itute.com

Online & home tutors **Registered business name: itute ABN: 96 297 924 083**

PHYSICS

2020

Trial Examination

(2 hours 30 minutes)

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	14	14	110
			Total 130

(Note: Use the formula/data sheets supplied by VCAA)

SECTION A –20 Multiple-choice questions (20 marks)

Instructions for Section A
Answer **all** questions in this section.
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, the diagrams are **not** drawn to scale.
Take the value of g to be 9.80 N kg $^{-1}$.

Question 1
Two large parallel conducting plates have a constant potential difference of 24 volts.
Which one of the following statements is **NOT** correct?

A. The electric field between the two plates away from the plate edges is uniform.

B. The electric field between the two plates away from the plate edges is static.

C. The electric field strength between the two plates increases with distance from the plate at low potential.

D. The electric field strength between the two plates decreases when the separation between them increases.

Question 2
Two different masses (consider each as a point mass) are 10 m apart.
Which one of the following statements about the gravitational field due to the two point masses is **NOT** correct?

A. The gravitational field can be zero.

B. The gravitational field always points towards one of the point masses.

C. The gravitational field can be perpendicular to the line joining the two point masses.

D. The gravitational field strength at a far away point (say 1 km away from each mass) is proportional to the sum of the two masses approximately.

Question 3
Electric current flows in the same direction in each of two parallel copper wires.
The two wires are 0.5 cm apart and the currents are 5A and 10A.
Which one of the following statements is correct?

A. A possible magnetic field line is a loop around the two wires.

B. The two wires repel each other.

C. The force on the wire with a 10A current is double the force on the wire with a 5A current.

D. The force on the wire with a 5A current is double the force on the wire with a 10A current.

Question 4
Which one of the following statements is correct when a negatively charged particle moves away from another negatively charged particle to infinity?

A. Electric potential energy increases.

B. Electric potential energy increases to infinity.

C. Electric potential energy decreases to zero.

D. Electric potential energy remains constant.

Question 5
An electron moves at constant velocity in a region with only uniform magnetic field and uniform electric field.
Which one of the following statements is correct?

A. Both fields are in the same direction

B. The two fields are in opposite directions

C. The two fields make a right angle

D. The two fields make an acute angle

Question 6
A carriage moves along a circular track of a rollercoaster in a vertical plane. The moving carriage is upside-down at the highest point of the track.
Which one of the following statements describes an **impossible** situation?

A. All riders in the carriage feel weightless.

B. All riders in the carriage have zero acceleration.

C. All riders in the carriage experience an upward reaction force.

D. All riders in the carriage experience a downward reaction force.

Question 7
Satellites P and Q are geostationary satellites.
Which of the following statements is **always** true?

A. Satellite P will collide with Satellite Q, or Satellite Q will collide with Satellite P.

B. Both satellites experience the same force of gravity.

C. Satellites P and Q move at the same velocity at any time.

D. Satellites P and Q accelerate towards the centre of Earth and are in free fall.

Question 8
A crate slides down an inclined plane at constant velocity.
Which one of the following statements is **NOT** correct?

A. The net force exerted by the crate on the inclined plane is vertically downwards.

B. The net force exerted by the inclined plane on the crate is vertically upwards.

C. The reaction force of the inclined plane on the crate is vertically upwards.

D. The weight of the crate is greater than the reaction force of the inclined plane on the crate in magnitude.

Question 9
A student measures the distance travelled by a bicycle as 52.68 ± 0.02 m and the time taken as 28.5 ± 0.5 s.
The calculated average speed (in m s^{-1}) of the bicycle is

A. 1.8 ± 0.1

B. 1.85 ± 0.03

C. 1.85 ± 0.04

D. 1.848 ± 0.033

Question 10
The kinetic energy (in joules) of an electron travelling at 1.5×10^{8} m s^{-1} is closest to

A. 1.0×10^{-14}

B. 1.3×10^{-14}

C. 1.5×10^{-14}

D. 2.5×10^{-14}

Question 11
A standing wave is formed in a string fixed at one end. The frequency of the standing wave is 6 Hz.
If the condition of the string remains the same, another possible standing wave has a frequency (in Hz) of

A. 2

B. 3

C. 8

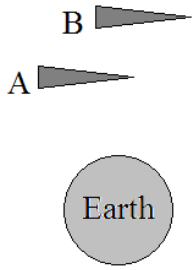
D. 12

Question 12

A and B are two identical spacecrafts. An observer on Earth measured the speed of A as $v_A = 0.5c$ and the speed of B as $v_B = 0.7c$, where c is the speed of light.

