INSIGHT

Year 11 *Trial Exam Paper*

2012
PHYSICS
Written examination 2

Worked solutions

This book presents:

- worked solutions, giving you a series of points to show you how to work through the questions
- mark allocation details
- tips

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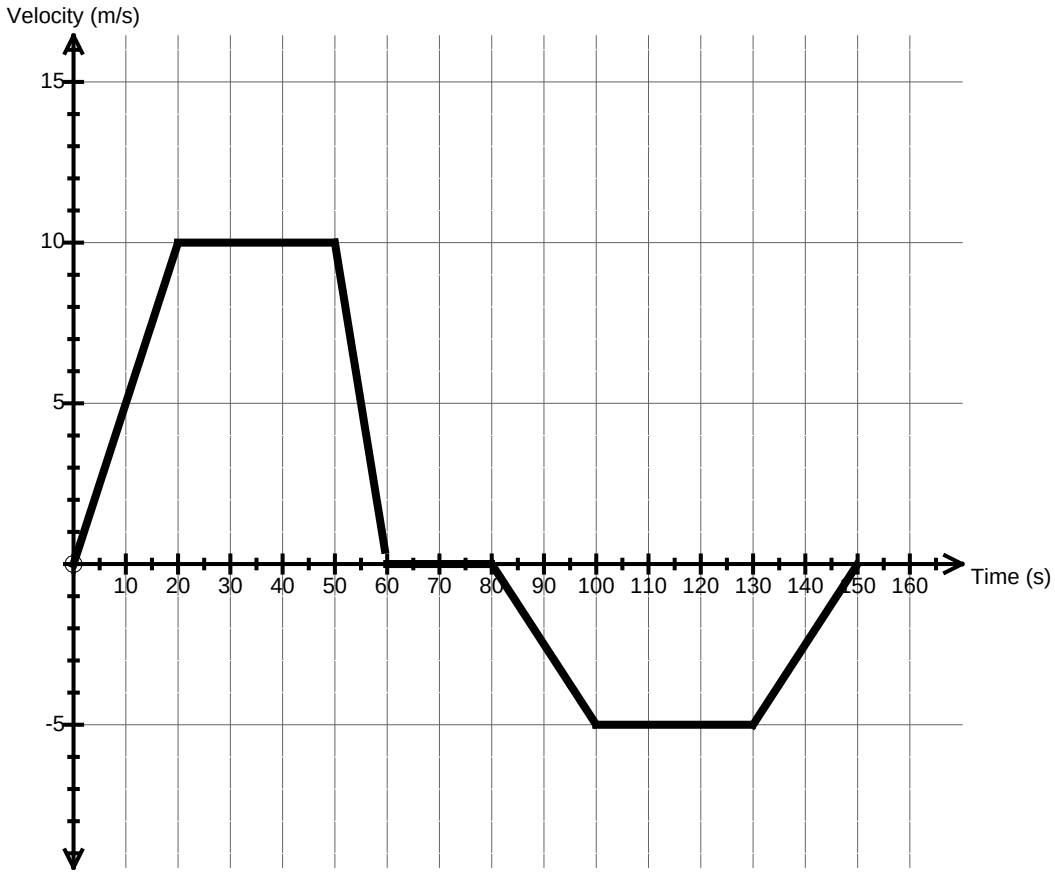
SECTION A – Core

Area of study 1 – Motion

The following information applies to questions 1 to 4.

Frankie is riding her bike on a straight path in the park. Her motion is represented by the following graph.



Question 1

Find the magnitude of Frankie's velocity after 10 seconds.

1 mark

Worked solution

Frankie's velocity at 10 seconds is read straight off the graph.

5 m s^{-1}

Mark allocation

- 1 mark for the correct answer.

Question 2

Calculate the magnitude of Frankie's acceleration during the last 20 seconds of her ride.

2 marks

Worked solution

During t = 130 and t = 150 seconds, the gradient is $\frac{5}{20}$ = 0.25 m s^{-2}.

0.25 m s^{-2}

Mark allocation

- 1 mark for trying to find a gradient.
- 1 mark for the correct answer.

Question 3

How far is Frankie from her starting point when she first stops?

2 marks

Worked solution

Displacement = Area under graph

$= (0.5 \times 20 \times 10) + (30 \times 10) + (0.5 \times 10 \times 10)$

$= 100 + 300 + 50$

$= 450$ m

450 m

Mark allocation

- 1 mark for trying to find area under the graph.
- 1 mark for the correct answer.

Question 4

What is the magnitude of Frankie's displacement at the end of her ride?

2 marks

Worked solution

Displacement = Area under graph

$= (0.5 \times 20 \times 10) + (30 \times 10) + (0.5 \times 10 \times 10) - \left[(0.5 \times 20 \times 5) + (30 \times 5) + (0.5 \times 20 \times 5)\right]$

$= 450 - 250$

$= 200 \text{ m}$

200 m

Mark allocation

- 1 mark for subtracting negative area from first positive area.
- 1 mark for the correct answer.

The following information applies to questions 5 to 8.

Jova is at his local archery centre, trying to impress his friends. He foolishly fires an arrow straight up. It travels 30 m into the air and has a mass of 0.20 kg.

Question 5

When the arrow is halfway up, what is the magnitude of its acceleration?

2 marks

Worked solution

Acceleration is always 10 m s^{-2} – the value for gravity.

10 m s^{-2}

Mark allocation

- 2 marks for the correct answer.

Question 6

How long is Jova's arrow in the air until it reaches the top of its flight?

2 marks

Worked solution

An arrow going up takes the same amount of time to come back down. This allows us to use initial velocity as zero, and then use the constant acceleration formula to calculate the velocity it strikes the ground at as it falls:

$t = ?,\ a = 10,\ s = 30,\ u = 0$

$$s = ut + \frac{1}{2}at^2$$

$$30 = 0 + \frac{1}{2} \times 10 \times t^2$$

$$t = 2.45 \text{ s}$$

2.45 seconds

Mark allocation

- 1 mark for substituting correct values into the correct equation.
- 1 mark for the correct answer.

Question 7

Calculate the gravitational potential energy that the arrow has acquired at the top of its flight.

2 marks

Worked solution

$$\text{GPE} = mgh$$
$$= 0.2 \times 10 \times 30$$
$$= 60 \text{ J}$$

60 J

Mark allocation

- 1 mark for the correct equation.
- 1 mark for the correct answer.

Question 8

Calculate the kinetic energy (E_k) that the arrow has at the top of its flight.

1 mark

Worked solution

$$E_k = \frac{1}{2}mv^2$$

But at the top of its flight, velocity equals zero.

$\therefore \; E_k = 0 \text{ J}$

0 J

Mark allocation

- 1 mark for the correct answer.

The following information applies to questions 9 to 14.

A 900 kg car is travelling east at 75 km h^{-1}.

velocity = 75 km h^{-1} east

Question 9

Calculate the speed of the car in m s^{-1}.

1 mark

Worked solution

$$75 \text{ km h}^{-1} = \frac{75}{3.6} \text{ ms}^{-1}$$

$$= 20.83 \text{ m s}^{-1}$$

20.83 m s^{-1}

Mark allocation

- 1 mark for the correct answer.

Question 10

Calculate the magnitude of momentum of the car.

2 marks

Worked solution

Momentum = mv

$$= 900 \times 20.83$$

$$= 18\,750 \text{ kg m s}^{-1}$$

19 000 kg m s^{-1}

Mark allocation

- 1 mark for using the correct equation.
- 1 mark for correct answer.

