. 01:30 hours
B. 10:30 hours
C. 12:30 hours
D. 14:30 hours

Question 8

In the 16^{th} Century, the Catholic Church opposed the findings of Copernicus – that the Earth orbited the sun.

Which model did the church prefer?

A. Tychonic
B. Lunar-centric
C. Heliocentric
D. Ptolemaic

Question 9

There is a region between Mars and Jupiter where there is a high concentration of celestial objects.

These objects are known as

A. asteroids.
B. nebulae.
C. comets.
D. planets.

The following information relates to Question 10.

The graph below shows the amount of electromagnetic radiation (light) that reaches the Earth's surface.

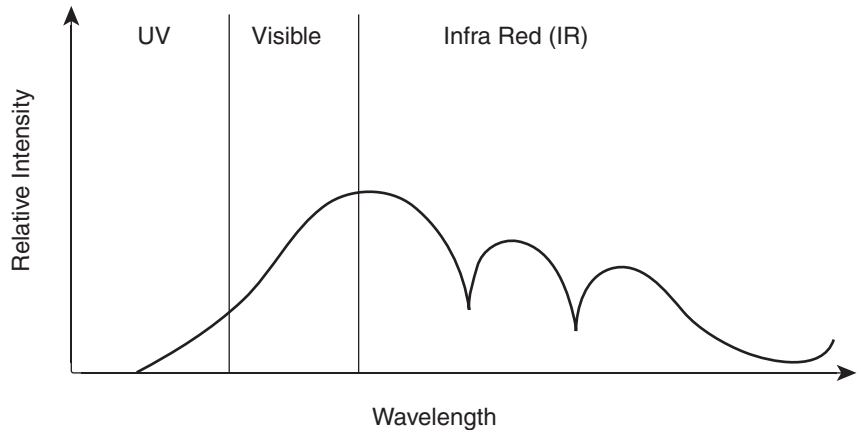


Figure 2

Question 10

The WISE (Wide-field Infrared Survey Explorer) telescope had to be launched into orbit around the Earth.

The main reason why it could not be Earth-based was because

A. it was too expensive to have on Earth.
B. not enough IR light reaches the Earth's surface.
C. too much IR light reaches the Earth's surface.
D. not enough UV light reaches the Earth's surface.

Question 11

The Hubble telescope had a manufacturing fault with the main mirror when it was first put into orbit. This led to the images being fuzzy and of a lower resolution.

This is most likely an example of

A. spherical aberration.
B. chromatic aberration.
C. design fault.
D. software fault.

Question 12

Galileo used a telescope to make many astronomical observations. One such observation was regarding stars and planets.

He observed that, when compared to viewing the sky with the naked eye,

A. stars and planets looked no different.
B. planets looked no different while stars appeared as discs.
C. stars looked no different while planets appeared as discs.
D. stars and planets appeared as discs.

END OF DETAILED STUDY 1 – ASTRONOMY

Detailed study 2 – Astrophysics

Question 1

The Sun is an example of a

A. white dwarf.
B. main sequence star.
C. red giant star.
D. gas giant.

Question 2

The Sun generates heat from fusion reactions inside its core.

The evidence for this is that the sun

A. is composed of mostly Hydrogen and Helium.
B. has been 'burning' for about 5 billion years already.
C. emits a continuous flux of neutrinos, a particle associated with certain fusion reactions.
D. All of the above provide evidence for nuclear fusion in the Sun's core.

Question 3

The Sun's surface temperature is about

A. 5500°C.
B. 550°C.
C. 5.5 million °C.
D. We cannot measure the Sun's surface temperature.

Question 4

Planets, stars and galaxies are thought to have been formed by the action of

A. electromagnetic forces.
B. strong nuclear forces.
C. gravitational forces.
D. inter-atomic forces.

The following information relates to Questions 5 to 7.

Measuring the distances to stars requires special techniques. Only for the stars that are relatively near to us can we measure the distance directly, using the parallax method. For stars that are further away we need to resort to indirect measurement such as the inverse square law of light.

Question 5

In the context of the text above, 'relatively near to us' means

A. about 100 million kilometres away.

B. up to 4 light-years away.

C. up to 1600 light-years away.

D. within our own Galaxy.

Question 6

Using parallax to measure the distance to stars requires a very large base line. The diagram below shows how such a measurement could be made.