Let L_A and L_B be the lengths of A and B respectively while they are in motion relative to Earth.

Which one of the following statements is **NOT** correct?



A. Measured by an observer on spacecraft A, $L_B < L_A$

B. Measured by an observer on spacecraft B, $L_B > L_A$

C. Measured by an observer on Earth, $L_B < L_A$

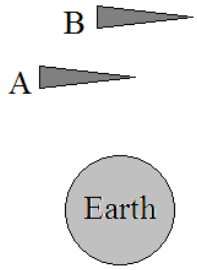
D. Measured by an observer on Earth, $L_B > L_A$

Question 13

A and B are spacecrafts travelling relative to Earth at speed $v_A = 0.5c$ and speed $v_B = 0.7c$ respectively, where c is the speed of light. Three observers, one on Earth, one in spacecraft A and one in spacecraft B, carry identical samples of a radioisotope.

The half lives of the radioisotope measured by the three observers are T_{Earth}, T_A and T_B respectively.

Select the correct statement.



A. $T_A > T_B$

B. $T_A < T_B$

C. $T_A > T_{Earth}$ and $T_B > T_{Earth}$

D. $T_A = T_B = T_{Earth}$

Question 14

A rectangular loop rotates inside a uniform magnetic field. Initially the magnetic flux through the loop is at its maximum value.

Which one of the following **CANNOT** be true?

A. There is no induced current in the loop.

B. There is an induced current in the loop.

C. The direction of the induced current depends on the initial direction of rotation of the loop.

D. The direction of the induced current is independent of the initial direction of rotation of the loop.

Question 15
A 1-kg particle and a 2-kg particle are projected one after another at the same velocity above the horizontal ground. Ignore air resistance in this question.
Which one of the following statements is **NOT** correct?

A. The particles hit the ground at the same angle.

B. Both particles follow the same path.

C. The range of the 1-kg particle is greater than the range of the 2-kg particle.

D. The particles reach the same maximum height above the ground.

Question 16
A person of mass m makes a turn of radius r at speed v on a motorcycle leaning at angle θ with the vertical. Sideway friction between the road and the tyres is F.
Which one of the following statements is **NOT** correct?

A. F decreases when m decreases.

B. θ increases when m increases.

C. F increases when r decreases.

D. θ increases when v increases.

Question 17
A student wants to find the perimeter of a rectangle.
Using a ruler with 1-mm graduations five measurements (in cm) of a shorter side are: 12.38, 12.4, 12.39, 12.4, 12.41, and four measurements of the longer side are: 20.52, 20.55, 20.54, 20.56.
The perimeter (in cm) of the rectangle is to be reported as

A. 65.9 ± 0.1

B. 65.88 ± 0.08

C. 65.877 ± 0.077

D. 65.877 ± 0.090

Question 18
Directional spread of sound does **NOT** depend on

A. the size of the obstacle

B. the frequency of the sound

C. the amplitude of the sound

D. the width of the gap

Question 19
Imaging using light is limited by

A. reflection of light

B. diffraction of light

C. interference of light

D. the particle nature of light

Question 20
Which one of the following CANNOT be considered as evidence for the dual nature of matter?

A. The quantised states of the atom

B. Electron diffraction patterns

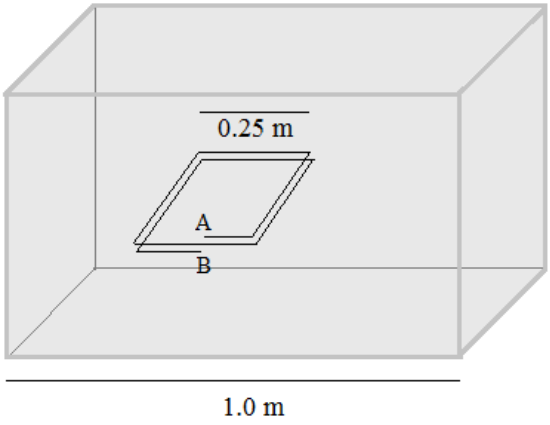
C. Interference patterns of single electron double slit experiments

D. The photoelectric effect

SECTION B

Instructions for Section B
Answer **all** questions in this section.
Where an answer box is provided, write your final answer in the box.
If 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 **must** be shown.
Unless otherwise indicated, the diagrams are **not** drawn to scale.
Take the value of g to be 9.80 N kg^{-1}.