The car then crashes into a truck (with mass 1600 kg) travelling west at 60 km/h and the two stick together.

velocity = 75 km h^{-1}east

velocity = 60 km h^{-1}west

Question 11

Find the velocity of the car and truck just after the collision. Include direction in your answer.

3 marks

Worked solution

Truck momentum = mv

= 1600 × 16.7 (m s^{-1} converted from 60 km h^{-1})

= 26 720 kg m s^{-1} west

Total momentum = 18 750 east + 26 720 west

= –18 750 west + 26 720 west

= 7970 kg m s^{-1} west

$7970 = (m_{car} + m_{truck})v$

$7970 = 2500 \times v$

$v = 3.188$ m s^{-1}

$v = 3.19$ m s^{-1}

Magnitude = 3.2 m s^{-1}	Direction = west

Mark allocation

- 1 mark for calculating total momentum.
- 1 mark for the correct answer (magnitude).
- 1 mark for the correct answer (direction).

Question 12

Calculate the magnitude of the impulse of the car.

2 marks

Worked solution

Initial momentum = 18 750 kg m s^{-1}

Final momentum = mv

$= 900 \times -3.17$

$= 2853$ kg m s^{-1}

Change in momentum = 18 750 + 2853 (We *add* the momentum because it has changed direction.)

$= 21\,603$

21 600 kg m s^{-1}

Mark allocation

- 1 mark for finding the final momentum.
- 1 mark for the correct answer.

Question 13

If the collision took 1.2 seconds, find the magnitude of force that the truck imparted on the car.

2 marks

Worked solution

Change in momentum (impulse) = Ft

$$21600 = F \times 1.2$$

$$F = 18000\,\text{N}$$

Mark allocation

- 1 mark for using the correct equation.
- 1 mark for the correct answer.

Question 14

Is this an elastic or inelastic collision? Support your decision with appropriate calculations.

3 marks

Worked solution

Kinetic energy before collision = $\frac{1}{2}mv^2$ (car) + $\frac{1}{2}mv^2$ (truck)

$= \frac{1}{2} \times 900 \times 20.83^2 + \frac{1}{2} \times 1600 \times 16.7^2$

$= 195\,250 + 223\,112$

$= 418\,362$ J

Kinetic energy after collision = $\frac{1}{2}mv^2$

$= \frac{1}{2} \times 2500 \times 3.17^2$

$= 12\,561$ J

As the kinetic energy after the collision is less than the kinetic energy before the collision, it is an *inelastic collision.*

Mark allocation

- 1 mark for calculating kinetic energy before collision.
- 1 mark for calculating kinetic energy after collision.
- 1 mark for stating that it is an inelastic collision.

Tip

- *All collisions in which objects stick together will always be inelastic*.

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The following information applies to questions 15 to 18.

Iggy is riding her bike down a frictionless hill, which has an incline of 15°. Iggy and her bike have a combined mass of 78 kg.

Question 15

What is Iggy's acceleration down the hill?

2 marks

Worked solution

$a = g\sin\theta$
$= 10 \times \sin(15^{o})$
$= 2.59$

$2.59\ m\ s^{-2}$

Mark allocation

- 1 mark for using the correct equation.
- 1 mark for the correct answer.

Question 16

Calculate the size of the normal force acting on Iggy and her bike.

2 marks

Worked solution

$F = mg\cos\theta$
$= 78 \times 10 \times \cos 15°$
$= 753.4\ N$

753.4 N

Mark allocation

- 1 mark for substituting correct values into the correct equation.
- 1 mark for the correct answer.

Later, Iggy gets a flat tyre on a flat road and has to push her 18 kg bike along. The bike needs to be pushed with a constant force of 20 N to maintain a constant velocity all the way home, which is 250 m away.

Question 17

What is the net force on the bike?

2 marks

Worked solution

F = ma

Constant velocity equals zero acceleration.

Hence, net force of zero.

0 N

Mark allocation

- 2 marks for the correct answer.

Question 18

How much work does it take to get the bike home?

2 marks

Worked solution

Work = force × distance

= 20 × 250

= 5000 J

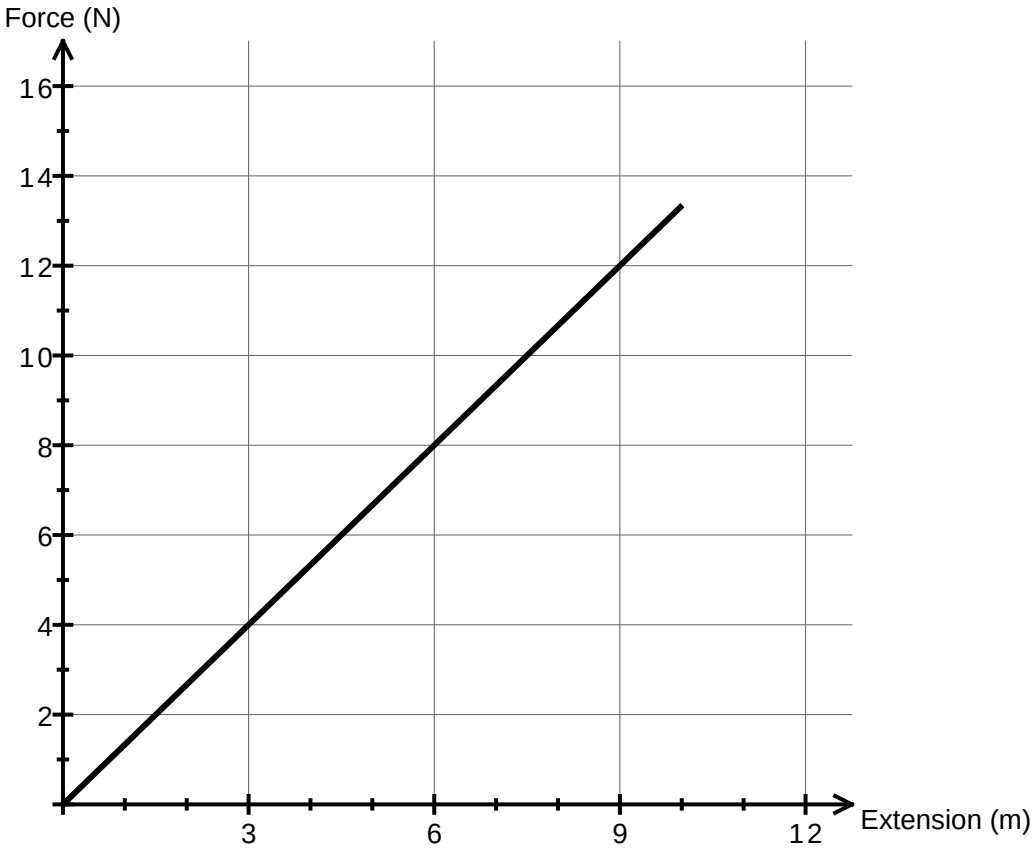
5000 J

Mark allocation

- 2 marks for the correct answer.

The following information applies to questions 19 and 20.

Tilly attached a spring to a beam and let it hang down. The spring can be modelled with the following graph.



Question 19

What is the spring constant?

2 marks

Worked solution

Spring constant = gradient

$$= \frac{12}{9}$$

$$= 1.33$$

1.33 N m^{-1}

Mark allocation

- 1 mark for evidence of finding gradient.
- 1 mark for the correct answer.

