Neap:

Trial Examination 2010

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 – Areas of study			
1. Motion	17	17	37
2. Wave-like properties of light	16	16	27
B Detailed studies			
1. Astronomy **OR**	13	13	26
2. Astrophysics **OR**	13	13	26
3. Energy from the nucleus **OR**	13	13	26
4. Investigations: Flight **OR**	13	13	26
5. Investigations: Sustainable energy sources **OR**	13	13	26
6. Medical physics	13	13	26
			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 sheets of paper and/or white out liquid/tape.

Materials supplied
Question and answer booklet of 36 pages. The question and answer booklet has a detachable data sheet in the centrefold.
Answer sheet for multiple-choice questions.

Instructions
Detach the formula sheet from the centre of this booklet during reading time.
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.
Unless otherwise indicated, the diagrams in the booklet are **not** drawn to scale.
All written responses must be in English.

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

SECTION A – CORE

Instructions for Section A

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

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 10

Area of study 1 – Motion

The following information relates to Questions 1 to 10.

Tommy is walking with a toy cart at a constant speed of 2.0 m s^{-1} on a flat horizontal section of grass as shown in Figure 1. The grass provides an average friction of 2.0 N on the cart. The rope with which Tommy pulls the cart makes an angle of 30° to the horizontal. The mass of the cart is 1.3 kg.

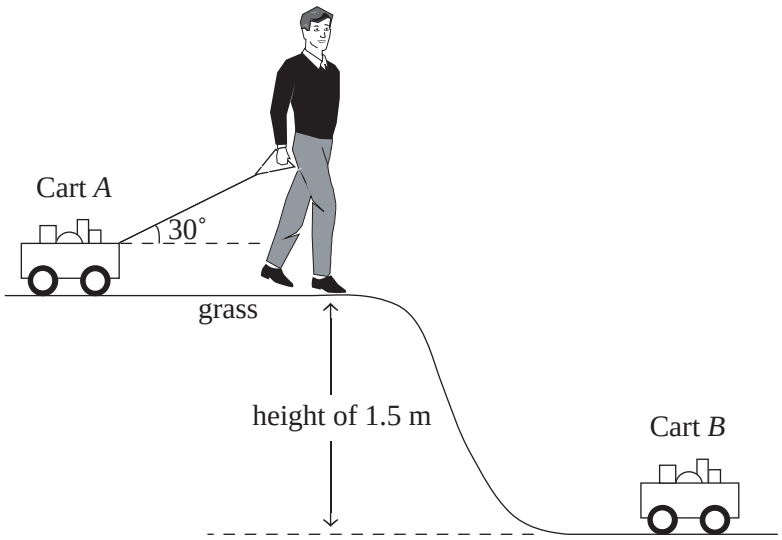


Figure 1

Question 1

On the diagram provided draw and label the forces acting on Cart *A*.

3 marks

Question 2

What is the net force on the cart? Explain how you arrived at this value.

_____

_____

_____

_____

N

2 marks

Question 3

What is the tension in the rope? Show your working.

N

2 marks

Tommy walks for 15 m along this flat section.

Question 4

What is the work done by Tommy?

J

2 marks

Tommy then comes to the end of the flat section where he stops the cart at the top of the sloping section of the path. At the bottom of the slope in the flat section is an identical cart (Cart *B*).

Question 5

The energy of Cart *A* at the top of the sloping section of the path is equal to

A. its kinetic energy.
B. its elastic potential energy.
C. its electric potential energy.
D. its gravitational potential energy.

1 mark

Question 6

Calculate the energy of Cart *A* at the top of the sloping section. Show your working.

J

2 marks

Tommy lets Cart *A* go down the slope by itself where it collides with Cart *B*. The two carts remain joined together after the collision. (Ignore any resistance from the grass and air as the cart goes down the slope.)

Question 7

What is the speed with which Tommy's cart hits the second cart?

$m\ s^{-1}$

2 marks

Question 8

What is the speed of the two joined carts immediately after the collision? Show your working.

m s^{-1}	2 marks

Question 9

The horizontal grass now provides the same resistance on each cart as mentioned previously.

How far do the carts travel before coming to rest?

m	3 marks

Question 10

Is this an example of an elastic or inelastic collision? (Circle your choice in the box provided.) Support your answer with calculations.

elastic	inelastic	2 marks

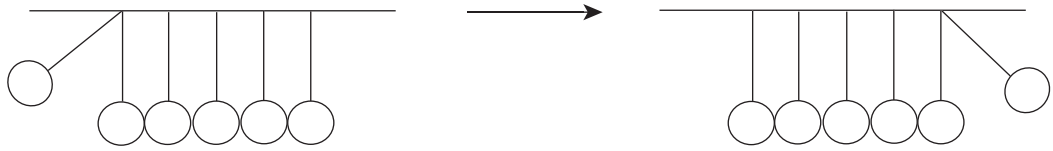


Figure 2

Newton's cradle, as shown in Figure 2, is often seen as a novelty toy but it can be used to explain some important physics concepts.

Question 11

Explain in terms of energy how, when the falling ball from the left (in Figure 2) strikes the stationary balls, the ball on the right side goes up by nearly the same height as the ball on the left fell.

_____

_____

_____

_____

_____

2 marks

The following information relates to Questions 12 to 15.

The 'blaster' is a spring-powered rocket launcher. Figure 3 gives the force–compression graph of the spring while Figure 4 shows its setup and firing. The mass of the rocket is 200 grams. Ignore the mass of the spring and air resistance.