Question 1
A uniform magnetic field is generated by an electromagnet.
Assume that the field exists in the shaded region only. Ignore the magnetic field of Earth.
The field direction is vertically upwards and its strength increases at 1.5 T per second.
A rectangular conducting coil has 2 turns and encloses an area of 0.10 m^2.
The coil moves across the magnetic field (left to right) horizontally at 2.0 m s^{-1}.



a. Calculate potential difference between terminal A and terminal B while the coil is completely inside the magnetic field.

2 marks

V

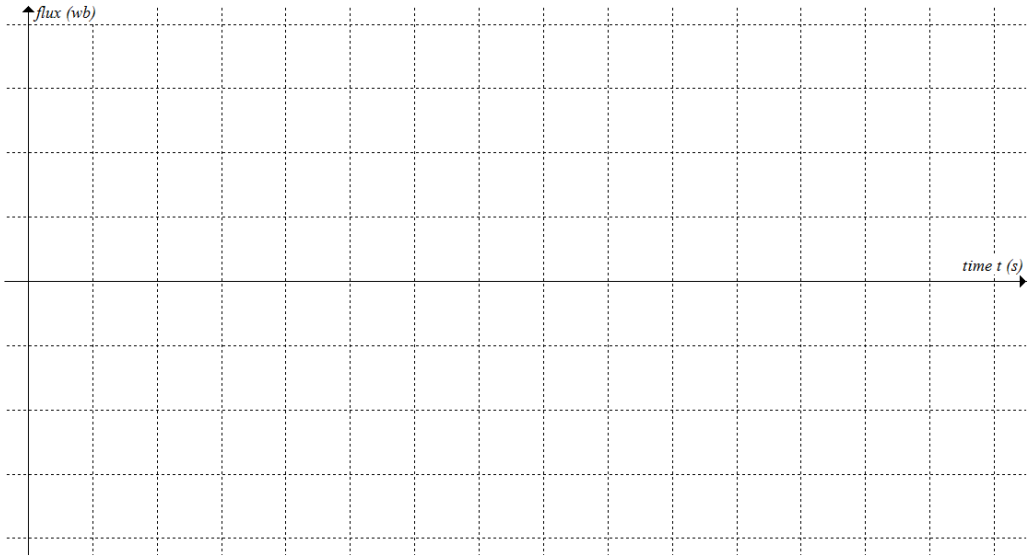
b. Determine which terminal (A or B) is at higher potential. Explain. 3 marks

Now consider the magnetic field is static and it has strength of $0.30\,\text{T}$.
The rectangular coil moves from left to right horizontally at $2.0\,\text{m s}^{-1}$.
The coil is initially outside and on the left of the magnetic field. It reaches the left edge of the field at $t = 0$.
Assume that the magnetic flux is positive when the coil enters the magnetic field.

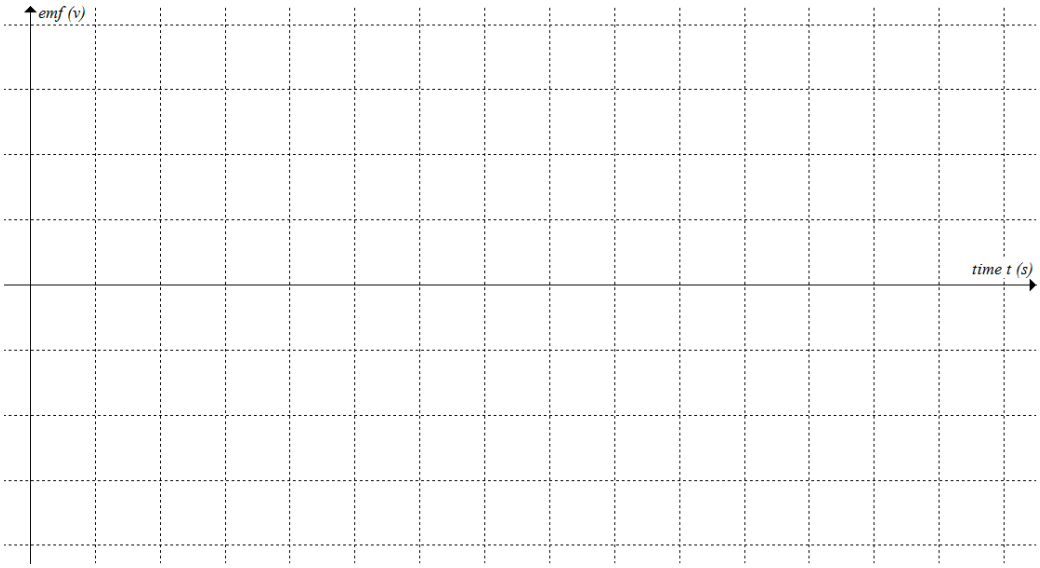
c. Calculate magnetic flux through the loop when it is completely inside the magnetic field. 1 mark