Question 20

Tilly then places 800 grams on the end of the spring. How much potential energy does the spring store?

2 marks

Worked solution

F = mg
= 0.8 x 10
= 8N
Therefore, 800g is equal to a force of 8N.
Potential energy = area under graph
= 0.5 × 6 × 8
= 24 J

24 J

Mark allocation

- 1 mark for evidence of finding area under line.
- 1 mark for the correct answer.

END OF AREA OF STUDY 1

END OF AREA OF STUDY 1

SECTION A – Core

Area of study 2 – Wave-like properties of light

Consider the graph shown in **Figure 1** below.

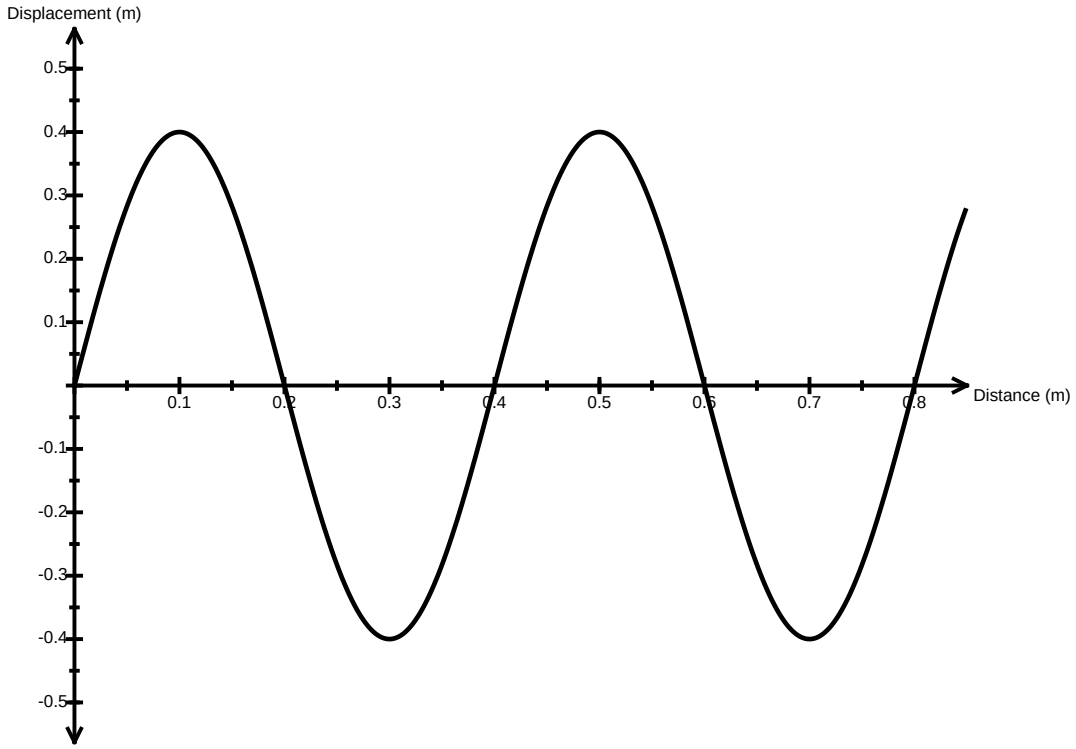


Figure 1

Question 1

What is the wavelength of the wave in the graph above?

1 mark

Worked solution

Wavelength is the distance taken for one complete wave.

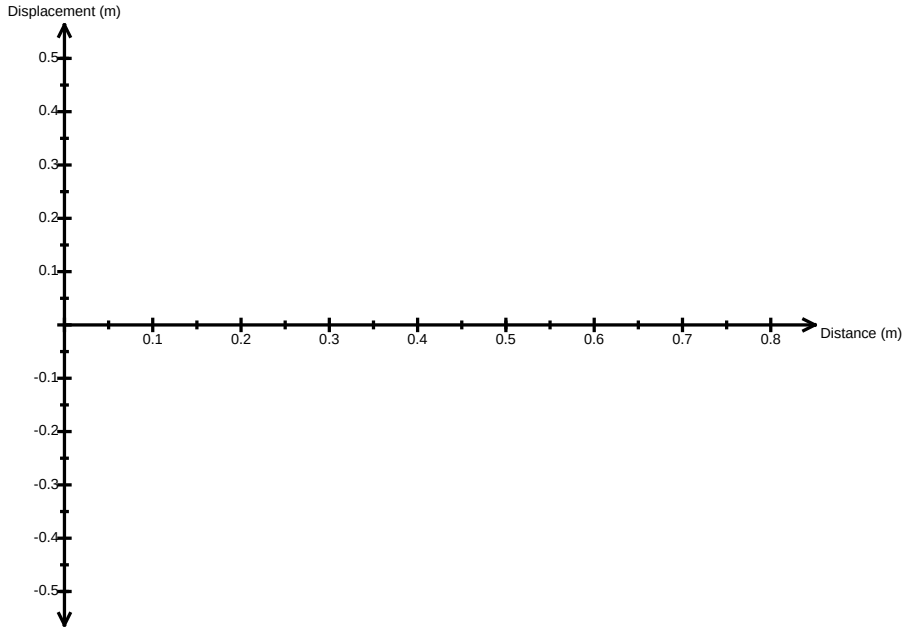
0.4 m

Mark allocation

- 1 mark for the correct answer.

Question 2

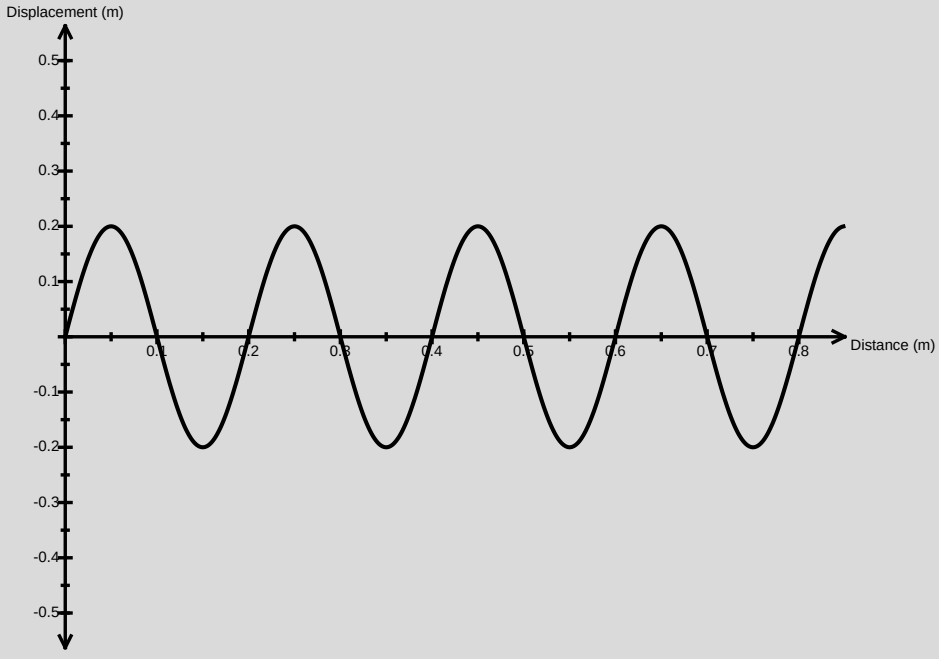
On the axes provided, draw a wave that is twice the frequency, but half the amplitude of the wave in **Figure 1**.