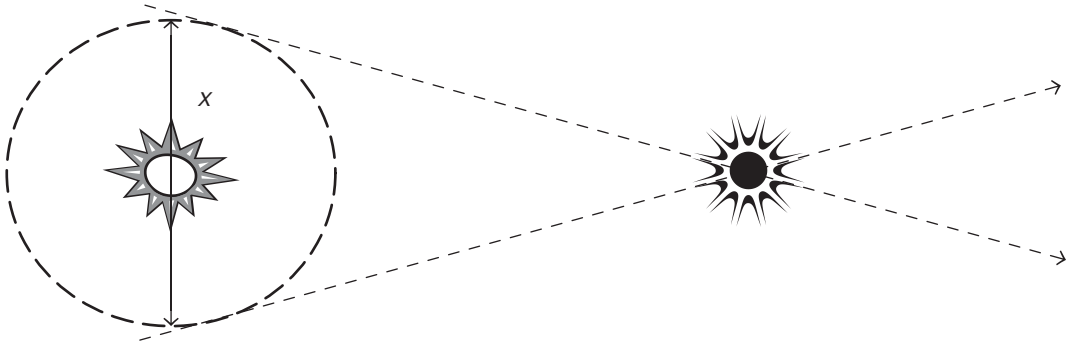


Figure 1

The baseline is marked *X* on the diagram and is equal to

A. the diameter of the sun.

B. the radius of the Earth's orbit around the sun.

C. the Astronomical Unit (AU) times two.

D. the diameter of the Earth.

Question 7

Using the inverse square law to measure the distance to the stars is considered an indirect method because it

A. is less accurate.

B. is unsafe to look directly at stars.

C. is a highly complex distance measurement.

D. requires the known distance of another star for comparison.

Question 8

Stars undergo various changes during their lifetimes.

Of the following options, which one combines a plausible beginning and end stage of a star's lifetime?

	Beginning stage	End stage
A.	Red giant	White dwarf
B.	Main sequence star	Brown dwarf
C.	White dwarf	Black hole
D.	Neutron star	Main sequence star

Question 9

The big bang theory is now considered to be a more complete cosmological model than the steady state theory.

This has come about mainly because

A. the big bang theory was the only one that could explain Hubble's observation of the expanding universe.

B. the big bang theory was the only one that could explain the large scale structure of the universe.

C. the steady state theory was unable to explain the presence of the Cosmic Background Radiation.

D. the steady state theory was unable to explain the red shift of distant galaxies.

Question 10

Edwin Hubble used Doppler Shift for light to show that most galaxies are

A. extremely large like our Milky Way Galaxy.

B. moving relative from our Milky Way Galaxy.

C. all of a similar size like our Milky Way Galaxy.

D. spiral galaxies like our Milky Way Galaxy.

The following information relates to Questions 11 to 12.

Hubble measured key characteristics for a large number of galaxies and represented this data in a graph like the one below.

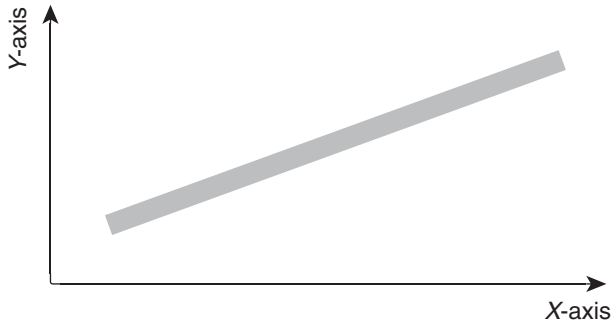


Figure 2

Question 11

From the table below, pick the most suitable labels for the *X* and *Y*-axes on this graph.

	***X*-axis**	***Y*-axis**
A.	Luminosity	Surface temperature
B.	Distance	Luminosity
C.	Distance	Speed of recession
D.	Luminosity	Speed of recession

Question 12

The most important conclusion that can be drawn from Hubble's data is that

A. the universe is expanding.
B. the universe is static and unchanging.
C. the universe is much larger than previously thought.
D. the universe is red shifted.

END OF DETAILED STUDY 2 – ASTROPHYSICS

Detailed study 3 – Energy from the nucleus

Question 1

The Sun is capable of providing humankind with vast amounts of energy.

In this context we can think of the sun as a giant

A. nuclear fusion reactor.
B. coal fired power plant.
C. nuclear fission reactor.
D. solar power plant.

The following information relates to Questions 2 to 4.

The graph below shows the binding energy per nucleon for various nuclei as a function of their mass number. The curve is divided into two sections: I and II.

