TSSM
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2021 Trial Examination

STUDENT NUMBER | | | | | | | | | Letter |

PHYSICS

Unit 2 – Written examination

Reading time: 15 minutes
Writing time: 1 hour and 15 minutes

QUESTION & ANSWER BOOK

Structure of book

Section	*Area of study*	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A - Multiple choice	1 & 3	15	15	15
B - Short answer	1 & 3	4	4	55
		Number of options	*Number of options to be answered*	
C - Options	2	12	1	20
			Total	90

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- A scientific calculator is allowed.
- Double-sided A3 notes are allowed.

Materials supplied

- Question and answer book of 82 pages.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

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

Table of Contents

SECTION A – CORE – Multiple-choice questions

Instructions

Section A consists of 15 questions. Answer all questions by writing the letter of the correct response in the box provided.

Choose the response that is correct or that best answers the question.

A correct answer scores 1; 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.

Unless otherwise indicated, diagrams are not to scale.

Take the value of g to be 9.8 m s^{-2}.

Question 1

In 95 seconds, a runner completes an 800 m sprint race. What was the runner's average speed?

A. 0.12 m s^{-1}

B. 7.60 m s^{-1}

C. 8.42 m s^{-1}

D. 1.35 m s^{-1}

Question 2

A car is travelling at 150 km h^{-1}. What is its speed in m s^{-1}?

A. 550 m s^{-1}

B. 43 m s^{-1}

C. 23 m s^{-1}

D. 42 m s^{-1}

Question 3

A yacht travels 3 km east and then 4 km north. What is the displacement of the yacht from its initial position?

A. 5 km N37°E

B. 7 km N37°E

C. 5 km N53°E

D. 7 km N53°E

Question 4

A ball rolls along a table in a straight line. It is observed to change its speed from 8.5 m s^{-1} to 3.5 m s^{-1} in 2 seconds. What is its average acceleration?

A. -2.5 m s^{-2}

B. 8.0 m s^{-2}

C. 2.5 m s^{-2}

D. -4.0m s^{-2}

Question 5

Which of the following are vector quantities: speed, acceleration, force, mass, displacement, velocity, density, time, distance and charge?

A. Speed, mass, density, time, distance and charge.

B. Force, acceleration, charge, velocity and displacement.

C. Speed, acceleration, density, displacement, distance and charge.

D. Force, acceleration, velocity and displacement.

Question 6

Which of the following **is not** an example of Newton's Third Law?

A. A truck and a car collide. During the collision the car imparts an impulse on the truck and the truck imparts an equal and opposite impulse on the car over the same time period.

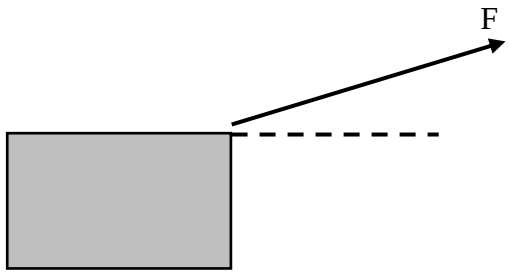
B. A truck and a car collide. During the collision the car exerts a force on the truck and the truck exerts and equal and opposite force on the car.

C. The normal force exerts an equal and opposite force to the weight of an object sitting on the table.

D. The earth exerts a gravitational force on a ball and the ball exerts an equal but opposite gravitational force on the earth.

Question 7

A force is applied to a block as shown below. What is the horizontal component of this force?



A. $\frac{F}{sin\ \theta}$

B. $Fsin\ \theta$

C. $Fcos\ \theta$

D. $\frac{F}{cos\ \theta}$

Question 8

A 100 g tennis ball is initially travelling 8 m s^{-1} to the right. It collides with a brick wall and rebounds with a velocity of 2 m s^{-1} to the left. What is the impulse on the ball?

A. 0.6 kg m s^{-1} to the left

B. 1.0 kg m s^{-1} to the left

C. 1.0 kg m s^{-1} to the right

D. 0.6 kg m s^{-1} to the right

Question 9

Regarding weight and mass, which of the following are true?

A. Both your mass and weight depend on the gravitational field you are placed in.

B. Your weight doesn't depend on the gravitational field, but your mass does.

C. A scale measures your mass directly.

D. Your mass doesn't depend on the gravitational field, but your weight does.

Question 10

As a spring is stretched from its equilibrium point the amount of force required increases linearly. It can be said that the spring follows Hooke's law. At the 2 cm mark the force required was 10 N. Determine the spring constant, *k*.

A. $500\ \text{N m}^{-1}$

B. $200\ \text{N m}^{-1}$

C. $10\ \text{N m}^{-1}$

D. $5\ \text{N m}^{-1}$.

Question 11

A 2 kg box sits on a frictionless inclined plane which is tilted 35° from the horizontal. Determine the magnitude of the net force down the plane.

A. $2 \times \cos 35°$

B. $19.6 \times \sin 35°$

C. $19.6 \times \cos 35°$

D. $9.8 \times \sin 35°$

Question 12

An electron is placed in between two oppositely charged plates. The electron experiences a constant force of 1200 N and is displaced by 8 mm. How much work is done on the electron by the charged plates?

A. 9.6 J

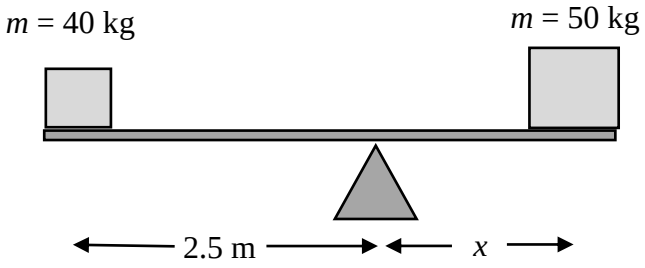
B. 1.5 J

C. 960 J

D. 9600 J

Question 13

Two boxes of different mass are placed on a balance as shown in the figure below. In this configuration the system is in static equilibrium (it is balanced). Determine the value for *x*.



A. 1 m

B. 1.5 m

C. 2 m

D. 2.5 m

Question 14

What is one way to account for random errors?

A. Random errors are fundamental to any experiment and cannot be reduced.

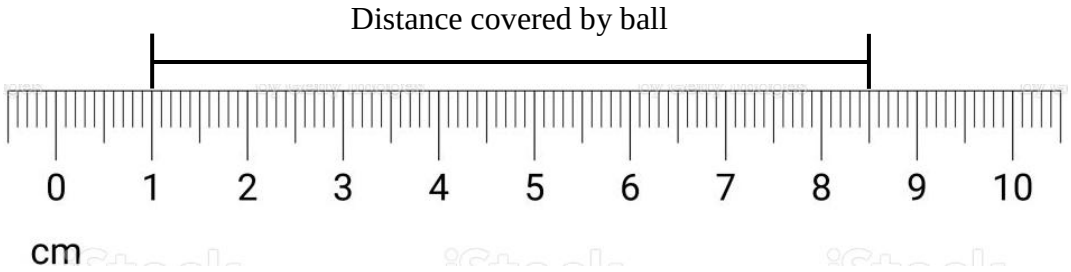
B. Check the methodology is measuring exactly what it should be measuring.

C. Conduct multiple trials of each data point.

D. Make sure your results can be replicated by another scientist.

Question 15

A ruler is used to measure the distance a ball rolls along the ground as shown below. What distance does the ball cover?



A. 8.5 ± 0.5 cm

B. 7.5 ± 0.5 cm

C. 8.5 ± 0.05 cm

D. 7.5 ± 0.05 cm

END OF SECTION A

SECTION B – CORE – Short Answer Questions

Instructions

Section B consists of 4 questions. Answer all questions in the spaces provided.
Your answers should be expressed correctly using appropriate physics terms.
Numerical answers should be calculated fully and expressed with the appropriate number of significant figures.
Where an answer box has a unit printed in it, give your answer in that unit.
In questions where more than one mark is available, appropriate working should be shown.
Take the value of g to be 9.8 .

Question 1 (15 marks)

Starting from home, a man takes his dog for a run. The velocity of the man at different moments in time is shown below in Figure 1.

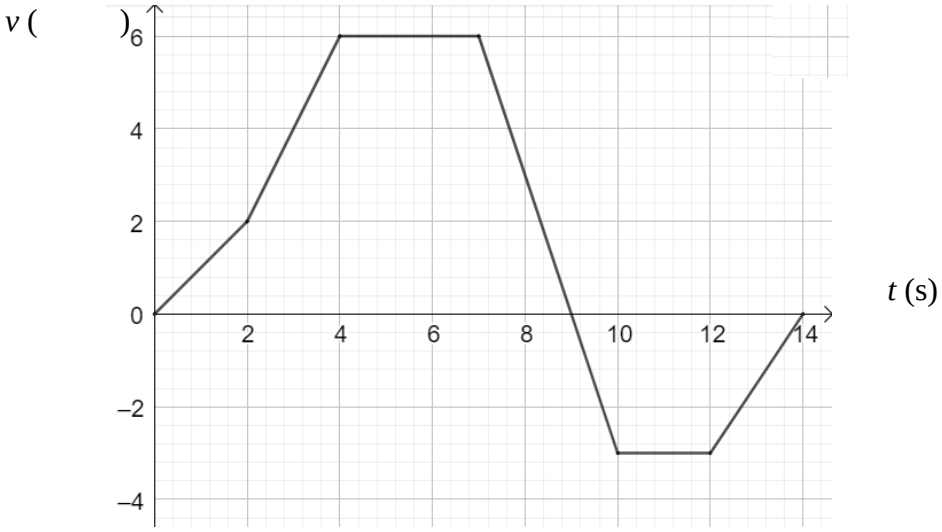


Figure 1

a. Find the average acceleration between $t = 0$ s and $t = 4$ s.