2 marks

Worked solution

Amplitude is the height of the crest of the wave, i.e. the peak. Doubling the frequency will halve the wavelength.



Mark allocation

- 1 mark for the correct height (amplitude).
- 1 mark for the correct frequency.

Question 3

A blue light ray, travelling at 3×10^8 m s^{-1}, has a wavelength of 552 nm.
Convert 552 nm to metres.

1 mark

Worked solution

550 nm = 552×10^{-9} m = 5.52×10^{-7} m

5.52×10^{-7} m or 552×10^{-9} m

Mark allocation

- 1 mark for the correct answer.

Question 4

What is the wave's frequency?

2 marks

Worked solution

$$v = f\lambda$$

$$3 \times 10^8 = 5.52 \times 10^{-7} \times \lambda$$

$$\lambda = 5.43 \times 10^{14}$$

5.43×10^{14} Hz

Mark allocation

- 1 mark for using the correct equation.
- 1 mark for the correct answer.

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Question 5

Calculate the time period of the wave's motion.

1 mark

Worked solution

$$T = \frac{1}{f}$$
$$= \frac{1}{5.43 \times 10^{14}}$$
$$= 1.84 \times 10^{-15} \text{ s}$$

1.84×10^{-15} s

Mark allocation

- 1 mark for the correct answer.

Question 6

Explain the difference between a transverse wave and a longitudinal wave. Give one example of each.

4 marks

Worked solution

- In a transverse wave, the motion of particles is at right angles to the direction of the wave. (1 mark)
- Examples include water, light, strings on an instrument and 'Mexican waves'. (1 mark)
- In a longitudinal wave, the motion of the particles is parallel to the direction of the wave. (1 mark)
- Examples include sound, earthquakes (pressure waves) and tsunami waves. (1 mark)

Mark allocation

- 1 mark for each correct answer

The following information applies to questions 7 and 8.

Thelma and Louise are playing with some different coloured lights and filters. They notice that when they shine two different lights together, they get a different colour.

Question 7

If Thelma shines red and blue light together, what colour will it produce?

1 mark

Worked solution

Red plus blue will make magenta.

Magenta

Mark allocation

- 1 mark for the correct answer.

Question 8

Louise places a red filter over both her eyes. She then takes a blue filter and puts it on top of the red, still covering both eyes. She then looks at a rainbow. What colours will she see? Explain.

2 marks

Worked solution

- Louise will see no colours. (1 mark)
- The red filter will allow only red light to pass through and the blue filter will block the red light, resulting in no light reaching Louise's eyes. (1 mark)

Mark allocation

- 1 mark for each correct answer

The following information applies to questions 9 and 10.

Jiminy has created a new super liquid called Spooge. It has a refractive index of 1.62.

Question 9

Calculate the critical angle for the air/Spooge boundary.

2 marks

Worked solution

$$\sin\theta = \frac{1}{n}$$

$$\sin\theta = \frac{1}{1.62}$$

$$\theta = \sin^{-1}(0.617)$$

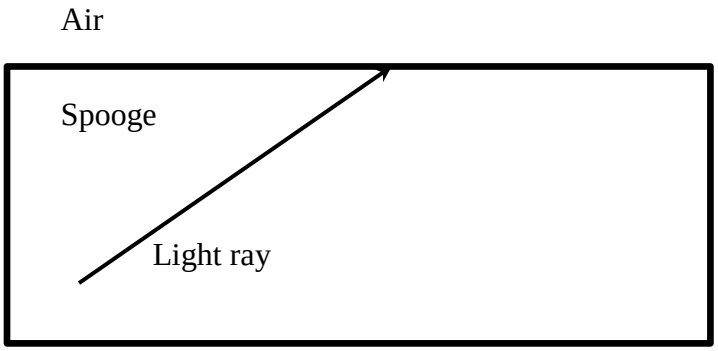
$$= 38.12°$$

Mark allocation

- 1 mark for using the correct equation.
- 1 mark for the correct answer.

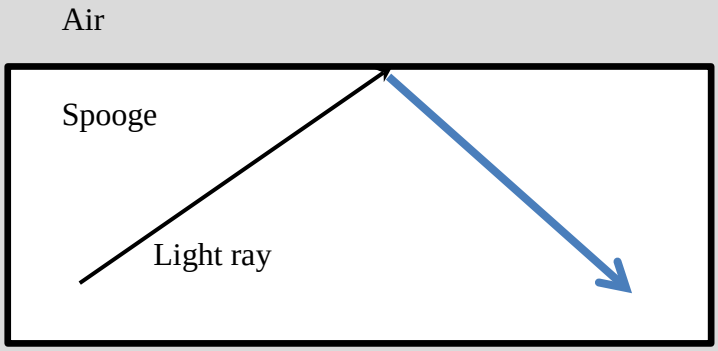
Question 10

Jiminy then sets up a situation in which the incident angle is slightly larger than the critical angle. On the diagram below, draw in the path of the resultant ray.



2 marks

Worked solution



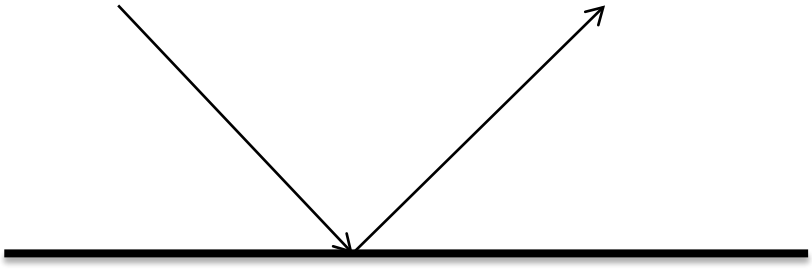
The light gets reflected as from a mirror.

Mark allocation

- 2 marks for drawing the ray correctly.

Question 11

Jonny shines a torch onto a plane mirror, as shown below.



On the diagram above, draw in the

a. normal.

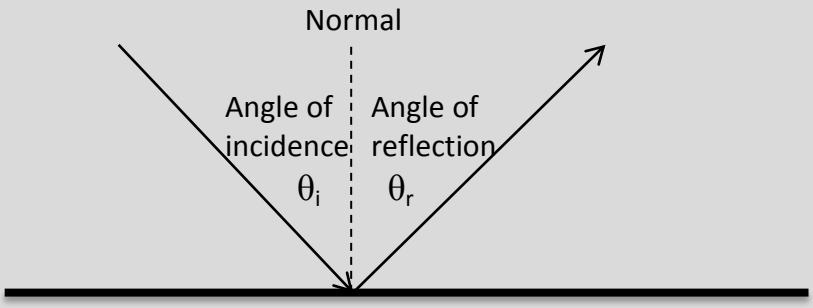
b. angle of incidence.

c. angle of reflection.

3 marks

Worked solution

The angle of incidence is taken from the normal.



Mark allocation

- 1 mark for each correct answer.

Question 12

Identify two ways in which we know that light has wave-like properties.