wb

d. Sketch a graph of magnetic flux versus time from $t = 0$ to $t = 0.7\,\text{s}$. 3 marks

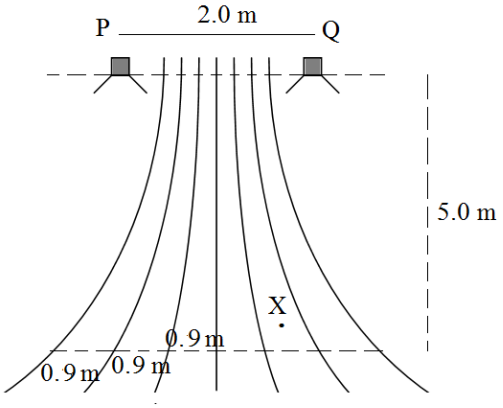


e. Sketch a graph of induced emf versus time from $t = 0$ to $t = 0.7\,\text{s}$. 3 marks



Question 2

The following diagram shows the aerial view of a setup for investigating the interference of sound from two loudspeakers P and Q in phase.
The solid lines/curves indicate locations where constructive interference occurs.
Point X is in the middle of two adjacent solid curves.
Relevant measurements are displayed in the diagram. The speed of sound is 344 m s^{-1}.



Not drawn to scale

a. Explain the occurrence of constructive interference of the sound from the two loudspeakers with reference to compression/rarefaction, superposition, wavelength and path difference.

3 marks

b. Determine the frequency of the sound used in the investigation. 2 marks

Hz

c. Find the difference in the distances from P to X and from Q to X. 2 marks

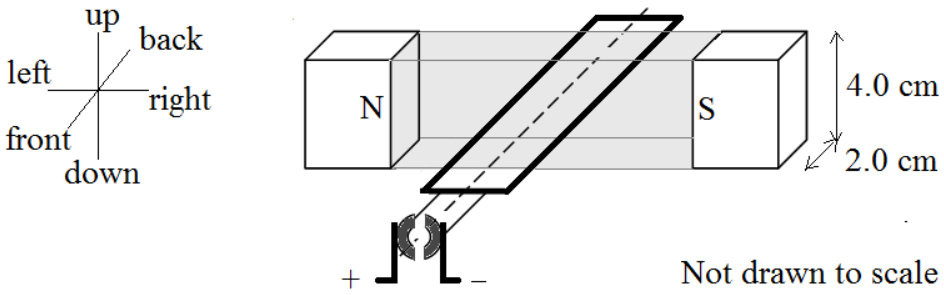
m

d. Determine the number of solid lines (locations of constructive interference) between loudspeakers P and Q.

2 marks

Question 3

The following diagram shows a drawing of a simple motor at $t = 0$.
The rectangular coil of wire measuring 2.0 cm by 8.0 cm has 25 turns clockwise viewed from above.
The coil is placed in a magnetic field.
Assume that the magnetic field exists in the shaded region **only** and has strength of 0.50 T.
The coil is connected to a battery through a split-ring commutator. The current through the battery is 2.0 A.