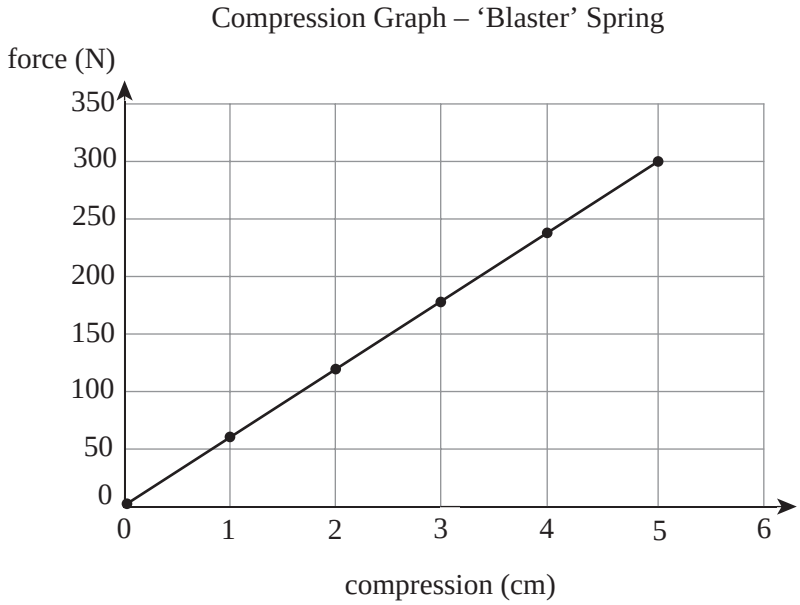


Figure 3

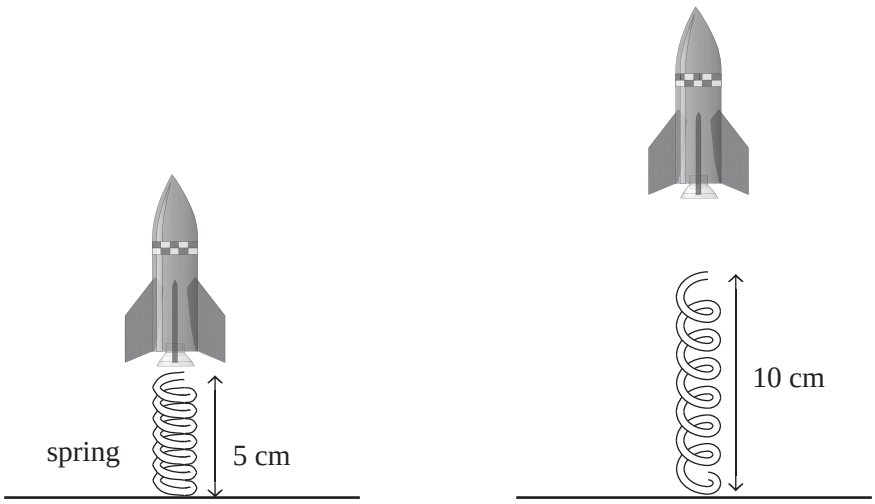


Figure 4

Question 12

What is the spring constant?

N m^{-1}

2 marks

Question 13

What height does the rocket reach?

m	3 marks

Question 14

How long does the rocket stay in the air?

s	3 marks

Question 15

The spring contacts the rocket for 0.25 s. What is the average spring force acting on the rocket?

N	2 marks

Question 16

Aristotle thought that a body would prefer to be in a state of rest and that to be in motion was against its 'natural' state.

How does this differ from Newton's first law of motion?

_____

_____

_____

_____

2 marks

Question 17

Aristotle would also explain that when the rocket is falling back to Earth, its speed of return would depend on the amount of 'earth' (mass) it contained. Thus a rocket twice as heavy would fall back down twice as fast.

How would Galileo explain the motion of the falling rocket?

_____

_____

_____

_____

2 marks

END OF AREA OF STUDY 1

Area of study 2 – Wave-like properties of light

Question 1

Light waves can be represented by a wave diagram such as the one shown in Figure 5.

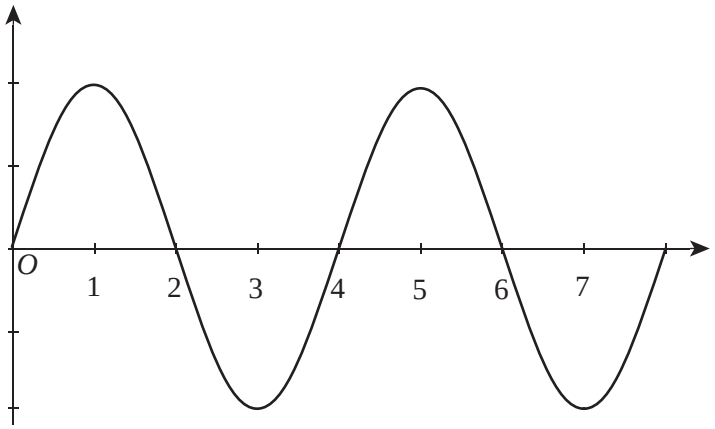


Figure 5

Which of the following would be a suitable quantity to use for the *y*-axis in Figure 5?

A. Electric charge (*Q*)
B. Distance (*x*)
C. Electric current (*I*)
D. Electric field strength (*E*)

1 mark

The *x*-axis could represent distance.

Question 2

Calculate a suitable multiplication factor for the units on the *x*-axis for distance if the wave in Figure 5 represents visible light in the **blue part** of the spectrum with a frequency of 7.5×10^{14} Hz.

2 marks

Question 3

How long would it take for the wave to travel one wavelength?

s

1 mark

Question 4

On the graph in Figure 5 sketch a similar wave diagram to represent a wave of **equal intensity** from the **red** part of the spectrum.

2 marks

Question 5

Which two wave properties do both the red and the blue waves have in common?

_____

_____

2 marks

Optical fibres are often used to transmit light signals between communication devices. The glass that is used to produce optical fibres is not 100% transparent to all forms of light. The graph shown in Figure 6 shows how light is absorbed by a particular type of glass.

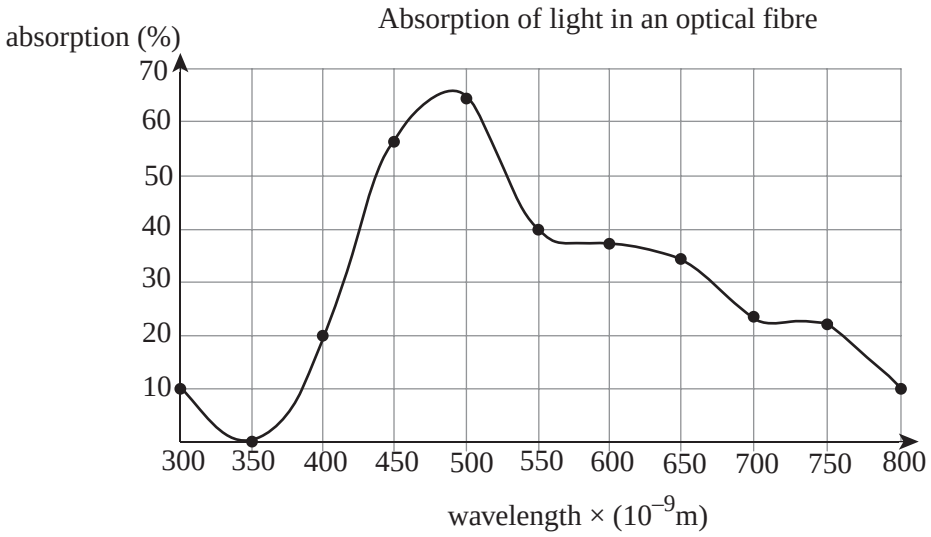


Figure 6

Question 6

For this optical fibre, what is the wavelength of the light that is least absorbed by the glass?

	m

1 mark

Question 7

What is the name given to the region of the electromagnetic spectrum from which the light referred to in Question 6 comes? (This region is invisible to the human eye.)