2 marks

Worked solution

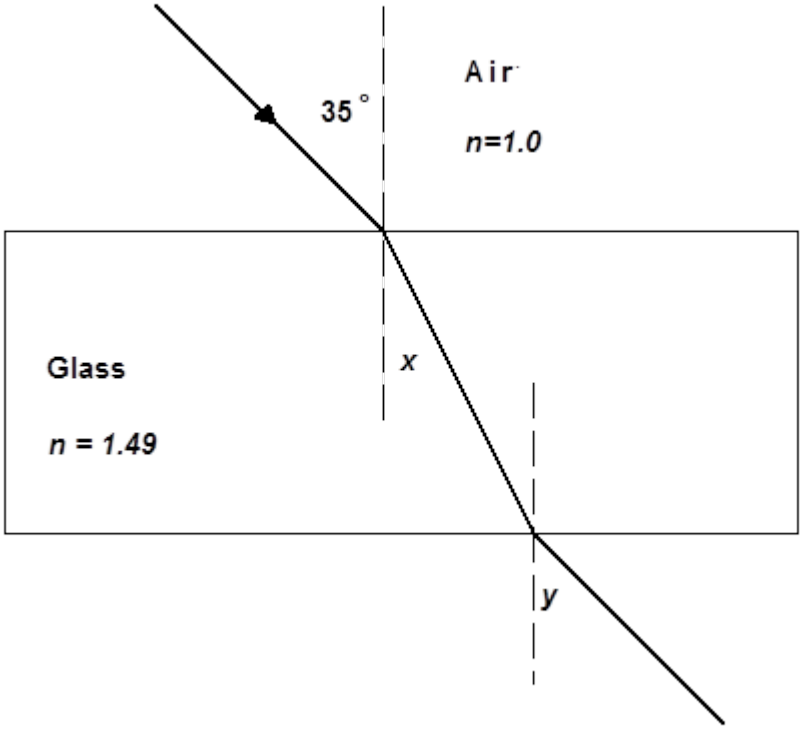
Any two of polarisation, interference, diffraction, reflection, refraction or Doppler effect.

Mark allocation

- 1 mark for each correct answer.

The following information applies to questions 13 and 14.

Darlene is playing with a piece of glass and a ray of light, as shown below.



Question 13

Calculate the angle *x*.

2 marks

Worked solution

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$1 \times \sin 35° = 1.49 \times \sin x$$

$$\sin x = \frac{\sin 35°}{1.49}$$

$$x = \sin^{-1}\left(\frac{\sin 35°}{1.49}\right)$$

$$= 22.64°$$

22.64°

Mark allocation

- 1 mark for substituting correct values into the correct equation.
- 1 mark for the correct answer.

Question 14

Find the angle *y*.

1 mark

Worked solution

The angle y = angle of incident angle.

$\therefore\ y = 35°$

35°

Mark allocation

- 1 mark for the correct answer.

Question 15

Explain what dispersion is. Give an example of where dispersion may be observed.

3 marks

Worked solution

Dispersion is when different colours refract at different angles, splitting white light into its component colours. (2 marks)

Examples of where dispersion may be observed include a triangular prism or a rainbow. (1 mark)

Mark allocation

- 2 marks for definition of dispersion
- 1 mark for example of where dispersion may be observed

Question 16

Which of the following will experience the greatest dispersion? Choose the correct answer.

A. Violet because it has the largest wavelength, λ.
B. **Violet because it has the shortest wavelength, λ.**
C. Red because it has the largest wavelength, λ.
D. Red because it has the shortest wavelength, λ.

2 marks

Worked solution

B

Light of shorter λ gets dispersed the most, and violet light has a smaller λ than red light.

Mark allocation

- 2 marks for the correct answer.

END OF SECTION A

SECTION B – Detailed studies
Detailed study 1 – Astronomy

Question 1

A group of stars, such as 'The Big Dipper' or 'The Saucepan', is called a
A. galaxy
B. **constellation**
C. cluster
D. nebula

2 marks

Answer is B

Worked solution

'The Big Dipper' and 'The Saucepan' are considered to be constellations.
A galaxy contains billions of stars, whereas a cluster is a few stars in close proximity to each other. Although stars in constellations may be spread far apart, they *appear* to be close together when viewed from Earth.

Question 2

Alpha Centauri is 4.3 light years from Earth. This distance equates to
A. 1.29×10^9 m
B. 4.1×10^{13} m
C. **4.1×10^{13} km**
D. 4.1×10^{10} m

2 marks

Answer is C

Worked solution

One light year is the distance light travels in a year, which is
$3 \times 10^8 \times 60 \times 60 \times 24 \times 365 \text{ m} = 9.5 \times 10^{12} \text{ km}$
$4.3 \times 9.5 \times 10^{12} \text{ km} = 4.1 \times 10^{13} \text{ km}$

Question 3

Tomba likes to lie on his back and watch the Southern Cross for hours. He notices that it appears to be rotating around the South Celestial Pole. This is due to
A. **diurnal motion**
B. annual motion
C. the Earth's motion around the Sun
D. the stars' motion around the Earth

2 marks

Answer is A
Worked solution

The Earth rotates on its axis, causing the stars' apparent motion, and is called diurnal motion. Annual motion is caused by the Earth's motion around the Sun.

Question 4

The term *heliocentric* literally means
A. Earth motion
B. Earth centred
C. star centred
D. **Sun centred**

2 marks

Answer is D

Question 5

Galileo observed sunspots on the surface of the Sun and was able to conclude that the Sun rotated on an axis with a period of approximately
A. **27 hours**
B. 27 days
C. 27 weeks
D. 1 year

2 marks

Answer is A

Question 6

Ally is showing her brother a new telescope that she has borrowed. She explains to her brother that it has an objective lens with a focal length of 62 cm and an eyepiece with a focal length of 3.1 cm. When her brother asks what the magnification of the telescope is, Ally replies
A. **20**
B. 0.05
C. 192.2
D. 5

2 marks

Answer is A

Worked solution

$$M = \frac{f_o}{f_e}$$
$$= \frac{62}{3.1}$$
$$= 20$$

Tip

- *Magnification does not have any units.*

Question 7

Two popular systems of mounting a telescope are

A. altazimuth and equatorial
B. altitude and azimuth
C. altazimuth and altitude
D. altitude and equatorial

2 marks

Answer is A

Question 8

The term *planet* literally means

A. Earth like
B. Sun orbiter
C. wandering star
D. moon companion

2 marks

Answer is C

Question 9

Dorothy is watching a spectacular sunrise from the banks of the Mitta Mitta River in north-east Victoria. She looks straight up and notices that the Moon is directly overhead. What type of moon is she looking at?

A. full moon
B. new moon
C. half moon waning
D. half moon waxing

2 marks

Answer is C

Question 10

Which of the following is the reason for Earth's seasons?

A. Earth's tilt on its axis
B. how close Earth is to the Sun
C. the rotation of the Earth
D. sunspot activity

2 marks

Answer is A

Worked solution

Although the Earth does differ in its proximity to the Sun as it orbits the Sun, this does not cause the seasons. Otherwise all of the Earth would have winter *at the same time.*

Detailed study 2 – Medical physics

Question 1

A doctor needs 4 grams of a radiotracer to use in her hospital. If the radiotracer has a half-life of 4 hours, and takes 12 hours to deliver from the manufacturer, how much will the doctor need to order?

A. 0.5 gram
B. 2 grams
C. 16 grams
D. **32 grams**

2 marks

Answer is D

Worked solution

12 hours is 3 half-lives, so the sample will go from 32 g to 16 g in the first half-life, from 16 g to 8 g in the second half-life, and from 8 g to 4 g in the third, and final, half-life.

