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2011 Trial Examination

STUDENT NUMBER

Figures										Letter
Words										

PHYSICS

Unit 1 – Written examination 1

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

QUESTION AND ANSWER BOOK

Structure of Book

Section	*Number of questions to be answered*	*Number of marks*
A-Core-Areas of Study		
1. Nuclear physics and radioactivity	15	35
2. Electricity	16	35
B. Detailed Studies		
1. Astronomy OR	10	
2. Astrophysics OR	10	
3. Energy from the nucleus OR	10	20
4. Flight OR	10	
5. Sustainable energy sources OR	10	
6. Medical physics	10	
		Total 90

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, and rulers, up to 2 pages (A4) of prewritten notes and an approved calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out or liquid/tape.

Materials supplied

- Question and answer book of 38 pages (including a multiple choice answer sheet).

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.
- Write your answers in the spaces provided.

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

SECTION A

Instructions for Section A
Answer **all** questions **for both** of the Areas of Study in this section of the paper.
You should take the value of g to be 10 N kg^{-1} and the value of c to be 3×10^{8} ms^{-1}.

Areas of study **Page**

Area of Study 1 – Nuclear Physics and Radioactivity

Question 1
Which of the following ranks α, β and γ radiation in order of decreasing penetration power?

A. $\gamma > \beta > \alpha$
B. $\alpha > \beta > \gamma$
C. $\beta > \gamma > \alpha$
D. $\gamma > \alpha > \beta$

2 marks

Question 2
Which of the following ranks α, β and γ radiation in order of increasing ionising ability?

A. $\gamma > \beta > \alpha$
B. $\alpha > \beta > \gamma$
C. $\beta > \gamma > \alpha$
D. $\gamma > \alpha > \beta$

2 marks

A radioactive isotope of Thorium, identified by the symbol $^{230}_{90}Th$, decays by alpha particle emission.

Question 3
State how many protons and neutrons comprise the Thorium-230 nucleus.

2 marks

Question 4
Write the equation for the nuclear decay of Thorium-230 to its Radium (Ra) daughter nucleus.

3 marks

SECTION A – Area of study 1 – continued
TURN OVER

A radioactive isotope, Strontium-90, is given by the symbol ${}^{90}_{38}Sr$.
Strontium-90 decays via beta emission to form an isotope of Yttrium (chemical symbol Y)

Question 5
Write the equation for the nuclear decay of Strontium-90 to its Yttrium daughter nucleus.

3 marks

Question 6
Briefly describe the changes to the nucleon configuration as Strontium-90 undergoes beta decay.

2 marks

Figure 1 shows a basic Geiger counter (with 2 detectors), which can be used to detect the beta radiation from Strontium-90.

Figure 1 (Image: Wikipedia commons)

Question 7
Briefly describe the operation of the Geiger counter as it detects a beta particle. Your explanation must refer specifically to the type of gas in the enclosed chamber, the location of the electrodes and the result of any ionisation that is achieved by the beta particle.

3 marks

SECTION A – Area of study 1 – continued

Questions 8 to 10 refer to the following information

The most prolific neutron absorbers are the radioactive isotopes of elements that happen to become stable by absorbing **one** neutron.
An example of these is Xenon-135, which itself is produced via the beta decay of Iodine-135.

Question 8
Write an equation for the *neutron absorption* process that stabilises Xenon-135.

2 marks

A phyicist is investigating the properties of a sample of I-135. The radioisotope initially records an activity of 32 kBq and 14 hours later is recorded at 8 kBq.

Question 9
Determin the half-life of I-135 in hours.

hrs

2 marks

According to his documentation, the physicist must wait 28 hrs before the sample is considered "safe" for a further experiment.

Question 10
Calculate the activity rate of the sample after 28 hrs.

kBq

2 marks

SECTION A – Area of study 1 – continued
TURN OVER

The following information applies to Questions 11 to 13

For effective sterilisation, a sample of particularly noxious hazardous waste requires a dose equivalent of 1.5 Sv, which is delivered through the use of fast neutrons which have a quality factor of 4.0. A total of 400 J is absorbed by the material during the sterilisation process.

Question 11
Determine the maximum mass of material that could be sterilised.

kg

4 marks

Question 12
Determine the dose equivalent required to sterilise the same mass (as found in Question 11) if gamma radiation with a quality factor of 1.0 was used instead. Note: The energy absorbed remains constant.

Sv

2 marks

Question 13
State one short term and one long term effect of excessive radiation exposure that the operators of the sterilisation process would need to be aware of and state one measue that would be taken to mitigate this risk.

2 marks

SECTION A – Area of study 1 – continued

Part of the decay chain for Thorium-230 is a multi-step process starting with Radon-220 that eventually reaches stable Lead-208.
This involves **three** alpha decays and **two** beta decays, linking the following isotopes:

$$^{220}_{86}Rn,\ ^{208}_{82}Pb,\ ^{212}_{83}Bi,\ ^{216}_{84}Po,\ ^{212}_{82}Pb,\ ^{212}_{84}Po$$

Question 14
List the order and type of decay from Radon-220 to Lead-208

3 marks

Question 15
Which of the following components of an element is most likely to influence its stability?

A. Number of protons

B. Number of neutrons

C. Number of electrons

D. Number of nuclei

1 mark

END OF AREA OF STUDY 1
SECTION A – continued
TURN OVER

Area of Study 2 – Electricity

Questions 1 to 3 refer to the following information

Figure 1 shows a 6 V DC supply, connected to a combination of ohmic resistors. The current through the unknown resistor is 1.25 A and the battery provides a total of 1.5 A to the circuit.

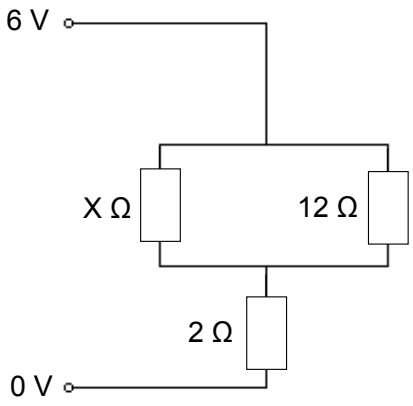


Figure 1

Question 1
Determine the voltage across the 12 **Ω** resistor.

