Neap:

Trial Examination 2013

VCE Physics Unit 2

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. Motion	3	3	38
2. Wave-like properties of light	8	8	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 37 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.

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.

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

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

Areas of study **Page**

Motion 3

Wave-like properties of light 8

Area of study 1 – Motion

Question 1 (17 marks)

Steven, a bungee jumper, steps from a high bridge and falls freely for 2.5 s after which the bungee cord begins to exert an upward force. Ignore the effects of air resistance.

a. Calculate the distance Steven falls during the first 2.5 seconds. 2 marks

m

b. What is Steven's vertical velocity after 2.5 s? 2 marks

m s^{-1}

c. Sketch a velocity versus time graph of Steven's velocity from the start of the jump until Steven reaches the lowest point. On your graph clearly mark the point (s) where the net force on Steven is zero with an 'X'. There is no need to include values on the axis of your graph. 3 marks

Steven weighs 650 N.

d. Calculate Steven's mass. 1 mark

kg

The bungee cord can be modelled as an ideal spring. The mass of the bungee cord can be ignored.

e. At the lowest point during the hump, Steven is 60 m below the starting point.

Calculate the energy stored in the bungee cord when Steven reaches the lowest point of his jump. 2 marks

J

f. Calculate the spring constant of the bungee cord. 3 marks

$N\ m^{-1}$

g. Draw suitable vector(s) on Figure 1 below to represent the force(s) on Steven at the lowest point of his jump. 2 marks

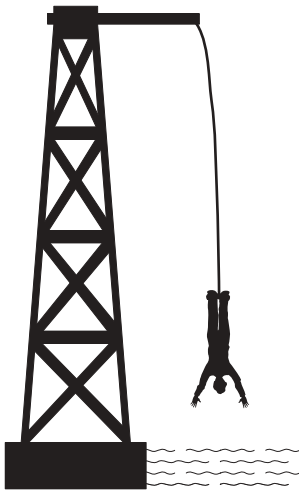


Figure 1

h. Describe what is happening to Steven when he is at his lowest point in terms of his

i. velocity 1 mark

_____

_____

ii. acceleration 1 mark

_____

_____

Question 2 (11 marks)

In October 2012, Felix Baumgartner broke the record of the highest free-fall jump in history. In this question, 'free fall' refers to the period of Felix's descent prior to the opening of his parachute.

Statistics of the event are as follows:

- Exit altitude: 39 km
- Total jump duration: 9 minutes
- Free fall time: 3 minutes 45 seconds
- Free fall distance: 36.5 km
- Maximum velocity: 1170 km h^{-1}
- Felix's mass: 73 kg

a. Calculate Felix's average speed during the jump. 2 marks

$m\ s^{-1}$

The maximum velocity is also Felix's terminal velocity.

b. Explain what is meant by the term 'terminal velocity'. In your answer you must refer to the forces acting on Felix during this time. 2 marks

c. Calculate the average acceleration during the period of free fall. 2 marks

$m\ s^{-2}$

d. At what point during Felix's jump would he have encountered the largest downward acceleration? Explain your answer. 2 marks

Assume that Felix reaches a downward velocity of 0 m s^{-1} just before he touches down on the ground.

e. Calculate the magnitude of the average force exerted on Felix by his parachute from the time directly after it was deployed until the moment he hits the ground. 3 marks

N

Question 3 (10 marks)

The record for the highest ever speed achieved by serving a standard 60 g tennis ball currently stands at 263 km h^{-1}, or 73 m s^{-1}. The feat was achieved by Samuel Groth in 2012.

a. Calculate the magnitude of the momentum of the tennis ball at that record speed. 2 marks

kg m s^{-1}

b. What was the power exerted by Groth if we assume that the impact with the tennis ball took 0.15 s? You can ignore the speed of the racket itself. 2 marks

W

c. The tennis ball bounces against a wall and rebounds with the same speed.

Calculate the magnitude of the impulse exerted by the wall on the ball. 2 marks

N m^{-1}

d. Explain why, during the collision of the ball with the wall, the law of conservation of momentum still holds. 2 marks

_____

_____

_____

During the collision with the wall the tennis ball is flattened, as shown in Figure 2 below.

ball before collison ball during collison

Figure 2

e. Using Newton's third law, explain the appearance of the ball during the collision. 2 marks

_____

_____

_____

Area of study 2 – Wave-like properties of light

Question 1 (1 mark)

A 'wave' such as a water wave can be best described as

A. the transfer of matter without the net transfer of energy.
B. the transfer of energy without the net transfer of matter.
C. the transfer of force without the net transfer of energy.
D. the transfer of matter without the net transfer of force.

Question 2 (3 marks)

A slinky like that shown in Figure 1 can be used to demonstrate two types of waves.

Figure 1

Explain in the space provided below the two types of waves that can be produced. Space has been left to draw diagrams to help aid you explanation.

Question 3 (7 marks)

Nick is investigating the wave properties of water using a ripple tank. The tank has a plane-wave generator that creates waves in the tank. He takes a snapshot of the ripple tank 0.5 seconds after the generator has started, as shown in Figure 2.

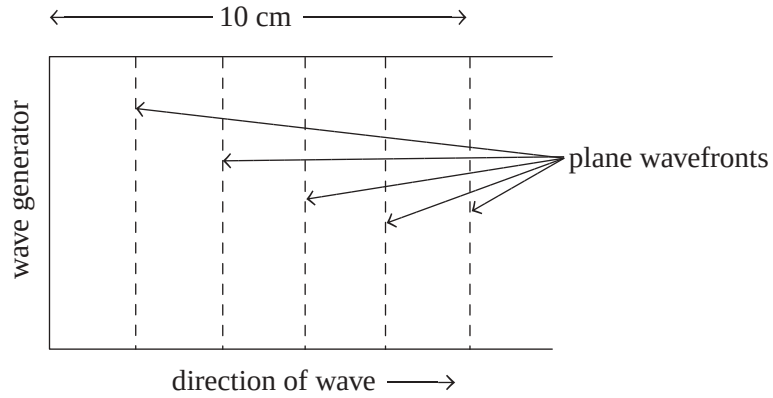


Figure 2

a. What is the wavelength of the waves? 1 mark

cm

b. What is the frequency of the waves? 2 marks

Hz

c. Calculate the speed of the water waves. 1 mark

cm s^{-1}

d. If the water wave is viewed side-on it looks like Figure 3 below.

