Neap:

Trial Examination 2009

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	34
2. Wave-like properties of light	16	16	30
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 40 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**

Area of study 1 – Motion

Question 1

Which of the following is not a vector?

A. mass
B. velocity
C. displacement
D. acceleration

1 mark

A 70 kg skier is going down a 20° slope at a constant speed of 15 m s^{-1} as shown in Figure 1.

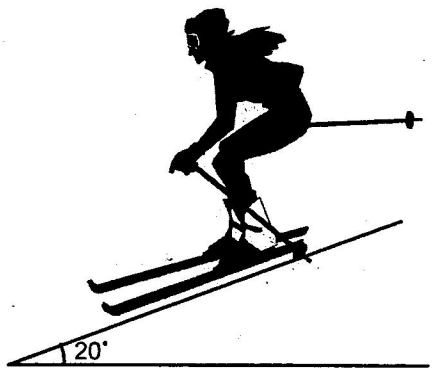


Figure 1

Question 2

Draw and label the forces acting on the skier in Figure 1.

3 marks

Question 3

What is the magnitude of the friction acting on the skier?

N

2 marks

The skier comes to a horizontal section where she steadily comes to rest in 5.0 s.

Question 4

What is the acceleration of the skier during the horizontal section?

	$m\ s^{-2}$

2 marks

Question 5

How far does she travel along the horizontal section before coming to rest?

	m

2 marks

Question 6

How much energy is used to stop the skier in the horizontal section?

	kJ

3 marks

Question 7

With regards to Figure 1, which one of the following statements is correct?

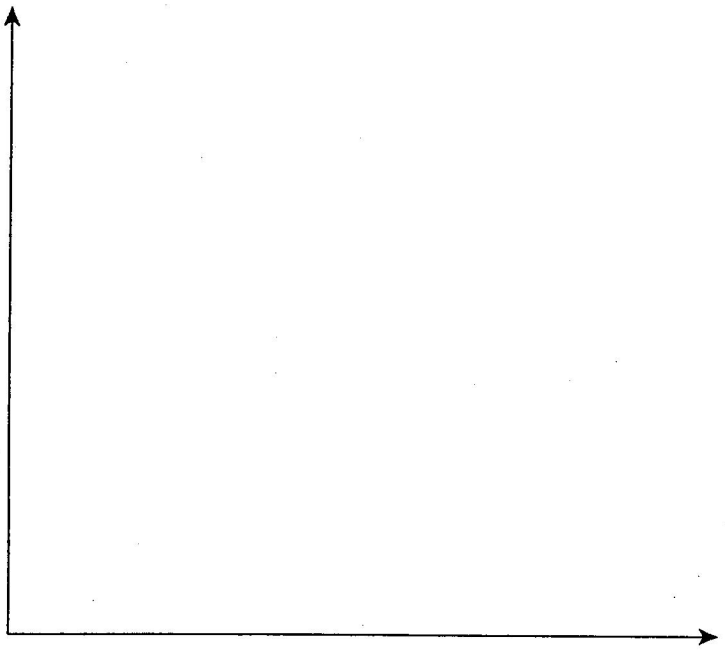
A. The normal reaction and weight forces are equal.
B. The normal reaction is less than the weight force.
C. The normal reaction is greater than the weight force.
D. There is no relationship between the weight and reaction forces.

1 mark

A bus travelling at a constant speed of 40 km h^{-1} passes a stationary scooter. The scooter accelerates to 60 km h^{-1} in 10 seconds and it remains at this speed until it catches up with the bus.

Question 8

Sketch the speed (m s^{-1}) versus time (s) graphs for both vehicles on the axes below. Make sure your graph is clearly labelled with all appropriate SI values.



3 marks

Question 9

How long will it take for the scooter to catch the bus?

s

3 marks

Question 10

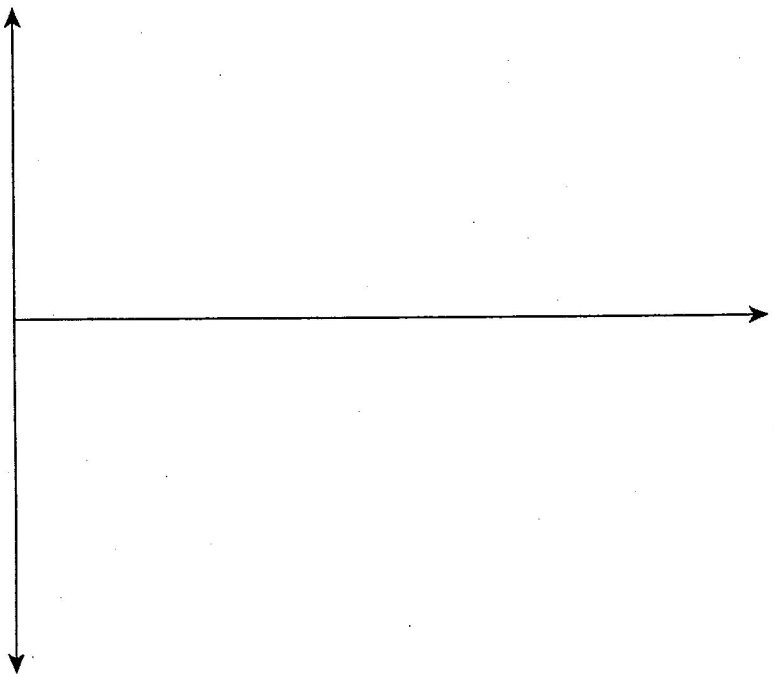
How far has each travelled by the time the scooter catches the bus?

m

1 mark

Question 11

The scooter, once it has caught the bus, slows down and comes to rest in 5 s. Draw the acceleration versus time graph of the scooter for its entire journey (i.e. when it starts to move). Make sure your graph is clearly labelled with all appropriate SI values.



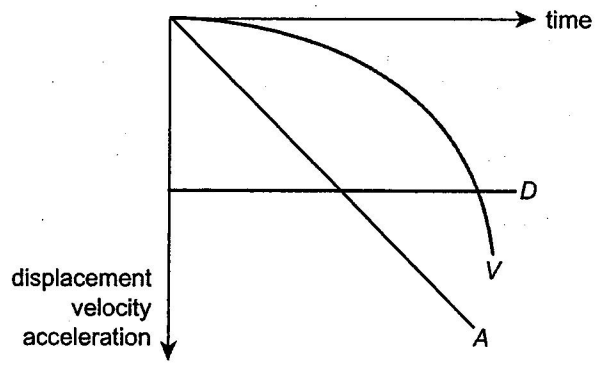
2 marks

Question 12

A ball is dropped vertically from the top of a 250 m tower. Which of the following graphs best represents displacement (D), velocity (V) and acceleration (A)?

Note: Take down as negative from the top of the tower and ignore air resistance.

A.