	V

2 marks

Question 2
Determine the total resistance of the circuit.

	Ω

2 marks

SECTION A – Area of study 2 - continued

Question 3
Determine the value of the unknown resistor, X.

	Ω

2 marks

Questions 4 to 6 refer to the following information

Figure 2 shows a basic DC circuit involving a 12 V supply and two 10 W globes.

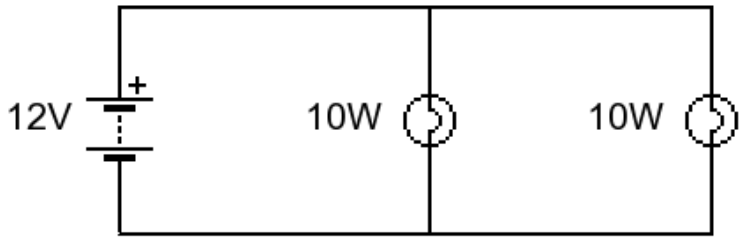


Figure 2

Question 4
Determine the total current in each 10 W globe.

	A

2 marks

Question 5
Determine the rate of flow of charge from the battery per second.

	C

2 marks

SECTION A – Area of study 2 – continued
TURN OVER

Question 6
Determine the total charge provided by the battery over a 2 minute period.

	C

2 marks

Questions 7 to 8 refer to the following information

Figure 3 shows a combined voltage-current graph for two components, A and B.

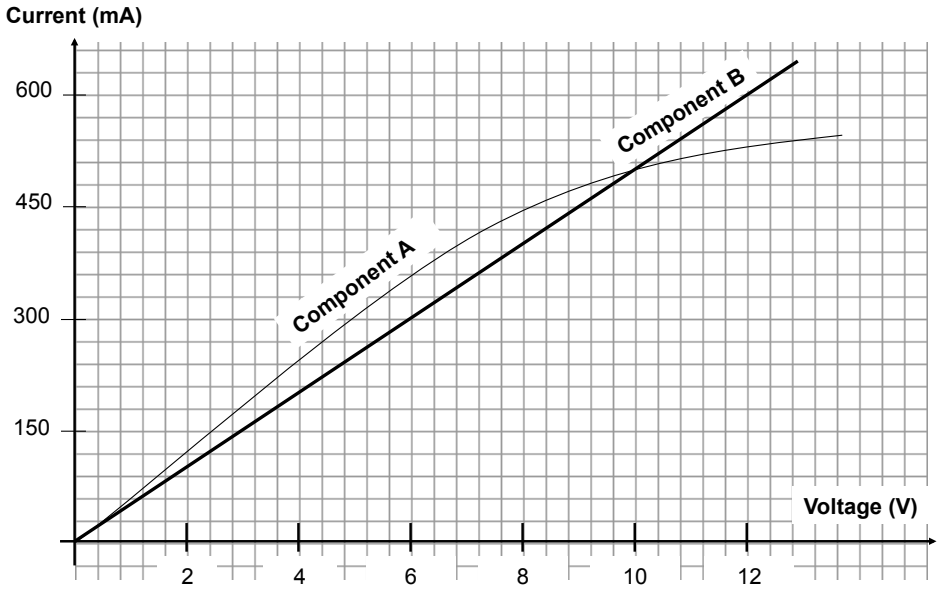


Figure 3

Question 7
Which of the two components could be described as **ohmic**? Explain your answer.

2 marks

SECTION A – Area of study 2 – continued

Components A and B are connected in parallel with a 6 V DC supply.

Question 8
Determine the total current that must be supplied.

A

2 marks

Questions 9 and 10 refer to the following information

Tony has a new heater that costs $2.24 to run for 8 hours. Tony knows he is charged at a rate of $0.14 per kWh for his electricity usage.

Question 9
Determine the total energy used by the heater in joules.

J

2 marks

Question 10
Determine the power rating for the heater.

W

2 marks

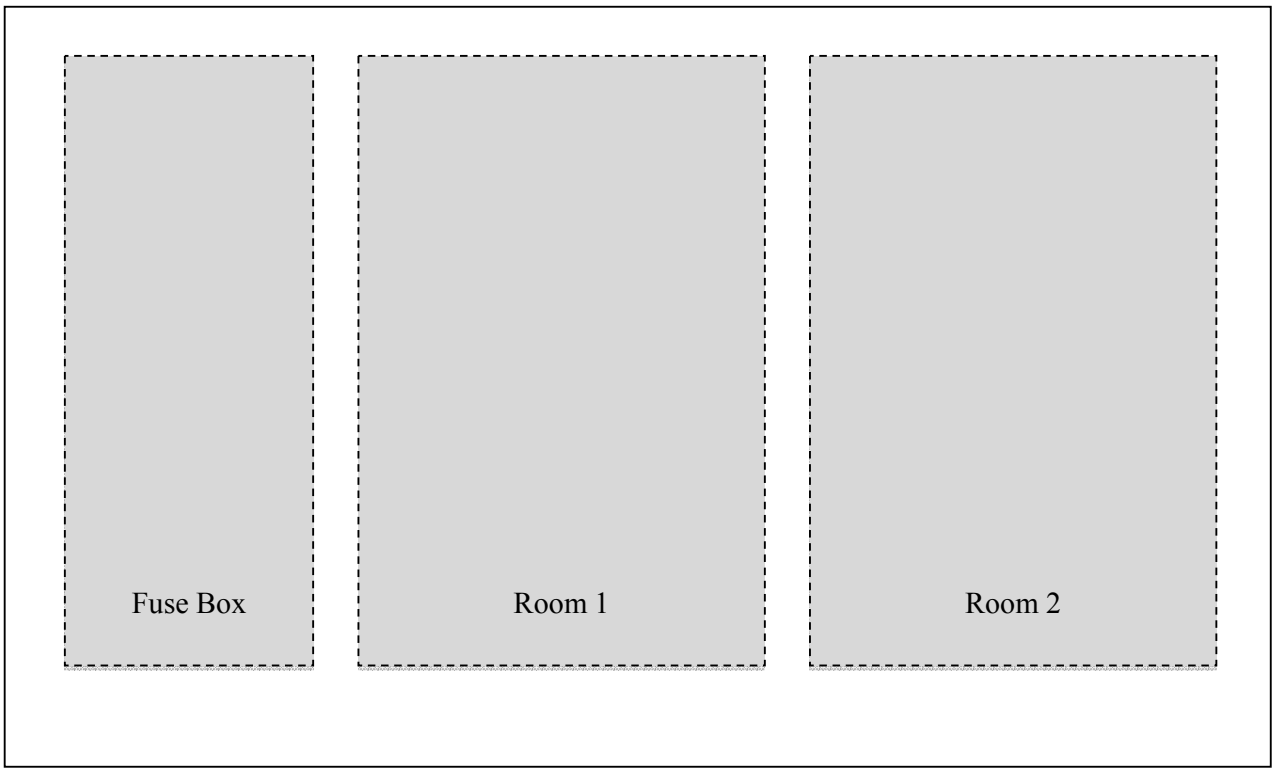
SECTION A – Area of study 2 – continued
TURN OVER