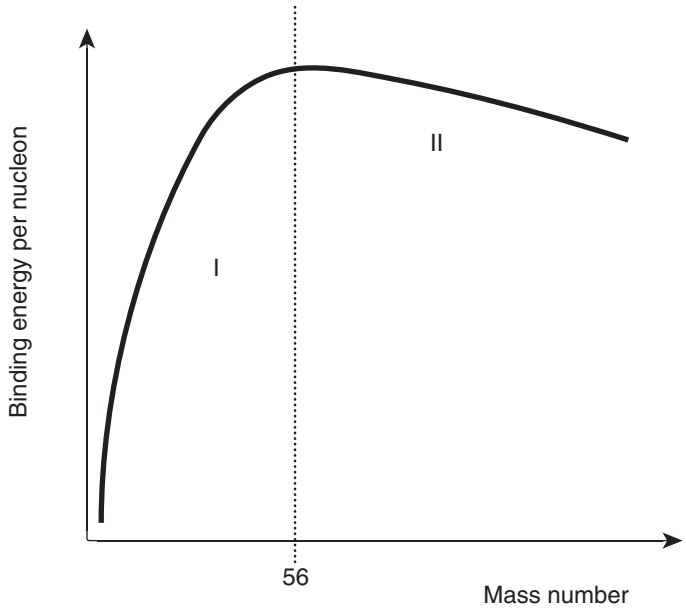


Figure 1

Question 2

Which of the following options is correct?

A. Section I shows the nuclei that can release energy by nuclear fission.
B. Section II shows the nuclei that can release energy by nuclear fission.
C. Section I shows the nuclei that can release energy by both nuclear fission and fusion.
D. Section II shows the nuclei that can release energy by nuclear fission and fusion.

Question 3

The nucleus with mass number 56 can be considered the nucleus with

A. the most massive nucleons.
B. the least massive nucleons.
C. the most total binding energy.
D. the least total binding energy.

Question 4

Nuclear binding energy can be defined as the energy needed to

A. join the nucleons together to make a nucleus.
B. join the nucleus of an atom to its electrons to make an atom.
C. separate all of the electrons from the nucleus of an atom.
D. separate all of the constituent nucleons from a nucleus.

Question 5

People opposed to nuclear fission power often use the argument that nuclear fission leads to the production of highly radioactive waste products.

The isotopes produced in fission reactions are highly radioactive because these isotopes contain

A. too few neutrons to keep them stable.
B. too many neutrons to keep them stable.
C. too much binding energy to keep them stable.
D. too few nucleons to keep them stable.

Question 6

Plutonium-239 (Pu-239) is a potential source of nuclear energy because Pu-239

A. is a very heavy isotope of Plutonium.
B. is highly unstable.
C. is able to undergo neutron capture.
D. is a fissionable nucleus.

Question 7

Nuclear fission of U-235 relies on the capture of thermal neutrons.

This means that the neutrons used to cause fission in U-235 must be

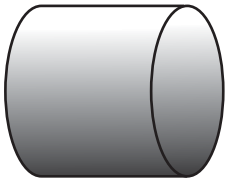
A. extremely hot.
B. fast moving.
C. slow moving.
D. not moving at all.

Question 8

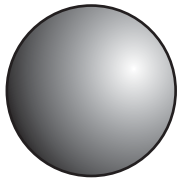
To optimise the capture of thermal neutrons in a working fission reactor it is important to minimise the surface area of the fuel cell.

Which of the following fuel configurations would provide optimum neutron capture?

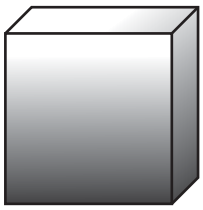
A.



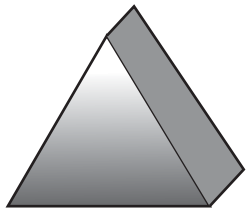
B.



C.



D.



Question 9

For a sustained nuclear fission reaction it is necessary to initiate a chain reaction.

One of the requirements for achieving a chain reaction is

A. the production of multiple free neutrons during each fission reaction.
B. sufficient density of the nuclear fuel to maximise the probability of neutron capture.
C. optimum configuration of nuclear fuel to reduce the loss of free neutrons.
D. All of the above are requirements for a nuclear chain reaction.

Question 10

In a typical Uranium-235 fission reaction 193 MeV of energy is produced.

