Student Number

2019

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

PEM

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
  Black pen is preferred
- Draw diagrams using pencil
- Approved calculators may be used
- A data sheet, formulae sheets and Periodic Table are provided at the back of this paper
- Write your student number in the space provided

Total marks – 100

100 marks
This exam has two parts, Part A and Part B

Part A – 20 marks
- Attempt Questions 1-20
- Allow about 35 minutes for this part

Part B – 80 marks
- Attempt Questions 21-34
- Allow about 2 hour and 25 minutes for this part

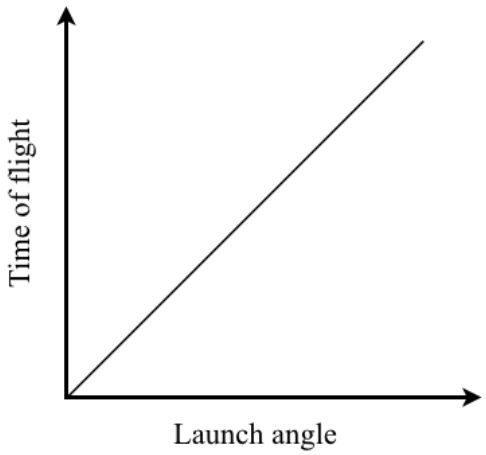
Part A – 20 marks
Attempt Questions 1-20
Allow about 35 minutes for this part

Use the multiple choice answer sheet for Questions 1-20

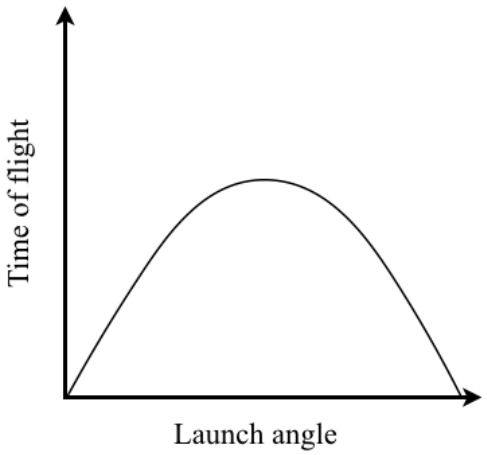
---

1 Which graph below correctly represents the relationship between launch angle and time of flight for a projectile?

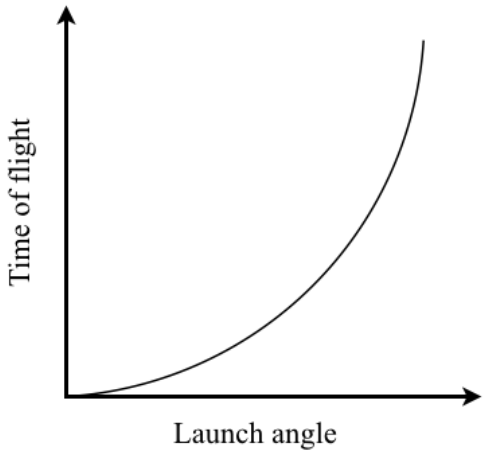
(A)



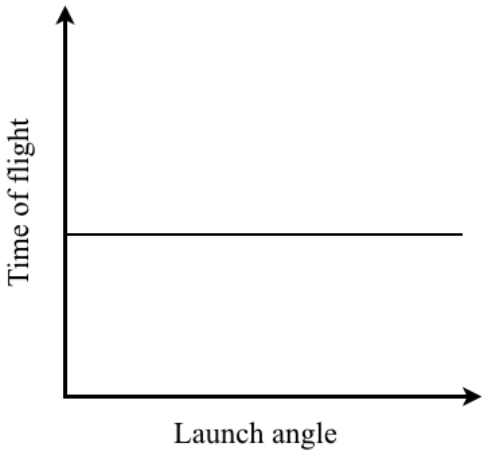
(B)



(C)



(D)



2 Using a homemade projectile launcher a student undertook a depth study to analyse projectile motion.

The student determined that the launcher did not produce a consistent initial velocity.