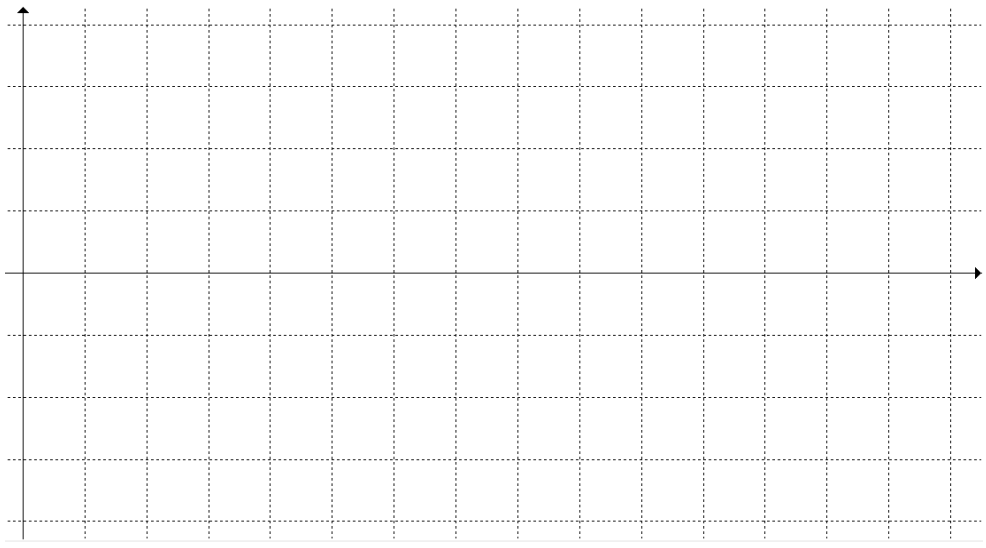
a. Determine the direction of rotation of the coil viewing from the front. 1 mark

b. Calculate the magnetic force (magnitude) on the right side of the coil. 2 marks

N

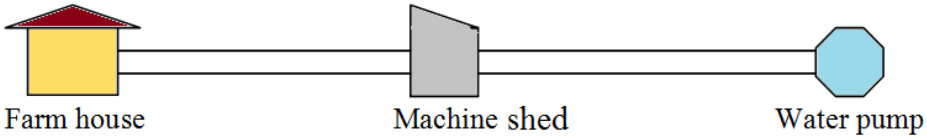
Now the battery is replaced with a CRO (cathode ray oscilloscope), and the magnets rotate clockwise at constant speed viewing from the front about the dotted line.
The left terminal of the coil is earthed, i.e. at zero potential. The frequency of rotation is 25 Hz.

c. Sketch a graph of the potential at the right terminal versus time showing one complete rotation from $t = 0$.
Label the axes and show units. Scale is required for the time axis only. 4 marks



Question 4

An extension cord of resistance $1.9\ \Omega$ connects a shed to a farm house where the mains supply is $240\ V$.
The machine operates properly in the voltage range 220v – 240v and it is rated 2.0 kw at 240v.
A second identical extension cord connects a water pump to the shed.
The water pump operates efficiently in the range 220v – 240v and it is rated 0.75 kw at 240v.



a. State the voltage at the shed when the first extension cord is plugged into a power point in the farm house and the machine and water pump are switched off.

1 mark

Assume that the resistances of the machine and water pump remain the same.

b. Calculate the resistance of the machine. 1 mark

Ω

Now the machine in the shed is switched on and the water pump is off.

c. Determine the power of the machine in the shed and the voltage it operates at.

3 marks

kw	v

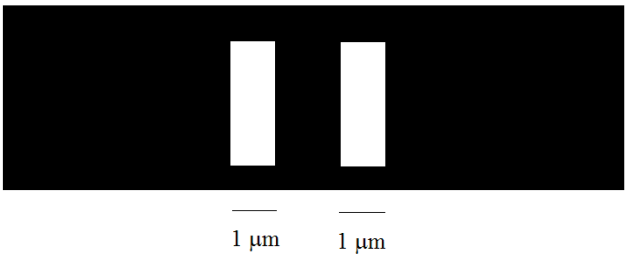
Now the machine in the shed and the water pump are both on.

d. Show that the machine in the shed operates properly. 4 marks

e. Does the water pump operates efficiently? Explain with calculations. 3 marks

Question 5

A student tries to repeat Young's double slit experiment using laser green light (wavelength 530 nm).
The student uses the prepared double slit shown below. The width of each slit is 1.0 μm.
After passing through the double slit, the laser green light falls on a screen in front of the double slit.



