INSIGHT

Trial Exam Paper

2011

YEAR 11 PHYSICS

Written examination 1

Worked solutions

This book presents:

- worked solutions to core and detailed studies, 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 – Nuclear physics and radioactivity

Question 1
Plutonium can be written as

$$^{244}_{94}\text{Pu}$$

Find the
a. mass number.
b. atomic number.
c. number of protons.
d. number of neutrons.

4 marks

Worked solution
a. Mass number = 244
b. Atomic number = 94
c. Number of protons = 94
d. Number of neutrons = 244 – 94 = 150

The following information applies to questions 2 and 3.
Different types of radiation have different characteristics.
The three forms of radiation are alpha, beta and gamma.

Question 2
Which radiation type has the greatest speed?

1 mark

Explain your selection.

1 mark

Worked solution
Gamma radiation. (1 mark)
It is a form of electro-magnetic radiation. It travels at the speed of light. (1 mark)

Question 3
Which radiation type has the greatest penetrating power?

1 mark

Explain your selection.

1 mark

Worked solution
Gamma radiation. (1 mark)
It has no mass, no charge, and a very high frequency and energy. (1 mark)

Question 4
After Albert Einstein released his Theory of Relativity, physicists soon realised that mass and energy were interchangeable. In an early experiment, physicists converted 1.5×10^{-24} grams into energy. How much energy would this produce?

2 mark

Worked solution

1.5×10^{-24} grams $=$ 1.5×10^{-27} kilograms

$$E = mc^2$$
$$= 1.5\times10^{-27}\times(3\times10^{8})^2$$
$$= 1.35\times10^{-10}\text{ J}$$

1.35×10^{-10} J

Mark allocation

- 1 mark for converting grams to kilograms correctly.
- 1 mark for the correct answer.

Question 5

An early pioneer of radiation was Ernest Rutherford. In an early experiment, Rutherford bombarded nitrogen-14 with alpha particles. Oxygen-17 was one product of the experiment. Write a decay equation for this experiment.

2 marks

Worked solution

$^{14}_{7}\text{N} + {}^{4}_{2}\alpha \rightarrow {}^{17}_{8}\text{O} + {}^{1}_{1}\text{H}$

Mark allocation

- 2 marks for the correct answer.
- It is okay to have He instead of alpha (α) sign.

Question 6

Professor Honeydew is working on a new experiment. If he originally had 20 kilograms of radioactive material that had a half-life of 28 hours, how much would be left after 1 week? Give your answer in **grams**.

3 marks

Worked solution

There are $24\times7=168$

$$\frac{168}{28} = 6 \text{ half-lives}$$
$$20\times\left(\frac{1}{2}\right)^{6} = 0.3125 \text{ kilograms}$$
$$= 312.5 \text{ grams}$$

312.5 g

Mark allocation

- 1 mark for calculating 6 half-lives.
- 1 mark for correct workings.
- 1 mark for the correct answer, in grams.

Question 7

Beaker is helping out with some experiments. He notices that his sample of radioactive potassium has an activity of 40 kBq.
Calculate the average time between the decay of nuclei.

2 marks

Worked solution

$40\text{ kBq} = 40\,000\text{ Bq}$

$= 40\,000$ decays per second

$\Rightarrow$ time between decays $= (40\,000)^{-1}$

$= 2.5 \times 10^{-5}$ s

$= 2.5 \times 10^{-5}$ s

Mark allocation

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

Question 8

Beaker turns up to work after 24 hours and detects that the activity has dropped to 5 kBq. Calculate the half-life of the potassium.

2 marks

Worked solution

40 kBq to 20 kBq is one half-life.
20 kBq to 10 kBq is another half-life.
10 kBq to 5 kBq is another half-life.

3 half-lives in 24 hours = 1 half-life is 8 hours.

8 hours

Mark allocation

- 2 marks for the correct answer.

Question 9

Explain why the activity level has dropped.

2 marks

Worked solution

As more and more of the sample decays, less radioactive atoms are left. (1 mark)
As a result, within a given time period, fewer will decay hence decreasing the decay rate. (1 mark)

Question 10

Radon-218 decays to polonium-214 as shown below.

$^{218}_{86}\text{Rn} \rightarrow {}^{214}_{84}\text{Po} + x$

Complete the decay equation by finding the element x and thus the type of decay.

2 marks

Worked solution

The numbers along the top and the bottom should add up.

$218 - 214 = 4$

$86 - 84 = 2$

Giving $x = {}^{4}_{2}\text{He}$ (1 mark)

Type of radiation is alpha. (1 mark)

Question 11
Harry, a patient, is getting some tests done at his local hospital. He notices that the radiologist is shielding herself behind a lead screen.
What sort of radiation is Harry about to receive? Explain your answer.

2 marks

Worked solution
X-rays or gamma rays. (1 mark)
Other types of radiation do not have enough energy that one must worry about using protective lead screens. (1 mark)

Question 12
Harry receives the full blast of the radiation and notices that the radiologist does not.
Why does the radiologist hide behind the screen and yet allows Harry to receive the full blast?