An electrician would like a simple sketch of a household circuit, consisting of the following components:

1. **Fuse box**, showing connection to the external mains supply, a neutral bar and an earth connection.
2. Two rooms connected to the fuse box:
    a. **Room 1**: 1 light, 1 oven (with own circuit breaker at fuse box)
    b. **Room 2**: 1 light, 1 power point (with own circuit breaker at fuse box)

    Note that the two lights should share a circuit breaker.

Question 11
Use the space below to draw a circuit diagram to match the description above.



4 marks

SECTION A – Area of study 2 - continued

Two students are discussing unfortunate accidents that they have witnessed at home.
Student A describes an electric shock of 0.1 sec through a dry left arm.
Student B ponders a similar shock of 0.4 sec through a wet body trunk.

Question 12
Identify the student who is describing the most severe shock and explain why it would be expected to be more life threatening.

2 marks

Questions 13 and 14 refer to the following information

Figure 5 shows a diode circuit.
Figure 6 shows the characteristic curve for the diode.

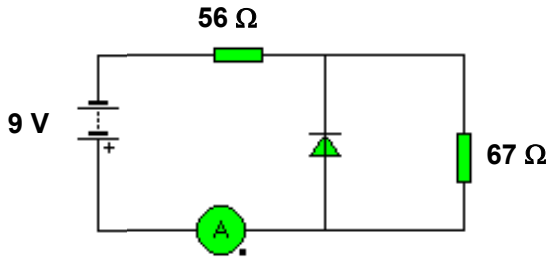


Figure 5

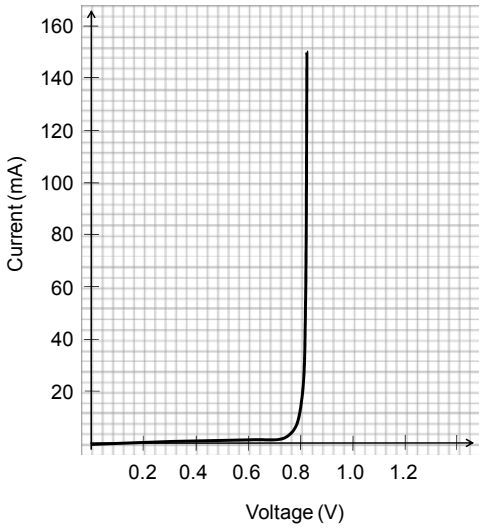


Figure 6

Question 13
Determine the voltage across the 56 **Ω** resistor

V

1 mark

SECTION A – Area of study 2 - continued
TURN OVER

Question 14
Determine the power dissipated by the diode.

W

3 marks

SECTION A – Area of study 2 - continued

Consider the following arrangement of a thermistor and resistor, powered by a 9 V DC source

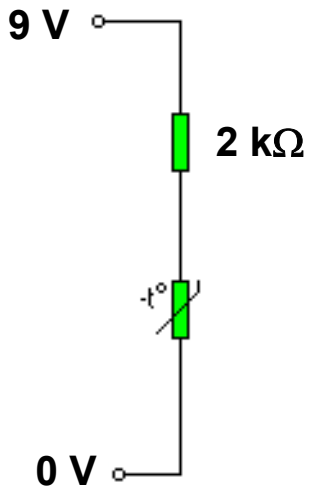


Figure 7

The characteristic curve for the thermistor is shown in Figure 8

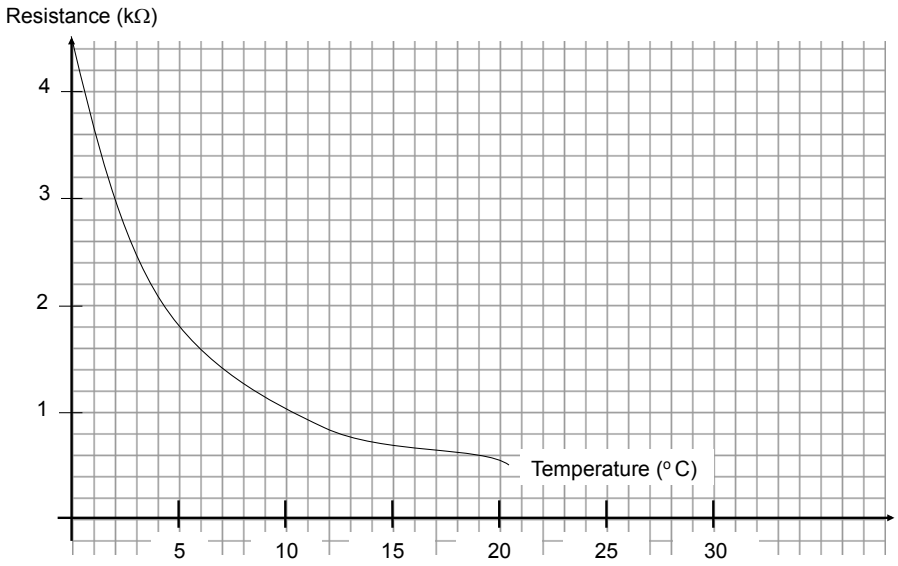


Figure 8.