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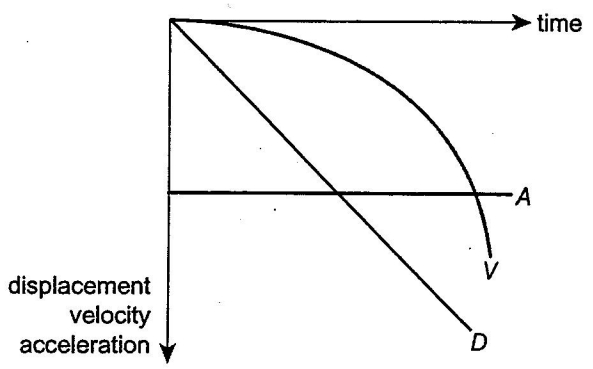
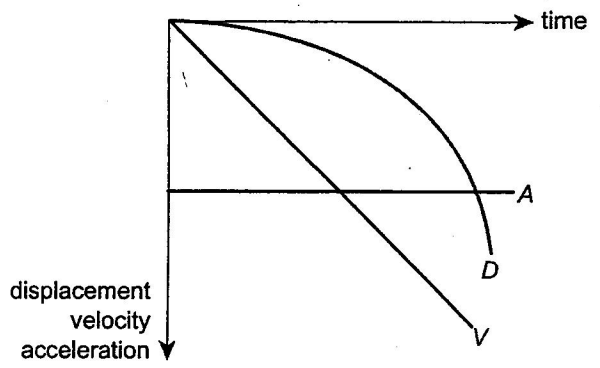


C.



D.

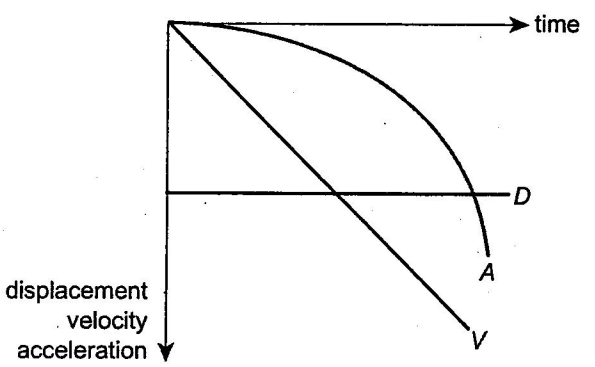


Figure 2

2 marks

The following information refers to Questions 13–14

Quynh and Bilge are investigating a spring to see whether it can be used as part of a bumper absorber system on the 'Extreemo' toy car's bumper bar. They conduct an experiment and produce the following graphical result.

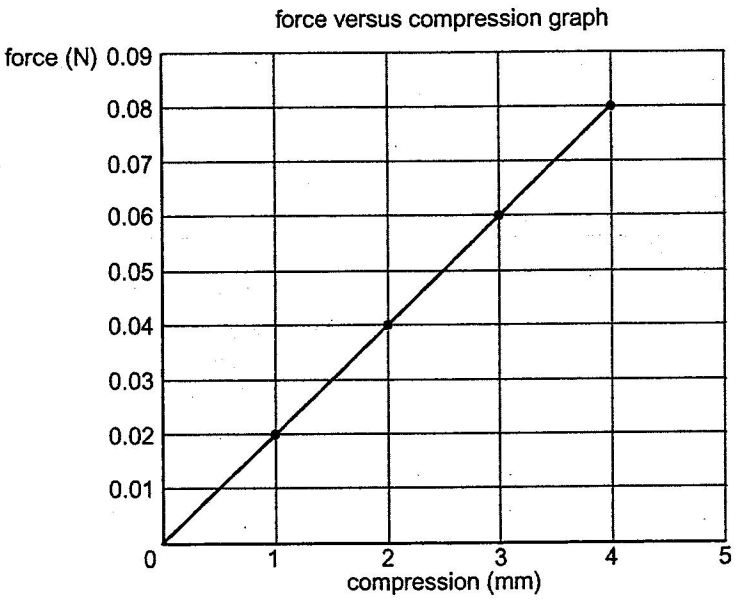


Figure 3

Question 13

What is the spring constant?

$N\ m^{-1}$

2 marks

For the next stage of the investigation, Quynh and Bilge attach the spring to the 'Extreemo' toy car's bumper bar. They set up a head-on collision between the stationary 'Extreemo' car and another moving toy car (mass 100 g), which is travelling at 18 cm s^{-1} just before impact. The maximum compression of the spring is reached at 1 cm.

Question 14

Will the spring be able to absorb the impact from the other toy car and thus prevent the 'Extreemo' car from being damaged? Assume the spring constant does not change.

Support your answer with calculations and circle either Yes or No.

YES/NO

3 marks

The following information refers to Questions 15–17.

Matilde and Gabriel are playing at the swings in a nearby park. Matilde is at the highest point in her swing as shown in Figure 4 (i.e. she is momentarily stationary). All calculations are performed at the centre of mass for Matilde.

Matilde's mass is 18 kg. At the lowest point of the swing, her centre of mass is 0.8 m above the ground.

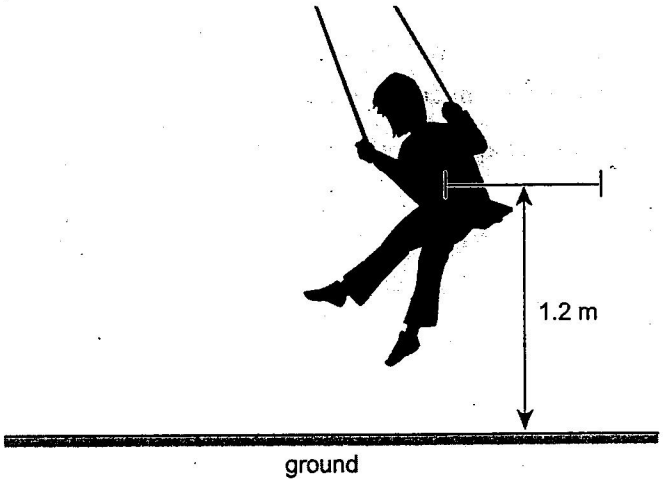


Figure 4

Question 15

What is the change in potential energy for Matilde?

	J

1 mark

Question 16

Gabriel decides to stand in front of Matilde to stop her swinging when she is at the lowest point of her motion.

Assume Matilde comes to a complete standstill, neither Gabriel nor Matilde rebounds from the collision and that Matilde's momentum is transferred to the Earth via Gabriel.

How much momentum is transferred to Gabriel?

	Ns

2 marks

Question 17

If the collision occurs for 0.3 s what is the force of the impact on Gabriel?

	N

1 mark

END OF AREA OF STUDY 1

Area of study 2 – Wave-like properties of light

Isaac Newton and Christiaan Huygens both developed theories on the nature of light during the 17th century. Newton proposed that light was made of particles, whereas Huygens believed that light was a wave. To be successful, both theories had to explain well-known behaviours of light, such as reflection and refraction.

Newton proposed that refraction occurred when light particles in air were accelerated towards the surface of a denser transparent medium such as glass. This meant that Newton's theory predicted that light particles moved faster in glass than in water.

Question 1

Explain how Huygens' explanation of refraction leads to a different prediction about the speed of light in glass. Draw a diagram to support your answer.

3 marks

The refractive index of a certain type of window glass is $n = 1.4$

Question 2

Use the information given above to calculate the speed of light in glass.

m s^{-1}

2 marks

Question 3

Use your answer to Question 2 to determine whether Newton or Huygens was correct. Justify your answer.