Question 2

The percentage of radiation that we are exposed to in our lives as a result of **human-made radiation** is approximately

A. **15%**
B. 75%
C. 85%
D. 95%

2 marks

Answer is A

Worked solution

Background radiation and radiation from the Sun far outweighs the amount of radiation we receive from a few X-rays and mobile phones etc.

Question 3

An ultrasound machine is delivering ultrasounds at 1.9 MHz, with a speed of 1600 m s^{-1}. What will be the wavelength (λ) of these waves?

A. **8.42×10^{-4} m**
B. 842 m
C. 8.42×10^{8} m
D. 1187 m

2 marks

Answer is A

Worked solution

$$v = f\lambda$$

$$\lambda = \frac{v}{f}$$

$$= \frac{1600}{1.9 \times 10^{6}}$$

$$= 8.42 \times 10^{-4} \text{ m}$$

Tip

- *Always convert any prefixes to SI units as early as possible. Make sure you are familiar with them all, especially k, m, M and* μ.

Question 4

Which area of medical physics occurs as a result of radioactive decay?

A. X-rays
B. CT scans
C. MRI scans
D. **PET scans**

2 marks

Answer is D

Worked solution

PET scans detect emissions from radioactive tracers that are injected into the human body.

Question 5

Which of the following instruments does not use a form of electromagnetic radiation?

A. ultrasound
B. X-ray
C. CT scan
D. lasers

2 marks

Answer is A

Worked solution

Ultrasound uses sound waves. Lasers, X-rays and CT scans all use electromagnetic radiation.

Question 6

If an X-ray has a frequency of 5×10^{14} MHz, what is its period?

A. 2×10^{-21} s
B. 2×10^{19} s
C. 2×10^{13} s
D. 2×10^{-15} s

2 marks

Answer is A

Worked solution

$$5\times10^{14}\ \text{MHz} = 5\times10^{14}\times10^{6}\ \text{Hz}$$
$$= 5\times10^{20}\ \text{Hz}$$
$$\text{Period} = \frac{1}{f}$$
$$= \frac{1}{5\times10^{14}\times10^{6}}$$
$$= 2\times10^{-21}\ \text{s}$$

Tip

- *Convert MHz to Hz before starting the problem.*

Question 7

If an X-ray has a wavelength of 1.2×10^{-6} m, what is its frequency?

A. 3.96×10^{-6} Hz
B. **2.5×10^{14} Hz**
C. 2.5 Hz
D. 2500 Hz

2 marks

Answer is B

Worked solution

$$v = f\lambda$$

$$f = \frac{v}{\lambda}$$

$$= \frac{3\times10^{8}}{1.2\times10^{-6}}$$

$$= 2.5\times10^{14} \text{ Hz}$$

Tip

- *The speed of any electromagnetic radiation will be 3×10^{8} m s^{-1}.*

Question 8

A CT scan uses

A. **X-rays**
B. sound waves
C. lasers
D. optical fibres

2 marks

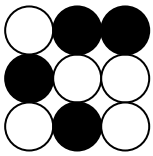
Answer is A

Worked solution

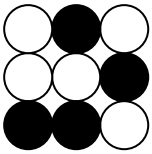
CT scans take X-rays at all angles to produce a 3D picture.

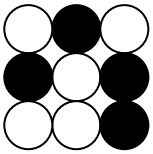
Question 9

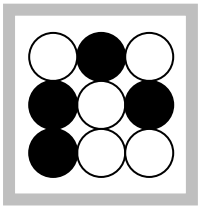
An endoscope needs its optical fibres to be coherent. The diagram below shows one end of an endoscope.

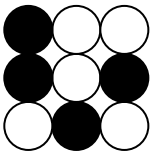


Which of the following is incoherent to the diagram shown above?

A. 

B. 

C. 

D. 

2 marks

Answer is C

Worked solution

Options A, B and D are simply rotations of the original.

Question 10

Which radiation is appropriate for diagnosis and therapy, respectively?

A. α, β

B. γ, α

C. β, γ

D. α, γ

2 marks

Answer is B

Worked solution

- For diagnosis, a radiation with a low quality factor is important, and a high penetrator is required for tracers.
- For therapy, a high quality factor is needed to kill unwanted cells, but a poor penetrator is required to restrict damage to the immediate area.

SECTION B – END OF DETAILED STUDY 2

Detailed study 3 – Energy from the nucleus

Question 1

Which of the following statements about $^{235}_{92}\mathrm{U}$ is correct?

A. 143 protons, 92 neutrons and 235 nucleons
B. **92 protons, 143 neutrons and 235 nucleons**
C. 235 protons, 92 neutrons and 92 nucleons
D. 92 protons, 235 neutrons and 92 nucleons

2 marks

Answer is B

Worked solution

$^{\text{nucleons}}_{\text{protons}}\text{Symbol}$

neutrons = nucleons – protons

Question 2

Which of the following equations can occur in a typical nuclear power station?

A. $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Np} + {}^{92}_{36}\mathrm{Kr} + 3\,{}^{1}_{0}\mathrm{n}$
B. $^{235}_{920}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Np} + {}^{92}_{36}\mathrm{Kr} + 2\,{}^{1}_{0}\mathrm{n}$
C. $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Np} + {}^{91}_{36}\mathrm{Kr} + 3\,{}^{1}_{0}\mathrm{n}$
D. $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Np} + {}^{92}_{36}\mathrm{Kr} + 3\,{}^{1}_{0}\mathrm{n}$

2 marks

Answer is A

Worked solution

Uranium absorbs a neutron, which is $^{1}_{0}\mathrm{n}$, and emits 3 neutrons. Then balance the top and bottom equations.

Question 3

What holds the nucleus of an atom together?

A. gravitational force
B. weak nuclear force
C. **strong nuclear force**
D. electrostatic force

2 marks

Answer is C

Question 4

During World War II, the Americans, along with the British, developed the world's first atomic/nuclear bombs. The code name for this was

A. Manhattan Project
B. USA Atomic Commission
C. NASA
D. General Electric

2 marks

Answer is A

Question 5

The only nuclear bombs ever to be used against other people were the two dropped in World War II by the Americans. The blast killed over 150 000 people from the blast. Hundreds of thousands more were killed by radiation sickness in the years that followed. The bombs were dropped on which two cities?

A. Tokyo and Hiroshima
B. Hiroshima and Nagasaki
C. Tokyo and Nagasaki
D. Hiroshima and Kyoto

2 marks

Answer is B

Question 6

In a nuclear power station, $^{235}_{92}U$ needs a **slow neutron** to initiate fission. What slows down these neutrons?

A. a moderator
B. control rods
C. fuel rods
D. radiation shields

2 marks

Answer is A

Worked solution

Control rods absorb neutrons to slow down the chain reaction by limiting the number of neutrons available. Fuel rods supply the uranium, whereas radiation shields stop harmful radiation from escaping.

Question 7

In a nuclear power station, the role of the control rods is to

A. limit the number of neutrons available
B. control the temperature
C. use the fuel
D. make electricity

2 marks

Answer is A

Question 8

A fusion reaction may be found easily by

A. going to NASA
B. going to Russia
C. going to England
D. looking up at the stars

2 marks

Answer is D

Question 9

Fusion reactors are not used today because

A. fission is more environmentally friendly
B. they are too expensive to build and run
C. fuel is cheap
D. they have less radioactive waste

2 marks

Answer is B

Worked solution

Fusion is currently unviable because of the enormous costs of the high temperature and pressure needed.