The type of error this produced would be best defined as:

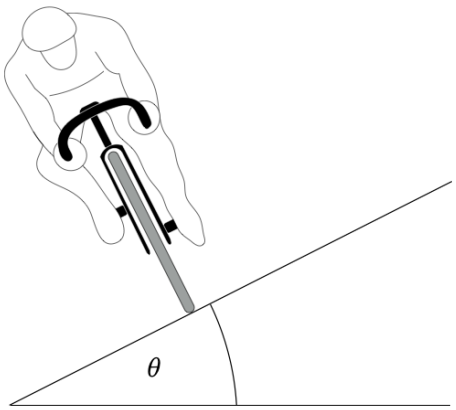
(A) Instrumental error

(B) Human error

(C) Systematic error

(D) Random error

3 The diagram below shows a cyclist turning on a banked track.



Which of the following statements about the forces acting on the cyclist are correct?

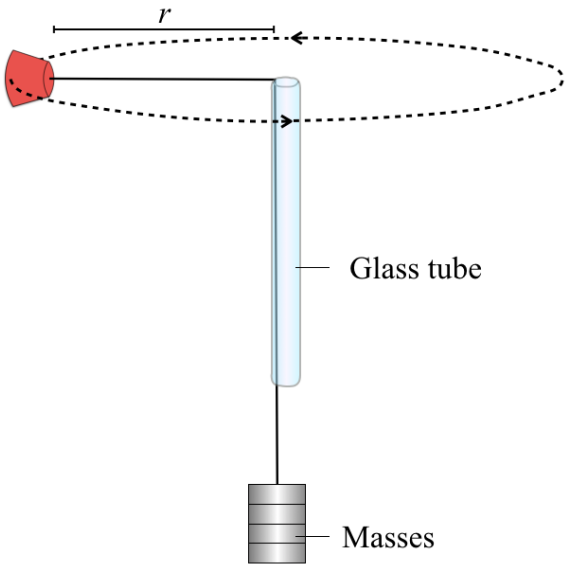
(A) All the forces are balanced, allowing him to travel at a constant speed.

(B) The net force acting on the cyclist creates a centripetal force.

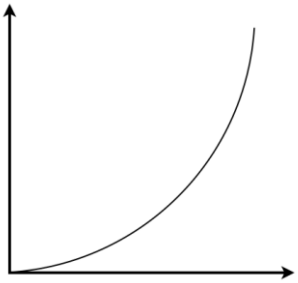
(C) The force acting on the cyclist parallel to the bank is balanced by the centripetal force.

(D) The component of the normal force perpendicular to the slope is equal to the weight force.

4 A class undertook a depth study in pairs to investigate centripetal force using the apparatus below.



One day a student was sick and their partner had to interpret their results. The lab partner found a graph with unlabelled variables as shown below.



Which pair of variables was most likely graphed?

(A) F and v

(B) F and r

(C) v and r

(D) a and v/r

5 Thompson's charge-to-mass experiment:

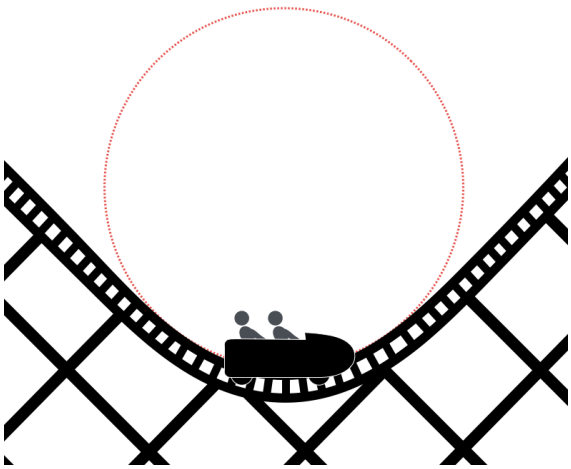
(A) calculated the mass of the electron.

(B) measured the charge of an electron.

(C) provided evidence that cathode rays had mass.

(D) demonstrated that cathode rays travelled in straight lines.

6 A rollercoaster trolley with a constant velocity on a dip has a centripetal acceleration due to the circular path, as shown in the diagram.