2 marks

Below is a diagram representing a transversal wave on a string:

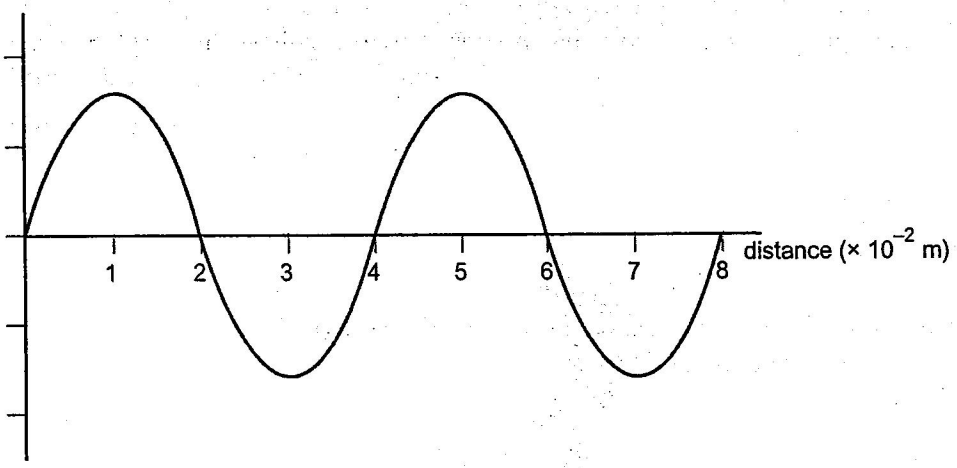


Figure 5

Question 4

The quantity indicated on the x-axis is 'distance'.

The most likely quantity indicated by the y-axis is

A. time
B. distance
C. pressure
D. loudness

1 mark

Question 5

On Figure 5 clearly indicate the

- amplitude and
- wavelength.

2 marks

Question 6

The wave in Figure 5 travels at a speed of 50 cm s^{-1}.
Calculate the period of this wave.

s

2 marks

Violet light has a wavelength of about 3.5×10^{-7} m. Another form of 'light' has a wavelength of 1.5×10^{-7} m.

Question 7

Would the 'light' with wavelength 1.5×10^{-7} m be visible to the human eye? Explain your answer.

2 marks

Question 8

Name the form of 'light' that has wavelength 1.5×10^{-7} m and explain why it is correct to refer to it as 'light'.

2 marks

Question 9

Which one of the two forms of light would be refracted more when passing from air into a denser medium?

1 mark

The window of the giant tank in the Melbourne Aquarium is made from a special type of plastic. The plastic window is 0.40 m thick. A light ray starts in the water, travels through the plastic and emerges in the air, as shown in Figure 6.

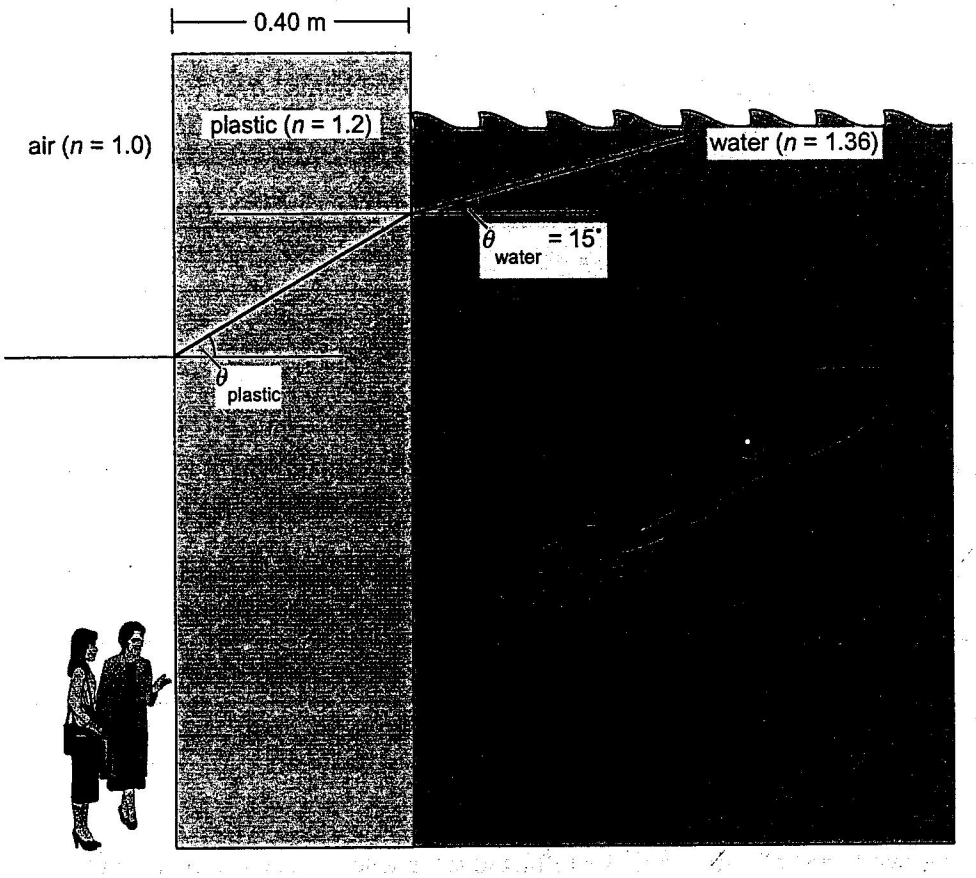


Figure 6

The refractive indices (n) for air, plastic and water are as follows:

air = 1.0

plastic = 1.2

water = 1.36

Question 10

Draw the light beam as it emerges into the air onto the diagram above.

1 mark

Question 11

Calculate the value for $\theta_{plastic}$.

	°

2 marks

Question 12

At what value for $\theta_{plastic}$ would all of the light be internally reflected off the plastic–air boundary?

	°

2 marks

Question 13

What is the name of the angle you calculated in Question 11?

_____

_____

1 mark

Question 14

Complete the following sentences by circling the correct option from the choice of three that is given within each set of brackets.

When light passes through a single polarising filter the emerging light is [**unpolarised / polarised / unaffected**]. As a result the emerging light will be [**less / equally / more**] bright than the incoming light. If you now put a second filter directly behind the first one in order to reduce the light intensity to about 25% of the original incoming light, the angle between the two filters should be [**90° / 45° / 180°**].

3 marks

Sally and Arnold have been given the job of designing light effects for their school musical. They have the following colours of light available: green, yellow and blue. They also have the following gels (filters) which can be fitted in front of the lights: red, cyan and magenta.

For a particular scene Sally and Arnold require a red light on stage.

Question 15

Describe two ways in which Sally and Arnold will be able to provide red light on stage.

2 marks

During the second act white light is needed, but only two lights can be used at once.

Question 16

Describe how Sally and Arnold will be able to provide white light on stage. Explain your answer.

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

Question 1

Gabriel wants to track the motion of a particular star over a number of hours. He decides that the best system to use is the altitude–azimuth coordinate system.

Matilde, however, disagrees and says that the right ascension–declination system is better suited.

Who is correct?