Question 10

Australia has

A. no nuclear reactors and no nuclear power plants
B. nuclear reactors and nuclear power plants
C. **nuclear reactors but no nuclear power plants**
D. nuclear power plants but no nuclear reactors

2 marks

Answer is C

Worked solution

Two nuclear reactors in Lucas Heights, New South Wales, provide research and medical material.

SECTION B – END OF DETAILED STUDY 3

Detailed study 4 – Astrophysics

Question 1

The correct name of the closest star to Earth is

A. **Sun**
B. Sol
C. Helios
D. Solar

2 marks

Answer is A

Worked solution

The Sun doesn't have a 'real' star name like Alpha Centauri does.

Question 2

If an astronomer observes a star undergoing a Doppler effect into red shift, then that star is travelling

A. towards us
B. **away from us**
C. parallel to us
D. at right angles to us

2 marks

Answer is B

Worked solution

For a star travelling away from us, light reaching Earth will appear to have a longer wavelength than usual. Red light has a longer wavelength than other light.

Question 3

Billions of stars that are in close proximity to each other, orbiting a central point are called a

A. constellation
B. **galaxy**
C. nebula
D. cluster

2 marks

Answer is B

Worked solution

A galaxy contains billions of stars, whereas a cluster has a few stars in close proximity to each other. Although stars in a constellation may be spread far apart, they *appear* to be close together when viewed from Earth.

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Question 4

The brightness level of a star is **not** due to
A. its proximity to the Earth
B. the size of the star
C. the quantity of light emitted
D. **the colour of the star**

2 marks

Answer is D

Worked solution

Colour is closely related to the temperature of the star, *not* its brightness.

Question 5

The universe is
A. getting smaller as gravity pulls everything together
B. getting bigger but its expansion is slowing down
C. **getting bigger and accelerating out as it does so**
D. in a steady state

2 marks

Answer is C

Worked solution

Strangely, to date, no-one has determined the reason why, and proved it. Research into dark matter and string theory is continuing.

Question 6

The Milky Way is what shape?
A. elliptical
B. **spiral**
C. irregular
D. delicious

2 marks

Answer is B

Worked solution

The shape of the Milky Way galaxy is spiral.

Question 7

Which of the following are **not** regions of a Hertzsprung–Russell diagram?

A. giants
B. supergiants
C. main sequence
D. **red dwarfs**

2 marks

Answer is D

Worked solution

White dwarfs have a region, but red dwarfs do not.

Question 8

Astronomers in the 18th century knew that the universe was finite because

A. **the night sky was dark**
B. they knew of galaxies
C. of advances in the telescope during this time
D. of the size of the Sun

2 marks

Answer is A

Worked solution

If the universe was infinitely big, everywhere you looked in the night sky would hold a star, and the night would not be dark.

Question 9

The Big Bang has been calculated to have occurred

A. 5000 years ago
B. 4 billion years ago
C. 4 million years ago
D. **14 billion years ago**

2 marks

Answer is D

Question 10

The theory of the Steady State Universe was discounted in the mid 1960s with the discovery of which of the following in the background from the Big Bang?

A. **microwaves**
B. X-rays
C. ultraviolet rays
D. infrared rays

2 marks

Answer is A

Worked solution

If you turn on your TV to an un-tuned channel, some of the static produced is from the radiation from the Big Bang.

SECTION B – END OF DETAILED STUDY 4
TURN OVER

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Detailed study 5 – Investigations: Flight

Question 1

In which of these scenarios is the aircraft **not** going to crash?

A. When the aircraft reaches a point called the critical angle of attack
B. **When an aircraft travelling at a top speed of 100 kmh^{-1} meets a headwind of 100 km h^{-1}.**
C. When an aircraft travelling at a top speed of 100 km h^{-1} has a tailwind of 100 km h^{-1}.
D. When the skin friction drag and the pressure drag exceeds thrust

2 marks

Answer is B

Worked solution

An aircraft travelling at 100 km h^{-1} with a tailwind of 100 kmh^{-1} will have zero wind speed.

Question 2

The mathematical relationship between the distance an aircraft will glide forward to the altitude loss is known as

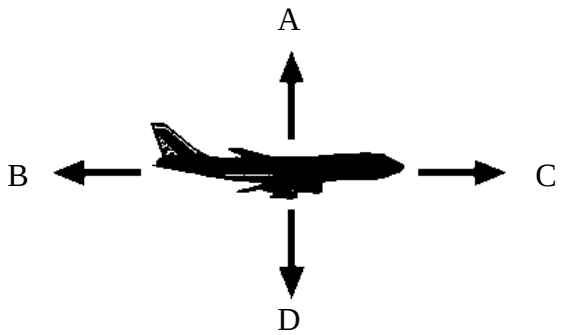
A. **glide ratio**
B. lapse ratio
C. aspect ratio
D. adiabatic ratio

2 marks

Answer is A

Question 3

An aeroplane in flight is shown below.



Which of the following correctly describes the forces on this aircraft?

A. A is thrust, B is drag, C is lift, D is weight.
B. A is lift, B is weight, C is thrust, D is drag.
C. A is weight, B is thrust, C is drag, D is lift.
D. **A is lift, B is drag, C is thrust, D is weight.**

2 marks

Answer is D

Question 4

For an aircraft travelling at a constant velocity

A. all forces must be equal
B. thrust is equal to drag, lift is greater than weight
C. lift is greater than weight, thrust is greater than drag
D. **the sum of all forces equals zero**

2 marks

Answer is D

Worked solution

All forces will not have to be equal, as drag and lift may be completely different.

Question 5

Who was a great artist, an architect, and a man of science and conducted the first scientific experiments in the field of aviation?

A. Joseph Montgolfier
B. **Leonardo da Vinci**
C. Oliver Wright
D. Wilbur Wright

2 marks

Answer is B

Question 6

Match the following motions to their proper axes.

A. Motion about the vertical axis is yaw; motion about the longitudinal axis is pitch; and motion about the lateral axis is roll.
B. **Motion about the lateral axis is pitch; motion about the vertical axis is yaw; and motion about the longitudinal axis is roll.**
C. Motion about the lateral axis is roll; motion about the vertical axis is pitch; and motion about the longitudinal axis is yaw.
D. Motion about the lateral axis is pitch; motion about the vertical axis is yaw; and motion about the horizontal axis is roll.

2 marks

Answer is B

Question 7

Sir Isaac Newton gave us three laws of motion. Of the following, which one applies to an aeroplane in flight?

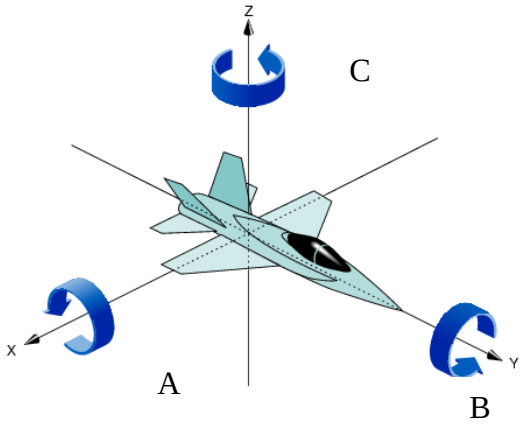
A. A body at rest will remain at rest unless acted upon by some outside force.
B. A force acting upon a body causes it to accelerate in the direction of the force. Acceleration is directly proportional to the force and inversely proportional to the mass of the body being accelerated.
C. For every action there is an equal and opposite reaction.
D. **All of these answers are correct.**

2 marks

Answer is D

Question 8

Which of the following correctly shows yaw, pitch and roll?