_____

_____

(1 mark)

SECTION B – continued
TURN OVER

b. Find the average acceleration between $t = 0$ s and $t = 14$ s.

(1 mark)

c. Find the instantaneous acceleration at $t = 8$ s.

(1 mark)

d. Find the man's displacement between $t = 0$ s and $t = 9$ s.

(3 marks)

SECTION B – continued

e. Find the man's displacement between $t = 9$ s and $t = 14$ s, and hence find the overall displacement during his entire journey.

(3 marks)

f. At what time intervals and/or instantaneous points in time is the man at zero velocity?

(3 marks)

g. At what time intervals and/or instantaneous points in time does the man have zero acceleration?

(3 marks)

SECTION B – continued
TURN OVER

Question 2 (15 marks)

Different boxes are placed on an inclined plane as shown in Figure 2. The length of the inclined plane is 17 m. When the box is in motion there is always a constant frictional force, F_f, that opposes the movement of the box.

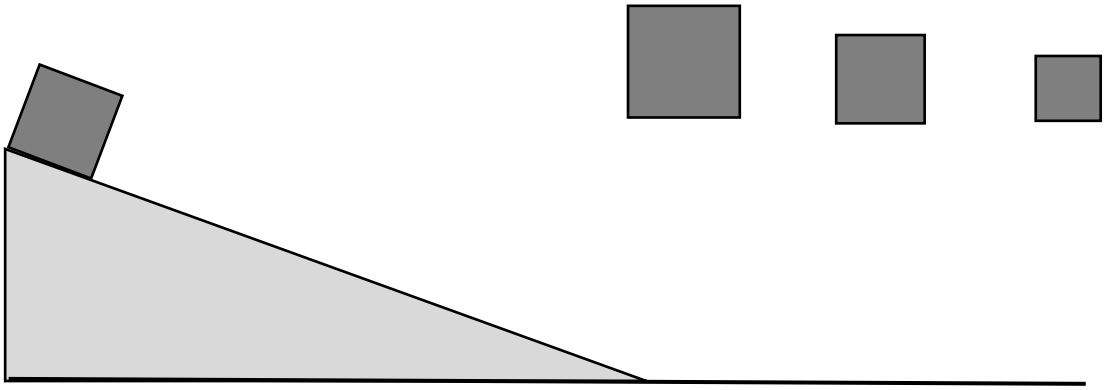


Figure 2

a. Label all the forces on the box that is sitting on the inclined plane.

(3 marks)

b. Using the appropriate vector resolution (draw this on the above graph), show that the acceleration of a box is,

$$a = g \sin\theta - \frac{F_f}{m}$$

(This will only apply when g $\sin\theta \geq \frac{F_f}{m}$)

(3 marks)

SECTION B – continued

c. Find the largest frictional force under which **all** the boxes will accelerate down the plane.

(3 marks)

After some experimentation it was found that the frictional force of the ramp is, $F_f = 33$ N.

d. Find the acceleration of the largest block m_1. Hint: Use the formula from part b.

(2 marks)

e. If the block starts at rest, what is its final velocity at the bottom of the incline? Note: the length of the incline is 17 m.

(2 marks)

f. Now the block is moving along the ground (zero incline). The ground also has some frictional force, which is different to the frictional force on the inclined plane. At two different points along the ground the velocity of the box was measured to be $v_1 = 5\ \text{m s}^{-1}$ and then $v_2 = 3\ \text{m s}^{-1}$. Find the work done by the ground on the box between these two points.

J

(2 marks)

SECTION B – continued

TURN OVER

Question 3 (10 marks)

A simplified version of a plane has an amount of air in its engine. The plane and air weigh 5100 kg. Over a short period of time the engine pushes 100 kg of air out the back at a speed of 2000 km h^{-1}.

a. Convert 2000 km h^{-1} into m s^{-1}.

(1 mark)

b. It is to be assumed that there is no air resistance and that the initial velocity of the plane and air is zero. The plane faces to the left as shown in Figure 3. Calculate the velocity of the plane after the 100 kg of air has been pushed out the back.

Figure 3

(3 marks)

to the

c. What is the impulse on the plane by the air?

(2 marks)

to the

SECTION B – continued

d. If it takes 3.6 seconds to move the 100 kg of air out of the engine, find the average force applied to the plane by the air.

_____

_____

(2 marks)

to the

e. Without any calculations what is the average force applied to the air by the plane. Justify your answer.

_____

_____

_____

_____

(2 marks)

Question 4 (15 marks)

Students at school are investigating the properties of springs. They decide to stretch a given spring away from its relaxed state by set extensions. The students aim to investigate whether the spring follows Hooke's law.

a. Write down an appropriate hypothesis.

_____

(1 mark)

b. What is the independent variable?

_____

(1 mark)

c. What is the dependent variable?

_____

(1 mark)

SECTION B – continued

TURN OVER

d. Name an appropriate control variable.

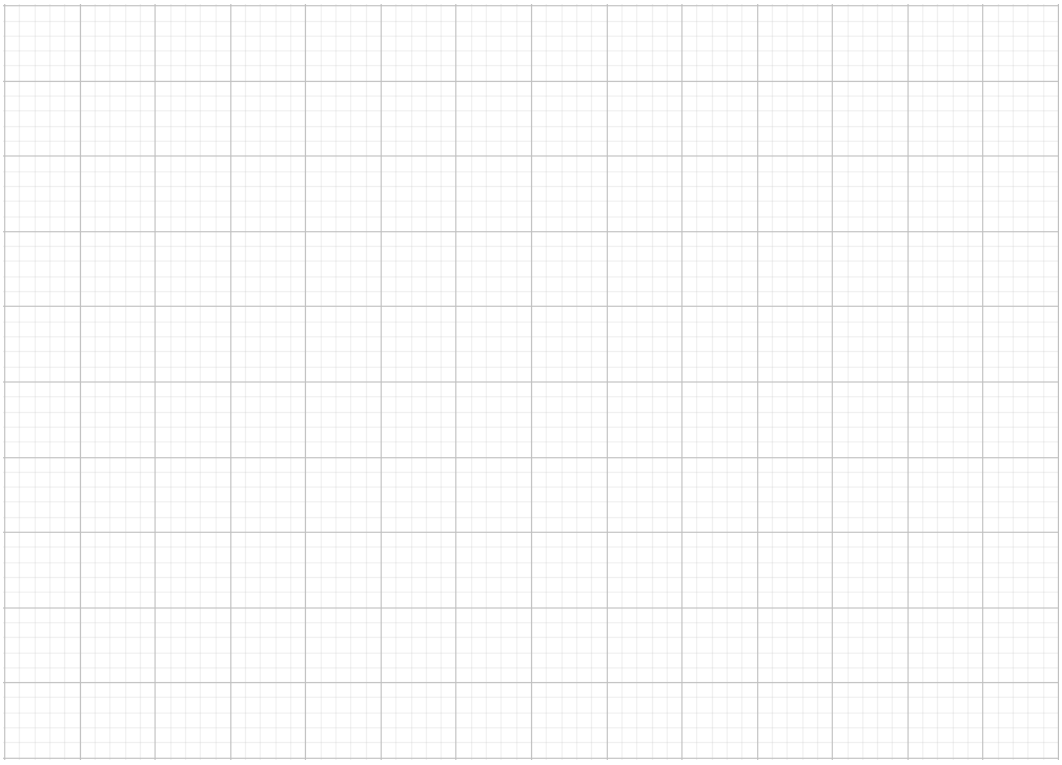
_____

(1 mark)

The results from the students' experiment are shown in the table below.

Table 1

Extension (cm) ± 0.05	Force (N) ± 0.05
1.0	3.2
2.0	6.9
3.0	11.0
4.0	14.3
5.0	18.4
6.0	21.1



e. In the space provided above, graph the students' results. Be sure to include ALL appropriate information on the graph.

(6 marks)

SECTION B – continued

f. Does the spring follow Hooke's law? Explain.

_____

_____

(2 marks)

g. What would be an appropriate analysis technique to determine the gradient of a set of experimental data?

_____

(1 mark)

h. Determine the spring constant of the spring.

_____

_____

_____

(2 marks)

END OF SECTION B
TURNOVER

SECTION C: OPTIONS

Instructions for SECTION C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.1: What are stars?

Multiple Choice Questions (1 mark each)

Question 1

Which of the following isn't part of the electromagnetic spectrum?

A. Gamma rays

B. Beta radiation

C. Green light

D. Microwaves

Question 2

There are many ways in which we can measure the distance to stars. One of those ways is stellar parallax. How is this accomplished?

A. By using the colour of a star to determine its temperature, astronomers can determine its absolute luminosity and hence how far away it is.

B. Due to the expanding universe the more distant stars move away from us at a faster rate than the close ones. How much a star's spectra is red-shifted allows astronomers to calculate how far away it is.

C. When the earth moves around the sun closer stars will appear to move more than distant stars. We can measure this small movement to determine how far away a star is.

D. Astronomers use the periodic change in the brightness of a known star to determine the distance to other stars. This is done by comparing the apparent brightness of both stars.

Question 3

How many arc seconds are there in a degree (°)?