A. Gabriel
B. neither
C. both
D. Matilde

Look carefully at Figure 1.

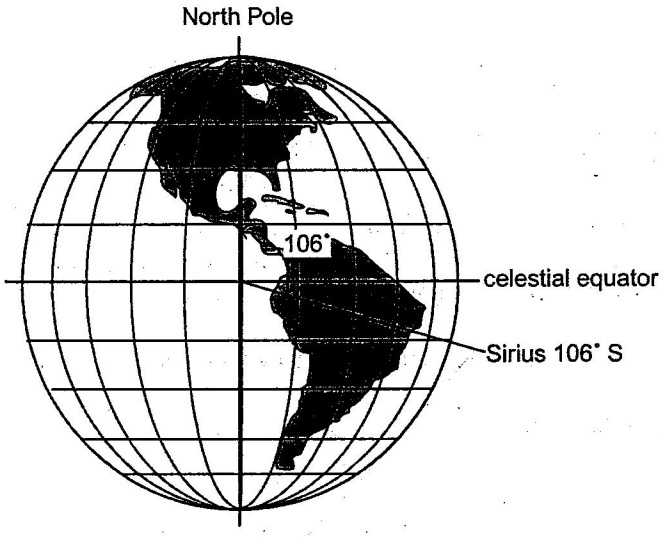


Figure 1

Question 2

Sirius (a star) is located approximately 106° south from the North Pole. Sirius's declination is

A. –106°
B. 106°
C. –16°
D. 344°

Question 3

Sirius's distance from Earth is 8.6 light-years. Given that the speed of light is 3.0×10^8 m s^{-1}, the distance in kilometres is

A. 8.1×10^{13} km
B. 2.6×10^5 km
C. 9.5×10^{12} km
D. 2.6×10^8 km

Question 4

On May 6 1960, Mars was near the celestial equator. The correct set of coordinates using the right ascension–declination system would most likely be

A. 24 h 47 min right ascension and 2° 55′ declination
B. 24 h 47 min right ascension and –2° 55′ declination
C. –23 h 47 min right ascension and 2° 55′ declination
D. 23 h 46 min right ascension and –2° 55′ declination

Question 5

Ptolemy's model had difficulty in accounting for the motion of Mars through the sky. He had to introduce 'epicycles' to its orbit. Epicycles were introduced to explain

A. how the motion of all celestial bodies occurs.
B. how Mars sometimes appeared to move opposite to its usual direction.
C. how Mars travelled in its usual direction.
D. how the Moon orbited Earth.

Galileo made many observations of celestial bodies. His observations of one celestial body over a period of time are recorded in Figure 2.

The body involved is shown to the same relative scale in each observation.

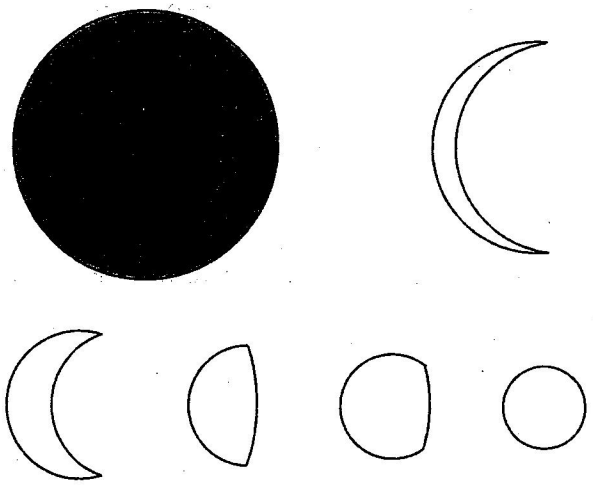


Figure 2

Question 6

The body shown above might be

A. the Moon
B. Venus
C. the Sun
D. Halley's comet

Question 7

Galileo stated that for the situation described in the previous question to occur, the celestial body must

A. orbit around Earth.
B. remain stationary.
C. orbit around another planet.
D. orbit around the Sun.

Look carefully at the diagram of the telescope provided below. Assume the mirrors to be spherical rather than parabolic.

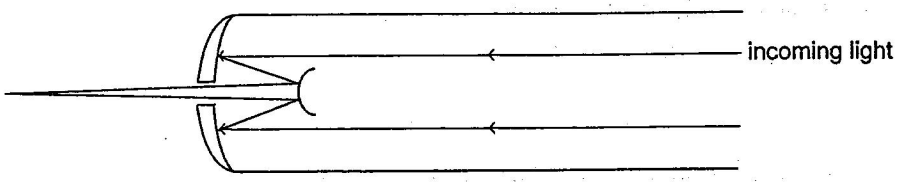


Figure 3

Question 8

This type of telescope is called

A. a Galilean telescope.
B. a Newtonian telescope.
C. a Cassegrain telescope.
D. a Gregorian telescope.

Question 9

An advantage of the type of telescope shown in Figure 3 is that

A. the viewer looks through the telescope in the same direction as the star being viewed.
B. it forms an upright image rather than an inverted one.
C. it uses lenses, which are cheaper than mirrors.
D. it avoids spherical aberration.

Question 10

Which of the following cannot be used by Earth-based astronomical observatories?

A. radio waves
B. γ-rays
C. visible light
D. microwaves

Question 11

The term 'resolution' is very important when applied to telescopes. It refers to

A. the ability to produce sharp images.
B. the ability to avoid spherical aberration.
C. the ability to avoid chromatic aberration.
D. the ability to digitise images for later use.

Question 12

Telescopes led to the discovery of many kinds of celestial objects, one being termed 'nebulae'. 'Nebulae' refer to

A. groupings of two stars.
B. clouds of gas.
C. groupings of asteroids.
D. planets orbiting a star.

Question 13

Which of the following statements is correct?

A. An equatorial mount allows easy tracking of a star over an extended period of time.
B. An altazimuth mount requires only the right ascension to be adjusted.
C. An equatorial mount requires both the azimuth and altitude to be adjusted.
D. An equatorial mount will give better resolution than an altazimuth mount.

END OF DETAILED STUDY 1 – ASTRONOMY

Detailed study 2 – Astrophysics

The diagram below shows the visible light section of the solar spectrum.

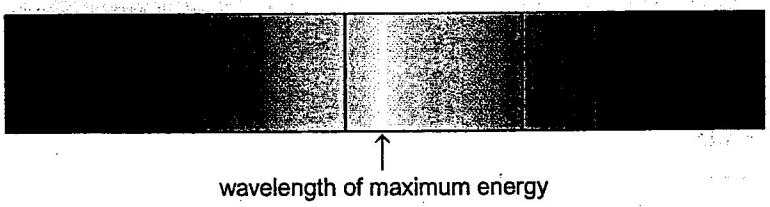


Figure 1

Question 1

The black vertical lines in the spectrum are

A. emission lines caused by the presence of certain elements in the solar atmosphere.
B. absorption lines caused by the presence of certain elements in the solar atmosphere.
C. emission lines caused by the absence of certain elements in the solar atmosphere.
D. absorption lines caused by the absence of certain elements in the solar atmosphere.