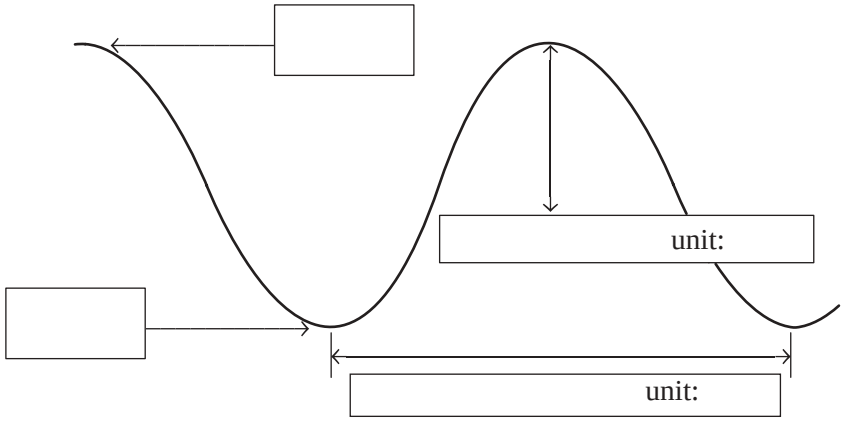


Figure 3

Using the information provided, fill in the blank spaces in Figure 3 with the given words below and their correct unit. Note there are more words provided than blank spaces. 3 marks

Words: *wavelength, period, frequency, amplitude, peak, trough, velocity*

Question 4 (6 marks)

A white light ray enters a water droplet as shown in Figure 4. The dotted-line rays represent the splitting of the white light into the two outermost colours, red and deep blue (note that there are the other colours of the visible spectrum in between).

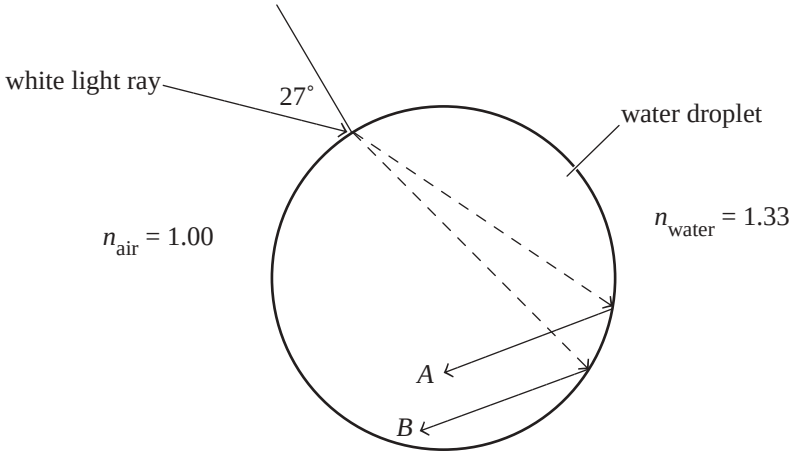


Figure 4

a. Explain why the white light ray has split into different colours. 2 marks

_____

_____

_____

_____

b. Explain what has occurred to produce the rays labelled *A* and *B* in Figure 4. In your explanation refer to how angles may play an important role in this process. 2 marks

_____

_____

_____

_____

c. If the incident angle of the white light ray is 27.0°, calculate the refractive angle of the red light ray. The refractive index of water for red light is 1.331 and air is 1.00. 2 marks

	°

Question 5 (3 marks)

Figure 5(a) shows a naked fibre (surrounded by air) while Figure 5(b) shows a fibre with 'cladding'.

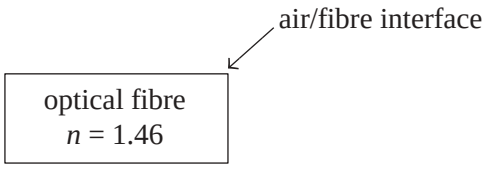


Figure 5(a)

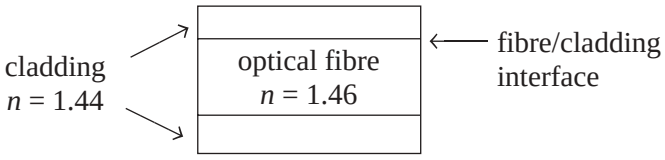


Figure 5(b)

Show, with calculations, how much the cladding increases the critical angle by for the optical fibre interface. Take the refractive index of air to be 1.00.

increase in critical angle	°

Question 6 (2 marks)

Both the particle model and wave model can describe some of the ways light behaves.

Fill in the table below with either a ✓ if the model can describe the behaviour or a ✗ if it cannot.

	Particle model	**Wave model**
Reflection		
Refraction		

Question 7 (2 marks)

In DVD players the wavelength of the laser used to read discs is approximately red in colour, while for a Blu-ray player the wavelength is in the blue end of the visible spectrum.

Which of the following statements is correct?

A. The frequency used in Blu-ray players is shorter than in DVD. Red light travels faster than blue light.

B. The frequency used in DVD players is shorter than in Blu-ray. Blue light travels faster than red light.

C. The frequency used in Blu-ray players is shorter than in DVD. Both travel at the same speed.

D. The frequency used in DVD players is shorter than in Blu-ray. Both travel at the same speed.

Question 8 (4 marks)

Hannah and Matt are investigating colour filters. They first shine a white light source on a blue sheet of paper.

a. Explain how the paper appears blue. 2 marks

Hannah and Matt then put a blue filter between the light and paper, as shown in Figure 6.

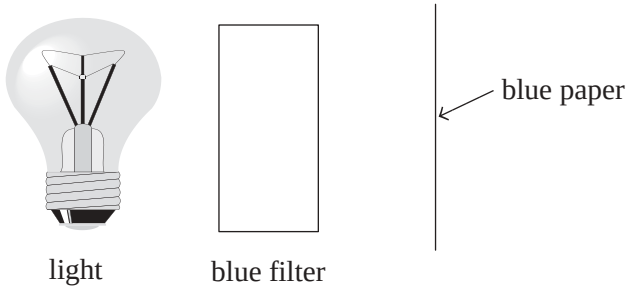


Figure 6

Matt predicts that the blue paper should appear black while Hannah disagrees and thinks it will still appear blue.

b. Explain who you think is correct. 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 $10\ \text{m s}^{-2}$

Detailed study **Page**

Detailed study 1: Astronomy. 15

Detailed study 2: Astrophysics 19

Detailed study 3: Energy from the nucleus 23

Detailed study 4: Investigations: Flight. 27

Detailed study 5: Investigations: Sustainable energy sources 31

Detailed study 6: Medical physics 34

Detailed study 1 – Astronomy

Question 1

The stars of the Southern Cross are an example of a constellation.

Which of the following is true for the stars of the Southern Cross?

A. These stars are close together.
B. These stars are about the same distance from the earth.
C. These stars form the same pattern regardless of from where in the galaxy we observe them.
D. These stars only make the Southern Cross shape when observed from Earth.