2 marks

Worked solution
Radiation has a cumulative effect. (1 mark)
It is perfectly okay to get a full blast once in a while, but repeated doses can become quite dangerous. (1 mark)

Question 13
When using alpha radiation (quality factor = 20), it is important that the patient does not receive too much. If a child has a mass of 40 kilograms and each treatment gives 3×10^{-4} joules, calculate the

a. absorbed dose.

2 marks

b. dose equivalent.

2 marks

Worked solution

a. Absorbed dose $= \dfrac{\text{energy}}{\text{mass}}$

$$= \frac{3 \times 10^{-4}}{40}$$

$$= 7.5 \times 10^{-6} \text{ Gy}$$

7.5×10^{-6} Gy

Mark allocation
- 1 mark for substituting the correct values into formula.
- 1 mark for the correct answer.

b. Dose equivalent = absorbed dose × quality factor

$$= 7.5 \times 10^{-6} \times 20$$

$$= 1.5 \times 10^{-4} \text{ Sv}$$

1.5×10^{-4} Sv

Mark allocation
- 1 mark for substituting the correct values into formula.
- 1 mark for the correct answer.

Question 14
Radiation from the Sun is constantly bombarding us, yet relatively few people get seriously sick from it. Give two reasons why.

2 marks

Worked solution
People are not in the Sun long enough each day. (1 mark)
The quality factor of the radiation ($\gamma = 1$) is very low. (1 mark)

Question 15
When an atom undergoes β^- decay, what happens to its

a. atomic number?

1 mark

b. mass number?

1 mark

Worked solution
a. Its atomic number increases by 1 unit. (1 mark)
b. Its mass number stays the same. (1 mark)

Total 35 marks

Area of study 2 – Electricity

The following information applies to questions 1–4.

Figure 1 below shows a circuit with a battery of 12 V and a current of 100 mA.

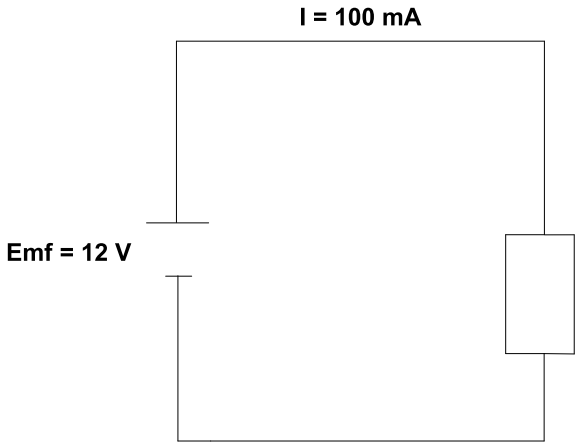


Figure 1

Question 1
The electrons will flow in which direction? (Circle the correct answer.)

Clockwise	Anti-clockwise

1 mark

Worked solution

~~Clockwise~~	Anti-clockwise

Electrons and conventional current flow in different directions.

Question 2
If the circuit has 100 mA running through it for 30 seconds, how much electric charge would have passed through the load? Include a unit in your answer.

2 marks

Worked solution
Charge = current × time
= 0.1 × 30
= 3 C

3 C	Unit: coulombs or C

Mark allocation
- 1 mark for the correct answer.
- 1 mark for giving the correct unit.

Question 3
How much energy will the circuit provide to the load in 30 seconds?

2 marks

Worked solution
$Energy = V \times I \times t$
$= 12 \times 0.1 \times 30$
$= 36$ J

36 J

Mark allocation
- 1 mark for substituting the correct values into the correct formula.
- 1 mark for giving the correct answer.

Question 4
What is the resistance of the battery in the circuit?

2 marks

Worked solution
$$R = \frac{V}{I}$$
$$= \frac{12}{0.1}$$
$$= 120\ \Omega$$

120 Ω

Mark allocation
- 1 mark for substituting the correct values into the correct formula.
- 1 mark for giving the correct answer.

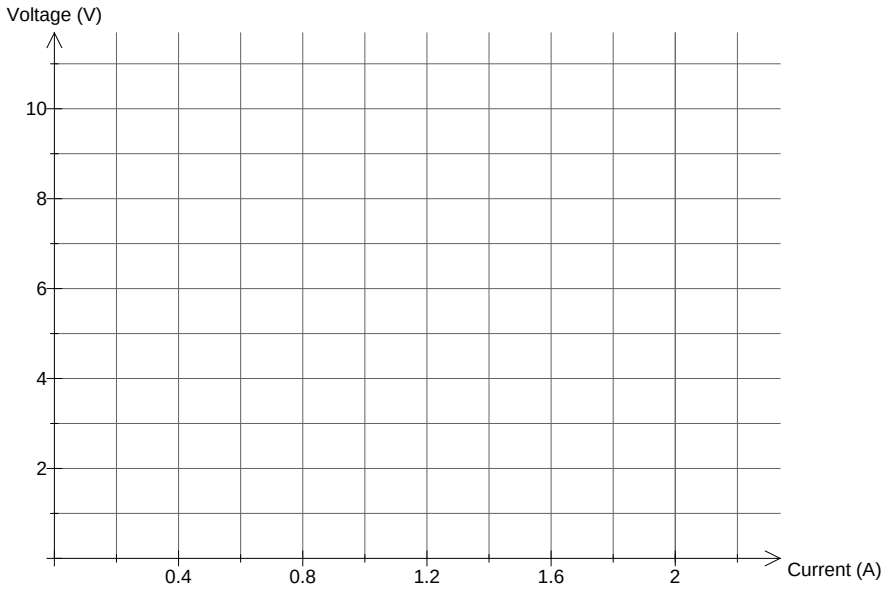
The following information applies to questions 5–7.