_____

1 mark

Binoculars use a set of prisms to lengthen the pathway of light. Figure 7 shows one such prism. This prism is made of glass with a refractive index of 1.45 for red light. A red light ray hits the side *AB* of the prism with an incident angle of 0° as shown.

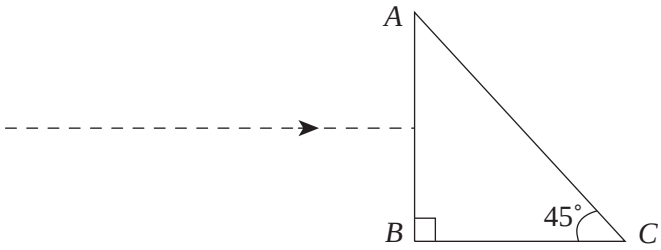


Figure 7

Question 8

What will happen to the direction of the ray as it enters the prism, from air, through side *AB*?

_____

_____

1 mark

Question 9

What will happen as the ray continues to side *AC*? Use a calculation to support your answer.

_____

_____

_____

2 marks

The same prism is now rotated and a ray of red light is directed to the prism as show in Figure 8.

The angle of refraction inside the prism is 25°.

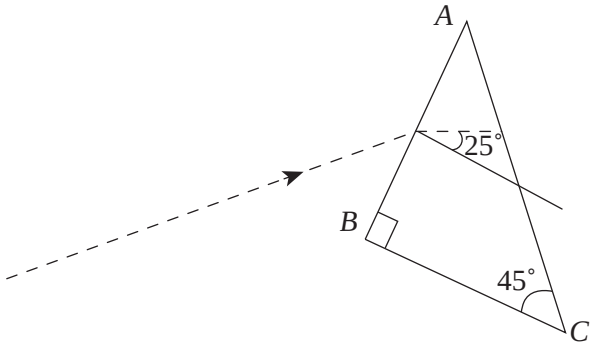


Figure 8

Question 10

Calculate the angle of incidence of the red light as it hits side *AB* from the air surrounding the prism.

	°

2 marks

Question 11

What would be the angle of refraction when the ray emerges into the air from the side *AC*?

	°

3 marks

Question 12

As a result, how many degrees has the ray diverged from its original direction prior to entering the prism?

	°

2 marks

Glass has a slightly higher refractive index for light of shorter wavelengths.

Question 13

Explain what would happen if white light, instead of red light, was used in Figure 8 as a result of such varying refractive indices.

_____

_____

_____

2 marks

Light and other forms of electromagnetic radiation can be modelled as waves, but also as particles.

Imagine kicking a soccer ball against a smooth wall and watching it bounce off.

Question 14

On Figure 9 clearly sketch how the ball would bounce off the wall.

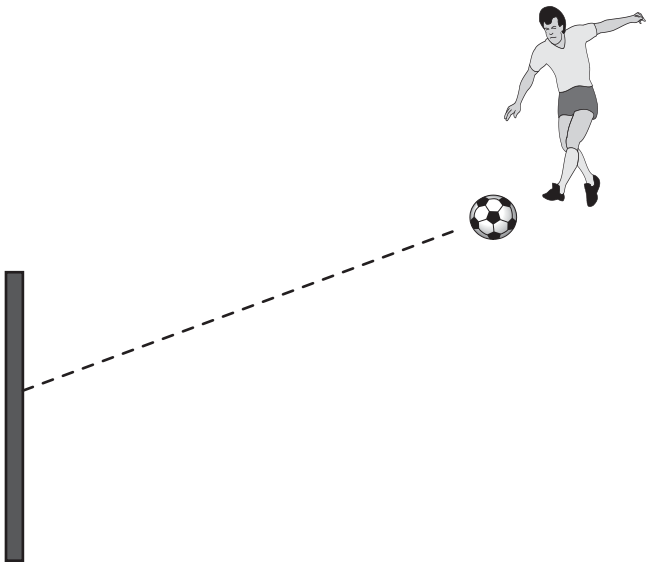


Figure 9

1 mark

Question 15

Explain how this particle behaviour, as demonstrated by a soccer ball, also matches our observations with light.

_____

_____

_____

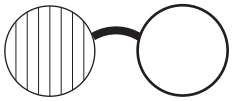
2 marks

In 3D movies, it is essential for the left and right eye to see different images. It is possible to create this 3D effect using polarisation filters. For the viewer to see the 3D effect, they have to wear glasses containing polarisation filters.

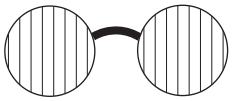
Question 16

Which of the following glasses would be suitable for watching a 3D movie (circle one option)? Explain your answer.

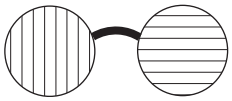
A.



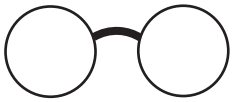
B.



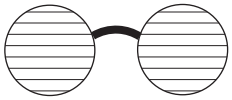
C.

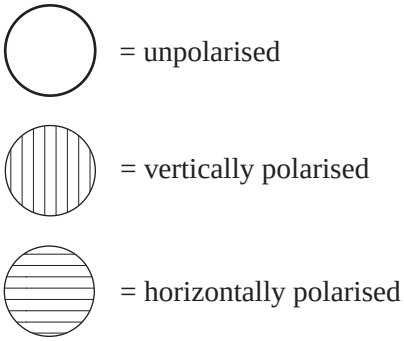


D.



E.





_____

_____

_____

_____

2 marks

END OF AREA OF STUDY 2

SECTION B – DETAILED STUDIES

Instructions for Section B

Select **one** Detailed study.

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

Write the name of your chosen Detailed study on the multiple-choice answer sheet **and** shade the matching box.

Choose the response that is **correct** or **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 17

Detailed study 2: Astrophysics 21

Detailed study 3: Energy from the nucleus 24

Detailed study 4: Investigations: Flight 27

Detailed study 5: Investigations: Sustainable energy sources 30

Detailed study 6: Medical physics 33

Detailed study 1 – Astronomy

The following information relates to Questions 1 to 4.

The Sun's distance from Earth is on average 150 million kilometres. This average distance is called 1 Astronomical unit (AU). The WISE (Wide-field Infrared Survey Explorer) telescope was recently launched into orbit in December 2009. It is designed to work in the infrared (IR) region of the electromagnetic spectrum. The telescope can pick up a Jupiter-sized object at a distance of 60 000 AU from the Sun. Light travels at 3×10^8 ms^{-1} in a vacuum.

Question 1

If there were such a Jupiter-sized object at the distance stated above, how long would it take light to reach Earth?

A. 0.347 days
B. 8 days
C. 347 days
D. 59 999 days

Question 2

What is the main advantage of placing the telescope into orbit?