Question 15
Determine the value of the total current in the circuit if the temperature is 10 °C

2 marks

A

Question 16

If the temperature increases, explain what would happen to the current through and voltage drop across the thermistor.

3 marks

END OF SECTION A

SECTION B

Instructions for Section B

Choose **one** of the following **Detailed Studies**. Answer **all** questions on the Detailed Study you have chosen. You should take the value of g to be 10 N kg^{-1} and the value of c to be 3.0×10^8 ms^{-1}.

There are ten questions for each section. Each question is worth **2 marks**

Detailed study **Page**

Detailed Study 1- Astronomy

Figure 1 shows a star map for the Southern hemisphere, with various constellations highlighted.

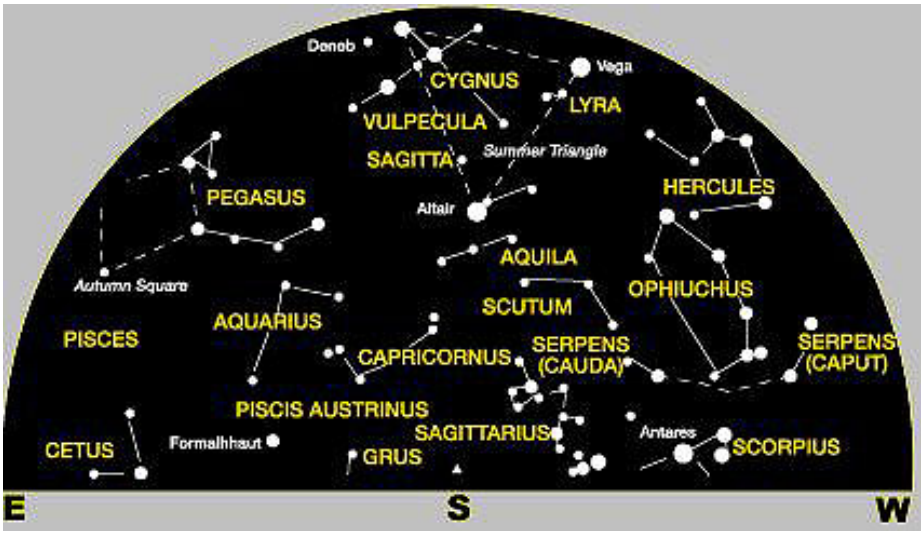


Figure 1: Image: www.nasa.gov

Question 1
Referring to Figure 1, which of the following is closest to the **azimuth** for the centre of the constellation Aquarius?

A. 40^{o}
B. 140^{o}
C. 90^{o}
D. 220^{o}

Question 2
Referring to Figure 1, which of the following is closest to the **altitude** for the centre of the constellation Aquarius?

A. 25^{o}
B. 90^{o}
C. 250^{o}
D. 110^{o}

Question 3
Considering an observer based in Melbourne, what is the term used to describe the point about which all stars in the southern sky appear to rotate?

A. Equinox
B. South Celestial Pole
C. Polaris
D. Zenith

An observer stands at the South Pole.
At 8:00pm, a star is seen at an altitude of 30^o from the horizon.

Question 4
At 2:00am the following morning, the star would be
A. Not visible, as it would be below the horizon
B. Directly overhead
C. On the horizon
D. At an altitude of 30^o

An observer stands in Melbourne, facing due South, in an area with minimal light pollution

Question 5
How many stars would make up the Southern Cross constellation and which would be the brightest?
A. 4 stars, alpha crux brightest
B. 5, epsilon crux brightest
C. 5 stars, alpha crux brightest
D. 5 stars, beta crux brightest

Question 6
What is the fundamental difference between the heliocentric model and Ptolemy's view of the solar system
A. Heliocentric places the Earth at the centre of the solar system, with the planets in orbit around it. Ptolemy places the Sun at the centre.
B. Ptolemy argued that each planet orbited the Sun at the same radius, whilst the heliocentric model allowed for orbits of different radii
C. Ptolemy argued that the Earth and the Sun were the only components of the solar system, whilst the heliocentric model recognised other planets.
D. Heliocentric places the Sun at the centre of the solar system, with the planets in orbit around it. Ptolemy places the Earth at the centre.

Figure 2 below shows a simplified version of a common type of telescope

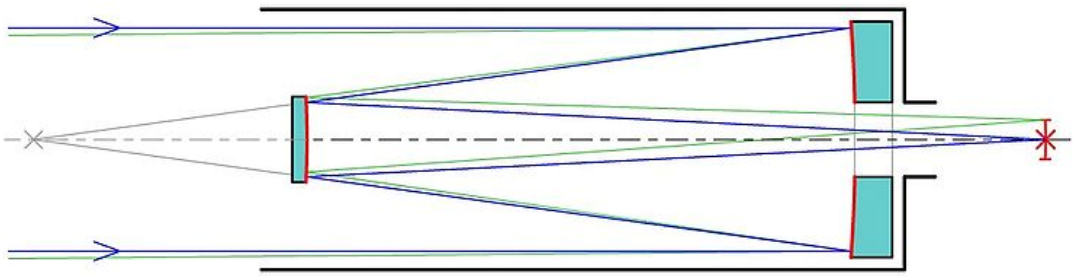


Figure 2: Image: Wikipedia commons. Benutzer: ArtMechanic

Question 7

Which of the following types of telescope would match that in Figure 2?

A. Newtonian
B. Cassegrain
C. Galilean
D. Keplerian

Question 8

Which of the following is true about the value of a radio telescope?

A. Radio telescopes are restricted to detecting electromagnetic radiation from astronomical objects within the AM band.
B. Images produced by radio telescopes have a much greater resolution that other telescopes
C. Radio telescopes make observations across a range of wavelengths from 400 – 700 nm
D. Radio telescopes can be effectively used in arrays to gather sufficient data, overcoming their lower individual resolution.