Veronica has obtained the following results from an experiment she carried out.

Voltage (V)	2.0	4.0	6.0	8.0
Current (A)	0.4	0.8	1.2	1.6

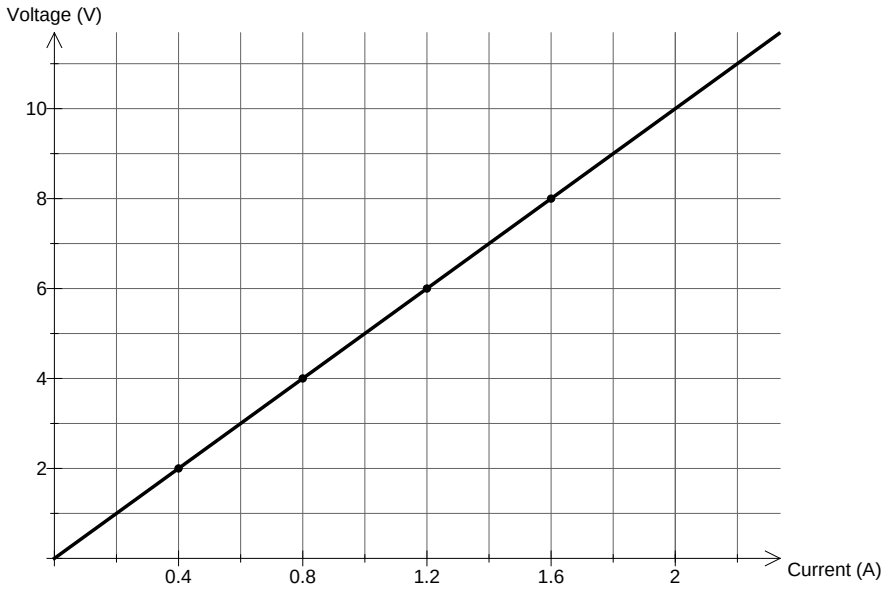
Question 5

Graph Veronica's results on the grid below.



2 marks

Worked solution



Mark allocation

- 1 mark for correct points.
- 1 mark for a straight line.

Question 6

Is the graph ohmic? Explain your answer.

2 marks

Worked solution
Yes, the graph is ohmic. (1 mark)
It is ohmic because the graph is linear/in a straight line. (1 mark)

Question 7
Calculate the resistance of the load in this experiment.

2 marks

Worked solution
Find the gradient of the line.

$$R = \frac{V}{I}$$
$$= \frac{8}{1.6}$$
$$= 5\Omega$$

5Ω

Mark allocation

- 1 mark for evidence of trying to obtain a **gradient**.
- 1 mark for giving the correct answer.

The following information applies to questions 8–10.

Hamish has set up the following circuit (Figure 2) in his garage.

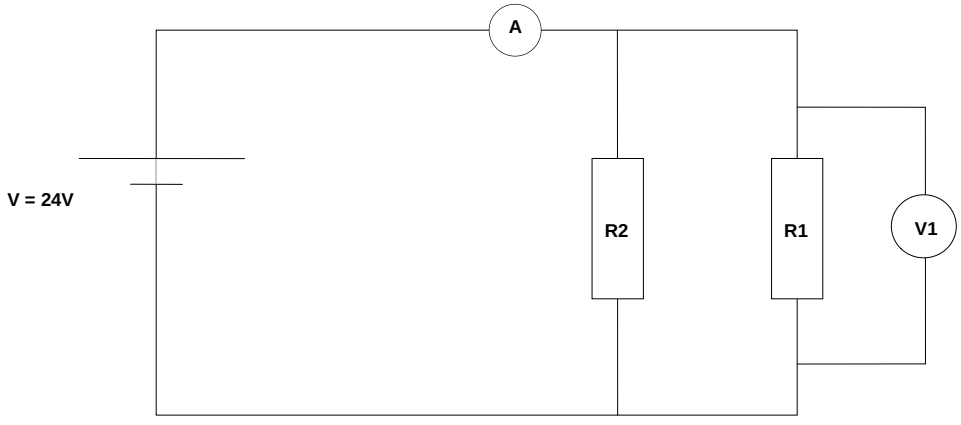


Figure 2

Question 8
What is the reading of the voltmeter, V1?

2 marks

Worked solution
The voltage drop across R1 will be the same as the supply voltage.

24 volts

Mark allocation

- 1 mark for calculating the current correctly.
- 1 mark for the correct answer.

Question 9

If there is 60 mA running through R1, what is the value of R1?

2 marks

Worked solution

$$R = \frac{V}{I}$$
$$= \frac{24}{0.06}$$
$$= 400\ \Omega$$

R1 = 400 Ω

Mark allocation

- 1 mark for converting 60mA to 0.06 A.
- 1 mark for giving the correct answer.