This means that the mass defect in such a nuclear reaction must be

A. 3.43×10^{-28} kg.

B. 1.03×10^{-19} kg.

C. 2.00×10^{-9} kg.

D. 2.15×10^{-15} kg.

Question 11

Nuclear reactions are much more energetic than chemical reactions because

A. the strong nuclear force is much weaker than the electro-magnetic force.
B. the strong nuclear force is stronger than the weak nuclear force.
C. the electro-magnetic force is weaker than the strong nuclear force.
D. the electro-magnetic force is weaker than the weak nuclear force.

Question 12

The following reaction represents an example of a nuclear fusion reaction

$$ {}_{1}^{2}\mathrm{H} + {}_{1}^{3}\mathrm{H} \rightarrow {}_{2}^{4}\mathrm{He} + X + \text{energy} $$

In this reaction the symbol *X* represents

A. a neutron.

B. a positron.

C. a proton.

D. an electron.

END OF DETAILED STUDY 3 – ENERGY FROM THE NUCLEUS

Detailed study 4 – Investigations: Flight

Question 1

The original manned flight was not done on a plane but with a balloon. Air is heated in a confined space.

They way lift is achieved in a balloon is by

A. decreasing the Bernoulli effect over the balloon.
B. increasing the Bernoulli effect over the balloon.
C. increasing the density of the hot air which creates buoyancy.
D. decreasing the density of the hot air which creates buoyancy.

The following information relates to Questions 2 to 4.

In Figure 1 an aeroplane is stationary along a runway.

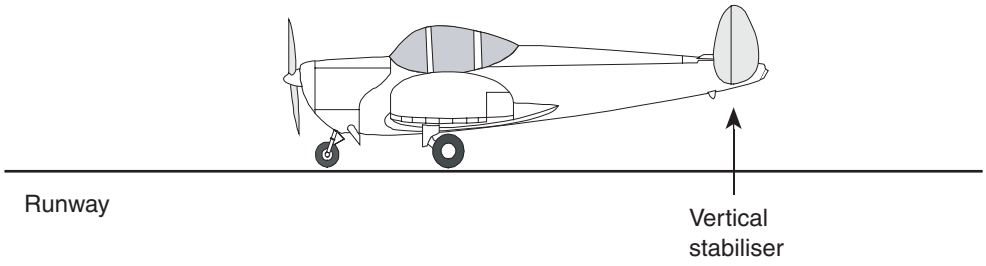


Figure 1

In Figure 2 the same aeroplane is now seen travelling above the runway at a constant speed and height.

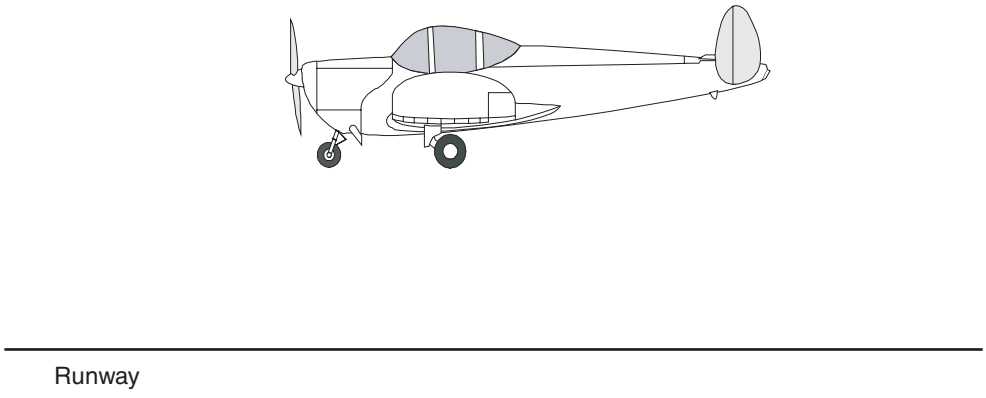


Figure 2

Question 2

Which of the option below best describes the opposite and equal forces acting on the plane?

	Figure 1	Figure 2
A.	Weight = Lift	Lift = Normal reaction
B.	Weight = Lift	Weight = Normal reaction
C.	Weight = Normal reaction	Lift = Normal reaction
D.	Weight = Normal reaction	Weight = Lift

Question 3

The air deflected over the aerofoil (wing) helps generate lift on the wing.

In terms of Newton's action-reaction pairs

A. the aerofoil pushes down (action) and the air pushes upward (reaction).
B. the aerofoil pushes upward (action) and the air pushes downward (reaction).
C. both aerofoil and air push downward.
D. both aerofoil and air push upward.