A. 360 arc seconds

B. 60 arc seconds

C. 120 arc seconds

D. 3600 arc seconds

Question 4

Finish off this sentence. When compared to a red star, a blue star will have a

A. higher surface temperature.

B. lower surface temperature.

C. Lower relative magnitude.

D. Higher relative magnitude.

Question 5

According to Einstein a star will lose mass proportional to the energy it loses. What is the most significant type of reaction that takes place inside a star to allow this to happen?

A. Nuclear fusion

B. Nuclear fission

C. Chemical redox reaction

D. Beta decay

Short Answer Questions

Question 6 (6 marks)

When looking at the sky astronomers talk about the angular size of objects and the angular distance between two points in the sky. This can be utilised in many different ways.

a. The angular size of the moon is 31 arc minutes. Convert the angular size of the moon into arc seconds.

_____

_____

(2 marks)

b. On Earth we measure the parallax angle of the star Sirius to be 0.38 arc seconds. Find the distance to the star in:

i. Parsecs

_____

_____

(2 marks)

pc

ii. Light-years

_____

_____

(2 marks)

ly

SECTION C – continued

Question 7 (6 marks)
If it was known that a distant star, A, had the same absolute brightness as some other star, B, for which its distance to Earth and absolute brightness was known, it would be straightforward to calculate the distance to A.

a. What do astronomers call stars like B?

_____

_____

(1 mark)

b. The star Proxima Centauri has an apparent magnitude of +11.1, whilst Orion Nebula has an apparent magnitude of +4.0.

i. From earth, which object looks the brightest?

_____

(1 mark)

ii. If Proxima Centauri has an absolute magnitude of 15.6, how far is it from Earth?

_____

_____

(2 marks)

pc

iii. If the Orion Nebula is 410 pc away from Earth, determine its absolute magnitude.

_____

_____

(2 marks)

SECTION C – continued
TURN OVER

Question 8 (3 marks)

Really heavy stars ($> 20M_{Sun}$) are so large that they produce the right conditions for a star to collapse into a black hole.

a. What large energy event of a star's life is required to produce a black hole?

_____

(1 mark)

b. A star that is 100 times heavier than Sun collapses into a black hole at the end of its life. Determine the Schwarzschild radius of this black hole.
$M_{Sun} = 2.0 \times 10^{30}$ kg, $G = 6.7 \times 10^{-11}$N m^2 kg^{-2}, $c = 3.0 \times 10^{8}$ m s^{-1}.

_____

_____

_____

(2 marks)

m

SECTION C – continued

SECTION C: OPTIONS

Instructions for Section C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.2: Is there life beyond the solar system?

Multiple Choice Questions (1 mark each)

Question 1

What is the difference between emission and absorption spectra?

A. Absorption spectra show a continuous spectrum of radiation, whilst emission spectra show distinct wavelengths of radiation.

B. Their spectra show the same characteristics; they are just produced by a different process.

C. Absorption spectra show distinct black lines in the continuous spectrum. Emission spectra show distinct wavelengths.

D. All the above.

Question 2

Astronomers see that a star is wobbling due to a massive object orbiting around it. Due to this wobbling the star sometimes moves towards and away from Earth. As the star moves towards the Earth its spectral lines will be shifted

A. Towards the yellow end of the spectrum.

B. Towards the red end of the spectrum.

C. Towards the blue end of the spectrum.

D. There will be no spectral line shift.

Question 3

When light bends as it goes from one medium to another, this is known as

A. Absorption

B. Diffraction

C. Dispersion

D. Refraction

Question 4

The circumstellar habitable zone is defined as

A. The specific zone on an exoplanet in which life can arise.

B. The specific range of radii from a parent star in which a planet could sustain life.

C. The specific zone on an exoplanet in which water is in liquid form.

D. The specific range of radii from a parent star in which a planet could have liquid water.

Question 5

How is gravitational microlensing used to detect exoplanets?

A. If there is a galaxy directly behind a star it can use its gravitational field to focus the light from the galaxy. This focussing allows us to see a magnified image of the star and hence its exoplanet.

B. A star's strong gravitational field can be used to magnify the image of an exoplanet orbiting it. This can only happen when the planet is misaligned with the star.

C. A star's strong gravitational field can be used to magnify the image of an exoplanet orbiting it. This can only happen when the planet is perfectly aligned with the star.

D. If there is a star directly behind another star the one in front can use its gravitational field to act like a lens. If there is more lensing and distortions than expected, astronomers can determine if the closer star has an exoplanet.

Short Answer Questions

Question 6 (4 marks)

a. Explain how astronomers use the transit method to detect exoplanets and their size.

_____

_____

_____

_____

(2 marks)

b. The transit method does very well at determining certain properties of an exoplanet. What are two properties that can be determined?

_____

_____

_____

_____

(2 marks)

SECTION C – continued
TURN OVER

Question 7 (6 marks)

a. The radial velocity method utilises the fact that a star will wobble when something is orbiting it. Why does this wobbling occur? Make sure to reference the centre of mass.

(3 marks)

b. At one point in the stars wobble its velocity is perpendicular to the direction of viewing and hence its spectrum won't be Doppler shifted. One of the absorption lines is measured to be at 656.0 nm. Later in time the star now has a velocity parallel to the direction of viewing. The spectrum is now shifted, and the absorption line is measured to be 656.2 nm.

i. Is the star moving away or towards Earth?

(1 mark)

ii. What is the magnitude of the velocity of the star?

(2 mark)

SECTION C – continued

Question 8 (5 marks)

a. State what the Fermi paradox is and its conclusion.

_____

_____

_____

(2 mark)

b. What is a possible explanation of this apparent paradox?

_____

(1 mark)

c. The Drake equation is used to give us an estimate of the number of civilisations in the Milky Way galaxy. Find the number of civilisations in the Milky Way galaxy if: there is 1 star formed per year, 0.5 of those stars have planets, each star has 2 planets on which life can form, all of those will develop life, 0.5 will develop intelligent life, 0.1 of those will be able to communicate and the lifetime a civilisation will communicate is 10,000 years.

_____

_____

(2 marks)

Civilisations

SECTION C – continued

TURN OVER

SECTION C: OPTIONS

Instructions for SECTION C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.3: How do forces act on the human body?

Multiple Choice Questions (1 mark each)

Question 1

A person stands on the ground. The forces on their body mean that the person is under what kind of load?

A. Frictional forces.

B. Compression.

C. Tension.

D. Shear.

Question 2

Three objects are connected via a rod of negligible weight as shown in Figure 4 below. Determine the centre of mass.

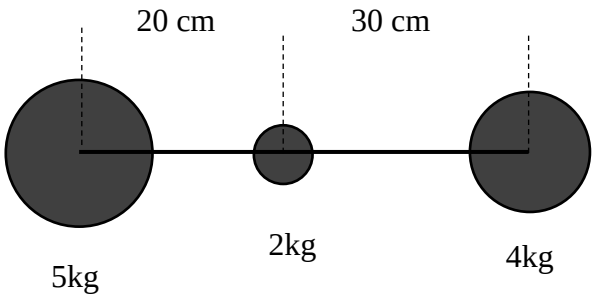


Figure 4

A. 20 cm to the right of the 5 kg object

B. 21.8 cm to the left of the 4 kg object.

C. At the centre of the 5 kg object.

D. 1.8 cm to the right of the 2 kg object.

SECTION C – continued

Question 3

Consider the bicep tendon, forearm and elbow joint as a lever. What is the most practical position along the forearm to attach the bicep tendon?

A. Some distance away from the elbow, more than halfway down the forearm.

B. As far from the elbow joint as possible.

C. At the elbow, the point of rotation.

D. Some distance away from the elbow, but no more than halfway down the forearm.

Question 4

A person bends their leg at their knee. The contracting of the hamstring muscle results in the heel being brought closer to the upper leg. What class of level is the knee, hamstring and lower leg system?

A. Class 1 lever.

B. Class 2 lever.

C. Class 3 lever.

D. Class 4 lever.

Question 5

A steel cable of radius 0.2 cm is used to hang an object that pulls down on the cable with 2 N of force. Determine the stress on the cable.

A. 1.59×10^5 N m^{-2}

B. 1.59×10^5 N

C. 15.9 N m^{-2}

D. 1.59 N m^{-2}

SECTION C – continued

TURN OVER

Short Answer Questions

Question 6 (15 marks)

The foot, tibia and Achilles tendon can be simplified down to a class 2 lever (see Figure 5.) Imagine a person standing on the edge of a step with their heel over hanging and the ball of their foot as the pivot point. (Note: the force vectors are only suggestive of direction, ignore their magnitude.)

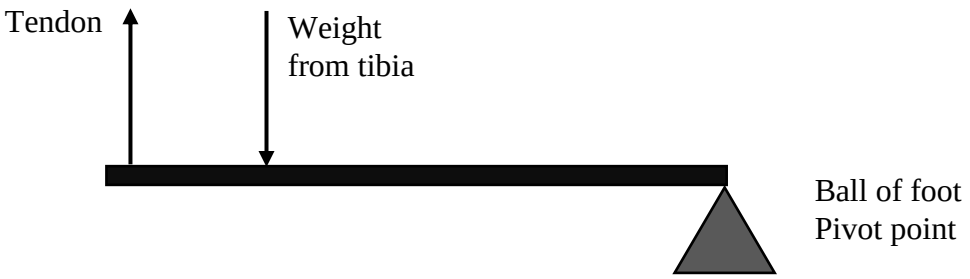


Figure 5

a. In Figure 5 label the two other parts of the lever: load and effort.

(2 marks)

b. What force does the tendon have to produce if the weight force is 550 N, the distance from the ball of the foot to the tibia (weight force) is 18 cm and the distance from the ball of the foot to the tendon is 23 cm. Assume the foot is not rotating or moving.