A. It is cheaper than building the telescope on Earth.
B. It is easier to maintain the telescope in space.
C. It avoids interference from Earth's atmosphere.
D. It can be used any time of the day.

Question 3

If the WISE telescope were to be constructed on Earth and also have the same resolution, it **would require** an optical system with

A. a larger diameter.
B. a smaller diameter.
C. the same diameter.
D. diameter is not important

Question 4

In terms of telescope design, the WISE telescope would be most effective if it used a

A. spherical lens.
B. parabolic mirror.
C. parabolic lens.
D. spherical mirror.

Question 5

Edwin Hubble was an American astronomer who, in the first half of the 20th century, used a telescope to show that our universe was much bigger than previously thought. He did this by observing certain galaxies outside our own Milky Way.

A galaxy is generally thought of as a

A. large collection of stars only, usually held in some shape.

B. large collection of stars, planets and interstellar material usually held in some shape.

C. large collection of asteroids/planets and stars only, usually held in some shape.

D. large grouping of stars that lie close together as observed from Earth.

Question 6

Ptolemy was considered a great astronomer and his geocentric model of the universe was widely accepted until the late 16th Century.
Part of the logic and persistence for the geocentric model was that

A. Earth appeared to be not moving and the Sun, Moon and stars seemed to circle Earth.

B. Earth appeared to be moving and the Sun, Moon and stars seemed to circle Earth.

C. Earth appeared to be not moving and the Moon and stars seemed to circle the Sun.

D. Earth was believed to be flat and moving.

Question 7

Copernicus' landmark theory written in *De revolutionibus orbium coelestium (On the Revolutions of the Celestial Spheres)*, is credited with changing our understanding of the universe and beginning the study of modern astronomy.

Copernicus' model was

A. Tychonic – the Sun and Moon revolve around Earth, while other planets revolve around the Sun.

B. Ptolemaic – all celestial bodies orbited Earth.

C. heliocentric – the Sun and other planets orbited Earth.

D. heliocentric – the Earth and other planets orbited the Sun.

The following figure relates to Questions 8 to 10.

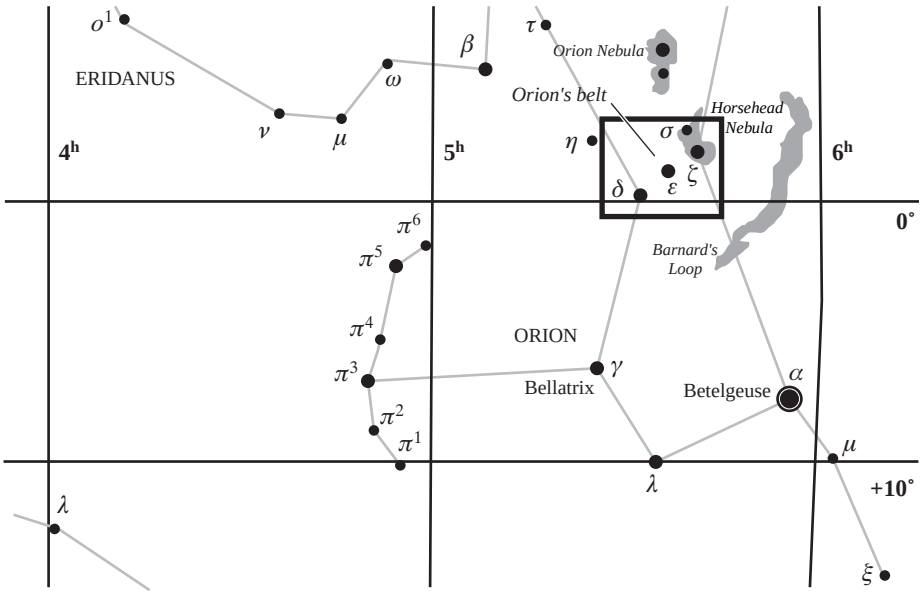


Figure 1

Question 8

The grid in Figure 1 shows the right ascension (RA)–declination grid for a section of the sky.

The coordinates of Bellatrix are approximately given by

A. declination +7° RA 7 h.

B. declination +5.4° RA 7 h.

C. declination +7° RA 5.4 h.

D. declination –7 ° RA 5.4 h.

Question 9

The right ascension–declination grid roughly equates to

A. declination = azimuth, RA = altitude.

B. declination = altitude, RA = azimuth.

C. declination = longitude, RA = latitude.

D. declination = latitude, RA = longitude.

Question 10

The map of the stars in Figure 1 will eventually no longer be accurate and will need updating.

This change is due to the

A. slow change of the Earth's axis relative to its orbital plane.

B. slow change of the Sun's axis relative to its orbital plane.

C. tilt of the Earth's axis relative to its orbital plane.

D. tilt of the Sun's axis relative to its orbital plane.

Questions 11 to 13 refer to Figures 2A to 2C, which are diagrams of different telescopic systems.

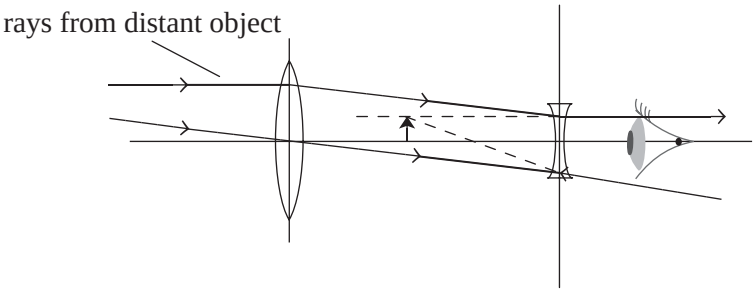


Figure 2A

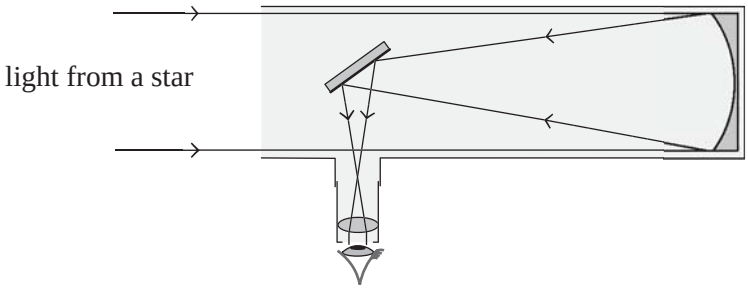


Figure 2B

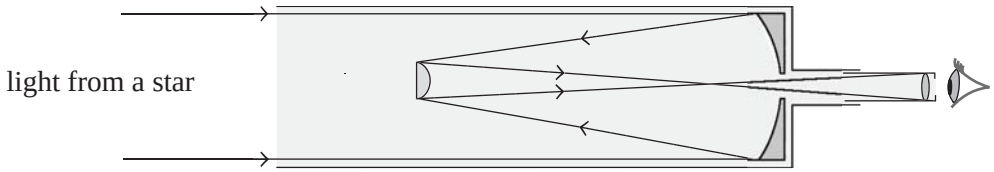


Figure 2C

Question 11

The telescope used by Galileo would most likely be

A. Figure 2A.
B. Figure 2B.
C. Figure 2C.
D. none of the above

Question 12

The telescope used by Newton would most likely be

A. Figure 2A.
B. Figure 2B.
C. Figure 2C.
D. none of the above

Question 13

The light collecting power of a telescope is proportional to its

A. radius.
B. length.
C. radius squared.
D. length squared.

END OF DETAILED STUDY 1 – ASTRONOMY

Detailed study 2 – Astrophysics

Question 1

Our own sun is an example of a star.