Question 2

A sidereal day is the time between seeing star 'X' in exactly the same position two nights running.

A sidereal day

A. is exactly 24 hours long.
B. is slightly less than 24 hours long.
C. is slightly more than 24 hours long.
D. varies according to the time of year.

Question 3

Standing on the geographical South Pole you would observe

A. that all stars rise in the West and set in the East 12 hours later.
B. that all stars would make circular paths parallel to the horizon.
C. the Southern Cross at the Zenith.
D. different stars at the Zenith every night.

Question 4

Melbourne is situated 38° South of the equator.

This means that in Melbourne the South Celestial Pole is

A. invisible.
B. observed at the Zenith.
C. observed at an altitude of 38°.
D. observed at an altitude of 52°.

Question 5

One piece of evidence for the heliocentric (Copernican) model of the solar system is

A. the moon shows different phases.
B. the Sun rotates around its own axis, as observed by looking at sunspots.
C. Mercury and Venus show different phases but the outer planets do not.
D. Mars, and other planets, show retrograde motion.

Question 6

Figure 1

The Moon is always facing the same way towards us, so that we always see the same craters, mountains and valleys on its surface. We can never see the far side of the Moon.

This is because

A. the Moon does not rotate around its own axis.

B. the Moon's rotation around its axis has exactly the same period as its orbital rotation around the Earth.

C. the Earth does not rotate around the Moon.

D. the Earth's rotation around its axis has exactly the same period as the Moon's orbital rotation around the Earth.

Question 7

Figure 2

On Figure 2 you can see the Southern Cross constellation. At the bottom left of the Southern Cross there is a dark area in the sky called the 'Coal Sack Nebula'.

This dark area

A. is an area with less bright stars when compared to the surrounding sky.

B. is caused by a dirty or faulty telescope.

C. contains a large amount of cool dust and gas which blocks the light from stars behind it.

D. is an example of a black hole.

Use the following information to answer Questions 8 to 10.

A simple telescope is made from two convex lenses. Its magnification can be calculated by the following formula

$$M = \frac{f_{\text{objective}}}{f_{\text{eyepiece}}}$$

Question 8

The telescope described above is an example of

A. a refracting telescope.
B. a reflecting telescope.
C. a Newtonian telescope.
D. a Galilean telescope.

Question 9

If you want to achieve a magnification of 15, and the telescope has an objective lens of f = 75 mm, which of the following would you need to choose for the eyepiece?

A. a convex lens of f =1125 mm
B. a convex lens of f = 5 mm
C. a concave lens of f = 1125 mm
D. a concave lens of f = 0.2 mm

Question 10

To improve the amount of detail that can be seen you should chose a telescope with a

A. greater magnification.
B. greater length.
C. greater eyepiece diameter.
D. greater objective diameter.

Question 11

Modern telescopes usually have an ‘electronic data collection system’.

This means that

A. the telescope’s movement is electronically controlled.
B. the telescope’s focus is electronically controlled.
C. the telescope’s magnification can be electronically changed.
D. the telescope’s image is electronically recorded.

Question 12

The graph in Figure 3 shows the opacity of the Earth's atmosphere. 100% means that no light can penetrate through the atmosphere

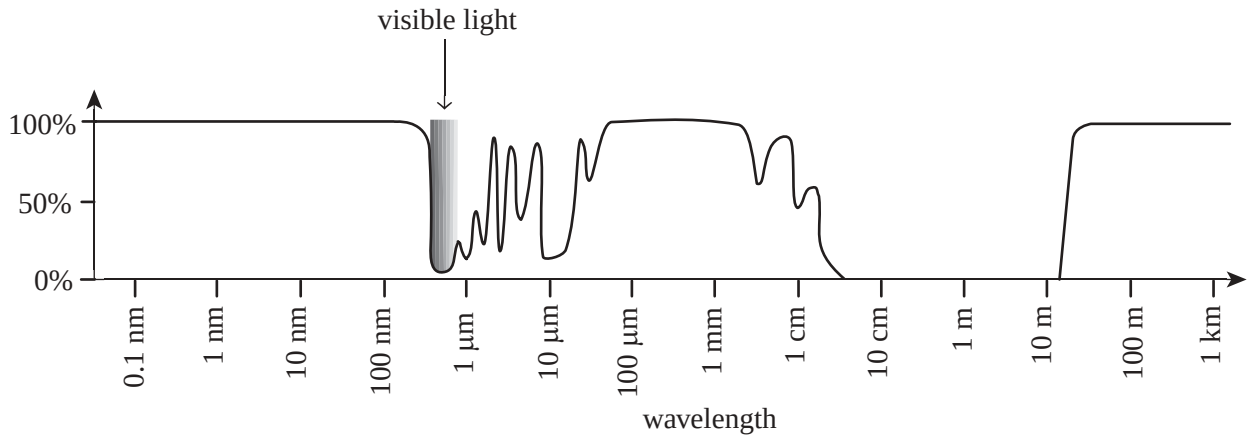


Figure 3

The chart shows that

A. the atmosphere is opaque to radio waves of 5 m wavelength.

B. the atmosphere is transparent to X-rays.

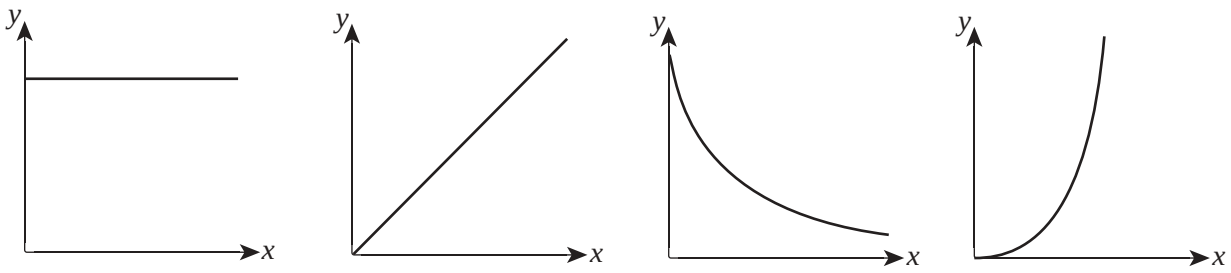
C. in order to observe anything in the microwave part of the spectrum, a space-based telescope is required.

D. extremely long wavelengths greater than 10 m can only be observed from a space-based telescope.

END OF DETAILED STUDY 1 – ASTRONOMY

Detailed study 2 – Astrophysics

Use the following information to answer Questions 1 to 3.



Graph A **Graph B** **Graph C** **Graph D**

Figure 1

Question 1

If the brightness of a star (*y*-axis) as a function of its distance (*x*-axis) was plotted, which of the graphs in Figure 1 would best describe its shape?