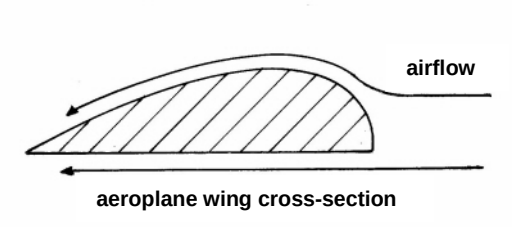
A. A = yaw, B = pitch, C = roll
B. A = pitch, B = yaw, C = roll
C. A = roll, B = pitch, C = yaw
D. **A = pitch, B = roll, C = yaw**

2 marks

Answer is D

Question 9

Bernoulli's principle is used to describe lift with the wings of an aircraft.



The wing produces lift because

A. the air is moving faster over the top of the wing, creating a lower air pressure, which sucks the wing up.

B. the air is moving faster over the top of the wing, creating a higher air pressure, which pushes the wing up.

C. the air is moving slower over the bottom of the wing, creating a lower air pressure, which sucks the wing up.

D. **the air is moving slower over the bottom of the wing, creating a higher air pressure, which pushes the wing up.**

2 marks

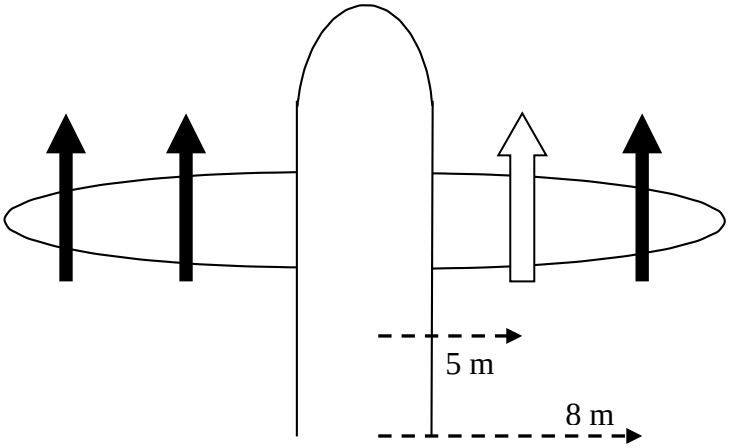
Answer is D

Worked solution

Things don't get 'sucked' due to a difference in air pressure; they get pushed by the higher pressure. Even a vacuum cleaner doesn't 'suck'; instead the air around the dirt pushes it in.

Question 10

A four-engine plane has identical engines that are delivering a force of 10 000 newtons of force each. The outside engines are 8 metres from the centre of the plane, and the inner engines are 5 metres from the centre of the plane. Suddenly, the right inner engine cuts out. At what force should the outside right engine now deliver so that the plane remains in a straight line?



A. 6300 N
B. **16 300 N**
C. 2000 N
D. 26 000 N

2 marks

Answer is B

Worked solution

$$\sum (F \times r)_{\text{left}} = \sum (F \times r)_{\text{right}}$$
$$10\,000 \times 8 + 10\,000 \times 5 = F \times 8$$
$$130\,000 = F \times 8$$
$$F = \frac{130\,000}{8}$$
$$= 16\,300 \text{ N}$$

Tip

- *There must be equal torques on both sides; otherwise rotation will occur.*

SECTION B – END OF DETAILED STUDY 5
TURN OVER

Detailed study 6 – Investigations: sustainable energy sources

Question 1

Which of the following is a sustainable energy source?
A. nuclear energy
B. natural gas
C. petroleum
D. **solar**

2 marks

Answer is D

Worked solution

At least while the Sun shines, which it will for billions of years.

Question 2

Rob has put together 12 solar cells, each producing 12 V at 20 mA each.
How much power can Rob harness?
A. 240 W
B. 2880 W
C. **2.88 W**
D. 0.24 W

2 marks

Answer is C

Worked solution

Each cell:

$P = VI$

$= 12 \times 20 \times 10^{-3}$

$= 0.24 \text{ W}$

$\therefore$ 12 cells produce $0.24 \times 12 = 2.88$ W

Question 3

Miriam has a heater that is only 20% efficient. If she needs it to have an output of 500 W to warm her toes, then the heater must have an input of

A. 400 W
B. 1400 W
C. **2500 W**
D. 4000 W

2 marks

Answer is C

Worked solution

20% of 2500 W = 500 W

Question 4

Which one of the following is not a cause of climate change gases?

A. wood fires
B. deforestation
C. herds of cattle
D. **nuclear power plants**

2 marks

Answer is D

Worked solution

Nuclear power plants have a lot of other negatives, however they are not a cause of climate change. Herds of cattle produce enormous amounts of methane.

Question 5

Which one of the following forms of energy conversion does **not** require a turbine for creating electricity?

A. nuclear power
B. wind power
C. hydro power
D. **solar power**

2 marks

Answer is D

Worked solution

Solar panels produce electricity without the need for a turbine. The others convert mechanical energy to electrical energy through a turbine.

Question 6

Of the following, which does **not** influence the amount of solar power being produced?

A. **temperature**
B. insolation
C. panel area
D. efficiency of panels

2 marks

Answer is A

Question 7

A house uses twelve 100 W light globes for an average of 5 hours per day for each globe. The inhabitants change to 15 W energy-efficient light globes.
If electrical energy costs $0.24 per kWh, how much will they save in 1 year?

A. $525.60
B. $78.84
C. **$446.76**
D. $604.44

2 marks

Answer is C

Worked solution

Cost for 1 year:
Lights use 1.2 kW per hour, so

$$1.2\,\text{kW} \times 5 = 6\,\text{kWh per day}$$

$$6 \times 365 = 2190\,\text{kWh per year}$$

$$2190 \times \$0.24 = \$525.60$$

New lights use 85% less:

85% of $525.60 = $446.76

Question 8

A hydropower station is built so that the water falls 50 metres and can handle 40 000 litres per second. Theoretically, how much power is possible?

A. 20 MW
B. 2 MW
C. 0.2 MW
D. 200 MW

2 marks

Answer is A

Worked solution

Each litre of water has a gravitational potential energy of 500 J (*mgh*).
So, 40 000 litres per second will give 500 × 40 000 W.
$= 2 \times 10^7$ W
$= 20 \times 10^6$ W
= 20 MW

Question 9

As energy converts from one form to another, some energy will be lost. This energy is lost as

A. mechanical energy
B. light energy
C. heat energy
D. electrical energy

2 marks

Answer is C

Worked solution

Most is lost as heat through friction.

Question 10

In a hydroelectrical power plant, the energy transfer that occurs is

A. gravitational potential energy → kinetic energy → electrical energy
B. gravitational potential energy → heat → kinetic energy → electrical energy
C. kinetic energy → gravitational potential energy → electrical energy
D. kinetic energy → gravitational potential energy → heat → electrical energy

2 marks

Answer is A

Worked solution

Water starts up high (gravitational potential energy), then increases speed on the way down (kinetic energy), and then turns a turbine (electrical energy).

END OF SOLUTIONS BOOK