Not drawn to scale

a. Compare what appears on the screen with the result of Young's double slit experiment.
Illustrate your answer with sketches. 3 marks

b. Explain your answer to part a with reference to light behaviors, wavelength and slit width. 2 marks

Question 6

The radius of a spherical planet is R metres and it is greater than the radius of Earth.
At an **altitude** of $2R$ metres the gravitational field strength is $1.8\,\text{N kg}^{-1}$.

a. Determine the centripetal acceleration of a 500 kg satellite and its weight at altitude of $2R$ metres. 2 marks

	m s^{-2}		N

b. Calculate the gravitational field strength of the planet at altitude of $1.5R$ metres. 2 marks

	N kg^{-1}

The planet has two satellites A and B. The orbital radius of satellite A is two times that of satellite B.

c. Calculate the value of $\frac{v_B}{v_A}$ where v_A and v_B are the speeds of A and B respectively. 2 marks

d. Calculate the value of $\frac{T_B}{T_A}$ where T_A and T_B are the periods of A and B respectively. 2 marks

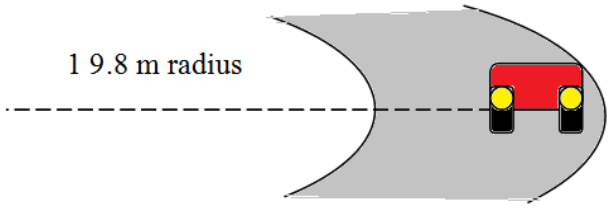
e. Satellite A has a mass of 500 kg. Calculate the increase in its gravitational potential energy when its altitude increases from $2R$ metres to $(2R+100)$ metres.

2 marks

	J

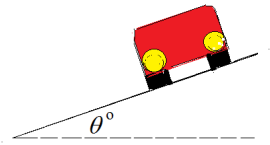
Question 7

A 1200-kg car makes a circular turn (radius 19.8 m) travelling at 7.5 m s^{-1} on a horizontal road surface.



a. Show that the total sideway friction between the tyres and the road surface is 3410 N approximately. 1 mark

Consider the road surface of the turn is banked at angle $\theta°$ instead of horizontal.



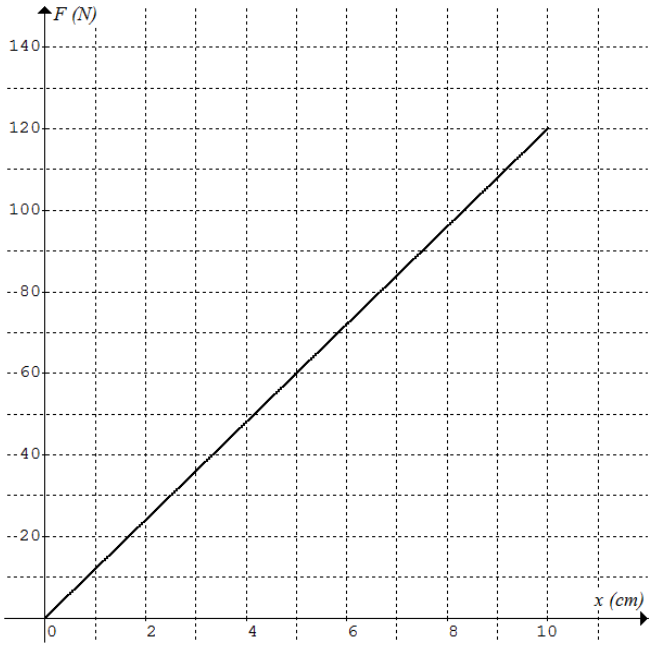
b. The car travels at 7.5 m s^{-1}.
Show that at $\theta° \approx 16.2°$ sideway friction between the tyres and the road surface is not required 2 marks

c. The car increases its speed to 8.5 m s^{-1}.
Calculate the friction between the tyres and the road surface when $\theta° \approx 16.2°$. 3 marks

N

Question 8

The graph of compressive force F (N) versus compression x (cm) of a spring is shown below.
The spring is 20 cm long without compression. It is 10 cm long when fully compressed.



a. Calculate the spring constant of the spring. 1 mark

N m^{-1}

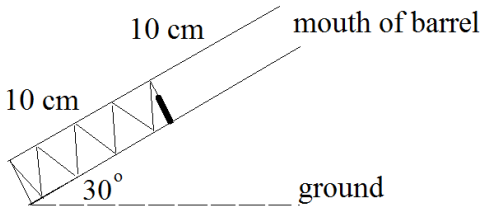
b. Calculate the energy required to compress the spring by 5.0 cm. 1 mark

J

c. Calculate the **extra** energy required to compress the spring by another 5.0 cm. 1 mark