It looks very different to other stars because

A. the Sun is much hotter than other stars.
B. the Sun is much closer to us than other stars.
C. the Sun is much bigger than other stars.
D. all of the above

Question 2

One way of measuring distances in space is by using the inverse-square law of light.

This method assumes that for two identical stars

A. the star that is four times further away must be sixteen times less bright.
B. the star that is four times further away must be four times less bright.
C. the star that is four times further away must be two times brighter.
D. the star that is four times further away must be two times less bright.

Question 3

The Sun's luminosity can be calculated from the solar irradiance, the amount of energy received from the Sun here on Earth per square meter, and the distance between the Sun and us.

To make this calculation, the following assumption/s must be made:

A. The Sun's energy is radiated equally strong in all directions.
B. No energy is absorbed between the Sun and us.
C. The Sun's total energy output is more or less constant.
D. all of the above

Question 4

Apart from electromagnetic radiation, the Sun also emits particles, including positively charged positrons.

These particles result from

A. nuclear fission inside the Sun's core.
B. nuclear fusion inside the Sun's core.
C. nuclear fission on the Sun's surface.
D. nuclear fusion on the Sun's surface.

Question 5

The Sun and other stars are large masses of mostly hydrogen gas held into a stable form by the following two forces:

A. gravity pulling inward and thermal pressure pushing outward.
B. gravity pulling inward and strong nuclear force pushing outwards.
C. gravity pulling outward and thermal pressure pulling inward.
D. gravity pulling outward and the electromagnetic force pulling inward.

Question 6

One of the nuclear reactions taking place inside a star's core can be written as:

$$^{1}_{1}\text{H} + ^{1}_{1}\text{H} \rightarrow \text{X} + ^{2}_{1}\text{H}$$

The missing term X is most likely:

A. $^{2}_{1}\text{H}$

B. $^{0}_{-1}\text{e}$

C. $^{0}_{+1}\text{e}$

D. $^{4}_{2}\text{He}$

The following figure refers to Questions 7 to 9.

The Herzsprung–Russel diagram

Figure 1

Question 7

The Herzsprung–Russel diagram plots

A. a star's brightness against its spectral class.

B. a star's brightness against its temperature.

C. a star's luminosity against its temperature.

D. a star's luminosity against its size.

Question 8

When a main sequence star becomes a red giant, its position on the Herzsprung–Russel diagram moves to the right because

A. the star gets much hotter.

B. the star gets much bigger.

C. the star gets much cooler.

D. the star gets much smaller.

Question 9

Which of the following two statements is correct?

I. A main sequence star more massive than the Sun is found higher on the Herzsprung–Russel diagram.

II. A main sequence star with a mass less than our sun would stay on the main sequence for a longer time compared to our sun.

A. **I** is correct.

B. **II** is correct.

C. Both statement **I** and **II** are wrong.

D. Both statement **I** and **II** are correct.

Question 10

Hubble was able to prove that galaxies are objects beyond our own Milky Way because

A. he was able to detect Cepheid variable stars in other galaxies.

B. he was able to measure the average brightness of Cepheid variables in other galaxies.

C. he was able to measure periods of Cepheid variables in other galaxies.

D. all of the above

Question 11

Hubble was able to measure the speed of recession for many galaxies by

A. measuring the reducing brightness of those galaxies over time.

B. measuring the Doppler shift of those galaxies.

C. measuring the parallax of those galaxies.

D. measuring the distance to those galaxies.

Question 12

Hubble's law shows that our universe is

A. expanding.

B. unchanging.

C. contracting.

D. uniform.

Question 13

The difference between the Steady State and the Big Bang models of the universe is that

A. in the Steady State universe Hubble's law does not apply.

B. in the Big Bang model the universe is expanding.

C. in the Steady State model the density of the universe remains unchanged over time.

D. in the Big Bang model the density of the universe remains unchanged.

END OF DETAILED STUDY 2 – ASTROPHYSICS

Detailed study 3 – Energy from the nucleus

Question 1

Australia is considering adopting nuclear power as an energy source.

It would most likely be used as a method to generate

A. heat.
B. light.
C. electricity.
D. transport.

Question 2

Nuclear fusion is currently still under development and cannot yet be used to commercially produce energy.

This is mainly because

A. the extremely high temperatures required are difficult to achieve.
B. the extremely high pressures required are difficult to achieve.
C. the extremely high temperature ionised gas required is difficult to contain.
D. the process produces too much radioactive waste.

Question 3

A typical fission reaction might look like this:

$$^{239}_{94}\text{Pu} + {}^{1}_{0}\text{n} \rightarrow {}^{114}_{46}\text{Pd} + {}^{122}_{48}\text{Cd} + \text{X}\,{}^{1}_{0}\text{n}$$

Which number does the X in this equation represent?

A. 4
B. 5
C. 6
D. 8

Question 4

Which of the following two statements is correct?

I. To achieve a self-sustaining chain reaction, the amount of plutonium must be smaller than the critical mass.
II. The shape of the plutonium mass is unimportant when trying to achieve a chain reaction.

A. **I** is correct.
B. **II** is correct.
C. Both statements are correct.
D. Both statements are incorrect.

Question 5

Pu-239 is a **fissionable** isotope of plutonium.

This means that

A. the nucleus of Pu-239 is highly unstable.
B. the nucleus of Pu-239 is radioactive.
C. the nucleus of Pu-239 contains lots of energy.
D. the nucleus of Pu-239 can split into two or more parts after capturing a neutron.

Question 6

During a fission reaction, the combined mass of the reactants is always

A. larger than the combined mass of the products.
B. smaller than the combined mass of the products.
C. equal to the combined mass of the products.
D. different to the combined mass of the products.

Question 7

Uranium-238 can be used

A. as a fissionable material just as uranium-235.
B. to produce plutonium-239 after neutron capture.
C. as fuel in a fusion reactor.
D. as a conventional fuel.