Question 10

If there is 180 mA running through R2, what is the value reading on the ammeter, A?
Write your answer in amperes.

2 marks

Worked solution

180 mA + 60 mA = 240 mA
= 0.240 A

0.240 A

Mark allocation

- 1 mark for converting from mA to amperes.
- 1 mark for the correct answer.

The following information applies to questions 11–13.

Hamish then experiments with his circuit by changing the resistors and the layout. Finally, he comes up with the circuit shown in Figure 3.

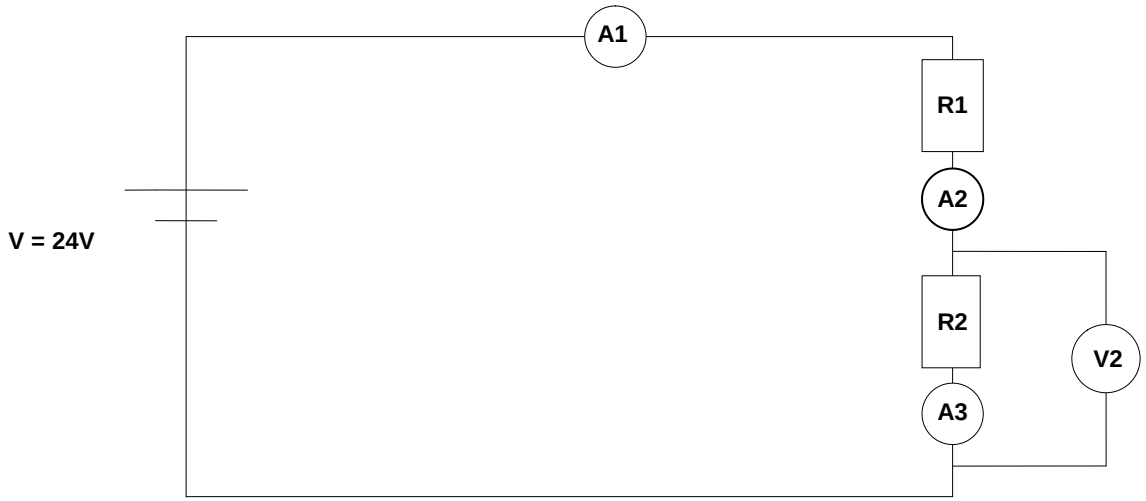


Figure 3

Question 11
If R1 = 250 Ω and R2 = 150 Ω, what is the total resistance of the circuit?

2 marks

Worked solution
Series circuit: $R_T = R1 + R2$
$= 250 + 150$
$R_T = 400\ \Omega$

$R_T = 400\ \Omega$

Mark allocation
- 1 mark for substituting the correct values into the correct formula.
- 1 mark for the correct answer.

Question 12
What is the reading on A1? Write your answer in milliamperes.

2 marks

Worked solution
Current through A1 will be total current through the circuit.

$$V = IR$$
$$I = \frac{V}{R}$$
$$= \frac{24}{400}$$
$$= 0.06 \text{ A}$$
$$= 60 \text{ mA}$$

60 mA

Mark allocation
- 1 mark for calculating 0.06 A.
- 1 mark for the correct answer.

Question 13
What is the reading on V2?

2 marks

Worked solution

$$V = IR$$
$$= 0.06 \times 150$$
$$= 9 \text{ V}$$

9 V

Mark allocation
- 2 marks for the correct answer.

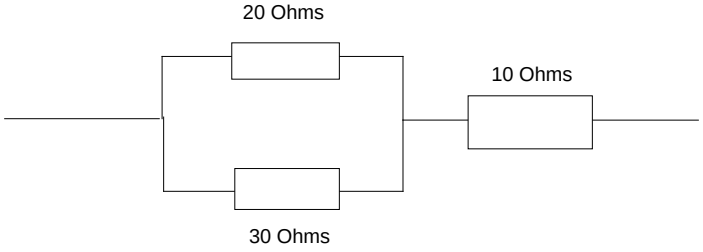
Question 14
Frankie is given three resistors: one 10 Ω, one 20 Ω and one 30 Ω.
Using a diagram, show how Frankie can use these resistors to make a total resistance of 22 Ω.

2 marks

Worked solution
Putting 20 Ω, and 30 Ω resistors in parallel gives 12 Ω.

$R_T^{-1} = 20^{-1} + 30^{-1}$
$R_T^{-1} = 0.0833^{-1}$
$\therefore \ R_T = 12 \ \Omega$ (1 mark)

Then add 10 Ω in series:
R = 12 + 10
= 22 Ω (1 mark)



Question 15
Electricity meters in the home measure
A. energy.
B. power.
C. current.
D. voltage.

A

2 marks

Worked solution
Consumers get charged for the amount of electrical energy that they use, not the characteristics of the supply. As power is reliant on current (as voltage is set at 240 V), we are charged for how much power we use *and* for how long.

Question 16
Name two contributing factors that will affect the severity of the consequences for a person who receives an electric shock.

2 marks

Worked solution
Any three of:
Period of time receiving electric shock.
How much current goes through the person.
The resistance of the person.
How much the voltage drops across the person.
The path the current takes through the body, especially through the heart.