Question 2

The arrow in the diagram indicates the wavelength of light at which the Sun sends out the most energy. From this information astrophysicists can determine

A. the Sun's age.
B. the Sun's distance from Earth.
C. the Sun's mass.
D. the Sun's surface temperature.

Before Edwin Hubble, astronomers believed that the universe was only about as large as our own Milky Way galaxy. Hubble showed that our galaxy was only one of many galaxies and that the universe was vastly bigger than previously thought. To show that other galaxies existed outside our own, Hubble used a new method for measuring distances in space.

Question 3

The new method that Hubble used to measure large, intergalactic distances was based on

A. the method of solar parallax.
B. variable stars called Cepheid variables, that could act as 'standard candles'.
C. the Doppler effect.
D. the reflection of laser light.

Question 4

How far did Hubble have to measure out into space to show that other galaxies existed outside our own?

A. 100 000 light years
B. 1 million light years
C. 50 million light years
D. billions of light years

Question 5

How many galaxies do modern astronomers estimate to be present in our universe?

A. thousands
B. millions
C. billions
D. they have no idea

Figure 2 represents a Herzsprung–Russell (H–R) diagram.

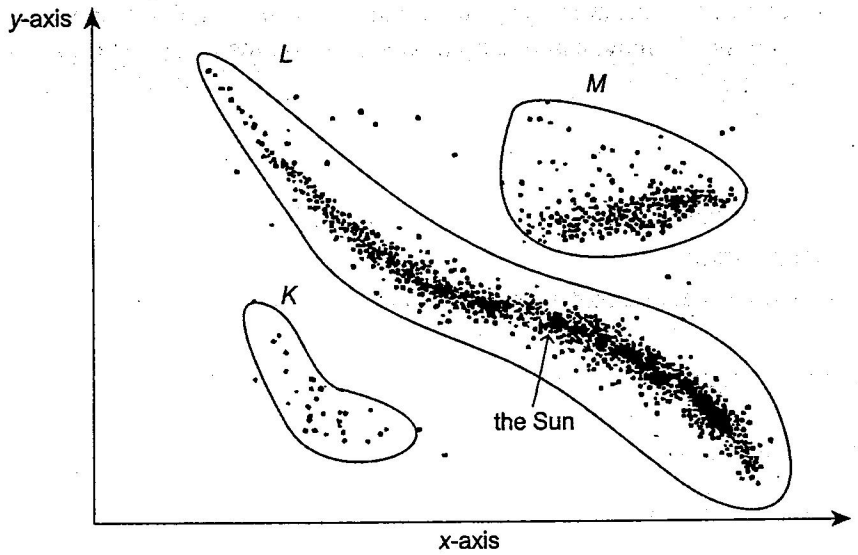


Figure 2

Question 6

Which of the following would provide a good label for the *x*-axis?

A. surface temperature
B. core temperature
C. luminosity
D. relative brightness

Question 7

In the following table, which row provides the correct labels for areas *K*, *L* and *M* in the H–R diagram?

	Area *K*	Area *L*	Area *M*
A.	main sequence stars	red giants	white dwarfs
B.	white dwarfs	main sequence stars	red giants
C.	red giants	main sequence stars	white dwarfs
D.	red giants	white dwarfs	main sequence stars

Question 8

The Sun's position is indicated on the H–R diagram. However, this position will change in the future because

A. the Sun is moving relative to the centre of the galaxy.
B. our galaxy is moving relative to our local group of galaxies.
C. the surface temperature and brightness of our Sun will change as it burns up hydrogen.
D. the mass of our Sun will change as it burns up hydrogen.

Question 9

Apart from lots of radiant energy, the Sun also emits positrons (positively charged electrons).
This is because positrons are

A. a product of the fission reactions inside the Sun's core.
B. a product of the fusion reactions inside the Sun's core.
C. some of the elements that make up the Sun.
D. a result of the interaction between the Sun and highly energetic cosmic rays.

Question 10

Hubble measured the Doppler shift of a range of galaxies to find out

A. how those galaxies were moving relative to Earth.
B. how far away those galaxies were.
C. whether the universe was expanding.
D. how hot those galaxies were.

Question 11

What Hubble found when he measured the Doppler shift of those galaxies indicated that

A. the universe was static.
B. the universe was very large.
C. the universe was expanding.
D. we are at the centre of our universe.

Question 12

The big bang theory is now the most likely explanation for the origin of our universe.

Which of the following observations does **not** provide empirical evidence for the big bang theory?

A. the red shift of all distant galaxies
B. the blue shift of all distant galaxies
C. the discovery of the microwave background radiation
D. the precise chemical make-up of our universe

Question 13

The force most influential in the formation of galaxies is

A. the electromagnetic force.
B. the gravitational force.
C. the strong nuclear force.
D. none of the above

END OF DETAILED STUDY 2 – ASTROPHYSICS

Detailed study 3 – Energy from the nucleus

Question 1

The diagram below shows a simplified model of an atom.

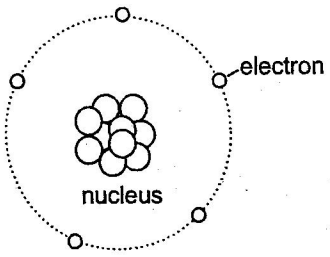


Figure 1

This diagram could best be improved by

A. drawing as many electrons as there are nucleons inside the nucleus.
B. drawing the radius of the electron 'orbit' twice as large.
C. drawing the nucleus as containing two different types of particle.
D. drawing many more nucleons inside the nucleus.

Question 2

The strong nuclear force is responsible for

A. the decay of neutrons into a proton and electron.
B. the attraction between the nucleus and the orbiting electrons.
C. the attraction between protons and protons only.
D. the attraction between all nucleons.

Question 3

Read the two statements below.

i. The amount of binding energy that is contained in the nucleus is directly related to the strength of the force that holds nucleons together.

ii. Nuclear reactions are more energetic than chemical ones because inside the nucleus the strong nuclear force is much stronger than the electromagnetic force.

In reference to the two statements,

A. **i.** is correct.
B. **ii.** is correct.
C. both **i.** and **ii.** are correct.
D. neither **i.** nor **ii.** are correct.