A. Graph A
B. Graph B
C. Graph C
D. Graph D

Question 2

Which graph best describes the total power output (also known as luminosity) of a star (*y*-axis) as a function of distance (*x*-axis)?

A. Graph A
B. Graph B
C. Graph C
D. Graph D

Question 3

The luminosity (l) of a star is also affected by its temperature (T). The relationship between luminosity and temperature is given by $l \propto T^4$.

Which graph best describes this relationship?

A. Graph A
B. Graph B
C. Graph C
D. Graph D

Use the following information to answer Questions 4 and 5.

One way in which a star's distance from Earth can be measured is shown in Figure 2. As the Earth orbits the Sun, measurements of a star's angle (from Earth) are taken 6 months apart and a distance can be calculated

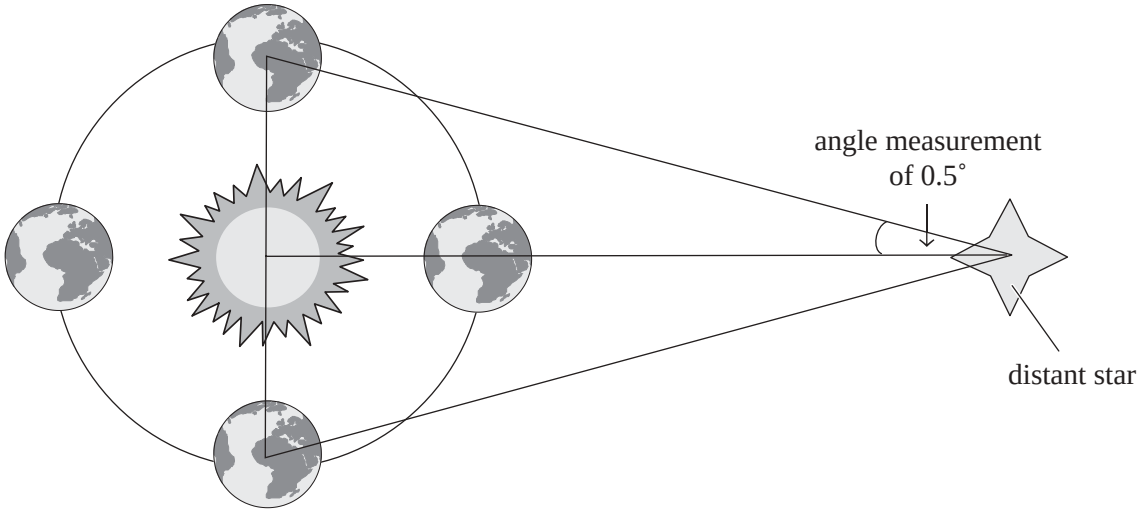


Figure 2

Question 4

What units would this type of distance measurement most likely be measured in?

A. metres
B. parsecs
C. astronomical units
D. light-years

Question 5

Given the Earth's distance from the Sun is an average of 150 million kilometres and using the angle of 0.5° shown in Figure 2, the star's distance in astronomical units (AU) [1 AU = 1.5 × 1011 m] is closest to

A. 150 AU
B. 0.12 AU
C. 100 AU
D. 115 AU

Question 6

In the science-fiction movie '2010', Jupiter ultimately becomes a small star.

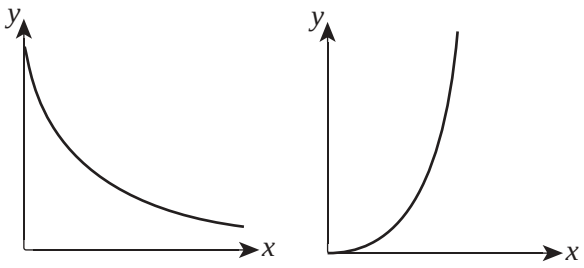
The reason why Jupiter is not actually at present a star is mainly due to its lack of

A. mass.
B. surface area.
C. time.
D. none of the above

Question 7

The type of reaction that occurs in a star is principally

A. quantum fluctuations.
B. fission.
C. fusion.
D. radioactivity.



Question 8

Stellar evolution looks at how stars change or evolve over time. One possible end state for a star is for it to end up as a 'neutron star'.

A possible sequence to occur before a star ends up as a neutron star could be

A. main sequence Æ red giant Æ supernova Æ white dwarf Æ neutron star
B. main sequence Æ red giant Æ supernova Æ black hole Æ neutron star
C. main sequence Æ red giant Æ planetary nebula Æ white dwarf Æ neutron star
D. main sequence Æ red giant Æ supernova Æ neutron star

Use the following information to answer Questions 9 and 10.

A person is standing at the traffic lights as a police car approaches (with its siren on), as shown in Figure 3

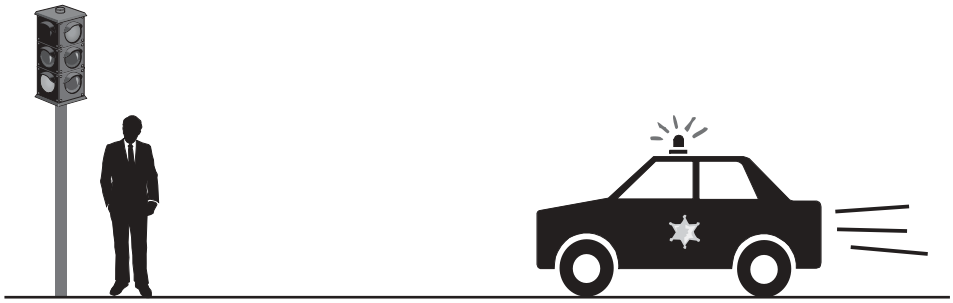


Figure 3

Question 9

To the person standing at the lights, the police siren seems to be higher in pitch (frequency) during the car's approach.

This phenomenon is best known as

A. the Doppler effect.
B. time dilation.
C. the Hubble effect.
D. the expansion effect.

Question 10

If we replace the person with the Earth and the police car with another galaxy, the visible light coming from the oncoming galaxy would be observed to be

A. red-shifted.
B. blue-shifted.
C. yellow-shifted.
D. green-shifted.

Question 11

In regards to galaxies, which of the following statements is incorrect?

A. Spiral galaxies tend to have a bulge in the centre and elliptical galaxies have stars that revolve randomly around the centre of mass.

B. Irregular galaxies tend to be smaller than other types of galaxies and spiral galaxies have a mixture of old and young stars.

C. Elliptical galaxies are often found within large clusters of galaxies and irregular galaxies can form as a result of collisions between galaxies.

D. Spiral galaxies have a minimum of four arms and elliptical galaxies are composed of only young stars.

Question 12

The Big Bang model can help explain the formation of galaxies.