Mark allocation
- 1 mark for each correct answer, up to 2 marks.

Question 17
A rechargeable battery is advertised as 2500 mA h. This is a measure of
A. how much energy it can store.
B. how much power it can deliver.
C. how long the battery will last for.
D. how much charge it can store.

D

2 marks

Worked solution
Current (mA) multiplied by time (hours) gives charge.

Question 18

A 240 V, 60 watt light globe operates for 4 hours per day. Calculate the current that flows through the light globe.

2 marks

Worked solution

$$P = VI$$

$$I = \frac{P}{V}$$

$$= \frac{60}{240}$$

$$= 0.25 \text{ A}$$

0.25 A

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for giving the correct answer.

END OF SECTION A

SECTION B – Detailed studies

NOTE: Each correct answer is worth 2 marks.

Detailed study 1 – Astronomy

Question 1
Which of the following is the reason for Earth's seasons?
A. How close Earth is to the Sun.
B. The rotation of the Earth.
C. Earth's tilt on its axis.
D. Sunspot activity.

C

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.*

Question 2
Beta Centauri is 525 light years from Earth. This distance is closest to
A. 9.5×10^{12} m
B. 9.5×10^{15} m
C. 5.0×10^{15} km
D. 5.0×10^{12} m

C

Worked solution
One light year is the distance light travels in a year, which is:
$3 \times 10^8 \times 60 \times 60 \times 24 \times 365$ m $= 9.5 \times 10^{15}$ m
$= 9.5 \times 10^{12}$ km
$525 \times 9.5 \times 10^{12}$ km $= 5.0 \times 10^{15}$ km

Question 3
Which of the following is an example of a diurnal circle?
A. Stars moving in a circular pattern during the night.
B. The motion of the Sun from east to west.
C. The clouds going across the sky.
D. The trajectory of the planets across the sky.

A

Worked solution
The diurnal motion of the stars is the apparent motion of the stars across the sky and is caused by the Earth's rotation on its axis.

Question 4
The term *geocentric* literally means
A. Earth's motion.
B. Earth-centred.
C. star-centred.
D. Sun-centred.

B

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.

A

Question 6
A telescope has an objective lens with a focal length of 84 cm and an eyepiece with a focal length of 2.1 cm. Therefore, the magnification of the telescope is
A. 40
B. 0.05
C. 176.4
D. 5

A

Worked solution

$$M = \frac{f_{obj}}{f_{eyepiece}}$$
$$= \frac{84}{2.1}$$
$$= 40$$

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.

A

Question 8
Which of the following is **not** a class of star?
A. A
B. O
C. M
D. T

D

Question 9
Cecile is watching a spectacular sunrise from the banks of the Kiewa 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

C

Question 10
A group of stars that **appear** to be in close proximity to each other when seen in the night sky from Earth, is called a
A. galaxy.
B. constellation.
C. cluster.
D. nebula.

B

Worked solution
A galaxy contains billions of stars, whereas a cluster contains 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. A nebula is a cloud of dust, plasma and hydrogen gas – it is not a group of stars.

Detailed study 2 – Astrophysics

Question 1
A star's source of energy is derived from
A. nuclear fusion.
B. nuclear fission.
C. radioactive decay.
D. radiation.

A

Worked solution
Stars are made from hydrogen, which undergoes fusion owing to the immense temperatures and heat inside the star.

Question 2
If an astronomer observes a star undergoing a Doppler effect into blue shift, then that star is travelling
A. towards us.
B. away from us.
C. parallel to us.
D. at right angles to us.

A

Worked solution
For a star travelling towards us, light reaching Earth will appear to have a shorter wavelength than usual. Blue light has a shorter wavelength than other light.

Question 3
A few stars that are in close proximity to each other are called a
A. constellation.
B. galaxy.
C. nebula.
D. cluster.

D

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.

Question 4
Two stars that rotate around each other are called a
A. nebula.
B. double-yolker.
C. double star system.
D. binary system.

D

Question 5
The colour of a star is most closely related to its
A. size.
B. temperature.
C. brightness.
D. density.

B

Question 6
Our Sun's spectral class type is
A. A
B. B
C. F
D. G

D

Question 7
Which of the following are **not** regions of a Hertzsprung–Russell diagram?
A. giants
B. supergiants
C. **s**ubdwarfs
D. giant dwarfs

D

Worked solution
White dwarfs and subdwarfs have a region, whereas giant dwarfs do not.

Question 8
How long does it take the light of the Sun to reach Earth?
A. 8 seconds
B. 8 minutes
C. 8 years
D. 8 light years

B

Worked solution
Yet it takes light 100 000 years to get out from the centre of the Sun!

Question 9
The start of the universe has been calculated to have occurred
A. 5000 years ago.
B. 4 billion years ago.
C. 14 million years ago.
D. 14 billion years ago.

D

Question 10
In 1964, Arno Penzias and Robert Wilson *accidentally* discovered cosmic background radiation. This was later shown to prove
A. the Big Bang theory.
B. the Steady State theory.
C. that dark matter exists.
D. there is extra-terrestrial life.

A

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

Detailed study 3 – Energy from the nucleus

Question 1

How many protons and nuetrons does $^{238}_{92}\text{U}$ have?