Question 4

Einstein's famous equation, $E = mc^2$, can be taken to mean that

A. energy can be converted into mass.

B. conservation of energy and conservation of mass must both be considered together in nuclear reactions.

C. mass is a special kind of concentrated energy.

D. all of the above are correct interpretations

Question 5

In nuclear fusion, energy is released because

A. the product has less mass than the reactants.

B. the product has more mass than the reactants.

C. the product is equal in mass to the reactants.

D. the product's mass is irrelevant.

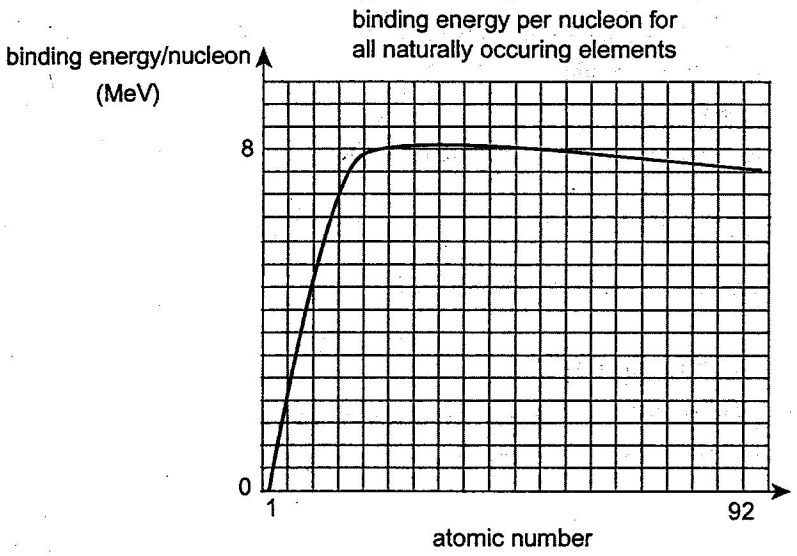


Figure 2

Question 6

The graph above shows that

A. the fusion of lighter elements into heavier ones always releases energy.

B. the fission of heavier elements into lighter ones always releases energy.

C. all possible nuclear reactions release energy.

D. fusion only releases energy for elements along the rising part of the graph.

Question 7

The graph shows that the element with atomic number 92 will have

A. less total binding energy than its products after undergoing fission.

B. more total binding energy than its products after undergoing fission.

C. less total binding energy than its products after undergoing fusion.

D. more total binding energy than its products after undergoing fusion.

Question 8

Nuclear fission occurs readily in the following two isotopes

A. uranium-235 and uranium-238.
B. uranium-235 and helium-4.
C. plutonium-239 and plutonium-235.
D. uranium-235 and plutonium-239.

Question 9

For a fission reaction to be sustainable in the form of a chain reaction

A. a minimum mass of fissionable material must be available.
B. slow moving neutrons must be present.
C. the fissionable material must be shaped in such a way that its surface area is reduced.
D. all of the above requirements must be met.

Question 10

Nuclear power plants rely on nuclear fission rather than nuclear fusion, because

A. fusion reactions cannot be kept at a high enough temperature and density using current technology.
B. fission reactions produce no carbon dioxide.
C. fission reactions produce no waste.
D. the material required to 'fuel' fission reactions is more plentiful than that required for fusion.

Question 11

In a modern nuclear fission reactor, 'heavy' water might be used

A. as a coolant.
B. as a moderator, to slow down fast neutrons.
C. to make steam that can drive a turbine.
D. as a control substance, to absorb excess neutrons.

Question 12

Two physics students, Fatima and Jack, are discussing nuclear fusion as it occurs inside the Sun.

Fatima says: " Fusion only occurs inside the core because it is much hotter there."

Jack counters: "No, it occurs inside the core because the hydrogen is under much more pressure there".

Who is correct?

A. Jack is correct.
B. Fatima is correct.
C. Both are correct.
D. Neither is correct.

Question 13

A nuclear 'chain reaction' is so named because

A. it produces a product that is also a reactant for the same reaction.
B. it produces lots of energy.
C. it happens very quickly.
D. it can only be stopped by withdrawing one of the reactants.

END OF DETAILED STUDY 3 – ENERGY FROM THE NUCLEUS

Detailed study 4 – Investigations: Flight

A passenger jet plane is in level flight cruising at a constant speed of 800 km h^{-1}. The engines provide a thrust of 30 kN.

Question 1

What is the magnitude of the total drag on the jet?

A. 24×10^3 kN

B. 30 kN

C. 6.7×10^3 kN

D. 26 kN

Question 2

Assuming that all the engine power is used to deliver thrust, what is the power output of the engines?

A. 24 MW

B. 30 MW

C. 6.7 MW

D. 6.7 kW

Question 3

Joan and Clinton are discussing the relationship between the exhaust gases and the forward motion of the jet plane.

Which of the following statements is correct?

A. Newton's third law explains why the plane moves forward.

B. Newton's second law explains why the plane moves forward.

C. Newton's first law explains why the plane moves forward.

D. Bernoulli's principle explains why the plane moves forward.

Question 4

In this scenario, the power from the engines must provide enough force

A. to overcome drag only.

B. to provide the plane with sufficient lift to overcome its weight only.

C. to provide the plane with sufficient lift to overcome its weight and drag.

D. to provide the plane with sufficient lift to overcome its weight and drag and to accelerate it.

Question 5

Look carefully at Figure 1. The arrows *A–D* represent different forces.
Note: the forces are not drawn to scale.

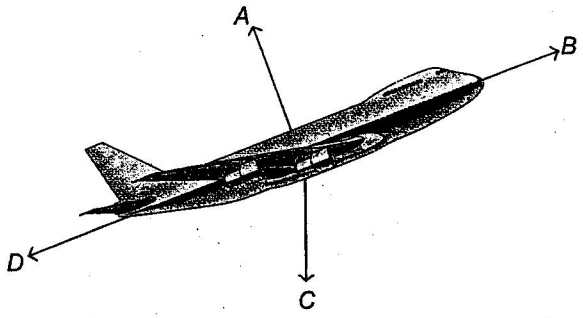


Figure 1

For an aircraft accelerating and gaining altitude after take-off, which of the following best represents the likely balance between the forces acting on the aircraft?

A. *A* is bigger than *C* and *B* is smaller than *D*.
B. *A* is smaller than *C* and *B* is smaller than *D*.
C. *A* is bigger than *C* and *B* is bigger than *D*.
D. *A* and *C* are equal and *B* and *D* are equal.

The helicopter in Figure 2 is hovering in a stationary position 100 metres above the ground.

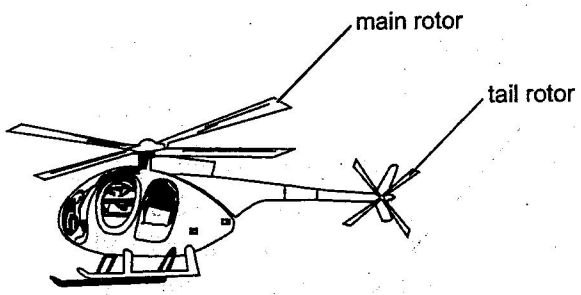


Figure 2

The main rotor provides a maximum torque of 500 kN m.
The tail rotor is located 4.00 m from the centre of mass of the helicopter and without it the helicopter would rotate in the horizontal plane.

Question 6

If the helicopter is hovering, it means that relative to the centre of mass

A. the torque from both rotors must be equal.
B. the tail rotor has a greater torque than the main rotor.
C. the main rotor has a greater torque than the tail rotor.
D. the torques from the two rotors have different centres of mass.

Question 7

The maximum force provided by the tail rotor is

A. 0.00 kN
B. 125 kN
C. 2.00×10^3 kN
D. 500 kN

Question 8

There is an old Greek legend about a young man named Icarus who flew using wings that resembled a bird's wings, made of feathers and wax. The ancient Greeks thought that *flapping* the wings would lift a person into the air. This is incorrect because

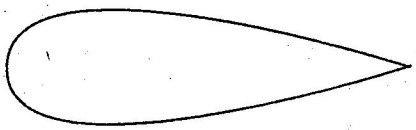
A. a bird's wings provide drag, not lift.
B. a bird's wings provide lift, not thrust.
C. flapping provides lift, not thrust.
D. flapping provides thrust, not lift.