The following information relates to Questions 8 to 12.

Figure 1 shows a schematic representation of a nuclear power station.

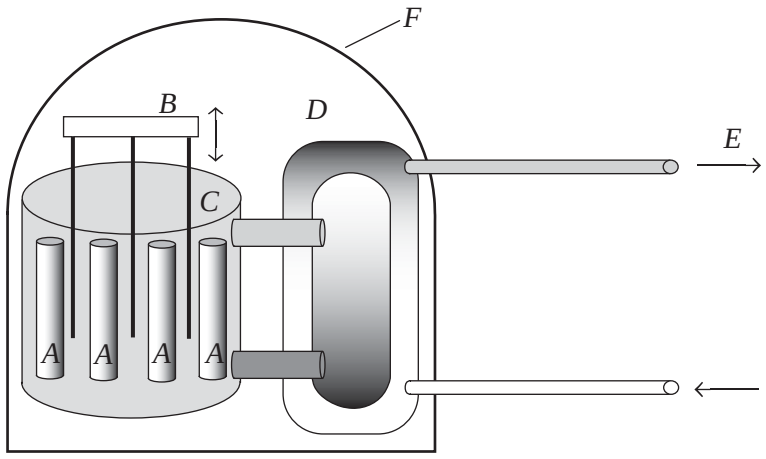


Figure 1

Question 8

Structure *C* is made of material that

A. absorbs neutrons.
B. reflects neutrons.
C. slows down neutrons.
D. speeds up neutrons.

Question 9

Structure *B* can be moved up or down.

When moved down it will

A. speed up the nuclear reaction by absorbing slow moving neutrons.
B. speed up the nuclear reaction by reflecting slow moving neutrons.
C. slow down the nuclear reaction by absorbing slow moving neutrons.
D. slow down the nuclear reaction by reflecting slow moving neutrons.

Question 10

The rods labelled *A* are where the nuclear reactions take place.

They contain

A. Uranium.
B. Cadmium.
C. Hydrogen.
D. 'heavy' water.

Question 11

Structure *F* is made of thick concrete.

Its function is to

A. safely contain the extreme heat inside the reactor.
B. give the power station a pleasing appearance.
C. stop people getting into the power station.
D. safely contain the radioactive materials inside the power station.

Question 12

Arrow *E* shows the flow of energy from the core of the power station.

This energy is now in the form of

A. heat.
B. radioactivity.
C. electro-magnetic radiation.
D. electricity.

Question 13

The use of nuclear fission to generate electricity is strongly resisted in Australia because of concerns about

A. the production of carbon dioxide and its contribution to climate change.
B. the production of radioactive waste materials that will remain dangerous for a long time.
C. the production of radioactive materials that could contribute to the greenhouse effect.
D. the lack of available nuclear fuel.

END OF DETAILED STUDY 3 – ENERGY FROM THE NUCLEUS

Detailed study 4 – Investigations: Flight

Question 1

The Bernoulli equation explains in terms of pressure how lift is generated on a wing.
The lift is generated because

A. the pressure above the wing is equal to the pressure below the wing.
B. the pressure above the wing is greater than the pressure below the wing.
C. the pressure below the wing is greater than the pressure above the wing.
D. both parts of the wing experience a loss in pressure.

Question 2

In terms of Newton's laws, lift is generated because
A. the wing forces the air apart.
B. the wing changes the air temperature, creating a temperature differential.
C. the wing exerts a downward force on the air and the air exerts an equal upward force.
D. the wing exerts an upward force on the air and the air exerts an equal downward force.

Question 3

Drag also affects any object travelling through a fluid.
Which of the following scenarios is an example of reducing **skin drag**?
A. placing a swim cap on a swimmer's head before swimming
B. crouching down when riding a bike
C. adding wing area to a Formula 1 car
D. pedalling harder on a push bike (but keeping the same shape)

The following information relates to Questions 4 to 11.

An experimental propeller plane with mass 10 000 kg is performing a test flight. It is flying horizontally at a constant speed of 540 km h^{-1} as seen in Figure 1.

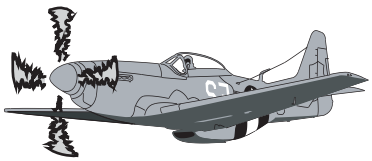


Figure 1

Question 4

With respect to the above situation, which of the following statements is correct?
A. The sum of all translational forces equals zero.
B. The sum of all rotational torques equals zero.
C. The lift force equals the weight force.
D. all the above

Question 5

The lift required to keep the plane in the air is

A. 0 kN
B. 10 kN
C. 100 kN
D. 10 000 kN

Question 6

The plane encounters an average drag of 8 kN.

What power must the engines develop to solely overcome the drag?

A. 0 MW
B. 1.2 MW
C. 4.0 MW
D. 8.0 MW

Question 7

The plane starts making its descent towards a runway which is directly ahead.

The plane will have to adjust which axis the most?

A. yaw
B. pitch
C. roll
D. none of the above

Question 8

The control surface that is principally involved in Question 7 is the

A. ailerons.
B. elevators.
C. rudders.
D. flaps.

Question 9

The plane is at a distance of 5 km from the airport when the engine suddenly fails. It travels 2.2 km horizontally while it drops a height of 200 m.

Its glide ratio is

A. 0.011 : 1
B. 1 : 1
C. 11 : 1
D. 91 : 1

Question 10

The engineers are concerned about the drag on the aircraft.

Which statement concerning drag is **incorrect**?

A. The pressure drag is affected by the aerofoil's shape.
B. The skin drag is affected by the aerofoil's smoothness.
C. The combined form and skin drag doubles as the speed doubles.
D. Induced drag is generated when lift occurs.

The lift coefficient is a measure of the lifting capacity of a wing. It is a dimensionless number and is derived from Bernoulli's equation:

$$C_L = \frac{L}{\frac{1}{2}\rho v^2 A}$$

where L is the lift force, ρ is the air density, v is the airspeed, and A is the area.

Question 11

Given that the average air density is 1.22 kg m^{-3} and area is 9.11 m^2 then the lift coefficient is closest to

A. 0.0
B. 0.06
C. 0.8
D. 1.0

The following information relates to Questions 12 and 13.

The graph in Figure 2 shows how the angle of attack of a wing affects the lift coefficient.