A. 146 protons, 92 neutrons
B. 92 protons, 146 neutrons
C. 238 protons, 92 neutrons
D. 92 protons, 238 neutrons

B

Worked solution

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

neutrons = nucleons – protons

Question 2

What holds the nucleus of an atom together?

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

C

Question 3

Einstein predicted that if 0.1 gram of matter (which is about a raindrop) was destroyed and converted to energy, the amount of energy released would be

A. 9.0×10^{12} J
B. 9×10^{15} J
C. 1 J
D. 1500 J

A

Worked solution

$$E = mc^2$$
$$= 0.1 \times 10^{-3} \times (3 \times 10^8)^2$$
$$= 9 \times 10^{12}\ \text{J}$$

Question 4

$^{2}_{1}H$ is present in heavy water. $^{2}_{1}H$ different from $^{1}_{1}H$ in that it has an extra

A. proton.
B. neutron.
C. electron.
D. oxygen.

B

Worked solution

If $^{2}_{1}H$ had an extra proton it would be helium.

Question 5

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

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, and radiation shields stop harmful radiation from escaping.

Question 6

The role of the control rods in a nuclear power station is to

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

A

Question 7

Nuclear fission reactors are used today instead of **fusion** reactors because they are

A. more environmentally friendly.
B. less expensive to build and run.
C. fuel is easier to find.
D. produce less radioactive waste.

B

Worked solution

Fission is unviable at this time owing to the enormous costs of creating the high temperature and pressure needed.

Question 8
Australia has
A. no nuclear reactors.
B. nuclear reactors, but no nuclear power plants.
C. nuclear power plants, but no nuclear reactors.
D. nuclear reactors and nuclear power plants.

B

Worked solution
Australia's two nuclear reactors, in Lucas Heights, NSW, provide research and medical material.

Question 9
The 'fast' in a fast-breeder reactor refers to the speed of
A. turbines.
B. the super-heated steam.
C. neutrons.
D. electricity supplied.

C

Worked solution
The neutrons don't need to be slowed due to the use of Pu-239

Question 10
Which of the following equations can occur in a typical nuclear power station?
A. ${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{141}_{56}\text{Np} + {}^{92}_{36}\text{Kr} + 3{}^{1}_{0}\text{n}$
B. ${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{141}_{56}\text{Np} + {}^{92}_{36}\text{Kr} + 2{}^{1}_{0}\text{n}$
C. ${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{141}_{56}\text{Np} + {}^{91}_{36}\text{Kr} + 3{}^{1}_{0}\text{n}$
D. ${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{142}_{56}\text{Np} + {}^{92}_{36}\text{Kr} + 3{}^{1}_{0}\text{n}$

A

Worked solution
Uranium absorbs a neutron and emits 3 neutrons. You must then balance the top and bottom equations.

Detailed study 4 – Investigations: Aerospace

Question 1
In Figure 1 below, which of the following correctly shows yaw, pitch and roll?

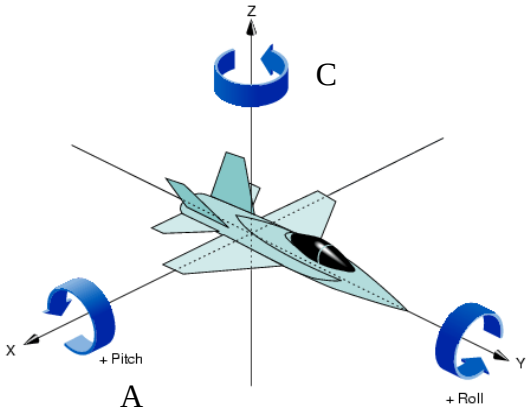


Figure 1

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

D

Question 2
Jimmy throws a paper plane vertically. He throws it from a height of 2 metres and notices that it travels 8 metres before it hits the ground. He calculates the glide ratio as
A. 0.04
B. 0.4
C. 4
D. 0.5

C

Worked solution

$$\text{Glide ratio} = \frac{\text{distance travelled}}{\text{altitude lost}}$$
$$= \frac{8}{2}$$
$$= 4$$

Question 3
An aircraft is flying from Melbourne to London. Its force vectors are shown in Figure 2 below.

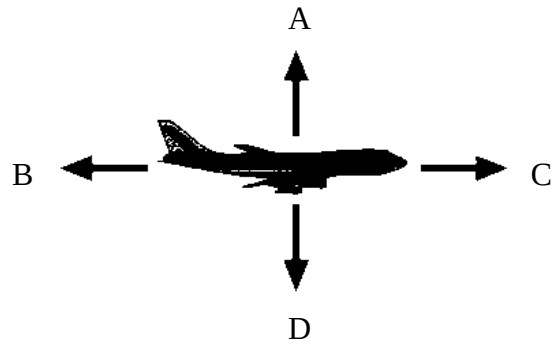


Figure 2

Which of the following correctly describes the forces on an 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.

D

Question 4
For the aircraft shown in Figure 2, it is
A. accelerating.
B. decelerating.
C. stationary.
D. travelling at a constant velocity.