(3 marks)

N

SECTION C – continued

c. An Achilles tendon can be thought of as a long cylinder of radius 1.5 cm. Determine the stress on the tendon.

(2 marks)

N

d. The tensile strength of the Achilles tendon is 110 MPa. Is the stress from part c enough to rupture the tendon?

(1 mark)

e. The resting length of the Achilles tendon is 25.0 cm. Under a stress of 14 MPa the tendon stretches to 25.5 cm.

i. Determine the percentage strain on the tendon.

(2 marks)

%

ii. Determine Young's modulus.

(2 marks)

MPa

SECTION C – continued

TURN OVER

The stress vs. strain graph for the Achilles tendon is shown in Figure 6 below.

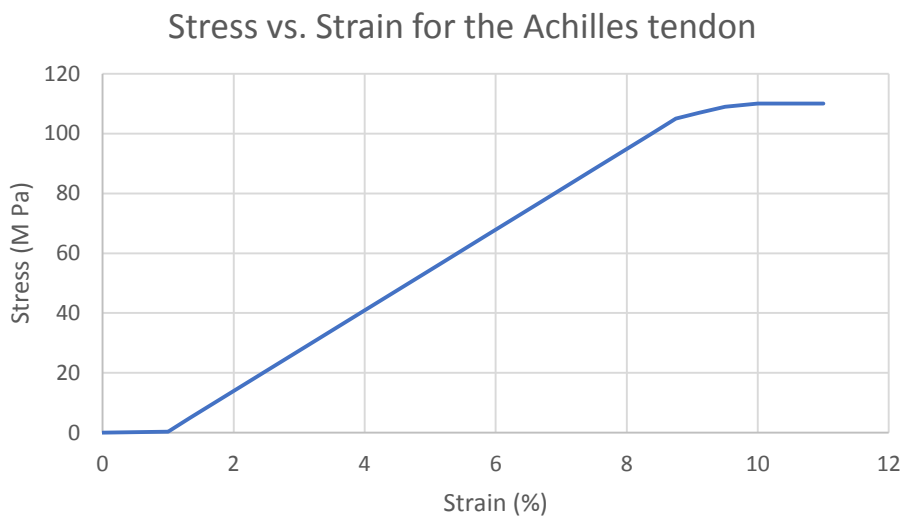


Figure 6

f. At what strain does the Achilles rupture?

(1 mark)

g. Determine after what strain the Achilles enters the plastic region. What does this imply?

(2 marks)

SECTION C – continued

SECTION C: OPTIONS

Instructions for Section C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.4: How can AC electricity charge a DC device?

Multiple Choice Questions (1 mark each)

The following applies to Questions 1 – 3

The voltage of an AC power supply was measured. Figure 7 below shows the results.

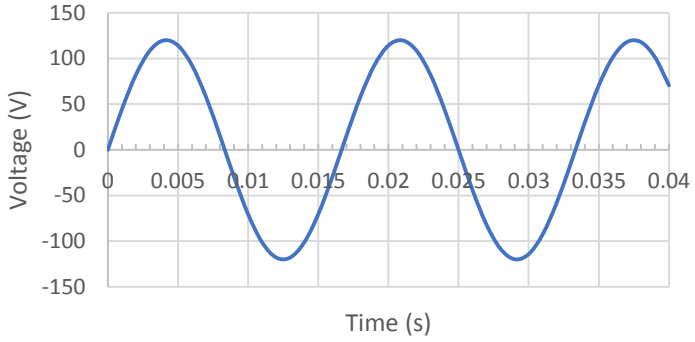


Figure 7

Question 1

The peak voltage of the AC power supply is closest to?

A. 240 V
B. 120 V
C. 230 V
D. 0.02 V

Question 2

The period of the AC power supply is closest to?

A. 0.017 s
B. 0.17 s
C. 0.0081 s
D. 0.081 s

Question 3

The frequency of the AC power supply is closest to?

A. 50 Hz

B. 60 Hz

C. 70 Hz

D. 80 Hz

Question 4

How are Zener diodes used to smooth DC voltage from a rectifier?

A. They are connected in the reverse direction to oppose any current flowing through them, this then has the effect of smoothing the voltage.

B. They are connected in the reverse direction, but contrary to normal diodes they have a breakdown region. This region allows the diode to operate at constant voltage and widely varying current, thus smoothing voltage across a load.

C. They are connected in the forward direction. This means that any ripples that have a reverse voltage are cancelled out and smoothed.

D. They are connected to the AC power supply to stop any current flowing when the voltage is negative. This is due to the fact that diodes only allow current to flow in one direction.

Question 5

A voltage of $120\ V_{rms}$ needs to be stepped down to $5\ V_{rms}$. How many turns are there in the primary coil for every turn in the secondary coil?

A. 12

B. 0.04

C. 600

D. 24

Short Answer Questions

Question 6 (9 marks)

Figure 8 shows the set up for a full-wave rectifier. The AC input supply is at a certain stage in its cycle where the polarity of the input is shown (see positive and negative terminals).

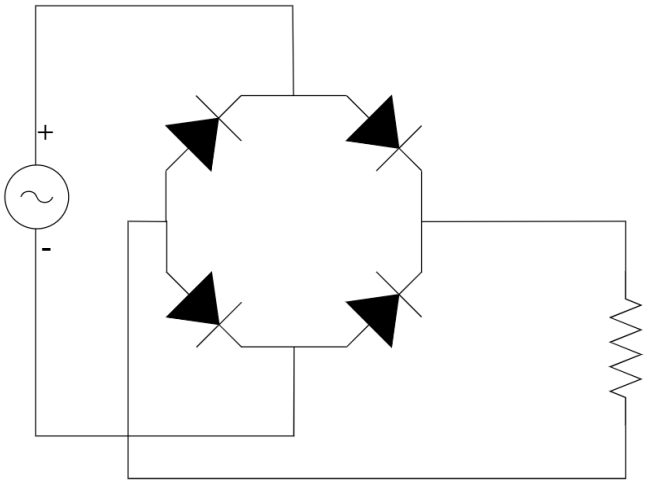
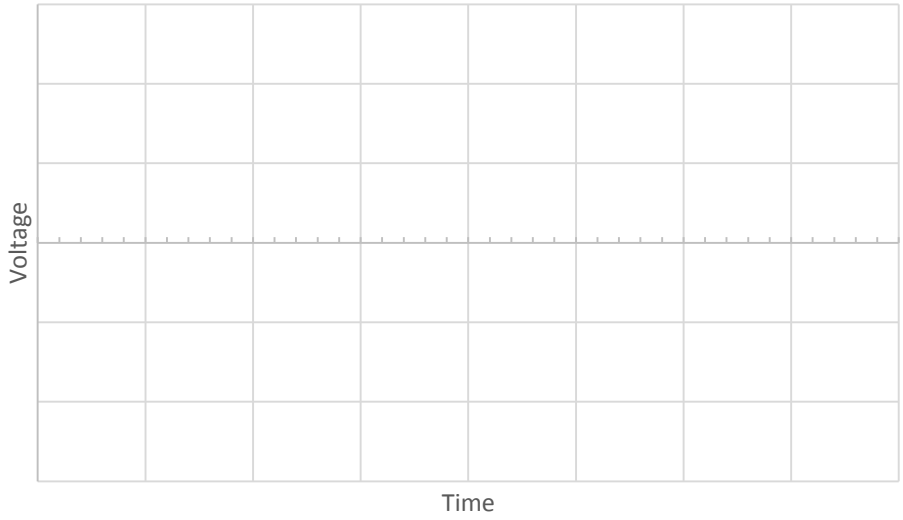


Figure 8

a. Clearly draw on the diagram the flow of current in the circuit at this stage in the AC cycle.

(1 mark)

b. On the axes below draw the output voltage across the resistor vs. time.



(2 marks)

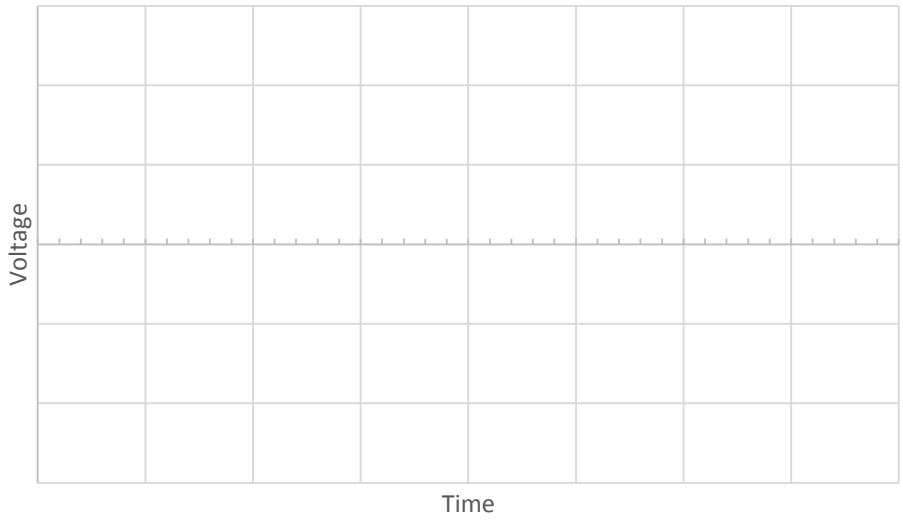
c. A capacitor can be used to smooth out the fluctuations of the output voltage. On figure 8 draw in where a capacitor should go.

(2 marks)

SECTION C – continued

TURN OVER

d. On the axes below draw the output voltage across the resistor vs. time after the capacitor has been included in the circuit.