It suggests that the early universe might have had

A. slight density variations in its mass distribution.

B. no density variation in its mass distribution.

C. extreme density variations in its mass distribution.

D. mass distribution has nothing to do with galaxy formation.

END OF DETAILED STUDY 2 – ASTROPHYSICS

Detailed study 3 – Energy from the nucleus

Question 1

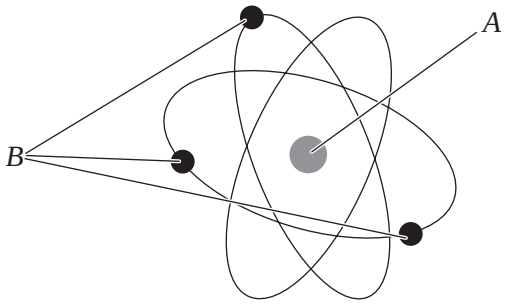


Figure 1

Consider the classic representation of an atom as shown in Figure 1. In this representation A is the nucleus and B are electrons.

Which of the following statements is correct?

A. A is held together by the electrostatic force and A–B are held together by the strong nuclear force.

B. A is held together by the strong nuclear force and A–B are held together by the electrostatic force.

C. A is held together by the electrostatic force and A–B are held together by the electrostatic force.

D. A is held together by the strong nuclear force and A–B are held together by the strong nuclear force.

Use the following information to answer Questions 2 and 3

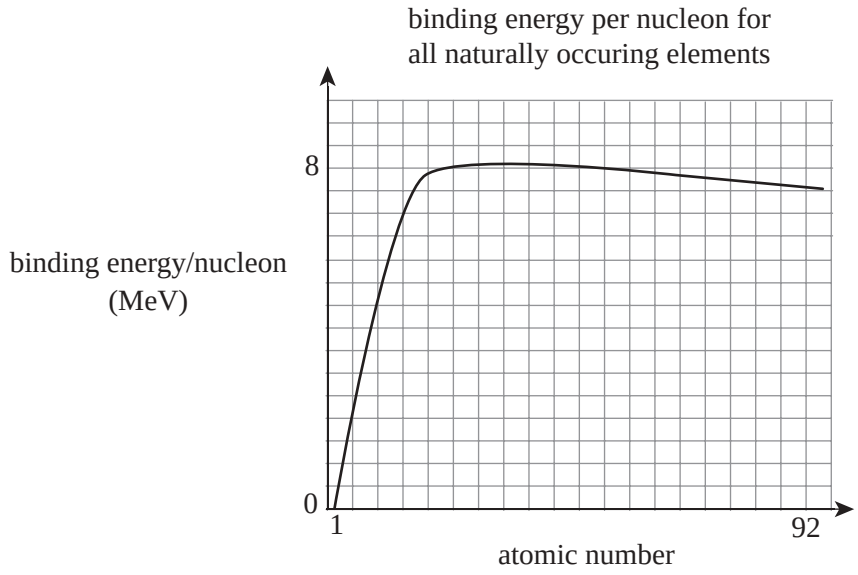


Figure 2

Question 2

The binding energy referred to in Figure 2 tells us the energy required to

A. pull apart nucleons.

B. pull apart individual protons.

C. pull apart individual neutrons.

D. pull apart electrons from the nucleus.

Question 3

Figure 2 shows the binding energy versus the atomic number for naturally occurring elements. The graph suggests that some elements undergo fusion while others undergo fission. For the purposes of this question, consider elements smaller than iron (atomic number 26) to be light elements and those larger than iron to be heavier elements.

Which of the following statements is correct?

A. The fission of light elements and the fusion of heavier elements results in greater atomic stability than before the reaction.

B. The fusion of light elements and the fission of heavier elements results in lower atomic stability than before the reaction.

C. The fusion of light elements and the fission of heavier elements results in greater atomic stability than before the reaction.

D. The fission of light elements and the fission of heavier elements results in greater atomic stability than before the reaction.

Question 4

The Sun's total energy output is approximately 3.9×10^{26} watts (1 watt = 1 joule per second). This energy comes from the fusion process as part of the Sun's mass is converted into energy.

Approximately how much mass per day does the Sun lose?

A. 3.7×10^{14} kg

B. 1.1×10^{23} kg

C. 3.9×10^{26} kg

D. 4.3×10^{9} kg

Question 5

When two hydrogen nuclei fuse to produce helium, 1.44 MeV (Megaelectron volts) of energy is released.

Assuming the total energy from the Sun given in **Question 4** comes from this reaction, how many reactions are there per second? $1 \text{ eV} = 1.6 \times 10^{-9}$ J

A. 3.9×10^{26}

B. 2.4×10^{45}

C. 2.7×10^{20}

D. 1.7×10^{39}

Question 6

Uranium and plutonium require the absorption of certain particles before they are able to split into smaller atomic fragments.

Which of the following options best identifies the particles?

	Uranium U-235	Plutonium-239
A.	slow-moving neutrons	slow-moving neutrons
B.	fast-moving neutrons	fast-moving neutrons
C.	slow-moving protons	fast-moving protons
D.	slow-moving neutrons	fast-moving neutrons

Use the following information to answer Questions 7 to 9

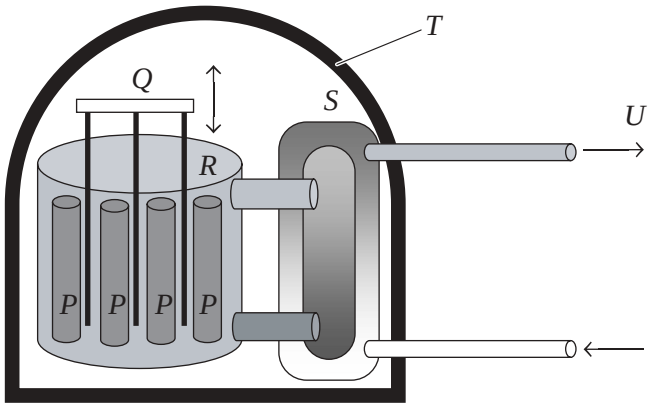


Figure 3

Figure 3 is a diagram of a typical nuclear reactor. The design essentially heats water to move a turbine which produces electricity with the heat coming from the nuclear reaction.

Question 7

The reactor core is located in the cylindrical container labelled *R*, and *S* connects the reactor to the rest of the other components needed to produce electricity.

Which of the following options correctly identifies component *S*?

A. fuel rods
B. heat exchanger
C. control rods
D. containment structure

Question 8

The component labelled *Q* can be raised and lowered into the *R* container.

Which of the following options correctly identifies component *Q* and its main function?