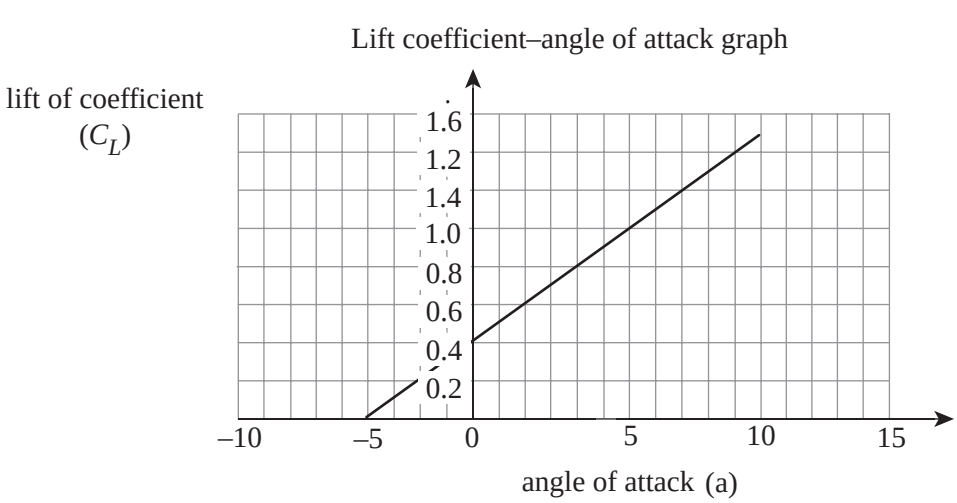


Figure 2

Question 12

At what angle of attack should the wing be set at, given the lift coefficient in Question 11?

A. 2.5°
B. 4.5°
C. –4.5°
D. –5.0°

Question 13

The plane's airspeed remains constant as the angle of attack is increased.

The plane will eventually reach a situation known as

A. maximum lift.
B. supersonic flight.
C. subsonic flight.
D. stall.

END OF DETAILED STUDY 4 – INVESTIGATIONS: FLIGHT

Detailed study 5 – Investigations: Sustainable energy sources

Question 1

An example of an energy source not currently in use in Australia would be

A. natural gas.
B. oil.
C. nuclear.
D. coal.

Question 2

In terms of greenhouse gases, which sequence goes from least to most polluting?

A. solar > natural gas > coal
B. solar > coal > natural gas
C. coal > natural gas > solar
D. natural gas > solar > coal

The following information relates to Questions 3 to 5.

Yallourn power station is a coal-fired station with 33% efficiency and it has a peak energy output of 1500 MW. The burning of coal produces approximately 30 MJ kg^{-1} of energy. In comparison the Earth receives approximately 1.8×10^{17} W of light energy from the Sun.

Question 3

Approximately how many tonnes per hour of coal are needed to produce the 1500 MW output?

A. 50 t h^{-1}
B. 180 t h^{-1}
C. 273 t h^{-1}
D. 545 t h^{-1}

Question 4

If humans could harness just 10% of the Sun's energy received by Earth, the number of power plants of Yallourn's size that could be replaced would be

A. 1.2 million.
B. 12 million.
C. 120 million.
D. 1.2 billion.

Question 5

A solar cell is typically around 25% efficient.

If a solar cell receives 1000 W of solar energy then

A. 25 W would be converted into electricity.
B. 75 W would be converted into electricity.
C. 250 W would be converted into electricity.
D. 750 W would be converted into electricity.

Question 6

Biofuels are increasingly being used as an alternative power source.

The energy in biofuels is stored in which form?

A. chemical
B. electrical
C. nuclear
D. mechanical

Question 7

A major drawback with the use of biofuels is that they

A. still produce greenhouse emissions.
B. tie up land that could be used for food crops.
C. are not a long-term sustainable source of energy.
D. produce a large amount of waste.

Question 8

The use of hybrid engines has become an increasingly popular way of using an alternative energy source in cars. The cars have the usual combustion engine but they also make use of 'regenerative braking' which enables energy to be stored in a battery.

The main energy transformations used in this process are

A. kinetic to gravitational.
B. kinetic to electric.
C. electric to kinetic.
D. gravitational to kinetic.

Question 9

Hydrogen 'fuel-cells' offer the possibility of producing clean energy. In essence, hydrogen is reacted with oxygen to produce water. In that reaction energy is released.

The main difficulty with fuel-cell technology is

A. eliminating the carbon dioxide produced.
B. producing the hydrogen gas required.
C. producing the oxygen gas required.
D. eliminating the waste water produced.

The following information applies to Questions 10 to 13.

Tidal energy uses the power generated by fast moving deep sea tidal streams, which are created by rising and falling tides, to turn turbines placed on the ocean floor. The turbines rotate and are connected to an electrical generator. As water enters the narrowing duct, it is accelerated through the turbine blades as shown in Figure 1. A 1.5 MW tidal system is made up of a five-bladed turbine and the power generated occurs at a speed of 3 ms^{-1}.

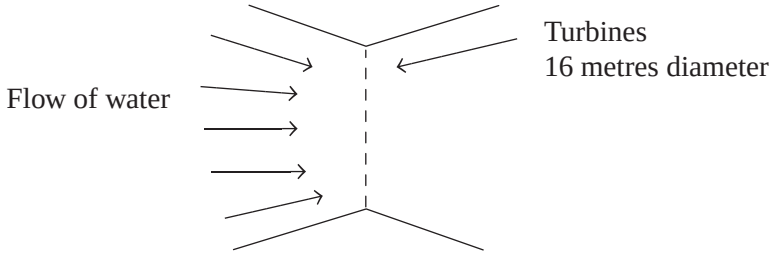


Figure 1

Question 10

Assuming 100% efficiency, the force on the blades is approximately

A. 0.5 MN
B. 1.5 MN
C. 2 MN
D. 4.5 MN

Question 11

Actually, to generate the 1.5 MW, the force on the blades needs to be around 1.8 MN.

This gives an approximate efficiency of the energy transfer as

A. 28%
B. 33%
C. 83%
D. 90%

Question 12

The main reason why there is narrowing of the duct into the turbine is to

A. increase the potential energy of the water.
B. decrease the friction of the water flow over the turbine.
C. decrease the force to turn the turbine.
D. increase the force to turn the turbine.

Question 13

A possible advantage that a tidal system might have over a solar photovoltaic system is

A. it can run in winter.
B. it can run all year round.
C. it is less sensitive to the ambient temperature of the environment.
D. it is easier to connect the tidal system to homes.

END OF DETAILED STUDY 5 – INVESTIGATIONS: SUSTAINABLE ENERGY SOURCES

Detailed study 6 – Medical Physics

Question 1

A radio pharmaceutical is

A. a radio specifically designed to have health benefits.
B. a radioactive isotope for sale in pharmacies.
C. a radioactive isotope that can be used for medical therapy or diagnosis.
D. a radioactive isotope that can be taken as a health supplement.

Question 2

A radioactive isotope can be used as a tracer in the diagnosis of certain conditions of the human body.