D

Worked solution
Forces B (drag) and C (thrust) are equal in magnitude and therefore the aircraft cannot be accelerating or decelerating. While it is flying, an aircraft cannot be stationary.

Question 5
For the aircraft shown in Figure 2, it is
A. rising.
B. descending.
C. travelling at a constant altitude.
D. stationary.

C

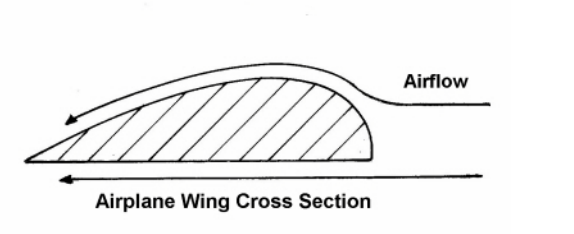
Worked solution
Forces A (lift) and D (weight) are equal in magnitude and therefore the aircraft cannot be rising or descending. While it is flying, an aircraft cannot be stationary.

Question 6
Sir Isaac Newton gave us three laws of motion. Of the options below, which one(s) apply to an airplane in flight?

A. A body at rest will remain at rest unless acted upon by some outside force.
B. 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.

D

Question 7
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.

D

The following information relates to questions 8–10.

A four-engine plane has identical engines that are delivering a force of 10 000 newtons of force each. The aircraft has a total mass of 200 000 kilograms and is travelling at a constant velocity and altitude.

Question 8
Calculate the drag that the plane endures.

A. 400 000 N
B. 2 000 000 N
C. 40 00 N
D. 200 000 N

C

Worked solution
If the plane is travelling at a constant velocity and altitude, then the drag and the thrust must be equal.

Question 9
Calculate the lift force of the plane.
A. 400 000 N
B. 2 000 000 N
C. 40 00 N
D. 200 000 N

B

Worked solution
If the plane is travelling at a constant velocity and altitude, then the drag and the thrust must be equal.
Lift force = weight force
$= mg$
$= 200\,000 \times 10$
$= 2\,000\,000$ N

Question 10
As shown in Figure 3 below, an aircraft's outside engines are 10 metres from the centre of the plane and the inner engines are 5 metres from the centre of the plane. Suddenly, the right outer engine cuts out.
At what force should the inside right engine be delivering now so that the plane remains in a straight line?

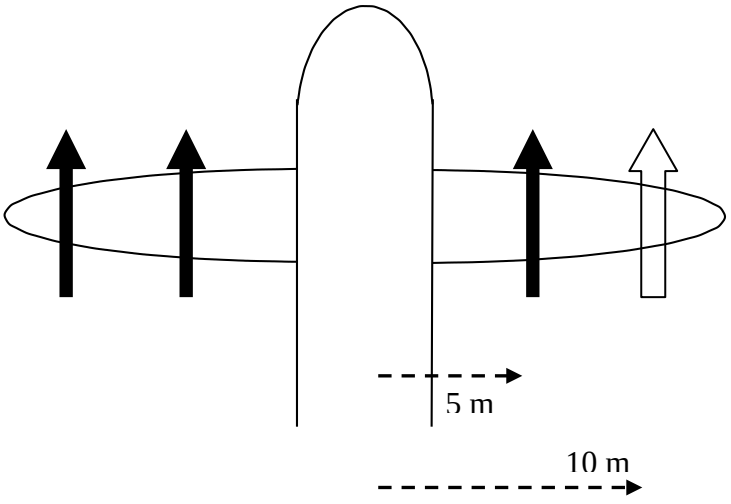


Figure 3

A. 6300 N
B. 16 300 N
C. 2000 N
D. 30 000 N

D

Worked solution

The torque on the left side of the plane = The torque on the right side of the plane

$$\tau\text{Left} = \tau\text{Right}$$

$$10 \times 10\,000 + 5 \times 10\,000 = 5 \times \text{thrust}$$

$$150\,000 = 5 \times \text{thrust}$$

$$\text{So thrust} = 30\,000 \text{ N}$$

Detailed study 5: Investigations – Alternative energy sources

Question 1
Which of the following is not a sustainable energy source?
A. coal
B. wind
C. geothermal
D. solar

A

Question 2
Rob has put together 12 solar cells, each producing 12 V at 200 mA each. How much power can Rob harness?
A. 2400 W
B. 28 800 W
C. 28.88 W
D. 0.24 W

C

Question 3
Deb has a heater that is only 40% efficient. If she needs it to have an output of 1000 W to warm her toes, then she will need to have an input of
A. 400 W
B. 1400 W
C. 2500 W
D. 4000 W

C

Worked solution

$$40\% \text{ of } 2500 = \frac{40}{100} \times 2500$$
$$= 1000$$

Question 4
Which of the following is not a major cause of greenhouse gases?
A. wood fires
B. deforestation
C. erupting volcanoes
D. nuclear power plants

D

Worked solution
Although nuclear power plants do not cause greenhouse gases, they have a lot of other negatives. In addition, herds of cattle produce enormous amounts of methane.