The following Table 1 applies to Questions 9 and 10.

Object	Absolute magnitude	Apparent magnitude
Star A	1.5	-3.5
Star B	0.6	4.5
Star C	6.7	-1.0
Star D	8.5	12.0

Table 1

Question 9
Which of the Stars in Table 1 would be brightest when viewed from Earth?

A. Star A
B. Star B
C. Star C
D. Star D

Question 10
Which of the Stars in Table 1 has the greatest luminosity?

A. Star A
B. Star B
C. Star C
D. Star D

END OF DETAILED STUDY 1
SECTION B - continued

Detailed Study 2 – Astrophysics

Question 1
Which of the following statements is a correct component of the Steady State Theory of the Universe?

A. The universe looks almost the same at all times and places
B. Earlier in time, galaxies were closer together
C. Intense sources of electromagnetic radiation, such as quasars, would be more prominent earlier in time
D. Cosmic background radiation would remain, due to photons from the early universe which had increased significantly in wavelength

Question 2
The cosmic background radiation discovered in 1965 by Penzias and Wilson is the remains of light from the early history of the universe which has:

A. Decreased in wavelength
B. Increased in wavelength
C. Increased in intensity
D. Increased in frequency

Question 3
When comparing distant galaxies, the furthest galaxies should be:

A. Red shifted more than closer galaxies
B. Blue shifted more than closer galaxies
C. Red shifted less than closer galaxies
D. Blue shifted less than closer galaxies

Questions 4 and 5 refer to the following information

Figure 1 shows a simplified version of the HR diagram. Labels have been used to identify various regions in the figure.

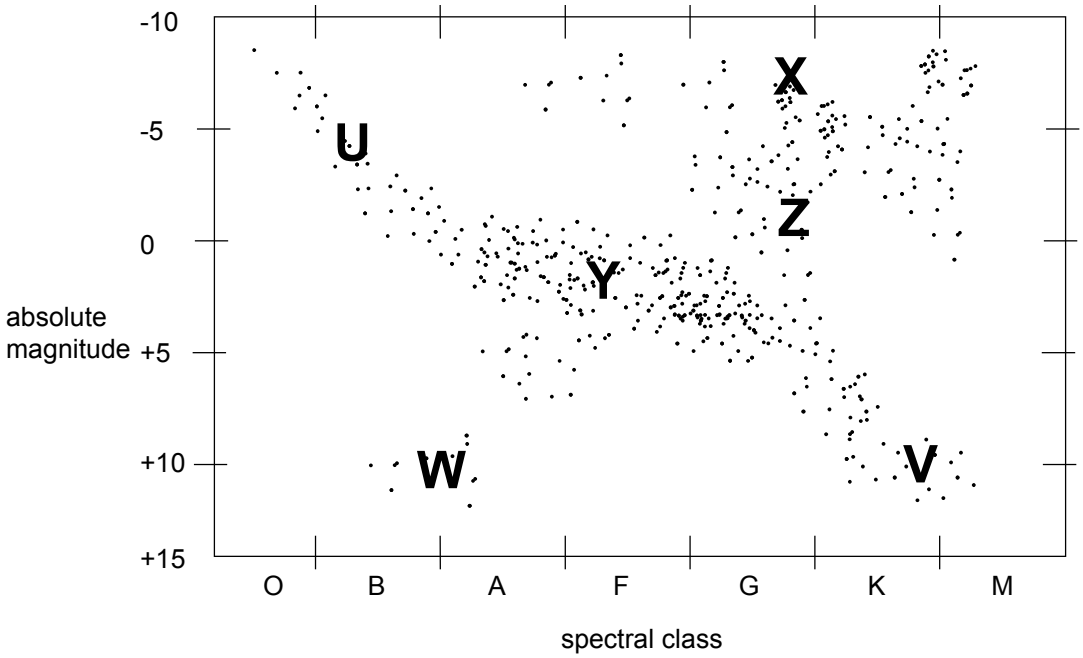


Figure 1

Question 4

Which label indicates the coolest stars?

A. U
B. V
C. W
D. X

Question 5

Which label indicates stars which are the very dense remains of the decay of a red giant? They are often surrounded by a planetary nebula.

A. X
B. Y
C. V
D. W

The parallax method of estimating stellar distances requires astronomers to compare the position of two objects, preferably at six-monthly intervals.

Question 6
Which of the following describes the key characteristics of the two objects?

A. Both objects must be less than 150 l.y. from earth.
B. Both objects must be greater than 150 l.y. from earth.
C. The object being measured must be less than 150 l.y. from earth, whilst the reference point must be significantly further away.
D. The reference point being measured must be less than 150 l.y. from earth, whilst the object being measured must be significantly further away.

Question 7
Which of the following describes the type of star that a white dwarf eventually becomes?

A. Main sequence yellow dwarf
B. Red giant
C. Red dwarf
D. Blue giant

Question 8
Which of the following types of star would be likely to lead to a supernova and residual black hole?

A. Main sequence star with mass 8 times our own sun
B. Main sequence star with mass less than our own sun
C. White dwarf
D. Red dwarf

Figure 2 shows galaxy Abell S740 (centrally), as photographed by the Hubble telescope

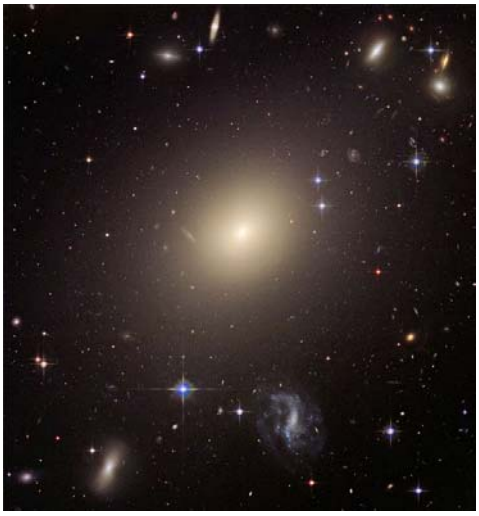


Figure 2: Image: nasa.gov

Question 9
Which of the following best describes the shape of galaxy Abell S740?
A. Elliptical
B. Irregular
C. Barred spiral
D. Disk