J

The spring is placed inside a cylindrical barrel inclined at $30°$ to the horizontal ground.
It is used to project a 0.20-kg object when fully compressed.
Ignore air resistance, friction and the mass of the spring.



d. Calculate the speed of the 0.20-kg object when it leaves the mouth of the barrel. 3 marks

m s^{-1}

e. Calculate the kinetic energy of the object when it reaches maximum height. 2 marks

J

f. Calculate the horizontal distance reached by the object from the mouth of the barrel. 3 marks

m

Question 9

A spaceship travels from Mars to Earth at high speed close to the speed of light c.
A spaceship observer measures the distance from Mars to Earth and the time taken to reach Earth.
An Earth observer measures the distance from Mars to Earth and the time taken for the spaceship to reach Earth.
Show that the spaceship observer and the Earth observer would calculate the same speed of the spaceship approaching Earth, with reference to proper time t_o, dilated time t, proper length L_o and contracted length L.

3 marks

Question 10

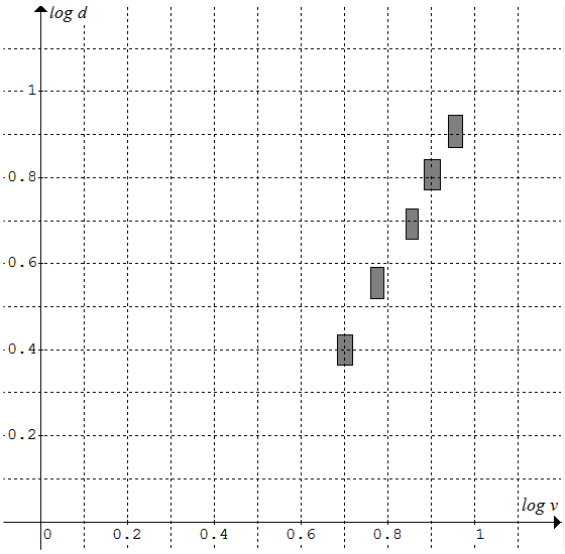
A student investigates the relationship between stopping distance d (m) of an object sliding on a floor and its initial speed v (m s^{-1}). The student takes several measurements of d and v with uncertainties included.

a. Name a significant controlled variable and explain why it needs to be controlled in the investigation.

2 marks

b. The student plots a graph of d versus v. The graph indicates relationship $d \propto v^n$ where n is a number to be determined. To find n a graph of $\log_{10} d$ versus $\log_{10} v$ with uncertainties included (represented by the height and width of each shaded region in the following graph). The value of n is the gradient of the line passing through the shaded regions.
Determine the minimum and maximum gradients possible for a line through the shaded region, and the value of n including error.

3 marks



min	max	n

c. The student also uses physics ideas to find the relationship between stopping distance d of the sliding object (mass m) and its initial speed v.
Using work done by force of friction on the object equals its change in kinetic energy, and
force of friction $= 0.1 \times$ normal reaction force of the floor on the object, write an expression for d in terms of v.

3 marks

d. Compare the student's experimental result in part b with the theoretical result in part c with reference to margin of error.

1 mark

e. With reference to the expression in part c, comment on the effects (if any) of number of passengers in a car and stopping distance in an emergency.

2 marks

Question 11
A series of fusion reactions take place in the Sun. The net effect is converting hydrogen into helium as described in the equation $4\,{}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + \text{other particles} + 27\ \text{MeV}$.