Question 4

If the vertical stabiliser (where the rudder is located) shown in Figure 1 was damaged, the plane would tend to

A. roll.
B. nose dive.
C. yaw.
D. pitch upwards.

The following information relates to Questions 5 to 7.

Bernoulli developed an equation that relates velocity, pressure and density. One version of the formula is:

$$P_1 + \frac{1}{2}pv_1^2 + pgh_1 = \text{constant}$$

Where P_1 = fluid pressure in N m^{-2}

p_1 = fluid density (air in this case) in kg m^{-3}

v_1 = fluid velocity in m s^{-1}

h_1 = height above ground in m

g = acceleration due to gravity (10 m s^{-2})

Question 5

If the height of the fluid does not change, what term decreases if the fluid velocity increases?

A. height
B. pressure
C. density
D. force due to gravity

Question 6

The Bernoulli equation is based on

A. conservation of gravity.
B. conservation of energy.
C. conservation of forces.
D. None of the above

Another version of the Bernoulli equation is:

$$P_1 + \frac{1}{2}pv_1^2 = P_2 + \frac{1}{2}pv_2^2$$

(Given constant height and density)

Question 7

The left-hand side of the equation is for air moving under the wing and the right-hand side is for air moving above.

If the density (p) is taken as 1.29 kg m^{-3} and an air velocity (v_2) above the wing is 125 m s^{-1} and below the wing (v_1) is 95 m s^{-1}, the difference in pressure $(P_1 - P_2)$ would be nearest to

A. 19.4 N m^{-2}.

B. 10 N m^{-2}.

C. 4.3×10^3 N m^{-2}.

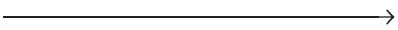
D. 8.5×10^3 N m^{-2}.

Question 8

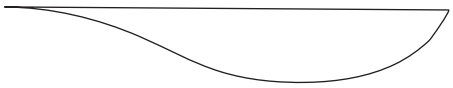
Aerobatic planes have a modified wing design, one that allows them to have the same lift if they are upside down as the right way up.

Which aerofoil design is most likely to be the best for an aerobatic plane?

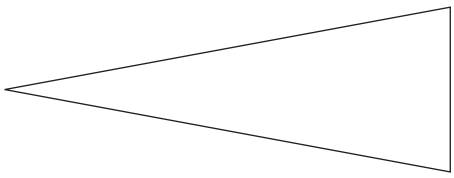
Direction



A.

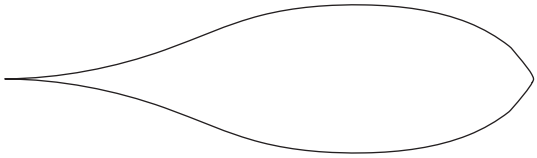


B.



C.

D.



The following information relates to Questions 9 to 11.

The Boeing 747-400 was the first in the jumbo fleet to introduce 'winglets' at the end of the wings. These are upturned wings placed at the end of the main wing. The diagram provided shows the air flow before and after the winglets were installed. As a consequence the fuel efficiency of the 747 improved by around 3.0%. When the plane is flying at a constant cruising speed of 900 km h^{-1}, the thrust produced by each engine (there are four engines) is around 250 kN. The drag at this speed on the plane is approximately 24 kN.

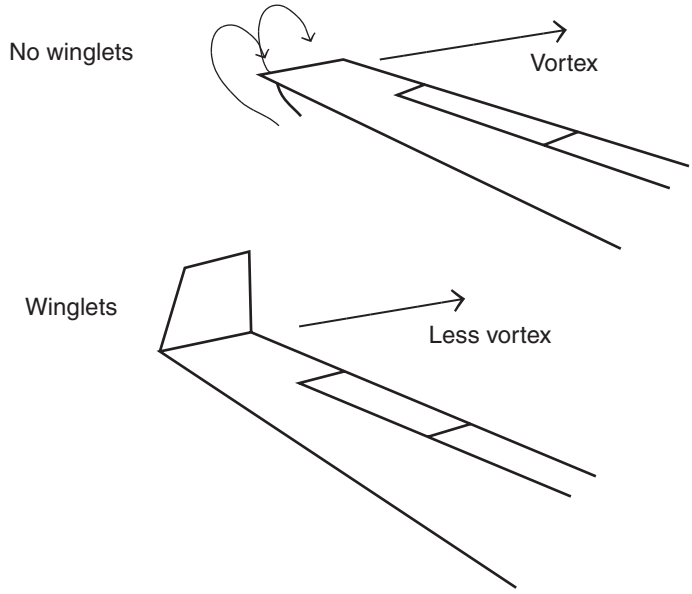


Figure 3

Question 9

The reason why the winglets increase fuel efficiency is that they

A. increase drag.
B. decrease drag.
C. increase thrust.
D. decrease thrust.

Question 10

If the original range of the 747 is approximately 13 000 km, how far extra has the range been extended by the use of winglets?