Question 10
Which of the following best describe the current state of our Sun?
A. Yellow main sequence
B. Red dwarf
C. White dwarf
D. Yellow giant

END OF DETAILED STUDY 2
SECTION B – continued
TURN OVER

Detailed Study 3 – Energy from the nucleus

Questions 1 to 4 refer to the following information

The equation below shows one of the many reactions that can occur when a slow moving neutron triggers the reaction of a Uranium-235 nucleus

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{236}_{92}U \rightarrow ^{140}_{x}Xe + ^{94}_{38}Sr + 2\,^{1}_{0}n + energy$$

Question 1
The value of ***x*** in the equation must be equal to
A. 52
B. 54
C. 92
D. 141

Question 2
This process is known as
A. Fission
B. Fusion
C. Alpha decay
D. Beta decay

Question 3
Given the average mass difference is 3.7×10^{-28} kg, what would be the expected energy that is released in each reaction?
A. 3.33×10^{-5} MeV
B. 208 MeV
C. 208 eV
D. 3.33×10^{-11} MeV

Question 4
Which of the following best describes the steps necessary to ensure an effective chain reaction takes place?
A. The two escaping neutrons must be increased in energy to ensure they are trigger a reaction in an adjacent U-235 nucleus.
B. The two escaping neutrons must be eliminated, lest they cause a fusion reaction in an adjacent U-235 nucleus
C. The energy must be drawn from the reaction site to prevent a meltdown and explosion of Xe-140 and Sr-94 fragments.
D. The two escaping neutrons must be slowed to ensure they are more likely to trigger a reaction in adjacent U-235 nuclei.

Questions 5 and 6 refer to the following information

One of the key reactions in a deuterium-deuterium reactor is the following between deuterium and helium-3

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

Question 5
Which type of reaction is this?
A. Fusion
B. Fission
C. Beta decay
D. Alpha decay

The energy released by this reaction is approximately 18.3 MeV

Question 6
Which of the following best approximates the energy released, in joules?
A. 2.93 J
B. 18.3×10^{-13} J
C. 18.3×10^{-19} J
D. 2.93×10^{-12} J

In order for this process to occur, the particles involved must overcome the electrostatic force..

Question 7
Which of the following best describes this effect?
A. The particles must overcome electrostatic attraction to move close enough for the strong nuclear force to take over.
B. The particles must overcome electrostatic repulsion to move close enough for the weak nuclear force to take over.
C. The particles must overcome electrostatic repulsion to move close enough for gravity to take over
D. The particles must overcome electrostatic repulsion to move close enough for the strong nuclear force to take over.

Questions 8 to 10 refer to the following information

Figure 1 shows a greatly simplified diagram of the core of a conventional fission reactor.

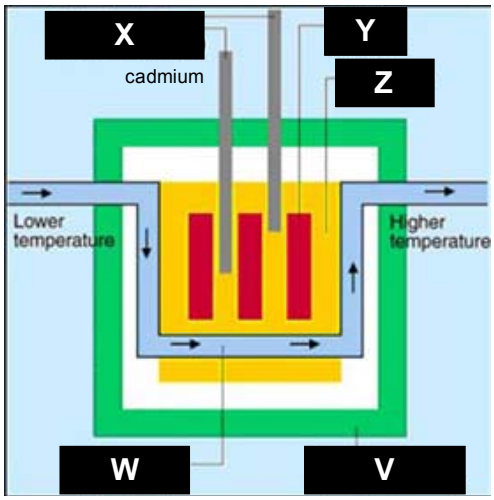


Figure 1

Question 8
Which component is identified by label Y?
A. Control rods
B. Fuel rods
C. Moderator
D. Coolant

Question 9
What is the function of component X?
A. Capture neutrons resulting from fission to control the rate of the chain reaction
B. Reduces the speed of fast moving neutrons so they may trigger fission in other U-235 nuclei
C. Contain pure U-235 for fission
D. Regulates the temperature of the reaction by capturing slow moving neutrons.

Question 10
Which of the following explains the enrichment of natural uranium ore for use in a light water reactor?
A. The uranium ore must be enriched from a naturally occurring 97% U-235 up to ~ 99% U-235 for effective fission
B. The uranium ore must be enriched from a naturally occurring 0.7% U-235 up to ~ 97% U-235 for effective fission
C. The uranium ore must be enriched from a naturally occurring 50% U-235 up to ~ 80% U-235 for effective fission
D. The uranium ore must be enriched from a naturally occurring 0.7% U-235 up to ~ 3% U-235 for effective fission

END OF DETAILED STUDY 3
SECTION B - continued

Detailed Study 4 – Flight

Questions 1 to 3 refer to the following information

Figure 1 shows an aircraft which must be trimmed for level flight.
C_G represents the centre of gravity.
The plane has a mass of 1.3×10^4 kg.
Each of its two engines produces 85 kN of thrust.