Which of the following descriptions best analyses the forces acting on the trolley?

(A) The gravitational force acting on the trolley is larger than when travelling on a flat surface.

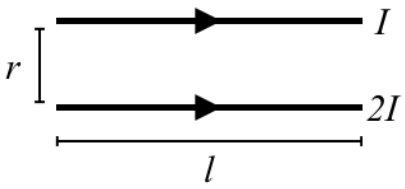
(B) The centripetal force is equal to the normal force.

(C) The sum of the Normal force and the gravitational force is equal to the centripetal force.

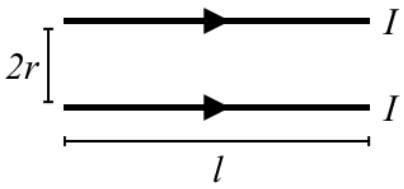
(D) The normal force is larger than when travelling on a flat surface because the centrifugal force is larger.

7 Which of the following pairs of current carrying conductors has the weakest force acting between them?

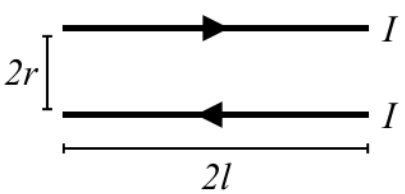
(A)



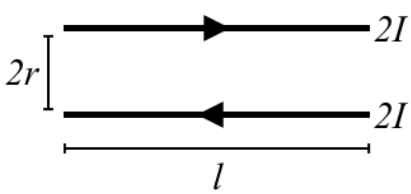
(B)



(C)

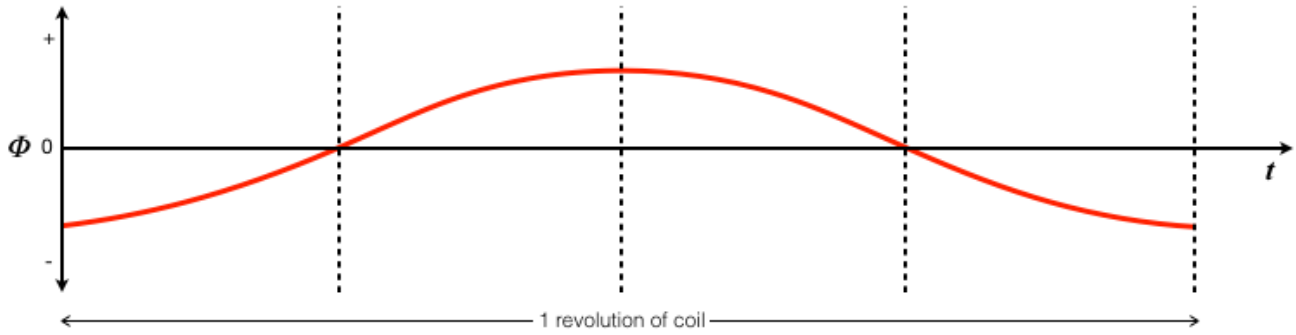


(D)



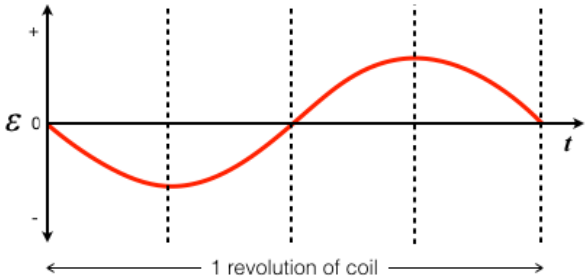
Use the following information to answer Question 8 and Question 9

The graph below shows the variation of flux of a generator coil as it completes a single revolution.