(2 marks)

e. If the output voltage is 6 V DC, the resistor is 15 kΩ and the capacitor has a capacitance of 1.1 mF, find the time constant of this circuit.

_____

_____

_____

(2 marks)

s

SECTION C – continued

Question 7 (6 marks)

A circuit consists of a DC power supply at 10 V and two resistors as shown in Figure 9. R_1 is a variable resistor that depends on temperature and R_2 is a fixed at 5 kΩ. At 50°C the variable resistor is at 20 kΩ and at 40°C it is at 30 kΩ.

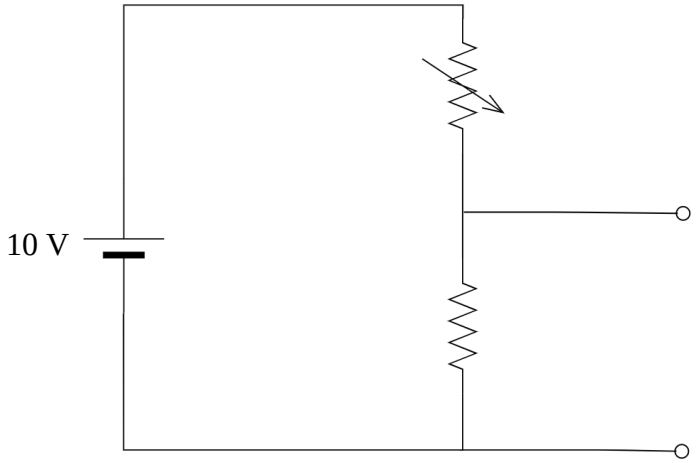


Figure 9

a. What is the current in the circuit when the temperature is 50 °C?

(2 marks)

A

b. Determine the output voltage, V_{out}.

(2 marks)

V

c. Give two appliances that would use a circuit like the one in figure 11.

(2 marks)

SECTION C – continued

TURN OVER

SECTION C: OPTIONS

Instructions for Section C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.5: How do heavy things fly?

Multiple Choice Questions (1 mark each)

Question 1

What is the weight force of a 40-ton Boeing 747?

A. 390 N

B. 40 N

C. 4.0×10^4 N

D. 3.9×10^5 N

Question 2

If an airplane was flying directly at you and it changed its pitch, what would this look like?

A. The nose of the plane would either move left or right.

B. The nose of the plane would either move up or down.

C. The nose of the plane would either rotate clockwise or anti-clockwise.

D. There is not enough information to determine this.

Question 3

What is form drag?

A. It is the aerodynamic resistance due to the contact of moving air with the surface of the aircraft.

B. The drag associated with the shape of an aircraft and the airflow around it.

C. As air-foils produce lift, they also produce drag, this is known as form drag.

D. The friction between two bodies that aren't moving.

SECTION C – continued

Question 4

What force opposes the lift force?

A. The drag force.

B. The weight force due to gravity.

C. The force generated by thrust.

D. The normal force.

Question 5

Water is pushed through a pipe with a diameter of 15 cm. At some point along the pipe the diameter constricts to 5 cm. In the 5 cm section it is true that

A. The velocity decreases and the pressure increases.

B. The velocity and pressure increase.

C. The velocity and pressure decrease.

D. The velocity increases and the pressure decreases.

Short Answer Questions

Question 6 (7 marks)

Imagine looking towards the front of a plane. Now consider, for simplicities sake, that the airplane wings are just a plank of wood balancing on a pivot at the halfway point as shown in Figure 10. At some point in the plane's flight it hits a patch of turbulence, which produces a force, F_T, of 5.2×10^3 N that acts 7 m from the centre of the plane. The pilot can move the aileron at the end of the opposite wing to counter-act this force by applying its own force, F_A.

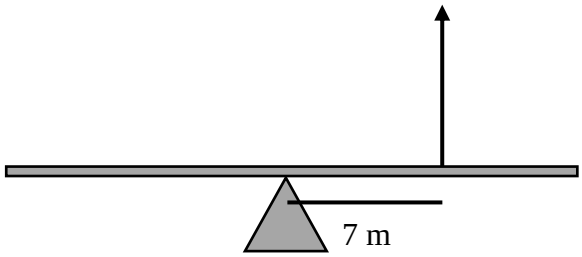


Figure 10

a. On the diagram above draw in the force F_A.

(2 marks)

b. If the wingspan of the plane is 24 m, determine how far from the pivot point F_A is applied.

_____

(1 mark)

m

c. Find the magnitude of F_A if the pilot is to keep the plane balanced.

_____

_____

_____

(2 marks)

N

SECTION C – continued

d. Thrust is one of the four forces acting on a plane if it wants to fly. With reference to Newton's laws of motion how is this possible?

_____

_____

_____

_____

_____

_____

(2 marks)

Question 7 (8 marks)

Airfoils are used to create lift when flying different types of aircraft. The typical cross section of an airfoil on an airplane will look something like the one below in Figure 11.

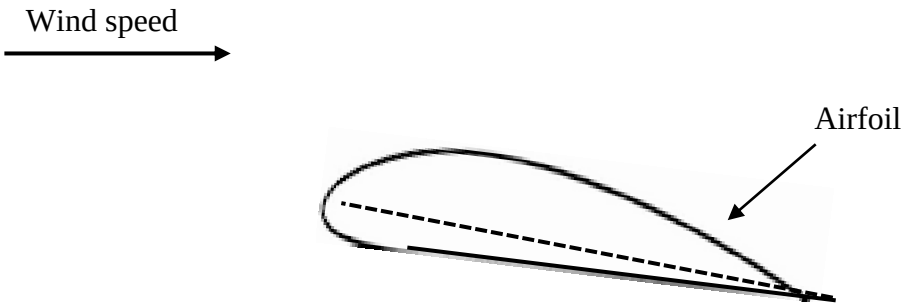


Figure 11

a. On Figure 11 draw in 6 streamlines around the airfoil (3 above and 3 below).

(2 marks)

SECTION C – continued

TURN OVER

b. Using the diagram invoke Bernoulli's principle to explain how lift is created.

_____

_____

_____

_____

_____

(3 marks)

A common stunt pilots can achieve is flying upside down. With the airplane upside down, the airfoil cross section is inverted, as shown in Figure 12. A naïve assumption would be that Bernoulli's principle breaks down here as the air foil is designed asymmetrically to perform the right way up.

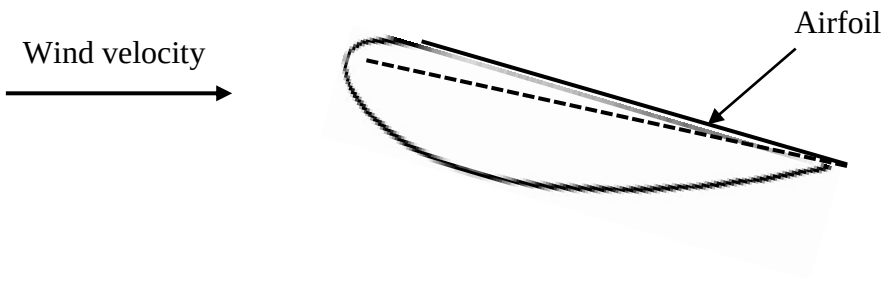


Figure 12

c. Define what is meant by angle of attack.

_____

_____

(1 marks)

SECTION C – continued

d. Explain how upside-down flight can still be achieved and if there would be any effect on lift.

_____

_____

_____

_____

(2 marks)

SECTION C – continued

TURN OVER

SECTION C: OPTIONS

Instructions for Section C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.6: How do fusion and fission compare as viable nuclear energy power sources?

Multiple Choice Questions (1 mark each)

Question 1

Why is the neutron better at being absorbed into a nucleus than other particles like alpha particles and protons?

A. It has a higher mass.

B. It is neutrally charged.

C. It has a lower mass.

D. It is massless.

Question 2

The purpose of a moderator in a nuclear reactor is?

A. To increase the percentage of uranium-238.

B. To absorb neutrons to control the reaction.

C. To slow down neutrons so that they can be absorbed more easily.

D. To change the shape of the uranium fuel.

Question 3

Which of the following isotopes of uranium is responsible for creating the chain reaction in a nuclear core?

A. Uranium-235

B. Uranium-238

C. Uranium-239

D. Uranium-240

SECTION C – continued

Question 4

What is not a limiting factor when creating a fusion reactor?

A. The amount of practical ways in which you can fuse different isotopes of hydrogen to form helium and produce energy.

B. The temperature you need to start the fusion reaction.

C. The abundance of tritium.

D. The abundance of deuterium.

Question 5

Where does the energy that is released in a nuclear fusion reaction come from?

A. The entire mass of a hydrogen atom is converted into pure energy according to $E = mc^2$.

B. The combined mass of the reactants is less than the combined mass of the products.

C. When a hydrogen atom absorbs a neutron a gamma ray is release as energy.

D. The combined mass of the reactants is greater than the combined mass of the products.

Short Answer Questions

Question 6 (6 marks)

When uranium-235 undergoes nuclear fission as it absorbs a neutron it can decay into many different pairs of products (if the atomic weight is conserved).

a. A possible reaction uranium-235 can undergo is shown below. Determine what Y and X are.

$$n + {}^{235}_{92}U \rightarrow {}^{95}_{38}Sr + {}^{139}_{Y}X + 2n$$

Y =	X =

(2 marks)

In all of uranium-235's reactions it produces more neutrons, which can then be used in the next reaction, and so on.

b. For the reaction to continue the next uranium-235 must be able to absorb the neutron. Why is it so hard for the next neutron to be absorbed?