For such a use, the isotope should be

A. an alpha-emitter.
B. a beta-emitter.
C. a gamma-emitter.
D. all of the above

Question 3

Technetium 99 (Tc-99) is used widely in medicine because

A. it has a short half-life of six hours.
B. it can be produced in the hospital where it will be used.
C. it emits gamma rays.
D. all of the above

Question 4

When a radioactive substance is used inside the human body it is important that the exposure to radioactivity is kept as short as possible because

A. only short exposure times can have health benefits.
B. all radiation exposure can cause harm; the risk for harm increases as the exposure time increases.
C. only long radiation exposure can cause harm.
D. all radiation can cause harm, but the risk is independent of the length of exposure.

Question 5

An optical fibre used in an endoscope has a glass core with a refractive index of 1.55 and a glass cladding of refractive index 1.42 as shown in Figure 1.

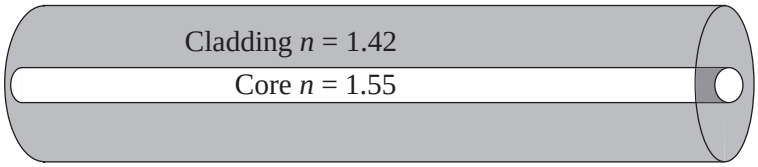


Figure 1

This means that the relative refractive index for this optical fibre is

A. 1.55

B. 1.42

C. $\frac{1.55}{1.42}$

D. $\frac{1.42}{1.55}$

Question 6

The cladding surrounding the core of an optical fibre is necessary to

A. avoid light loss at the surface of the core through contact between the fibre and a substance of higher refractive index.

B. avoid light loss at the surface of the core through contact between the fibre and a substance of lower refractive index.

C. avoid light gain at the surface of the core through contact between the fibre and a substance of higher refractive index.

D. avoid light gain at the surface of the core through contact between the fibre and a substance of lower refractive index.

Question 7

In an endoscope, optical fibres are used to provide images from inside the body. The images are transported along a bundle of optical fibres.

For this purpose the bundle of fibres needs to be

A. coherent.

B. incoherent.

C. polarised.

D. unpolarised.

The following information applies to Questions 8 and 9.

Figure 2 shows a cross-section of a typical fibre-optic endoscope.

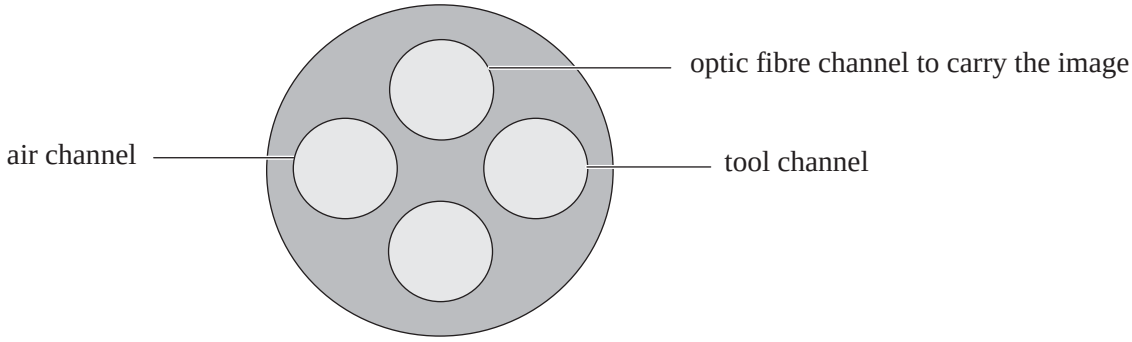


Figure 2

Question 8

Three channels are labelled.

The fourth channel is used for

A. a spare channel.
B. an extra tool channel when more than one tool is required.
C. a body fluid channel to carry away blood.
D. an optic fibre channel to provide illumination of the site.

Question 9

The air channel can be used to

A. provide the patient with oxygen during the operation.
B. remove air from the operation site.
C. to 'inflate' the operation site to give the surgeon room to move.
D. none of the above

Question 10

Which of the following are all examples of medical imaging techniques?

A. ultrasound, MRI, CAD
B. MRI, medical laser and PET
C. PET, ultrasound, CT
D. MRI, CT, medical laser

Question 11

X-rays are absorbed

A. more by substances with a high atomic number.
B. more by substances with a low atomic number.
C. equally by substances with different atomic numbers.
D. less by substances with a high atomic number.

Question 12

One imaging technique that makes use of X-rays is:

A. PET
B. MRI
C. CT
D. ultrasound

Question 13

X-rays can also be used to treat patients with cancer. In such cases, the X-rays are sent to the tumour from a range of different angles as shown in Figure 3.

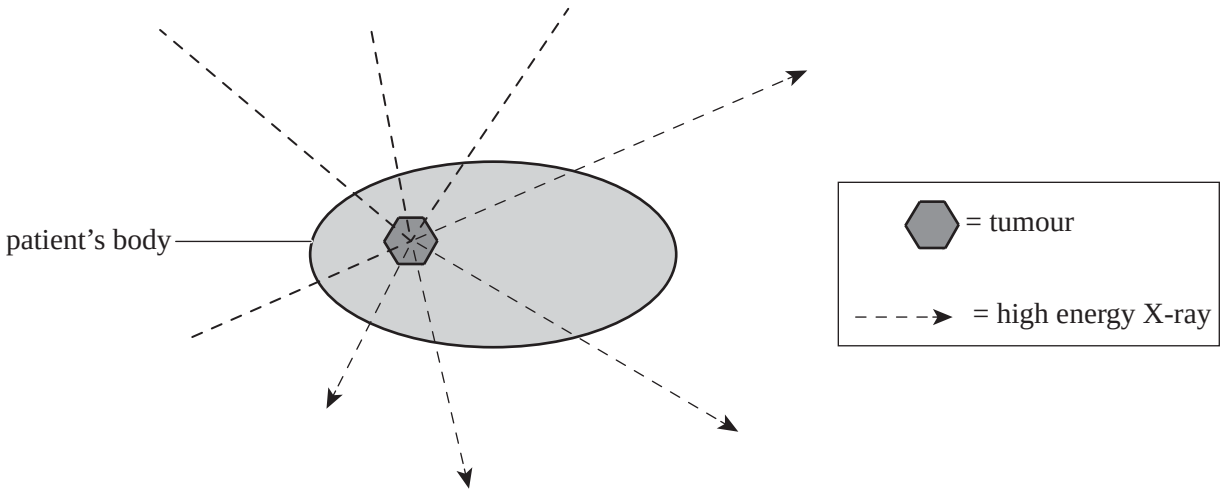


Figure 3

This technique is used so that

A. there is a higher chance of hitting the tumour.
B. the tumour is more precisely targeted.
C. the tumour receives a high dose of X-rays.
D. the surrounding healthy tissues receive a minimal dose of X-rays.

END OF QUESTION AND ANSWER BOOKLET