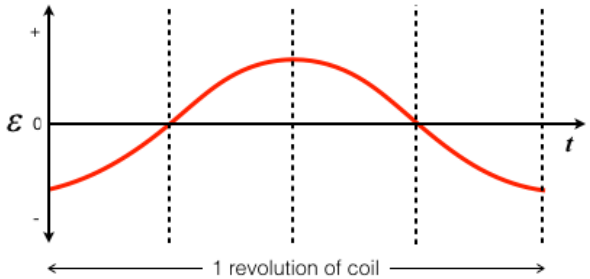


8 Which of the following graphs shows the corresponding EMF in the generator?

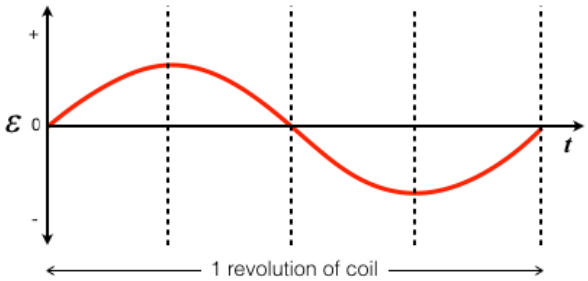
(A)



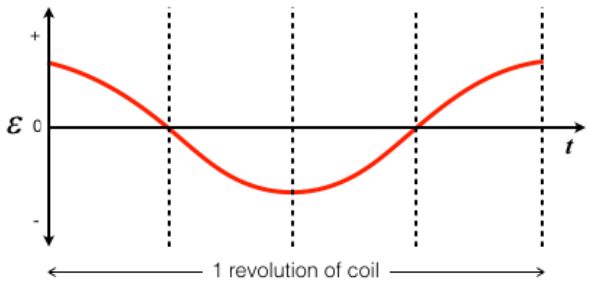
(B)



(C)

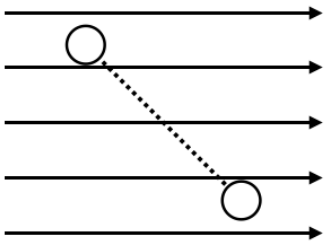


(D)

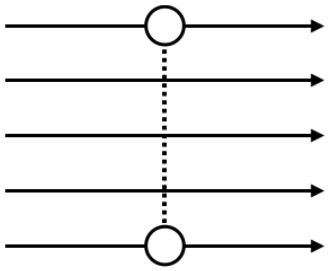


9 The following diagrams represent a cross section of the generator coil. Which position was the coil in at the beginning of the graph?

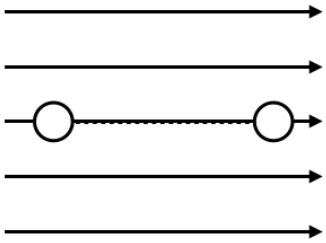
(A)



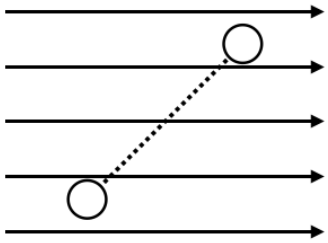
(B)



(C)



(D)



10 The main difference between a controlled and an uncontrolled nuclear chain reaction is:

(A) the number of neutrons released at each fission.

(B) the amount of energy released at each fission.

(C) the amount of subsequent fission reactions.

(D) the rate of fission reactions.

11 Which of the following formulas shows the correct decay of Cobalt-60 to Nickel-60?

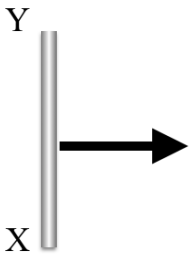
(A) ${}^{60}_{27}Co \longrightarrow {}^{60}_{28}Ni + {}^{0}_{-1}\beta + \bar{v}$

(B) ${}^{60}_{27}Co \longrightarrow {}^{56}_{25}Ni + {}^{4}_{2}He + energy$

(C) ${}^{60}_{27}Co \longrightarrow {}^{60}_{28}Ni + {}^{0}_{+1}\beta + v$

(D) ${}^{60}_{27}Co \longrightarrow {}^{60}_{27}Ni + {}^{0}_{+1}\beta + \bar{v}$

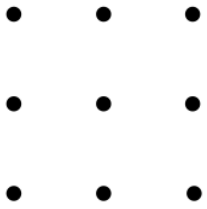
12 A wire conductor is moving to the right as shown below.