Racing cars often have wings to provide a downward force. This helps cars go around corners faster.

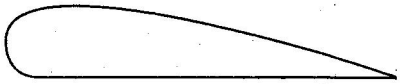
Question 9

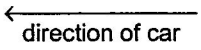
Which of the following wing designs would best do this?
Note: assume the car is moving to the left and is side on.

A.

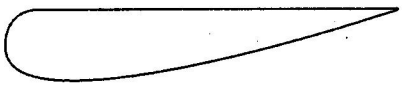


B.

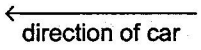




C.



D.



Question 10

Bernoulli's equation tells us that in the above scenario

A. the speed of the air increases as it moves from left to right across the top of the wing.
B. the speed of the air increases as it moves from left to right across the bottom of the wing.
C. the speed of the air remains constant as it moves from left to right across the bottom of the wing.
D. the speed of the air decreases as it moves from left to right across the bottom of the wing.

Question 11

Any object that moves through a fluid (air or water) will experience some resistance against its motion. Which of the following statements concerning drag is correct?

A. Pressure drag is affected by the shape of the object.
B. Skin friction drag is affected by the shape of the object.
C. Pressure drag and skin friction drag are equal in their effect on an object.
D. Skin friction drag contributes to the lift of a wing.

Question 12

Look carefully at Figure 3, which shows a wing moving through air.

Figure 3

Which of the following changes is likely to **decrease** drag?

A. increasing the speed
B. increasing the angle of attack
C. decreasing the angle of attack
D. dropping the flaps down

Question 13

Christian and Leeroy have constructed a small wind tunnel and are using it to test a wing design, as shown in Figure 4. The fan has five different settings by which they can vary the speed of the air going over the wing. The force meter is used to help determine the lift.

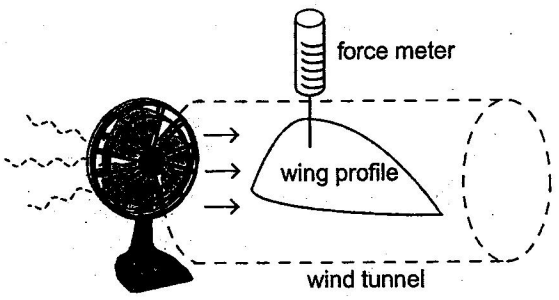


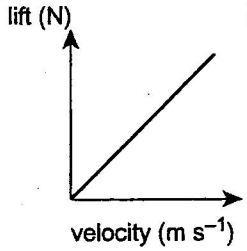
Figure 4

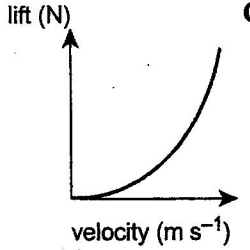
Christian and Leeroy vary the airspeed going over the wing but keep all the other variables constant. They then compare their results using the lift equation, which is derived from Bernoulli's equation.

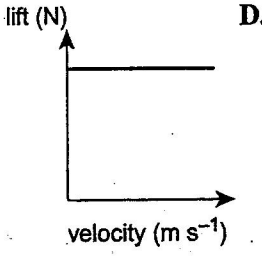
The lift equation is given by $L = \frac{1}{2} \times C_l \times \rho \times v^2 \times A$, where:

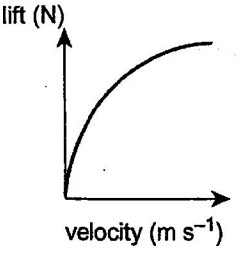
L is the lift (N); C_l is the coefficient of lift; ρ is the fluid density (kg m^{-3}); v is the velocity (m s^{-1}); and A is the wing area perpendicular to the direction of travel (m^2).

Assuming the angle of attack is kept constant, which of the following graphs would you expect Christian and Leeroy to obtain?

A.


B.


C.


D.


END OF DETAILED STUDY 4 – INVESTIGATIONS: FLIGHT

Detailed study 5 – Investigations: Sustainable energy sources

Question 1

In the paragraph below three options are given within each set of brackets. Only one option within each set of brackets is correct.

> Humans have traditionally relied on [**renewable / sustainable / non-renewable**] energy sources for transport, electricity, etc. However, due to an increase in greenhouse gas emissions humans need to look for [**renewable / sustainable / non-renewable**] energy sources that can be used up at a [**renewable / sustainable / non-renewable**] rate.

Which of the following solutions gives the correct options from each set of brackets in the right order?

A. renewable, sustainable, non-renewable
B. sustainable, renewable, non-renewable
C. non-renewable, sustainable, renewable
D. non-renewable, renewable, sustainable

Question 2

In Australia, which alternative energy source is the cleanest and most abundant, and therefore most suited to meeting our energy needs?

A. uranium
B. natural gas
C. tidal
D. solar

The federal Government has been phasing out inefficient incandescent light bulbs from November 2008, and after 2011 they will be unavailable. One fluoro-type brand claims that its 13 W spiral energy-saving globes last 10 000 hours, which is 10 times longer than an incandescent globe. They also save 80% on energy usage.

Question 3

What incandescent globe is equivalent to this type of fluoro?

A. 13 W
B. 65 W
C. 16 W
D. 130 W

Question 4

Both the 13 W fluoro globe and the equivalent incandescent globe are used for the life of the incandescent globe. Approximately how much energy is saved by using the 13 W fluoro globe instead of the incandescent globe?

A. 2.3×10^2 MJ
B. 1.9×10^2 MJ
C. 1.3×10^2 MJ
D. 4.7×10^1 MJ

Question 5

Victoria's greenhouse emissions were 2.2 million tonnes greater in 2008 than 2007. The government uses 'black balloons' to help people visualise the quantity of greenhouse gases being produced. One tonne of greenhouse gas equals 20 000 balloons. How many more black balloons did Victoria produce in 2008 than in 2007?

A. 44 billion
B. 44 million
C. 20 billion
D. 22 billion

Question 6

Table 1 compares three different alternative energy sources.
Table 2 contains possible advantages and disadvantages of the energy sources in a random order.

Table 1

	Advantage	Disadvantage
Biofuels		
Hydroelectric		
Wind		

Table 2

Advantages		Disadvantages	
A1	no greenhouse gas	**D1**	environmental impact (flooding)
A2	can be derived from many different materials	**D2**	weather dependent
A3	can easily control electrical output	**D3**	greenhouse gases produced

The sequence of advantages and disadvantages that would complete Table 1 is

A.

A1	**D1**
A2	**D2**
A3	**D3**

B.

A2	**D3**
A3	**D1**
A1	**D2**

C.

A2	**D2**
A3	**D1**
A1	**D3**

D.

A3	**D3**
A2	**D2**
A1	**D1**

Question 7

A farmer uses a wind turbine to run a pump in a dairy shed. Figure 1 shows a typical (simplified) wind turbine.