a. Convert 27 MeV to joules (J). 2 marks

J

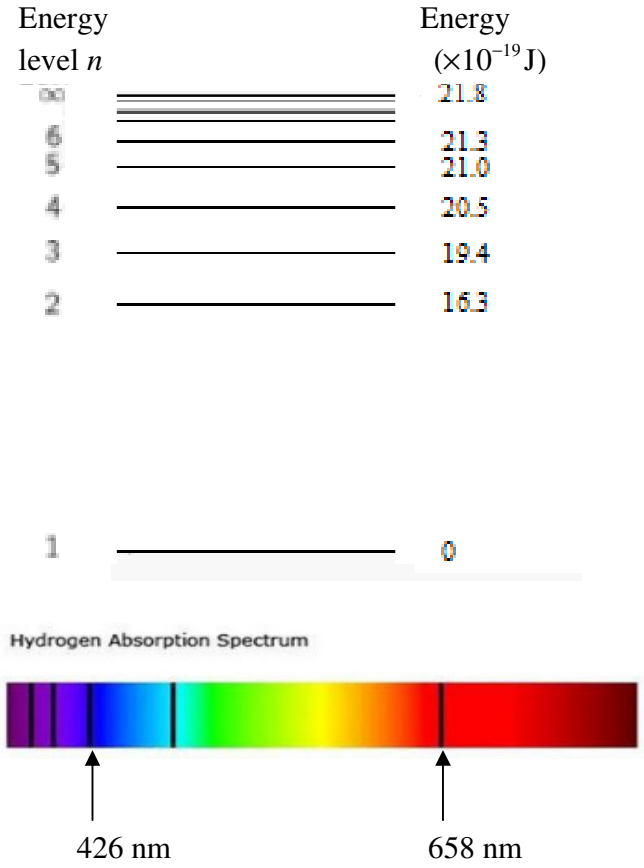
b. Calculate the difference in the total mass of the particles before and after the series of fusion reactions.

2 marks

kg

Question 12

The following diagrams show the energy levels of hydrogen atom and the absorption spectrum of light through hydrogen gas.



a. Explain the production of the dark lines in the spectrum. 2 marks

b. Calculate the photon energy corresponding to the 658 nm spectral line. 2 marks

	J

c. Determine the change in energy levels of the hydrogen atom corresponding to the 426 nm spectral line (photon energy $\approx 4.7\times10^{-19}$ J) due to electron changing state. 1 mark

From $n =$	to $n =$

Question 13
The following diagram shows the visible part of the electromagnetic spectrum.

Wavelength 400 nm 780 nm

Zinc metal has a threshold frequency of 1.04×10^{15} Hz.

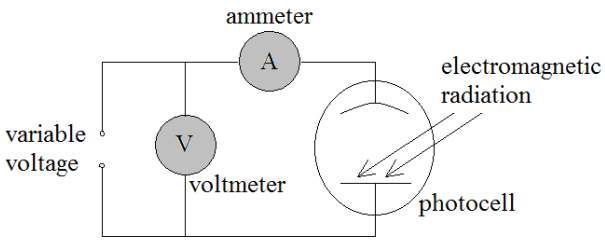
a. Can visible light be used on zinc metal to demonstrate the photoelectric effect? Explain with calculations.

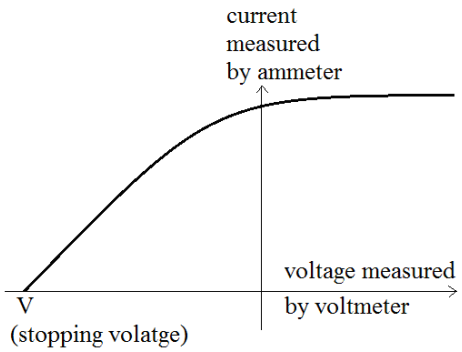
2 marks

b. Suggest a way to increase the emission of photoelectrons. 1 mark

c. Suggest a way to increase the average kinetic energy of electrons emitted. 1 mark

The following diagrams show a setup to investigate the photoelectric effect and a typical set of results.





d. Determine the voltage (magnitude) required to stop all photoelectrons emitted in the photocell when electromagnetic radiation $\lambda = 270$ nm is directed at the zinc electrode.

3 marks

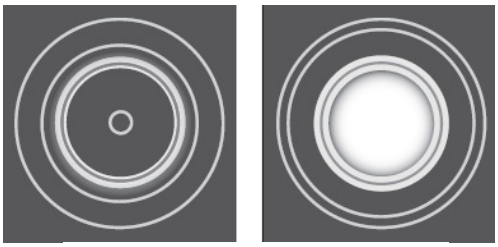
V

e. Explain why the current becomes constant when the accelerating voltage increases. 2 marks

f. Explain why the current decreases when the retarding voltage increases in magnitude. 2 marks

Question 14

Two diffraction patterns are shown below. One is obtained by directing a beam of X-rays into crystal targets, and the other is by directing a beam of electrons into the same crystal targets. The patterns are almost identical.
The wavelength of the X-rays used is 0.154 nm.



a. Show that the speed of an electron in the electron beam is 4.7×10^{6} m s^{-1} approximately. 2 marks

b. Calculate the voltage required to accelerate an electron from rest to 4.7×10^{6} m s^{-1}. 2 marks

v

End of examination