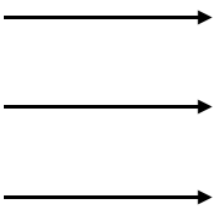
Which of the following magnetic fields would the conductor need to pass through in order to induce a current in the direction X to Y in the conductor?

(A)

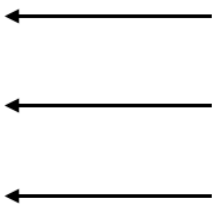
(B)



(C)



(D)



13 Foucault measured the speed of light by focusing a light onto a rotating mirror which reflected it onto a fixed mirror which in turn reflected it back. Whilst the light travelled to the fixed mirror and back, the rotating mirror rotated through an angle. By measuring the angle with a known angular velocity of the mirror, Foucault was able to calculate a value for the speed of light.

The smaller the measured angle the more uncertainty there was in the measurement.

What would be the easiest adjustment to make to the experimental design to increase the size of the angle and reduce the uncertainty in measurement?

(A) Increase the distance between the mirrors.

(B) Decrease the distance between the mirrors.

(C) Increase the rotational velocity of the rotating mirror.

(D) Decrease the rotational velocity of the rotating mirror.

14 Calculate the energy released from an electron-positron annihilation.

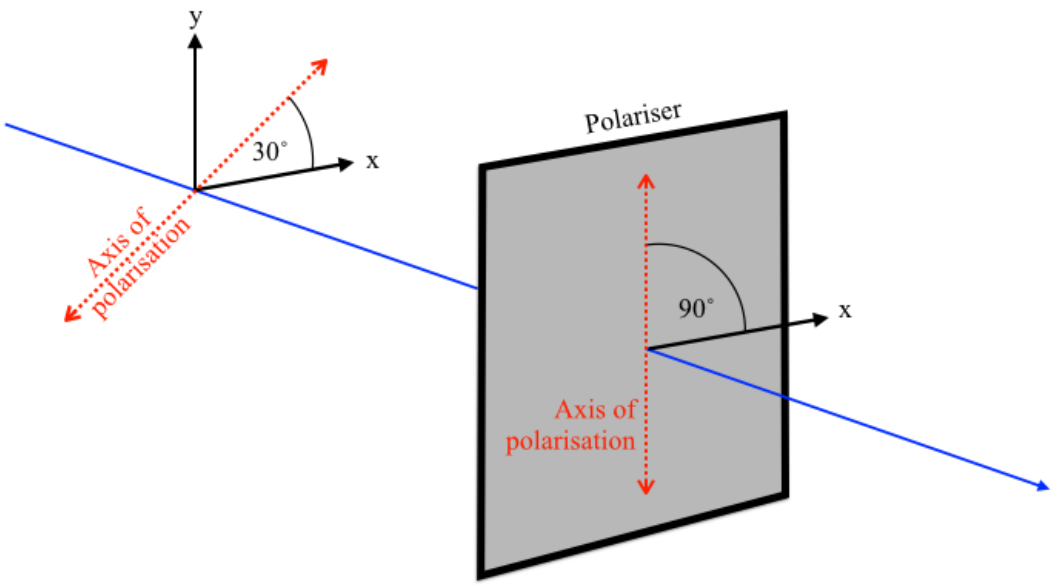
(A) 1.638×10^{-13} eV

(B) 8.19×10^{-14} eV

(C) 0.51 MeV

(D) 1.02 MeV

15 A polarised light source is entering a polarising filter as shown below.



What adjustment would produce the greatest reduction in light intensity?