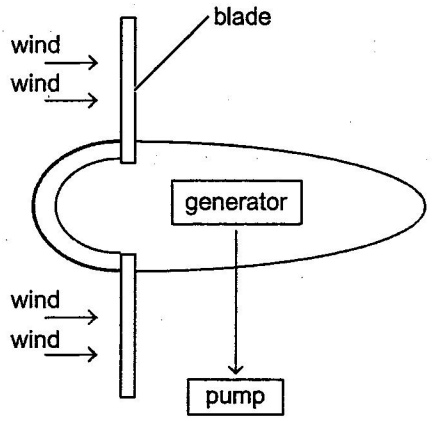


Figure 1

The energy transformations in this sequence are most likely to be

A. mechanical / electrical / mechanical
B. electrical / mechanical / electrical
C. electrical / electrical / mechanical
D. mechanical / mechanical / electrical

Question 8

An experimental wind turbine is set up off the west coast of Victoria. The blades are 6 m in length and can safely operate at a maximum air speed of 7 m s^{-1}. Assume that at this speed the mass of air passing over the turbine is 2000 kg s^{-1}. Under these conditions the electrical power output of the turbine is 20 kW. What is the approximate efficiency of the energy transfer?

Note: kinetic energy $= \frac{1}{2}mv^2$, *where* m = *mass (kg) and* v = *speed* ($m\ s^{-1}$).

A. 21%
B. 35%
C. 45%
D. 41%

Question 9

A refrigerator cannot operate by being wired directly to a solar panel.
Which of the following statements gives the most likely reason for this?

A. A refrigerator needs to run both day and night.
B. Solar panels only produce low current and a refrigerator needs large current.
C. Solar panels produce DC power and a refrigerator requires AC.
D. The voltage produced by solar panels is too low to run a refrigerator.

The smallest practical solar photovoltaic (PV) system that could be installed on a house would be a 1050 W (peak) system. This output would be obtained for an average of 4.79 hours a day during summer.

The size of the system is $7.7m^2$ and the installation cost is around $12 000–$18 000.

Question 10

The total energy that could be produced by this system in one week, on one house, would be approximately

A. 35.2 kJ.
B. 635 MJ.
C. 127 MJ.
D. 26.5 MJ.

The Sun's energy can also be harnessed by solar hot water systems to provide hot water. These systems are commonly used in countries where there is plenty of sunlight (e.g. Israel) but they are also popular in other countries, such as China, because they function even under grey skies and at very cold temperatures.

One design requires no electric power, pumps, valves, or moving parts. In Australia, after rebates from the government, an average solar hot water system (fully installed) costs around $2000–$3000.

Question 11

Referring to the information given in Question 10, when faced with either installing a solar hot water system or solar PV panels, a disadvantage of solar hot water would be that

A. energy-wise, solar hot water is less efficient than a solar PV.
B. cost-wise, solar hot water systems are cheaper than a solar PV.
C. solar hot water will provide more energy savings because there is a greater demand to heat water than to use electricity for other purposes.
D. solar hot water will provide less energy savings because there is a lesser demand to heat water than to use electricity for other purposes.

Question 12

Some politicians and scientists see nuclear fission as a way for Australia to produce 'clean' energy while still satisfying our energy needs. Fission produces large amounts of energy, for example one kilogram of uranium-235 is capable of releasing 6.8×10^{13} J of energy during nuclear fission. Comparatively, burning one kilogram of coal releases approximately 2.5×10^{7} J. How much coal (in tonnes) is required to produce the same amount of energy as of one kilogram of uranium-235?

A. 1.0 tonne

B. 1.0×10^{3} tonnes

C. 2.7×10^{3} tonnes

D. 2.7×10^{6} tonnes

Question 13

Using uranium-235 to produce electricity has several drawbacks.

Which of the following statements is **not** one of them?

A. Uranium-235 is hazardous to use and store.

B. Uranium-235 emits greenhouse gases, such as CO_2.

C. Uranium-235 is expensive to process and use.

D. Uranium-235 can be used to make bombs.

END OF DETAILED STUDY 5 – INVESTIGATIONS: SUSTAINABLE ENERGY SOURCES

Detailed study 6 – Medical Physics

Question 1

Radioactive materials can be used in medical applications for

A. diagnostic purposes only.
B. therapeutic purposes only.
C. both therapeutic and diagnostic purposes.
D. neither therapeutic nor diagnostic purposes.

Question 2

Which one of the following would **not** be a suitable choice for use as a **tracer** inside the human body?

A. an isotope emitting β and γ rays
B. an isotope emitting γ rays
C. an isotope emitting α rays only
D. none of the above would be suitable

Question 3

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

Select the best option of the treatment choices below.

	A suspected brain tumour	A broken upper arm
A.	CT scan	ultrasound
B.	CT scan	X-ray
C.	ultrasound	CT scan
D.	X-ray	X-ray

Question 4

A paediatrician needs to assess the growth of an unborn baby.

She chooses ultrasound as the best technique to do this, because ultrasound

A. is the most powerful technique.
B. provides the clearest possible image.
C. requires the cheapest equipment.
D. is non-ionising and non-intrusive.

Question 5

Ultrasound works by receiving

A. partially reflected sound from inside the body.
B. partially absorbed sound from inside the body.
C. fully reflected sound from inside the body.
D. none of the above

Question 6

Which of the following imaging techniques uses radio waves?

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

Question 7

Which of the following imaging techniques does not make use of ionising radiation?

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

Question 8

The C in CT stands for

A. cathode ray
B. chemical
C. composite
D. computer

Question 9

Which one of the following is a requirement for the use of radioisotopes inside the body?

A. The isotope should have an extremely long half-life.
B. The isotope should have a very short half-life of less than one second.
C. The isotope should have a moderately short half-life between one hour and one week.
D. The isotope can have a half-life of any value.

Question 10

Using a laser, surgeons can cauterise (or seal) small blood vessels during an operation.

The laser is used because

A. it delivers a large amount of energy.
B. it is really hot.
C. its energy can be finely focused onto a very small area.
D. it is a non-ionising form of radiation.

Question 11

An endoscope uses two separate bundles of optical fibres. The table below lists the type of bundle of optical fibres and possible purposes.

	Type of optical fibre	Purpose
i.	coherent bundle	delivery of light to the site of operation
ii.	coherent bundle	transferring the image to the operator
iii.	incoherent bundle	transferring the image to the operator
iv.	incoherent bundle	delivery of light to the site of operation

Which of the options match the bundle with its correct purpose?

A. **i.** and **iii.** are correct.
B. **ii.** and **iv.** are correct.
C. only **ii.** is correct.
D. none of the above

Question 12

Endoscopic surgery is often a preferred form of surgery because

A. it reduces the likelihood of infection for the patient.
B. only a small incision has to be made.
C. patients usually recover more quickly than from conventional surgery.
D. all of the above

Question 13

A tiger at the Melbourne Zoo has eaten a rubber tennis ball that a thoughtless visitor had thrown at it. The zoo vet needs to find the position of the ball in the tiger's alimentary canal.

Which would be the best imaging technique to use on this occasion?

A. X-ray, because the rubber will contrast strongly on the X-ray photograph.
B. CT scan, because the equipment would be easily available to the zoo vet.
C. Ultrasound, because the air in the ball will show up clearly.
D. PET scan, because this is the only technique that can be used on animals.

END OF QUESTION AND ANSWER BOOKLET