A. 390 km
B. 13 390 km
C. 39 000 km
D. 4333 km

Question 11

When the 747 is at cruising speed, what is the available power output?

A. 225 000 MW
B. 250 MW
C. 1000 MW
D. 244 MW

Question 12

The 'Mach Number' relates the speed of an object to the speed of sound in the material. It is given by the ratio:

$$\text{mach number} = \frac{\text{speed of object in medium}}{\text{speed of sound in medium}}$$

In air, sound travels at 330 m s^{-1}.

If a jet fighter is travelling at 1300 km h^{-1}, which selection best describes its Mach Number?

A. 1.09
B. 1.00
C. 4.03
D. 0.91

END OF DETAILED STUDY 4 – INVESTIGATIONS: FLIGHT

Detailed study 5 – Investigations: Sustainable energy sources

The following information relates to Questions 1 to 4.

Consider the following energy sources:

1.	Coal	2.	Wind
3.	Oil	4.	Solar
5.	Nuclear	6.	Hydroelectric

Question 1

Which of the options are non-renewable energy sources?

A. 1 and 3
B. 2, 4 and 5
C. 1, 3 and 5
D. 2, 4 and 6

Question 2

Which of the options are fossil fuels?

A. 1 and 3
B. 2, 4 and 5
C. 1, 3 and 5
D. 2, 4 and 6

Question 3

Of the renewable sources of energy, which is most effective during the day time?

A. 1
B. 4
C. 5
D. 6

Question 4

Of the renewable sources of energy, which is currently used the most in Australia?

A. 1
B. 4
C. 5
D. 6

The following information relates to Questions 5 to 6.

Consider the following energy conversions:

Option 1:	Chemical → Electrical
Option 2:	Light → Electrical
Option 3:	Mechanical → Electrical
Option 4:	Nuclear → Electrical
Option 5:	Gravitational → Electrical

Question 5

Which of the following choices would most likely be a battery as used in a torch?

A. Option 1
B. Option 2
C. Option 4
D. Option 5

Question 6

Which of the following choices would most likely use a radioactive material such as Uranium?

A. Option 1
B. Option 2
C. Option 4
D. Option 5

The following information relates to Questions 7 to 8.

Below is a graph showing the power consumption versus the luminosity of a compact fluorescent and an incandescent globe. The luminous flux is a measure of the strength of the light source as perceived by the human eye.