(A) Rotating the light source clockwise 10˚

(B) Rotating the light source counter clockwise 70˚

(C) Rotating the filter clockwise 130˚

(D) Rotating the filter counter-clockwise 110˚

16 Calculate the work function for copper, which has a threshold frequency of 1 x 10^9 MHz.

(A) 4.1 eV

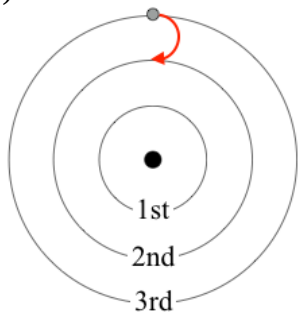
(B) 4.1 MeV

(C) 3.9 eV

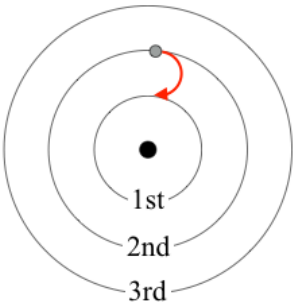
(D) 3.9 MeV

17 Which of the following examples below of an electron moving energy levels would produce the shortest wavelength?

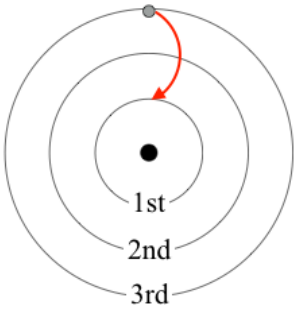
(A)



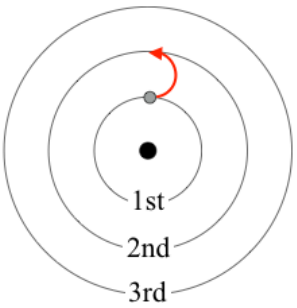
(B)



(C)



(D)



18 What significant change to the atomic model did the Gold foil experiment lead to?

(A) All atoms contained negative electrons.

(B) Electrons existed in energy shells surrounding the nucleus.

(C) The nucleus was a positive space.

(D) The atom is mostly empty space.

19 Calculate the wavelength of a tennis ball of mass 59.4g travelling at 170 km h^{-1}.

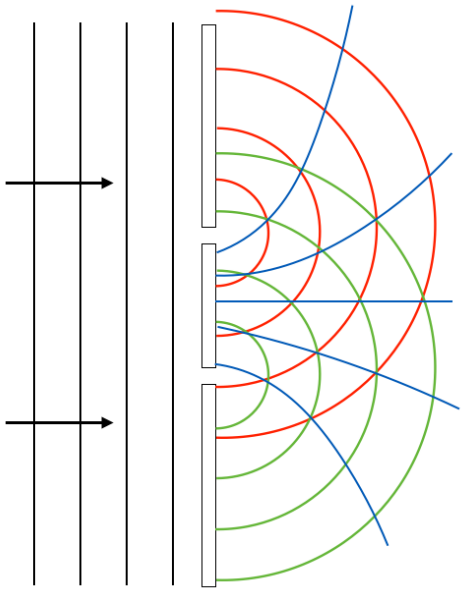
(A) 6.56×10^{-38} m

(B) 2.36×10^{-37} m

(C) 6.56×10^{-35} m

(D) 2.36×10^{-34} m

20 What phenomenon is best demonstrated in the experiment shown in the diagram below?



(A) Wave diffraction

(B) Wave interference

(C) Wave resonance

(D) Wave refraction

Part B – 80 marks
Attempt questions 21-40
Allow about 2 hour and 25 minutes for this part

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

Question 21 (2 marks)

Low Earth orbit satellites experience significant orbital decay, have a low life span and are difficult to monitor and troubleshoot. Explain why low Earth orbit satellites are still used extensively despite the above points. **2**

.....

.....

.....

.....

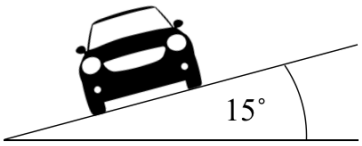
.....

.....

.....

Question 22 (5 marks)

(a) A car is travelling at the design speed of a banked track with a turning radius of 26.0 m, as shown in the diagram. The centripetal force acting on the car is 3040 N. **2**



Determine the mass of the car.

.....

.....

.....

.....

.....

.....

(b) Explain, in terms of forces, why a car would slide off a frictionless banked track if it exceeded the design speed. **3**

Question 23 (3 marks)

In terms of mechanical energy, describe why the work done on an object in uniform circular motion is equal to zero on a horizontal plane. **3**

Question 24 (3 marks)

Explain quantitatively and qualitatively why the mass of an object is not a factor in determining its escape velocity. **3**

Question 25 (5 marks)

Maverick's F18 plane is flying at a constant altitude of 200.0 m and a speed of 300.0 ms^{-1}. His rockets accelerate at 25.0 ms^{-2} for 10.0 seconds in a straight line until the fuel runs out. At this point the missiles follow normal projectile motion and cruise down to the surface.