_____

_____

_____

(1 mark)

c. What are three properties of the uranium rod that need to be considered if the chain reaction is to reach a supercritical level?

_____

_____

_____

(3 marks)

SECTION C – continued

Question 7 (3 marks)

Fast breeder reactors don't require the use of the rarer uranium-235 and opt for the much more abundant uranium-238. The reaction that takes place in fast breeder reactors, is as follows.

$$n + {}^{238}_{92}U \rightarrow {}^{239}_{92}U + \gamma$$

$${}^{239}_{92}U \rightarrow {}^{239}X + \beta^-$$

$${}^{239}X \rightarrow {}^{239}Y + \beta^-$$

a. Determine the elements X and Y.

X =	Y =

(2 marks)

b. Fast breeder reactors not only create energy, they also create something else that is usable?

_____

(1 mark)

Question 8 (6 marks)

Fusion reactors will form helium through a different set of reactions than those that happen in the sun. There are three reactions that are practical for a fusion reactor.

(1) ${}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{1}H + Energy$

(2) ${}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + X + Energy$

(3) ${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + n + Energy$

a. Determine what X is in equation 2.

(1 mark)

X =

SECTION C – continued

TURN OVER

b. In each of these reactions, energy is produced according to $E = mc^2$. Where does this energy go?

_____

_____

_____

(2 marks)

c. Given that the amount of energy released in reaction 2 is 3.27 MeV determine the difference in mass between the reactants and products.

_____

_____

_____

_____

(3 marks)

	kg

SECTION C – continued

SECTION C: OPTIONS

Instructions for Section C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.7: How is radiation used to maintain human health?

Multiple Choice Questions (1 mark each)

Question 1

Which of the following is ionizing radiation?

A. Microwaves
B. Blue light
C. Radio waves
D. Gamma rays

Question 2

A positron emission tomography (PET) scan directly detects what type of radiation?

A. Positrons
B. Electrons
C. Gamma rays
D. Alpha particles

Question 3

Cobalt-60 is commonly used to treat cancer. What is the process by which it is manufactured?

A. $n + {}^{59}_{27}Co \rightarrow {}^{60}_{27}Co + \beta^-$

B. $n + {}^{59}_{27}Co \rightarrow {}^{60}_{27}Co$

C. $n + {}^{59}_{27}Co \rightarrow {}^{60}_{26}Co + \beta^-$

D. It is already found to be naturally occurring in abundance.

Question 4

A 10 Sv dose of radiation is applied to a tumour of mass 25 g. If the radiation source emits alpha particles how much energy is delivered to the tumour?

A. 250 J

B. 13 J

C. .25 J

D. 0.013 J

Question 5

A person receives a 20 mSv dose of radiation to both their bladder and colon, and a 15 mSv dose to their liver. Calculate their effective dose if the weighting of the bladder is 0.05, the colon is 0.12 and the liver is 0.05

A. 4.2×10^{-3} Sv

B. 4.2 Sv

C. 35×10^{-3} Sv

D. 35 Sv

SECTION C – continued

Short Answer Questions

Question 6 (5 marks)

a. What does MRI stand for?

_____

(1 mark)

b. Explain how an MRI machine images the human body?

_____

_____

_____

_____

_____

_____

(3 marks)

c. Why is MRI imaging safer than X-ray imaging?

_____

(1 mark)

SECTION C – continued
TURN OVER

Question 7 (4 marks)

Radioactive tracers are used on patients for many different treatments. Phosphorus-32 in particular is used to identify and treat malignant tumours. Phosphorus-32 decays according to the following equation.

$$^{32}_{15}\mathrm{P} \rightarrow {}^{32}_{16}\mathrm{S} + \mathrm{X} + \upsilon_e$$

a. Determine what type of radiation X represents in the above equation.

_____

(1 mark)

b. Phosphates tend to build up around tumours. How could phosphorus-32 be used to treat cancerous tumours?

_____

_____

_____

(2 marks)

c. What is a radiopharmaceutical?

_____

_____

(1 mark)

Question 8 (6 marks)

a. Hard X-rays are used for the treatment of cancerous cells. What makes them better at treatment than soft X-rays?

_____

(1 mark)

SECTION C – continued

b. A 100 g tumour is treated with X-ray radiation therapy and absorbs 56 J of energy. Determine the dose equivalent of this treatment.

_____

_____

_____

(2 marks)

Sv

c. How are X-rays produced for imaging techniques?

_____

_____

_____

_____

_____

(3 marks)

SECTION C – continued

TURN OVER

SECTION C: OPTIONS

Instructions for Section C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.8: How do particle accelerators work?

Multiple Choice Questions (1 mark each)

Question 1

Particle accelerators can only accelerate

A. Charged particles
B. Neutral particles
C. Electrons
D. Massless particles

Question 2

After electrons are ejected from the electron gun in the LINAC section of the Australian Synchrotron what happens to them?

A. Strong potential differences accelerate them
B. Strong magnetic fields accelerate them
C. Complex magnetic fields focus them
D. High frequency RF waves accelerate them

SECTION C – continued

Question 3

Both a cyclotron and synchrotron are circular in nature. What differentiates the two?

A. Synchrotrons are just large-scale versions of cyclotrons, requiring a different way of engineering due to the size

B. Synchrotrons synchronously increase the magnetic field strength as the particles increase their speed

C. Cyclotrons are known as particle colliders, whilst synchrotrons are primarily used for just accelerating particles

D. Cyclotrons accelerate different particles to a synchrotron.

Question 4

The first proper particle accelerator was built in 1932 by Ernest Lawrence. In 2008 the Large Hadron Collider was built. Approximately how many more times more powerful is the LHC compared to the one built in 1932?

A. A million times more powerful

B. A hundred million times more powerful

C. A billion times more powerful

D. A hundred billion times more powerful

Question 5

The Australian Synchrotron can accelerate electrons up to energies of 3.0 GeV. What is this in joules?

A. 4.8×10^{-10} J

B. 4.8×10^{-13} J

C. 3.0×10^{-18} J

D. 3.0×10^{-10} J

SECTION C – continued

TURN OVER

Short Answer Questions

Question 6 (6 marks)

Electrons go through many stages whilst being accelerated in the Australian Synchrotron.

a. At the beginning of the process electrons are accelerated through a potential difference of 100 kV. Determine the amount of energy an electron gains across this potential.

(2 marks)

J

Within the booster ring electrons are accelerated to energies of 3.0 GeV and then delivered to the storage ring.

b. Within the storage ring there are many kinds of magnets. Describe two ways in which the magnets are used.

(2 marks)

c. Describe how synchrotron light is produced at each beamline.

_____

_____

_____

(2 marks)

Question 7 (6 marks)

The Large Hadron Collider (LHC) is a 27-kilometre underground ring that sits on the border of Switzerland and France.

a. What is the primary function of the LHC?

_____

(1 mark)

b. What is the name of the most commonly accelerated particle used in the LHC and how is it prepared?

_____

_____

_____

(2 marks)

c. Name three of the detectors at the LHC.

_____

_____

_____

(3 marks)

SECTION C – continued

TURN OVER

Question 8 (3 marks)

Particle accelerators are not just about investigating cutting edge theoretical physics. They have and will continue to have widespread practical uses. Name three practical applications of particle accelerators.

_____

_____

_____

(3 marks)

SECTION C – continued

SECTION C: OPTIONS

Instructions for Section C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.9: How can human vision be enhanced?

Multiple Choice Questions (1 mark each)

Question 1

A ray of light travelling through a medium, $n_1 = 1.2$, is incident on a second medium, $n_2 = 1.4$, at some angle, $0° < \theta < 90°$. Which of the following is true?

A. The light will diffract as it travels from n_1 to n_2. The ray of light will bend towards the normal.

B. The light will refract as it travels from n_1 to n_2. The ray of light will bend towards the normal.

C. The light will refract as it travels from n_1 to n_2. The ray of light will bend away from the normal.

D. The light will diffract as it travels from n_1 to n_2. The ray of light will bend away from the normal.

Question 2

When studying convex and concave lenses what does it mean for an image to be virtual?

A. A virtual image can't be seen through a lens.

B. A screen placed at the image location would show a well-defined image.

C. A screen placed at the image location would show nothing.

D. The image is created digitally, usually by a computer.

Question 3

The objective lens of a refracting telescope has a focal length of 100 cm and the eyepiece has a focal length of 3.5 cm. Determine the length of the telescope.

A. -3.38 cm

B. 3.38 cm

C. 28.6 cm

D. 103.5 cm

Question 4

If a light ray passes from air ($n_1 = 1.00$) to Perspex ($n_2 = 1.50$) at an angle of incidence of $50°$, what is the angle of reflection?

A. $50°$

B. $40°$

C. $31°$

D. $60°$

Question 5

An object is far away from an eye. The image produced at the back of the retina will be

A. Inverted

B. Upright

C. Always that same size as the object

D. Virtual

Short Answer Questions

Question 6 (6 marks)

The human eye is very similar to a camera, it can redirect light onto the retina (sensor) by using the cornea and lens (which both act similar to a convex lens).

a. The cornea and lens help to focus light on the back of the eye, but some people suffer from long sightedness and others from short sightedness.

i. For short sightedness, when looking at distance objects, determine whether the eye can focus the image in front of the retina, on the retina, or behind the retina.

_____

(1 mark)

ii. For long sightedness, when looking at close objects, determine whether the eye can focus the image in front of the retina, on the retina, or behind the retina.