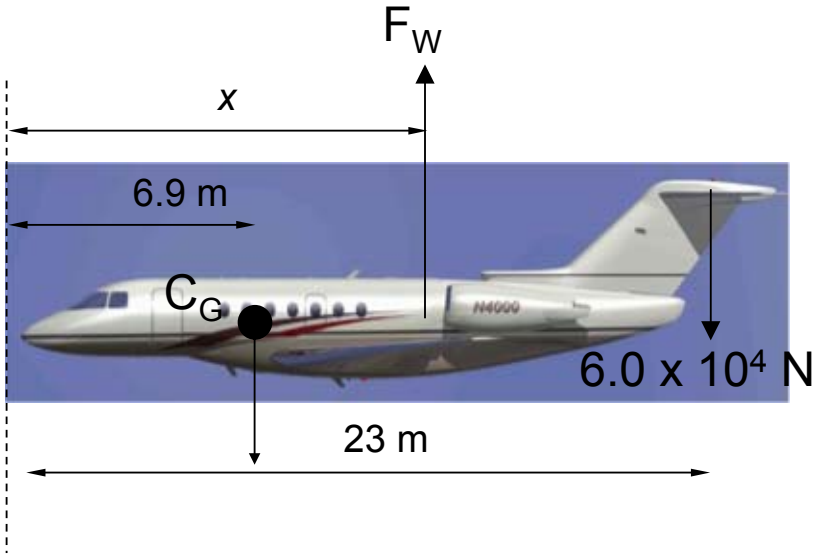


Figure 1

Question 1
Determine the size of force provided by the main wing, F_W:
A. 1.9 kN
B. 1.3×10^5 N
C. 1.9×10^5 N
D. 1.3 kN

Question 2
Which of the following is closest to the distance from the nose of the aircraft to the centre of the wing (where F_W acts)
A. 11.5 m
B. 13.8 m
C. 10.0 m
D. 12.0 m

Question 3
If the plane is cruising at a speed of 950 kmh^{-1}, which of the following is closest to the total drag acting on the plane?
A. 85 kN
B. 170 kN
C. 0 N
D. 340 kN

Question 4
Which of the following statements is true about the angle of attack required for take off?
A. The angle of attack must be decreased, but not so much as to stall the wing
B. The angle of attack must be increased, but not so much as to stall the wing
C. The angle of attack must be increased and take off will only occur once the wing is stalled.
D. The angle of attack must be decreased until the wing stalls.

Bernoulli's principle can be expressed as:
For a given height, $\frac{1}{2}\rho v^2 + P =$ constant

Question 5
Which of the following describes the effect of constricting a fluid flow by reducing the cross-sectional area?
A. Speed is increased and pressure decreases
B. Speed and pressure both increase
C. Speed and pressure both decrease
D. Speed is decreased and pressure decreases

Question 6
Which of the following types of drag is unavoidable due to the orientation of the wing lift force
A. Skin friction drag
B. Pressure (form) drag
C. Induced drag
D. Thrust drag

Question 7
Which of the following types of drag will be primarily reduced by ensuring a laminar boundary layer along the surface of the fuselage?
A. Skin friction drag
B. Pressure (form) drag
C. Induced drag
D. Thrust drag

Question 8
Which of the following types of drag will be primarily reduced by focusing on the streamlining of the aircraft by removing unnecessary objects from the fuselage?
A. Skin friction drag
B. Pressure (form) drag
C. Induced drag
D. Thrust drag

Question 9

Which of the following best explains the role of the **rudder** in the control of an aircraft?

A. It controls the yaw of the aircraft by modifying the airflow around the tail plane

B. It controls the roll of the aircraft by modifying the airflow over the trailing edge of the wings

C. It controls the pitch of the aircraft by modifying the airflow about the tail of the plane

D. It controls the pitch of the aircraft by modifying the airflow about the elevator

Question 10

Which of the following best describes jet engine thrust in terms of Newton's Third Law?

A. Hot gases are propelled backwards and the surrounding air is pushed backwards as well

B. Hot exhaust gases are propelled backwards and the surrounding air opposes with a force in the opposite direction to push the aircraft forward

C. The thrust force multiplied by the mass of the aircraft yields an acceleration

D. Inertia dictates that any thrust will continue to push the aircraft forwards.

END OF DETAILED STUDY 4
SECTION B - continued

Detailed Study 5 –Sustainable Energy Sources

Question 1
Which of the following is *false* about a **renewable** energy source?
A. It is not readily depleted and remains replaceable
B. It is not expected to deplete through constant use
C. It cannot be readily replaced or grown within a relatively short period of time
D. It includes solar, wind and wave power generation

Question 2
Which of the following is *false* about a sustainable energy source?
A. Must meet the needs of the current generation
B. Must not compromise the needs of future generations
C. Must be depleted within 20 years
D. Must have an overall neutral (at least) effect in social, environmental and economic terms.

Questions 3 and 4 refer to the following information

A hydroelectric energy solution involved 2 ML of water falling in 30 seconds. The total energy available is 1.2×10^9 J
Assume 1 kg L^{-1} for water and g = 10 N kg^{-1}

Question 3
The height through which the water falls must be closest to:
A. 0.6 m
B. 6 m
C. 60 m
D. 600 m

The generator used to complete the energy transformation into electricity produces 33 MW.

Question 4
Which of the following best approximates the efficiency of the system?
A. 8.3%
B. 83%
C. 17%
D. 1.7%

Questions 5 to 7 refer to the following information

A 15 W compact fluorescent globe is connected for 3 hours.
The globe is known to be 14% efficient when converting electrical energy to light

Question 5
Which of the following is closest to the amount of light energy emitted over 3 hours?
A. 2.3 kJ
B. 23 kJ
C. 162 kJ
D. 1.16 MJ

Compact fluorescent globes are on average 4 times more efficient than an incandescent globe in terms of their light output per watt.

Question 6
Which of the following would best describe the major source of difference in the two modes of light production?
A. Sound
B. Kinetic energy
C. Potential energy
D. Heat energy

Question 7
Which of the following best describes the energy transformations that have occurred during the lighting process with a compact fluorescent globe?
A. Electrical → Light (& Heat)
B. Light → Electrical (& Heat)
C. Light (& Heat) → Electrical
D. Electrical (& Heat) → Light

Questions 8 to 10 refer to the following information

A solar hot water system is operating on a household rooftop.
Heating 1 L of water by $1^{o}C$ requires 4.2 kJ of solar energy.
Solar energy is incident at 500 W m^{-2} on a sunny day.
5 m^{-2} of panels are used.
Overall the system heats water with an efficiency of 70%

Question 8
How long would it take for 9 MJ to be incident upon the panels?
A. 1 min
B. 1 day
C. 1 hour
D. 10 hours

Question 9
Based on the efficiency of the system, how many litres of water could be heated by 1^{o} C over one hour?