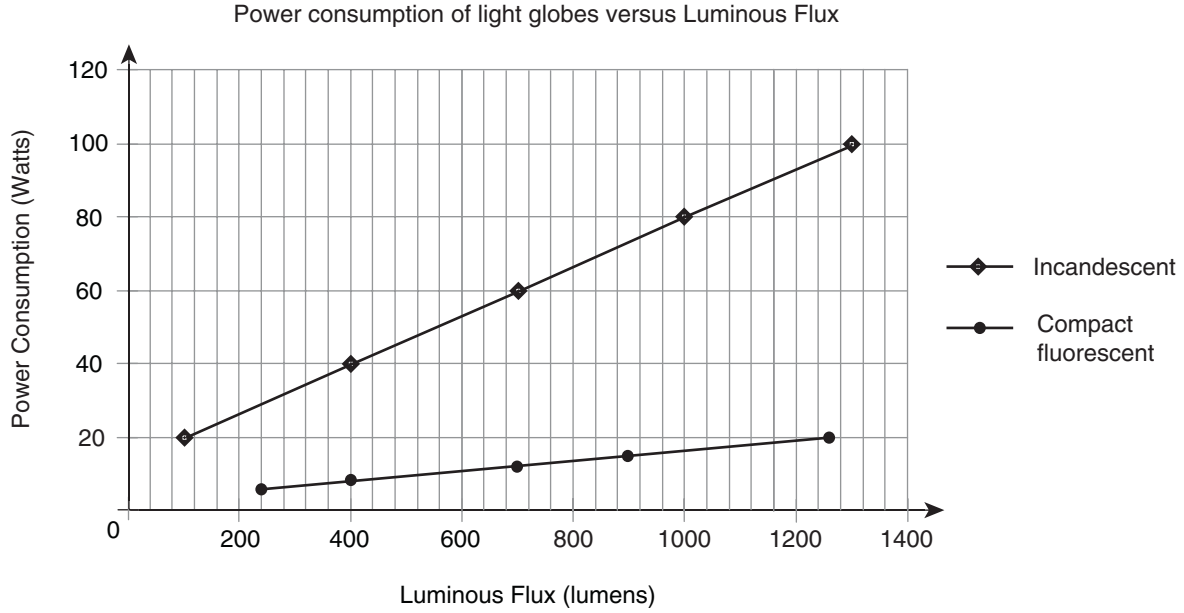


Figure 1

Question 7

A typical incandescent light globe uses 60 Watts of power.

Approximately what percentage does a compact fluorescent save when compared to an incandescent at this power consumption?

A. 17%
B. 83%
C. 10%
D. 60%

Question 8

A theoretically 100% efficient light source would produce 680 lumens per watt. A compact fluorescent produces about 66 lumens per watt.

This gives an efficiency of around

A. 66%.
B. 10%.
C. 90%.
D. 15%.

The following information relates to Questions 9 to 11.

Angelica and Betty are studying the current/voltage characteristics of a 100 cm^2 silicon solar cell. They expose the cell to three different intensities of light. The results are shown in Figure 2.

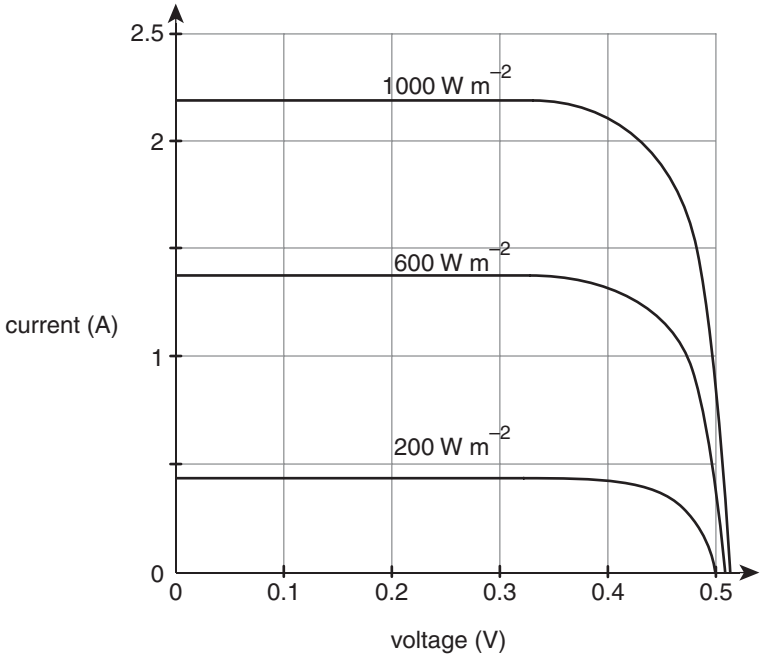


Figure 2

Question 9

What is the maximum power output of the solar cells when under illumination of power 600 W m^{-2}?

A. 600 W
B. 0.54 W
C. 1.25 W
D. 0.45 W

Question 10

When comparing the three graphs, which is most likely to have occurred on a very cloudy day?

A. 200 W m^{-2}
B. 600 W m^{-2}
C. 1000 W m^{-2}
D. cannot be determined

Question 11

Most solar panels are placed facing in a northerly direction when located on homes. The main reason this is the case is because it

A. avoids shade better.
B. has cheaper installation costs.
C. receives less light throughout the day.
D. receives more light throughout the day.

Question 12

Hydroelectric dams uses falling water (potential energy converted into kinetic energy) to spin a turbine to generate electricity. One such turbine has 120 kg per second of water falling through a pipe 45 m high.

What is the power of the water as it hits the turbine? (take $g = 10 \text{ m s}^{-2}$)

A. 54 kW

B. 5400 W

C. 1200 W

D. 450 W

END OF DETAILED STUDY 5 – INVESTIGATIONS: SUSTAINABLE ENERGY SOURCES

Detailed study 6 – Medical Physics

Question 1

A radiologist is making a choice about imaging two different disorders.

Select the best option from the choices below.