_____

(1 mark)

b. Explain the difference between a lens used to correct for long sightedness and a lens used to correct for short sightedness. Be sure to include key words such as: convex, concave, diverge and converge.

_____

_____

_____

_____

(4 marks)

Question 7 (7 marks)

Light rays from a distant object are incident on a **convex** lens, these rays converge 15 cm away on the other side of the lens.

a. What is the focal length of the convex lens?

_____

(1 mark)

SECTION C – continued

TURN OVER

b. If a screen was placed at the point of convergence, will a real image be produced?

_____

(1 mark)

An object with a height of 8 cm is placed 25 cm to the left of the lens.

c. What side of the lens does an image form?

_____

(1 mark)

d. How far away does the image form from the lens?

_____

(2 marks)

cm

e. By what magnification factor does the size of the object increase?

_____

(2 marks)

Question 8 (2 marks)

Two convex lenses are used to create a telescope. The objective lens has a focal length of 150 cm and the eyepiece lens has a focal length of 2 cm. Determine the magnifying power of the telescope.

_____

_____

(2 marks)

SECTION C – continued

SECTION C: OPTIONS

Instructions for Section C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.10: How do instruments make music?

Multiple Choice Questions (1 mark each)

Question 1

What is a longitudinal pressure wave?

A. A wave that oscillates the medium perpendicular to the direction of energy flow.

B. A wave that oscillates the medium in the same direction as the flow of energy.

C. A wave that has oscillating magnetic and electric fields.

D. A wave that oscillates back and forth in the same position inside the chamber of an instrument.

Question 2

A sound wave travelling through air has a speed of $330\ m\ s^{-1}$ and a frequency of 200 Hz. Find its wavelength.

A. 1.65 m

B. 20 m

C. 165 m

D. 0.60 m

Question 3

A pencil is dropped on the floor and it makes a sound by vibrating at its natural frequency. Which of the follow factors *do not* affect the natural frequency of the pencil?

A. The height at which the pencil is dropped.

B. The length of the pencil.

C. The material the pencil is made from.

D. The speed at which sound can propagate through the pencil.

Question 4

A tuba produces a frequency of 800 Hz. Determine the length of time the wave takes to complete a full cycle when oscillating.

A. 800 s

B. 800 cycles per second

C. 0.0013 s

D. 0.13 s

Question 5

Why do all musical instruments (including the human voice) sound different when playing the same frequency at the same volume?

A. All instruments have a different pitch. In addition to the fundamental frequency of the note, there is a unique set of other frequencies superposed in the waveform.

B. All instruments have a different timbre. All instruments have a different natural frequency, and thus will vibrate at a different fundamental frequency when played.

C. All instruments have a different timbre. In addition to the fundamental frequency of the note, there is a unique set of other frequencies superposed in the waveform.

D. All instruments have a different pitch. All instruments have a different natural frequency, and thus will vibrate at a different fundamental frequency when played.

Short Answer Questions

Question 6 (7 marks)

A particular string on a guitar has the properties such that the speed of sound travelling through it is 430 m s^{-1}. When plucked its fundamental frequency is 300 Hz.

a. Determine the length of the string.

(3 marks)

m

b. Draw the fundamental mode of vibration for a guitar string fixed at both ends.

(1 mark)

c. All musical notes are a superposition of the all the harmonics, with the fundamental frequency being the most dominant. In the same diagram as **a** draw in the 2nd harmonic with an appropriate amplitude.

(2 marks)

SECTION C – continued

TURN OVER

d. What is the frequency of the 2nd harmonic?

(1 mark)

Hz

Question 7 (6 marks)

A jack hammer produces 0.13 W of power.

a. What is the sound intensity 1 m from the jack hammer?

(2 marks)

b. What is the sound intensity *level* 1 m from the jack hammer?

(2 marks)

dB

c. What is the sound intensity *level* of the jack hammer at 100 m.

_____

_____

_____

_____

(2 marks)

dB

Question 8 (2 marks)

One end of a string is attached to a pole and the other end is oscillated up and down by a machine. What happens when the string is oscillated at integer multiples of the fundamental frequency of the string?

_____

_____

_____

(2 marks)

SECTION C – continued
TURN OVER

SECTION C: OPTIONS

Instructions for Section C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.11: How can performance in ball sports be improved?

Multiple Choice Questions (1 mark each)

Question 1

A basketball drops from the ring 3 m above the ground. It bounces back to a height of 1.2 m. Determine the coefficient of restitution between the ground and the ball.

A. 0.4

B. 1.2

C. 0.63

D. 2.5

Question 2

A bowling ball of mass 1.5 kg is bowled towards a stationary pin of mass 1.2 kg, at 9.0 m s^{-1}. The bowling balls final velocity is 5.0 m s^{-1} in the same direction. What is the velocity of the pin?

A. 5.0 m s^{-2} in the same direction as the ball.

B. 5.0 m s^{-2} in the opposite direction as the ball.

C. 9.0 m s^{-2} in the opposite direction as the ball.

D. 9.0 m s^{-2} in the same direction as the ball.

Question 3

A soccer ball is kicked up and to the right at an angle for 30° to the ground. Ignoring air resistance, which of the following is not true.

A. At the maximum height of the balls motion the vertical velocity is 0 m s^{-1}.

B. At the maximum height of the balls motion the acceleration is -9.8 m s^{-1}.

C. The horizontal velocity decreases.

D. The horizontal velocity stays constant.

Question 4

A ball rolls along the ground with a velocity of 5 m s^{-1} to the right. The part of the ball that is in contact with the ground

A. Is moving at 5 m s^{-1} to the right relative to the ground.

B. Is not moving relative to the centre of the ball.

C. Is moving at 5 m s^{-1} to the left relative to the ground.

D. Is moving at 0 m s^{-1} relative to the ground.

Question 5

A ball with a diameter of 10 cm is spinning with an angular frequency of 25 rad s^{-1}. Determine the velocity of the outer spinning edge of the ball.

A. $v = 1.3$ m s^{-1}

B. $v = 2.5$ m s^{-1}

C. $v = 250$ m s^{-1}

D. $v = 1.2$ m s^{-1}

Short Answer Questions

Question 6 (7 marks)

a. The shape of an object is important when it is moving through the air. It is known that golf balls have dimples on their surface. How do the dimples on a golf ball affect its flight through the air?

_____

_____

_____

_____

(2 marks)

b. A golf ball is hit, and at different stages of its flight its velocity changes due to both gravity and air resistance. At one point the golf ball has a velocity of $v_1 = 300$ km h^{-1}, and at a later stage its velocity is $v_2 = 100$ km h^{-1}. Determine the ratio of drag force between the two stages, $\frac{F_{D1}}{F_{D2}}$.

_____

_____

_____

_____

(2 marks)

c. A golf ball is hit off the tee in such a way that it starts to spin backwards as shown in Figure 13. The ball will start to deviate from its original trajectory according to the Magnus effect. Determine the direction of the force produced and explain how it is accomplished.

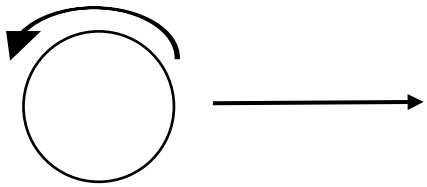


Figure 13

(3 marks)

SECTION C – continued

TURN OVER

Question 7 (8 marks)

A tennis ball is hit up and to the right at an angle of 35 ° to the ground with an initial velocity of 15 m s^{-1} as shown in Figure 14. Assume that the ball is hit at ground level. Ignore air resistance.

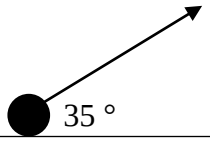


Figure 14

a. Determine the time it takes for the ball to hit the ground.

(3 marks)

b. How far horizontally does the ball travel?

m

(2 marks)

SECTION C – continued

c. A force was applied to the tennis ball by a tennis racket to accelerate it from rest to $15\ \text{m s}^{-1}$. If the mass of the ball is 0.055 kg and the collision time was 0.02 s. Find the magnitude of the force applied to the ball.

_____

_____

_____

_____

(2 marks)

N

d. What magnitude of force does the tennis ball apply on the tennis racket?

_____

(1 mark)

N

SECTION C – continued

TURN OVER

SECTION C: Options

Instructions for Section C

Select **ONE** Option and answer **all** questions within that option in the spaces provided.

Option 2.12: How does the human body use electricity?

Multiple Choice Questions (1 mark each)

Question 1

Which of the following charged particles is not responsible for carrying electrical signals throughout the human body?

A. Electron.

B. Potassium ion.

C. Calcium ion.

D. Chlorine ion.

Question 2)

When one neuron communicates with another neuron, where does this occur?

A. Dendrite

B. Axon

C. Synapse

D. Action potential

Question 3

If positive ions are allowed to flow into the post synaptic cell, this would be called?

A. Action potential.

B. Repolarisation.

C. Hyperpolarisation.

D. Depolarisation.

SECTION C – continued

Question 4

Why is there a delay between the atrial contraction and ventricular contraction in the heart?

A. To allow enough time for the heart to fill up with blood.

B. To allow enough time for the aorta to fill up with blood.

C. So that the heart gets to rests in between cycles.

D. People who have a delay between these contractions usually require a heart pacemaker.

Question 5

What is fibrillation?

A. A treatment for irregular and potentially life-threatening heart rhythms.

B. An irregular heart rhythm.

C. A treatment for when a heart ceases to produce any electrical activity.

D. When a capacitor is at maximum charge.

TURN OVER

Short Answer Questions

Question 6 (7 marks)

When the human body is subjected to external electric current severe injuries or death could occur. The human body can be modelled as a simple circuit as shown in Figure 15.