	Component *Q*	Main function
A.	fuel rods	slows down the reaction
B.	control rod	speeds up the reaction
C.	control rods	slows down the reaction
D.	fuel rods	speeds up the reaction

Question 9

In 1986 a nuclear powerplant in Chernobyl, Ukraine, blew its reactor core and radioactive material was released directly into the atmosphere. A design fault was that it did not have a containment structure.

Referring to Figure 3, which of the following options correctly identifies the missing component?

A. component *R*
B. component *U*
C. component *S*
D. component *T*

Question 10

Which of the options currently available correctly identifies the two most common isotopes used in the core of nuclear reactors?

A. U-235 and Pu-239
B. U-240 and Pu-239
C. Pu-239 and Pu-235
D. U-235 and U-240

Question 11

In a nuclear reactor the process of nuclear fission releases energy. The following is an incomplete equation for such a reaction.

$$^{235}_{92}\text{U} + X \rightarrow {}^{139}_{55}\text{C's} + {}^{94}_{37}\text{Rb} + Y$$

Which of the following options identifies *X* and best completes the above equation?

	X	***Y***
A.	$^{1}_{0}n$	$2 \times {}^{1}_{0}n$ + energy
B.	$^{1}_{0}n$	$3 \times {}^{1}_{0}n$
C.	$2 \times {}^{1}_{0}n$	$2 \times {}^{1}_{0}n$ + energy
D.	$^{1}_{0}n$	$3 \times {}^{1}_{0}n$ + energy

Question 12

One of the main reasons why fusion reactors are not used to generate electricity is that

A. fusion reactors produce too much radioactive waste.
B. current technology fusion reactors cannot maintain the temperature and density required.
C. fusion reactors produce too much greenhouse gases as waste.
D. the material required for fission reactions is more easily obtainable than that required for fusion.

END OF DETAILED STUDY 3 – ENERGY FROM THE NUCLEUS

Detailed study 4 – Investigations: Flight

Question 1

Comparing a hot-air balloon floating stationary and a cruising aircraft, which of the following forces are acting on the aircraft but not on the balloon?

A. thrust and lift
B. weight and lift
C. drag and thrust
D. thrust and weight

Question 2

Of the four main forces important in the aerodynamics of jet-powered aircraft, which of the following alternatives list two forces that are not normally considered reaction forces, as understood in Newton's Third Law of Motion?

A. weight and thrust
B. thrust and drag
C. lift and drag
D. drag and weight

Question 3

One way to explain the development of lift in aircraft uses Bernoulli's principle.

Alternatively, which of the following ideas can provide additional ways to explain lift?

A. conservation of energy
B. conservation of momentum
C. conservation of mass
D. none of the above

Question 4

Bernoulli's principle states that the pressure in a fluid is inversely proportional to

A. the fluid's temperature.
B. the fluid's acceleration.
C. the fluid's density.
D. the fluid's velocity.

Question 5

Using Bernoulli's equation, lift can be calculated as follows:

$$L = C_l \times \frac{1}{2} p v^2 A$$

Using the equation above, by what factor would lift (L) increase if the velocity (v) of an aircraft doubles?

A. lift would not increase
B. lift would increase by a factor 2
C. lift would increase by a factor 4
D. lift would increase by a factor 8

Question 6

In its original form, airbrush painting used an application of Bernoulli's principle. Figure 1 shows such an 'airbrush'.

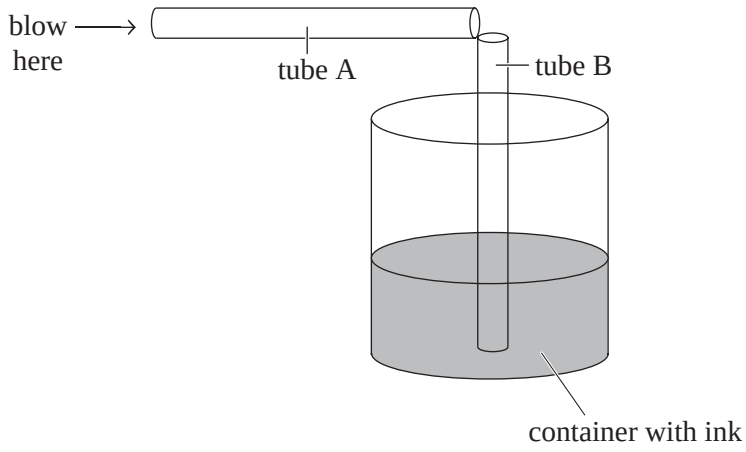


Figure 1

The airbrush is operated by blowing firmly into tube A.

Which of the following options best explains the working of the airbrush?

	Effect 1	**Effect 2**
A.	air pressure above tube B decreases	ink rises to the opening of tube B
B.	air pressure above tube B decreases	ink gets pushed down into tube B
C.	air pressure above tube B increases	ink rises to the opening of tube B
D.	air pressure above tube B increases	ink gets pushed down into tube B

Question 7

A modern commercial airliner can have a mass of 400 tonnes.

This means that in order to achieve take-off, the lift force needs to be

A. greater than 4×10^5 N

B. greater than 4×10^6 N

C. equal to 4×10^5 N

D. equal to 4×10^6 N

Question 8

Airliners usually cruise at high altitude.

The main reason for this is

A. it is safer that way as there is less traffic at high altitude.

B. it requires less fuel because the amount of lift required is less at high altitude.

C. it requires less fuel because the amount of drag experienced is less at high altitude.

D. it is faster, as aircraft are able to fly at higher velocities at high altitude.

Question 9

A cruising Boeing 747 uses about 140 MW of power while flying at a cruising speed of 900 km h^{-1}.

This means that its engines must create a total of

A. 0.156 MN of thrust.

B. 126 MN of thrust.

C. 560 kN of thrust.

D. 35 GN of thrust.

Use the following information to answer Questions 10 and 11.

The graph in Figure 2 shows how lift is affected by the angle of attack of an experimental wing model.