Question 5
Which of the following forms of energy conversion does **not** require a turbine for creating electricity?
A. tidal power
B. wind power
C. hydropower
D. solar power

D

Worked solution
Solar panels produce electricity without the need for a turbine. The other energy forms 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. insulation
C. panel area
D. efficiency of panels

A

Question 7
Although Australia has an abundance of uranium and nuclear power produces no greenhouse gases, nuclear power is not used in Australia. This is because
A. nuclear power plants kill lots of people each year.
B. the electricity produced would cost more than what we are paying now.
C. nuclear power plants are dangerous to the Earth.
D. coal mining is a safe practice.

B

Worked solution
Coal mining deaths worldwide averaged about 5000 people each year in the past decade, being the safest on record.

Question 8
A hydropower station is built so that the water falls 25 metres and can handle 4000 litres per second. Theoretically, how much power can it generate?
A. 10 MW
B. 1 MW
C. 0.1 MW
D. 100 MW

B

Worked solution
Each litre of water has a gravitational potential energy (*mgh*) of 250 J.
So 4000 litres per second will give:
$250 \times 4000 \text{ W} = 1 \times 10^6 \text{ W}$
$= 1 \text{ MW}$

Question 9
General Hospital is in an isolated part of the Sahara desert and is not on any electricity power grid. The hospital needs to have electricity on demand, at all times, no matter the weather, so it is shopping for its own power generator. Which of the following would be best?
A. electrical batteries
B. wind-powered generator
C. solar-powered generator
D. A combination of all of the above.

D

Question 10
In a coal-powered electrical power plant, energy is transformed by which of the following methods?
A. chemical energy → kinetic energy → electrical energy
B. chemical energy → heat → kinetic energy → electrical energy
C. kinetic energy → gravitational potential energy → electrical energy
D. kinetic energy → gravitational potential energy → heat → electrical energy

B

Worked solution
Coal (chemical energy) burns (heat), which heats the water and makes the turbine spin (kinetic energy), which in turn produces the energy (electrical energy).

Detailed study 6: Medical physics

Question 1
Which part of medical physics occurs due to radioactive decay?
A. X-ray
B. PET scans
C. MRI scans
D. CT scans

B

Worked solution
PET scans detect radioactive tracers that are injected into the human body.

Question 2
A doctor needs 2 grams of a radiotracer to use in her hospital. If it has a half-life of 4 hours and takes 16 hours to deliver from the manufacturer, how much will she need to order?
A. 32 grams
B. 4 grams
C. 8 grams
D. 16 grams

A

Worked solution
16 hours is 4 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; from 8 g to 4 g in the third half-life; and from 4 g to 2 g in the fourth (and final) half-life.

Question 3
If an X-ray has a period of 2×10^{-21} s, what is its frequency?
A. 5×10^{20} s
B. 5×10^{19} s
C. 5×10^{13} s
D. 5×10^{-15} s

A

Worked solution

$$f = \frac{1}{P}$$

$$f = \frac{1}{2 \times 10^{-21}}$$

$$= 5 \times 10^{20} \text{ Hz}$$

Question 4
An endoscope needs its optical fibres to be coherent. Figure 4 below shows one end of an endoscope.

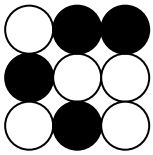
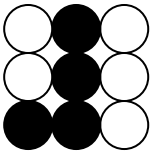
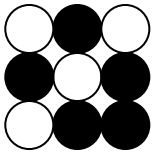
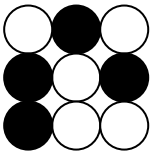


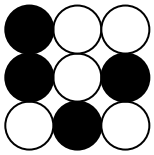
Figure 4

Which of the following is coherent to that shown in Figure 4?

A. 

B. 

C. 

D. 

D

Worked solution
Diagram D is simply a rotation of the original.

Question 5
Which radiation is appropriate for diagnosis and therapy, respectively?
A. α, β
B. γ, α
C. β, γ
D. α, γ

B

Worked solution
For diagnosis, a radiation with a low quality factor is important, as well as needing a high penetrator 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.

Question 6
Which one of the following would be used best as a tracer?
A. α
B. β
C. γ
D. X-rays

C

Worked solution
It would be best to use γ-rays so that the radiation can exit the body and be detected.

Question 7
Lead shields are used to protect people from
A. lasers.
B. X-rays.
C. CT scans.
D. ultrasound waves.

B

Worked solution
Lead shields are used to protect people from X-rays, whereas the rest can be absorbed by clothing.

Question 8
Which of the following instruments does not use a form of electromagnetic radiation?
A. lasers
B. X-ray
C. CT scan
D. ultrasound

D

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

Question 9
The percentage of radiation in our lives due to human-made radiation, such as X-rays and mobile phones, is approximately
A. 0.5%
B. 15%
C. 85%
D. 95%

B

Worked solution
Background radiation and radiation from the Sun far outweighs the amount of radiation emitted from a few X-rays and from mobile phones etc.

Question 10
If an X-ray has a frequency of 1.3×10^{14} Hz, what is its wavelength?
A. 2.3×10^{-6} m
B. 2.3×10^{14} m
C. 2.3 m
D. 2300 m

A

Worked solution

$$v = f\lambda$$

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

$$= \frac{3 \times 10^{8}}{1.3 \times 10^{14}}$$

$$= 2 \times 10^{-6} \text{ m}$$

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

END OF SECTION B