A. 2.14 L
B. 1500 L
C. 214 L
D. 21.4 L

Question 10
In order to provide useful hot water at 40 ^{o}C (assume tap water at 18 ^{o}C), what size tank could be heated over **two** hours?

A. 870 L
B. 1950 L
C. 87 L
D. 136 L

END OF DETAILED STUDY 5

Detailed Study 6 – Medical Physics

Question 1
Which of the following best describes why isotopes which emit gamma radiation are preferred to other radioisotopes for diagnostic purposes?

A. Alpha emitters do not ionise readily enough
B. Beta emitters penetrate furthest, but do not ionise as they are negatively charged
C. Gamma radiation is the heaviest type and thus most reliable
D. Gamma radiation penetrates furthest and can thus be detected outside the body.

Question 2
Which type of fibre would be most suitable for providing a light source to aid an internal procedure?

A. Hollow tube of reflective plastic
B. Incoherent bundle of fibres
C. Coherent single mode fibre
D. Incoherent single mode fibre

Question 3
Why is excessive exposure to X-radiation harmful for human patients?

A. X-radiation can cause electrons to be removed from atoms or molecules in a process we know as mutation
B. X-radiation can cause electrons to be removed from atoms or molecules in a process we know as ionisation
C. X-radiation can cause neutrons to be removed from atoms or molecules in a process we know as transmutation.
D. X-radiation can cause protons to be removed from atoms or molecules in a process we know as ionisation.

Question 4
Which of the following best explains why 3 – 5 MHz is a suitable frequency for a liver ultrasound?

A. This frequency penetrates most effectively to gain images of internal organs
B. Lower frequencies are too intense and penetrate too far into the body
C. Liver is a special type of tissue that will not be penetrated with higher frequencies
D. High frequencies are absorbed by the skin and thus do not produce accurate images

Question 5
An ultrasound transducer is designed to…

A. Both produce and detect resonation of hydrogen atoms in a tissue sample
B. Only produce high frequency signals through piezoelectric vibration
C. Only detect high frequency signals through piezoelectric vibration
D. Both produce and detect piezoelectric vibrations

Question 6
Why would an ultrasound scan be unsuitable for a detailed image of an adult brain?
A. Ultrasound radiation is too dangerous for the brain as it will damage tissue
B. Ultrasound radiation tends to reflect at the tissue/bone interface
C. The brain is too large for an ultrasound transducer to map
D. Ultrasound radiation is too low in frequency to be useful for brain imaging.

Question 7
Which of the following is true about computed axial tomography (CAT) scanning?
A. CAT scanning uses X-radiation which is raised and lowered above a patient to obtain an image of the cross section of the body.
B. CAT scanning uses radioisotopes which are rotated around a patient to obtain an image of the cross section of the body.
C. CAT scanning uses X-radiation which is rotated around a patient to obtain an image of the surface of the body.
D. CAT scanning uses X-radiation which is rotated around a patient to obtain an image of the cross section of the body.

Question 8
Which of the following characteristics is FALSE regarding the use of lasers in surgery?
A. Lasers have high intensity, making them ideal for cutting through living tissue
B. Lasers have high divergence, allowing them to target a wide area effectively.
C. Lasers have a narrow range of wavelengths, so specific lasers can be selected for particular tasks
D. Lasers can be easily guided by optic fibre to the site of the surgery

Question 9
Which of the following best describes part of the image formation process used in Magnetic Resonance Imaging (MRI)?
A. A strong magnetic field is beamed into the patient and protons reflect back the radiation which is then mapped
B. Protons release a range of RF pulses when the magnetic field is switched off
C. Electrons release a range of RF pulses when the magnetic field is switched on
D. Protons resonate when nearby hydrogen atoms are heated by the magnet

Question 10
Which of the following describes the formation of a positron used in Positron Emission Tomography (PET)?
A. A neutron disintegrates into a proton and positron
B. A neutron disintegrates into an electron and positron
C. A proton disintegrates into a neutron and positron
D. An electron disintegrates into a neutron and positron

END OF QUESTION AND ANSWER BOOK

DATA SHEET

Radioactivity	Electricity
Absorbed Dose = $\frac{Energy}{Mass}$	Electric current = $I = \frac{q}{t}$
Dose Equivalent = Absorbed Dose x Quality Factor	Resistance = $R = \frac{V}{I}$
Half Life: $N = N_0 \times 0.5^{\frac{t}{t_{half}}}$	Power transferred = $P = VI = \frac{V^2}{R} = I^2 R$
Astrophysics	Resistors in series: $R_{total} = R_1 + R_2 + ...$
Speed of light in a vacuum: c = 3 x 10^8 ms^{-1}	Resistors in parallel: $\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} .....$
Parallax angle: $\theta = \frac{1}{d}$	AC voltages: $V_{peak} = \sqrt{2} \times V$ RMS Frequency and period: $f = \frac{1}{T}$
Einstein's Equation: $E = \Delta mc^2$	**Alternative Energy Sources**
1 parsec = 3.086 x 10^{16} m	Efficiency (%) = $\frac{Useful\_energy\_output}{Energy\_input} \times 100$
1 AU = 1.50 x 10^{11} m	Pressure = $\frac{force}{area}$
1 amu = 1.7 x 10^{-27} kg	
Aerospace	**Nuclear Energy**
Power: $P = \frac{E}{t}$ or $P = Fv$	q = 1.6 x 10^{-19} C
Continuity: $Q = v_1 A_1 = v_2 A_2$	
Bernoulli: $\frac{1}{2}\rho {v_1}^2 + \rho g h_1 + P_1 = \frac{1}{2}\rho {v_2}^2 + \rho g h_2 + P_2$	
Torque: $\tau = Fd$	

Prefixes

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

SECTION B – DETAILED STUDY ANSWER SHEET

Detailed Study Attempted – Please tick appropriate box

1. Astronomy	
2. Astrophysics	
3. Energy from the Nucleus	
4. Flight	
5. Sustainable Energy Sources	
6. Medical Physics	

Answers – Circle ONE of A-D for each of the ten multiple choice questions.

Question	Answer			
1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D