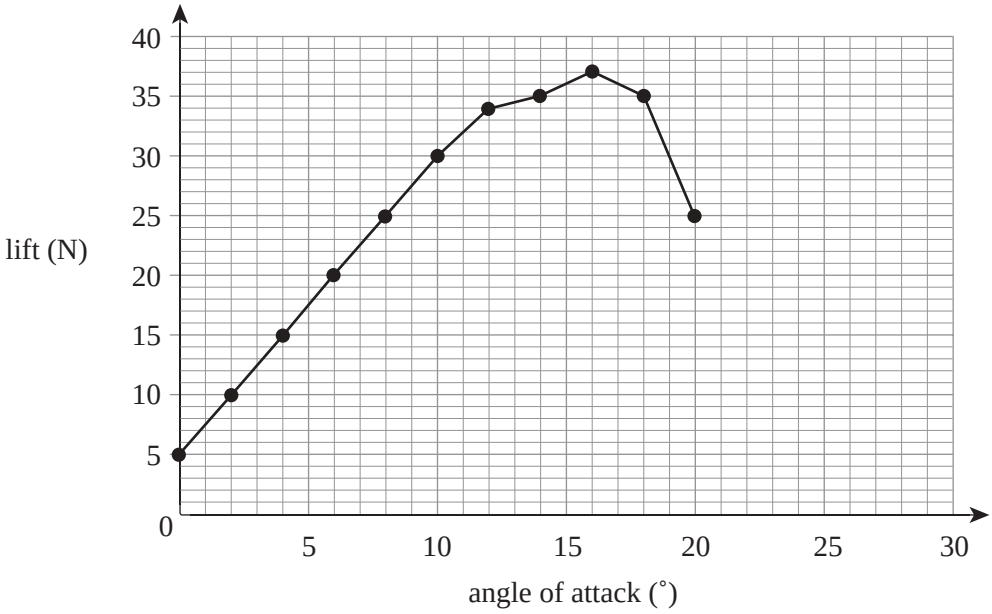


Figure 2

Question 10

The graph allows you to conclude that

A. lift is proportional to the angle of attack for angles greater than 17°.

B. lift is inversely proportional to the angle of attack for angles lower than 10°.

C. lift varies linearly with the angle of attack for angles lower than 10°.

D. lift is inversely proportional to the angle of attack for angles higher than 17°.

Question 11

The wing model stalls at

A. 20°

B. 17°

C. 16°

D. 12°

Question 12

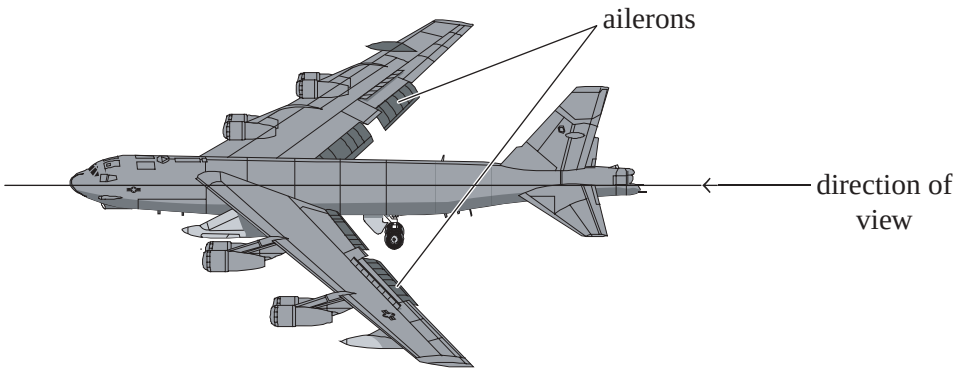


Figure 3

If the pilot of the plane in Figure 3 increases the drag on the left-hand wing of the aircraft by raising the wing's aileron, what would be the likely effect?

A. The aircraft would bank (rotate) clockwise (as seen from behind) and turn right.

B. The aircraft would bank (rotate) anti-clockwise (as seen from behind) and turn right.

C. The aircraft would bank (rotate) clockwise (as seen from behind) and turn left.

D. The aircraft would bank (rotate) anti-clockwise (as seen from behind) and turn left.

END OF DETAILED STUDY 4 – INVESTIGATIONS: FLIGHT

Detailed study 5 – Investigations: Sustainable energy sources

Question 1

Of the following energy sources, which one cannot be classed as a renewable energy source?

A. biofuel
B. nuclear energy
C. wind energy
D. tidal energy

Use the following information to answer Questions 2 and 3.

The graph in Figure 1 shows the performance of a 100 cm^2 solar cell.

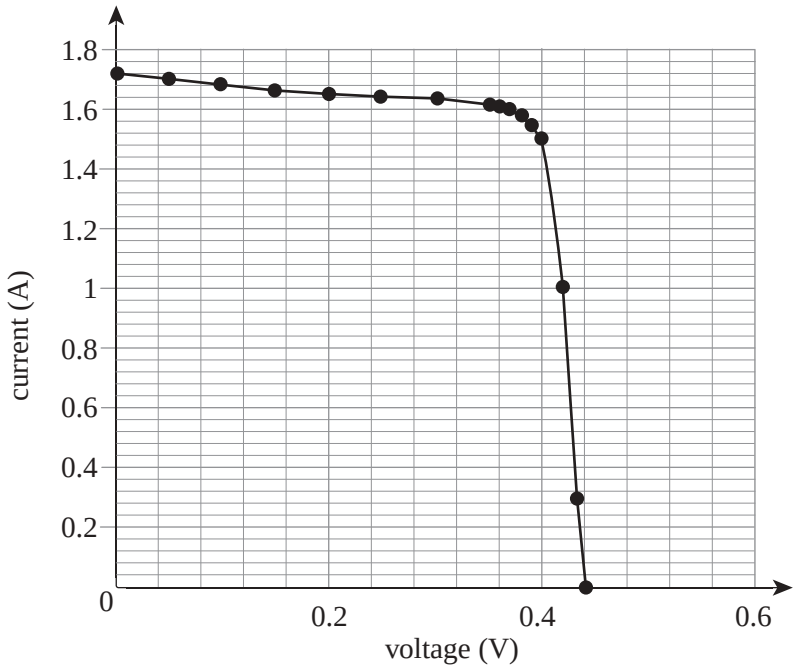


Figure 1

Question 2

From the graph, calculate the approximate maximum power output of the solar cell when illuminated by sunlight of 600 W m^2.

A. 600 W
B. 6 W
C. 0.6 W
D. 0.06 W

Question 3

Another solar cell, also 100 cm^2, provides 0.72 W under the same light conditions.

Using calculations, the efficiency of this cell must be

A. 12%
B. 0.12%
C. 0.72%
D. 72%

Question 4

A solar cell from a rooftop photovoltaic system has an efficiency of 10%. Assume that the roof receives on average 250 W m^{-2} of sunlight and that the system works 10 hours a day.

What area of solar cells would be required to power a typical house that uses 20 kWh per day?

A. 800 m^2

B. 80 m^2

C. 25 m^2

D. 8 m^2

Use the following information to answer Questions 5 to 8.

Hazelwood power station in Victoria is a brown-coal burning station. In 2003 it burned 17.3 million tonnes of coal to generate 4.32×10^{10} MJ of electricity. The energy content of brown coal is 29 MJ kg^{-1}.

Question 5

How many average homes can be powered using the electricity generated by Hazelwood in 2003?
*(Hint: See also **Question 4**, i.e. how much does a house use in a year?)*

A. 600 million homes

B. 16 million homes

C. 1.6 million homes

D. 0.6 million homes

Question 6

Using the data provided, the efficiency of Hazelwood power station is

A. 0.86%

B. 8.6%

C. 86%

D. 100%

Question 7

At full capacity, Hazelwood produces 1.6 GW of electrical power.