	A skeletal abnormality in an unborn baby	A suspected brain tumour in an adult patient
A.	CT scan	Ultrasound
B.	Ultrasound	X-ray
C.	Ultrasound	CT scan
D.	X-ray	CT scan

Question 2

Medical imaging techniques often rely on the partial absorption or reflection of waves.

Which of the following is correct?

A. CT scans rely on reflection of waves.
B. X-ray imaging relies on absorption of waves.
C. Ultrasound relies on absorption of waves.
D. An MRI relies on the reflection of waves.

Question 3

The image of an unborn baby below was made using a technique that

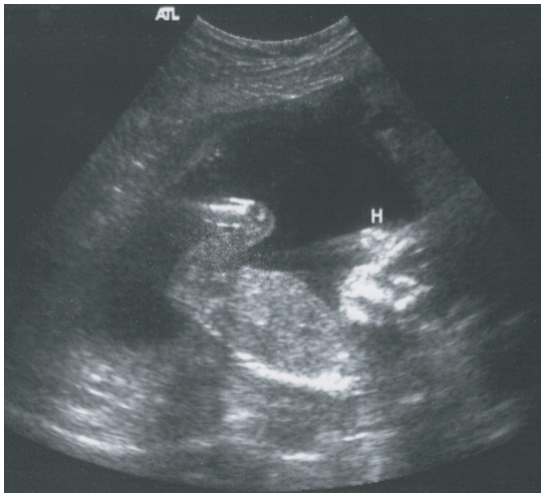


Figure 1

A. used a non-ionising form of electromagnetic radiation.
B. used sound to create the image.
C. X-rays in combination with computers.
D. used laser light as a non-ionising form of radiation.

Question 4

Radioisotopes can be used as a diagnostic tool. Patients ingest the isotope and the radiation can then be tracked by an external sensor.

A suitable choice of isotope would emit

A. alpha radiation because it would cause most ionisation in the body.
B. beta radiation because it would be unable to travel through a large layer of tissue.
C. gamma radiation because it would cause the least ionisation as it emerged from the body.
D. a combination of all three types of nuclear radiation.

Question 5

High energy X-rays can be used to kill tumour cells inside parts of the body, such as the brain, that would be difficult to access in other ways.

X-rays can be used for this purpose because

A. when tumour cells absorb the X-ray it allows for accurate imaging of the tumour.
B. when the X-ray is absorbed by tumour cells it causes fatal damage to the cell.
C. when tumour cells reflect the X-ray it causes fatal damage to the cell.
D. when tumour cells absorb the X-ray it allows for accurate imaging of the tumour.

Question 6

It is possible to have the front of your eyeball, the cornea, reshaped by laser surgery.

Lasers are used for this type of surgery because

A. lasers can be very accurately controlled over very small distances and depths.
B. lasers are capable of transferring large amounts of energy in a very small volume.
C. lasers can be tuned to a variety of different wavelengths.
D. laser flight can travel over large distances.

Question 7

In Magnetic Resonance Imaging (MRI), a large magnetic field is used to cause the alignment of atoms in the body.

The atoms that will align themselves with the external magnetic field are

A. carbon atoms.
B. nitrogen atoms.
C. oxygen atoms.
D. hydrogen atoms.

Question 8

Which one of the following medical imaging techniques makes use of radioactive isotopes?

A. PET
B. MRI
C. CT
D. X-ray

Question 9

Endoscopes make use of optical fibres to illuminate and transmit images from inside the body.

Optical fibres are used because they

A. can transmit light without attenuation.
B. are flexible and can bend in any direction required by the surgeon.
C. are able to carry light of many different wavelengths.
D. are strong and will not easily break while in use.

Question 10

The image produced by an endoscope travels through a 'coherent' bundle of optical fibres.

A coherent bundle of optical fibres is

A. a bundle of optical fibres of exactly the same length.
B. a bundle of optical fibres that remain in exactly the same relative position to each other throughout the bundle.
C. a bundle of optical fibres capable of carrying an image without distortion.
D. All of the above are correct.

Question 11

Endoscopes carry a second bundle of optical fibres that are not coherent.

This second bundle is needed to provide

A. a back-up to the coherent fibres.
B. illumination.
C. additional imaging.
D. a source of highly focussed energy.

Question 12

The image below shows the large intestine of a human patient. The patient was given some porridge, containing Barium, to eat before the image was made.

Figure 2

The image was most likely produced using

A. PET.

B. MRI.

C. Ultrasound.

D. X-ray.

END OF QUESTION AND ANSWER BOOKLET