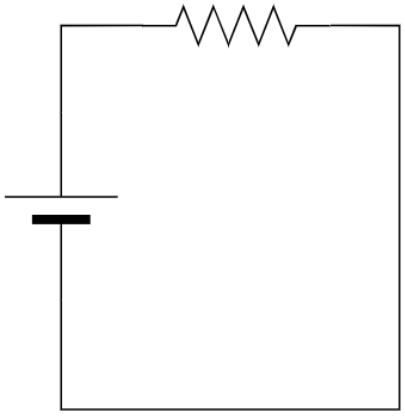


Figure 15

a. An electrician touches a live wire and electric current flows from his hand to his foot. If the potential difference of the wire is 240 V and the resistance of the electrician is 5 kΩ, determine the current.

(2 marks)

A

b. How much energy is dissipated as heat to the body if the duration of the current is 0.5 s.

(2 marks)

J

SECTION C – continued

c. If this current was felt for half a second what effect would this have on the body? Choose one of the following: Easily felt, painful, muscle paralysis, severe shock, breathing trouble, death.

_____

(1 mark)

d. If the electrician was wearing thick rubber soled shoes, which would act as a second 100 kΩ resistor in the series circuit above, determine the current flowing through the electrician.

_____

_____

(2 marks)

A

Question 7 (6 marks)

In some cases, applying a voltage across a human body can save a human life. A defibrillator seeks to pass an external current through the heart.

a. What is the function of passing an external current through the heart?

_____

_____

_____

_____

_____

_____

_____

_____

(4 marks)

SECTION C – continued

TURN OVER

b. To create a high enough current the defibrillator must discharge its current in a short amount of time. A defibrillator was used, and the time constant was measured to be 15 ms and the resistance of the circuit was 20 kΩ. Determine the capacitor's capacitance.

_____

_____

_____

(2 marks)

Question 8 (2 marks)

What does ECG stand for and what is its function?

_____

_____

_____

END OF QUESTION AND ANSWER BOOK

Formula and Data Sheet

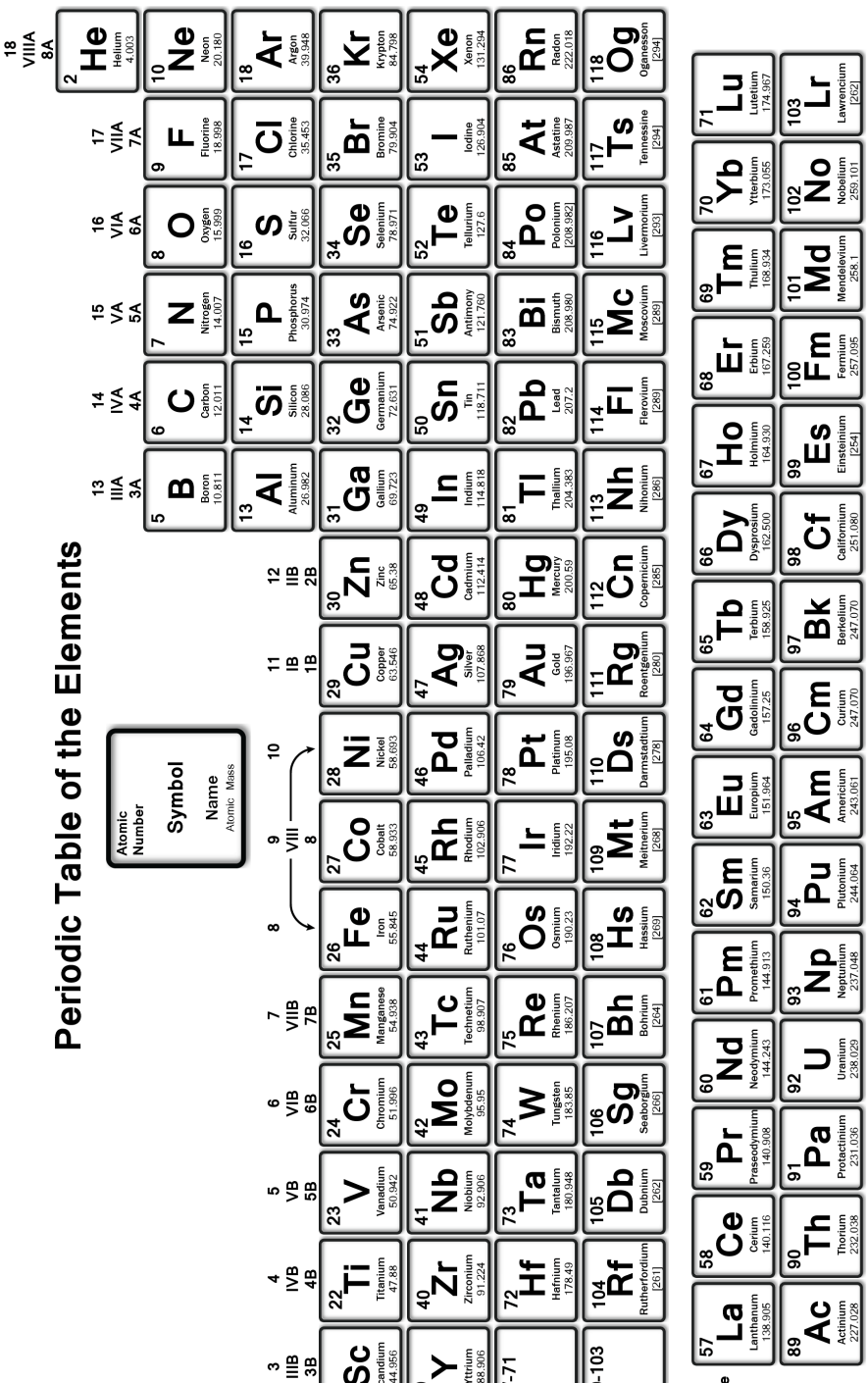
Velocity; acceleration	$v = \frac{\Delta s}{\Delta t};\ a = \frac{\Delta v}{\Delta t}$
Equations for constant acceleration	$s = ut + \frac{1}{2}at^2$ $s = vt - \frac{1}{2}at^2$ $s = \frac{1}{2}(u+v)t$ $v = u + at$ $v^2 = u^2 + 2as$
Newton's second law	$a = \frac{F_{net}}{m}$
Torque	$\tau = r_{\perp}F$
Gravitational potential energy changes near the surface of the Earth	$E_g = mg\Delta h$
Force in springs	$F = -k\Delta x$
Elastic potential energy	$E_s = \frac{1}{2}k\Delta x^2$
Kinetic energy	$E_k = \frac{1}{2}mv^2$
Mechanical work	$W = Fd$
Efficiency of energy transfer	$\eta = \frac{\text{useful energy out}}{\text{total energy in}}$
Power	$P = \frac{W}{t}$
Momentum; impulse	$p = m\Delta v;\ I = F\Delta t$
Gravitational field strength near the surface of the Earth	$g = 9.8\ \text{N kg}^{-1}$
Electric power	$V = IR;\quad P = VI$

Speed of light	$c = 3.0 \times 10^8 \text{ m s}^{-1}$
Wave speed	$v = f\lambda$
Doppler shift	$\frac{\Delta\lambda}{\lambda_0} = \frac{v}{c}$
Mass-energy equation	$E = mc^2$
Centre of mass	$x_m = \frac{x_1 m_1 + x_2 m_2 + ... + x_n m_n}{m_1 + m_2 + ... + m_n}$
Stress	$\sigma = \frac{F}{A}$
Strain	$\varepsilon = \frac{\Delta L}{L}$
Young's modulus	$E = \frac{\sigma}{\varepsilon}$
Transformer	$\frac{N_1}{N_2} = \frac{V_1}{V_2}$
Time constant	$\tau = RC$
Capacitance	$C = \frac{Q}{V}$
Bernoulli's equation	$P_1 + \rho v_1^2 A = P_2 + \rho v_2^2 A$
Lift	$F_L = \frac{1}{2} C_L \rho v^2 A$
Drag	$F_D = \frac{1}{2} C_D \rho v^2 A$
Power	$P = Fv$
Electron volt	$1 \text{ eV} = 1.602\,176 \times 10^{-19} \text{ J}$
Absorbed dose	$\text{absorbed dose} = \frac{\text{energy absorbed}}{\text{mass}}$
Equivalent dose	$\text{equivalent dose} = \text{absorbed dose} \times \text{quality factor}$
Snell's law	$n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$

Image position	$\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$
Image size	$\frac{H_i}{H_o}=\frac{v}{u}$
Sound intensity	$I=\frac{P}{4\pi d^2}$
Sound intensity level	$L=10\log_{10}\left(\frac{I}{1\times10^{-12}}\right)$
Coefficient of restitution	$e=\frac{v-V}{U-u}$
Linear and angular speed	$v=r\omega$
Rolling friction	$F_k=\mu N$

Prefixes/Units

$\text{p} = \text{pico} = 10^{-12}$	$\text{n} = \text{nano} = 10^{-9}$	$\mu = \text{micro} = 10^{-6}$	$\text{m} = \text{milli} = 10^{-3}$
$\text{k} = \text{kilo} = 10^{3}$	$\text{M} = \text{mega} = 10^{6}$	$\text{G} = \text{giga} = 10^{9}$	$\text{t} = \text{tonne} = 10^{3}\ \text{kg}$


Periodic Table of the Elements
Atomic Number
Symbol
Name
Atomic Mass
Lanthanide Series
Actinide Series