If Hazelwood should be replaced by wind power, approximately how many 3 MW wind turbines would be required?

A. about 2 turbines

B. about 20 turbines

C. about 500 turbines

D. about 2000 turbines

Question 8

The main reason the government is planning to replace Hazelwood power station is that

A. it is expensive to run.

B. it causes acid rain.

C. it is quite old and no longer working properly.

D. it produces more CO_2 per unit of energy produced than any other power station in Victoria.

Question 9

Large wind turbines can have a peak output of 5 MW. In reality, the output is usually smaller.

This is because

A. of measurement uncertainty when measuring the maximum output of the turbine.
B. available wind energy is variable.
C. available wind energy is always lower than that required for maximum power output.
D. they have to be turned off in strong wind conditions.

Question 10

The following equation is used to calculate the available mechanical power in wind:

$$P = \frac{1}{2}A\rho v^3$$

where A = surface area, ρ = air density and v = wind velocity

Using this equation, by what factor will the power of the wind increase when the wind velocity doubles?

A. The power will not increase.
B. The power will increase by a factor of 2.
C. The power will increase by a factor of 4.
D. The power will increase by a factor of 8.

Question 11

Which of the following correctly identifies the chain of energy transformations in a wind energy farm?

A. heat energy → kinetic energy → rotational energy → electrical energy
B. kinetic energy → rotational energy → electrical energy → heat energy
C. solar energy → kinetic energy → electrical energy → wind energy
D. wind energy → kinetic energy → heat energy → electrical energy

Question 12

The organisation 'Beyond Zero' has published a plan that could see Australia replace all fossil fuels with renewable energy.

This plan would most likely use

A. solar energy only.
B. wind energy only.
C. hydro energy only.
D. a mixture of wind, solar, hydro and geothermal energies.

END OF DETAILED STUDY 5 – INVESTIGATIONS: SUSTAINABLE ENERGY SOURCES

Detailed study 6 – Medical Physics

Question 1

The oldest and most common diagnostic technique used today to look inside the body is

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

Question 2

The term 'ultrasound', when applied to medical-imaging equipment, is used for

A. frequencies far above the human hearing range.
B. frequencies inside the human hearing range.
C. frequencies below the human hearing range.
D. frequencies just above the human hearing range.

Question 3

A typical ultrasound produces a sound signal with a frequency of 1 MHz. The typical speed of an ultrasound in muscle is around 1590 m s^{-1} and in fat about 1470 m s^{-1}. Wavelength, frequency and speed are related by the equation $v = \lambda f$.

As the ultrasound wave travels from fat to muscle, the wavelength

A. stays the same.
B. decreases.
C. increases.
D. increases then decreases.

Question 4

Typically, ultrasound is used to scan pregnant women rather than X-rays.

A reason for this could be

A. X-rays pass through the body too easily.
B. X-rays can damage living cells.
C. X-rays are difficult to detect once they enter the body.
D. X-rays are expensive to produce.

Question 5

Figure 1 is a simplified diagram of an endoscope showing two fibre-optic 'bundles'. Bundle A allows the image to be seen while bundle B provides a light source.

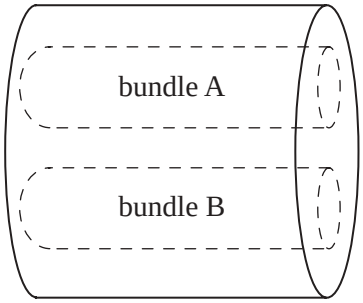


Figure 1

With regards to coherence, which of the following options is the best selection?

A. Bundle A should have incoherent fibres and Bundle B can be coherent.
B. Bundle A should have coherent fibres and Bundle B can be incoherent.
C. both are incoherent
D. both are coherent

Question 6

Endoscopes can typically have somewhere between 5000–25 000 optical fibre 'bundles'.

It is expected that by increasing the number of bundles the quality of the image will

A. decrease.
B. increase.
C. remain the same.
D. The number of bundles is not related to image quality.

Question 7

An endoscope can have a laser light source rather than an ordinary light source.

Which of the following statements correctly describes a key difference between the two types of light?

A. Both types can travel at different speeds through a vacuum.
B. Laser light is used in 'key-hole' surgery, whereas ordinary light is not.
C. Laser light consists of a much narrower range of wavelengths when compared to ordinary visible light.
D. Laser light can only be used inside the body, whereas ordinary light can only be used outside the body.

Question 8

A person is placed inside a scanning device, as shown in Figure 2.

Figure 2

One part of the scanning process involves the device emitting a pulse of low-energy radio waves which essentially shift protons (hydrogen atoms) within the body. As the protons move back to their original position they emit low-frequency radio waves that can be detected and analysed to produce an image.

The scanning device is most likely to be

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

Question 9

What half-life should radioisotopes that are injected into the body preferably have?

A. a long one (measured in months)
B. a short one (measured in seconds)
C. a moderate one (measured in hours)
D. The half-life can be any value as it is irrelevant.

Question 10

A radioactive tracer can be placed inside the body to help doctors look at how well specific organs within the body are working. The rays need to leave the body in order to be detected, with gamma-rays preferred over X-rays.

Which of the following options is the most likely reason for this preference?

A. X-rays have more energy than gamma-rays.
B. X-rays are harder to detect than gamma-rays.
C. X-rays travel more slowly through the body than gamma-rays.
D. X-rays are more readily absorbed by the body than gamma-rays.

Question 11

PET scanners can detect gamma-rays coming from the body. These gamma-rays are produced by the nuclear decay of certain radioactive isotopes. They produce positrons (positively charged electrons) rather than normal beta-particles.

The main reason why positrons are produced rather than beta-particles is that

A. the radioisotope undergoes a chemical reaction that produces positrons.

B. the radioisotope is deficient in the number of electrons in its nucleus.

C. the radioisotope is deficient in the number of protons in its nucleus.

D. the radioisotope is deficient in the number of neutrons in its nucleus.

Question 12

Medical staff who routinely work with radioactive materials need to take extra precautions to ensure they are not overexposed to radiation.

Which one of the following alternatives is **not** an appropriate safety measure for people who might be working with X-rays?

A. Access to the X-ray machine is arranged so that nobody can accidentally walk into the X-ray room while the machine is turned on.

B. They wear a detector of some type to monitor the amount of X-ray radiation.

C. They wear thick plastic aprons while the machine is turned on.

D. The X-ray machine is in an enclosed room and the controls used by the staff are kept in a separate room.

END OF QUESTION AND ANSWER BOOKLET