(a) Calculate the distance travelled by the rockets whilst they are using fuel. **2**

(b) Determine the distance from his target that Maverick should fire his missile in order to hit it. **3**

Question 26 (2 marks)

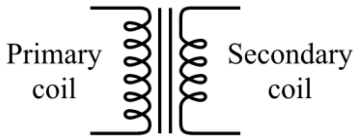
The Earths average distance from the Sun is 1.00 AU. The average distance of Saturn from the Sun is 9.00 AU. Calculate the period of Saturn. **2**

Question 27 (3 marks)

Justify Lenz's Law. **3**

Question 28 (3 marks)

Explain how the device shown in the diagram below works. **3**



Question 29 (4 marks)

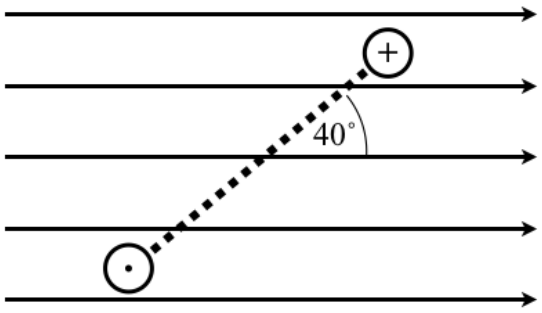
A power plant generates 150 MW of electricity for a town 20 km away. The transmission wires have a resistance of 0.01 W per km. The voltage drop between the plant and the town is 50 V.

(a) Calculate the power loss between the plant and the town **2**

(b) Calculate the voltage transmitted by the plant. **2**

Question 30 (5 marks)

Below is a diagram of a cross section of a coil in a magnetic field. The square coil of side length 12.00 cm has 8 turns, and a current of 3.00 A. The magnetic field has a strength of 2.50×10^4 T. What is the magnitude of the torque on the coil when it is in the position shown below.

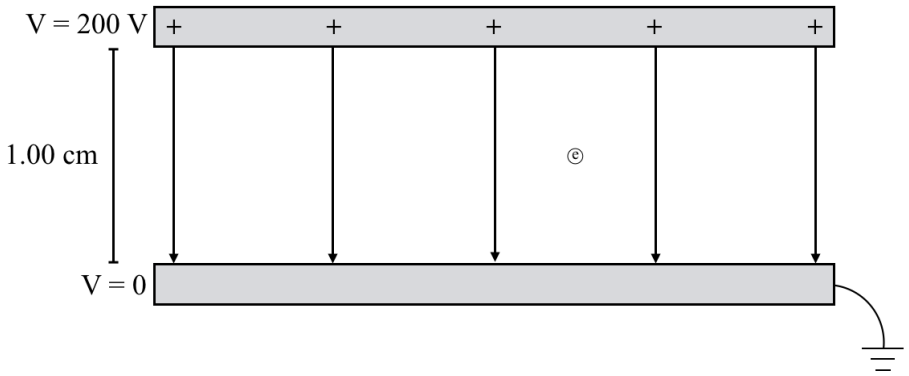


(a) Calculate the torque on the coil. **2**

(b) Determine the change in flux if it continues to rotate from the above position 30˚. **3**

Question 31 (5 marks)

Two parallel plates are set up as shown in the diagram below so that the positive plate is above the earthed plate.



An electron is placed exactly between the plates so that it is allowed to fall.

(a) Calculate the net force acting on the electron. **2**

(b) Determine how long it takes for the electron to touch a plate. **3**

Question 32 (6 marks)

Discuss the significance of Maxwell's contribution to the development of our current understanding of electromagnetism. **6**

Question 33 (6 marks)

(a) Describe the evidence that supported Newton and Huygens proposed models of light. **4**

(b) Describe why the wave theory of light was inadequate at explaining the photoelectric effect. **2**

Question 34 (5 marks)

(a) A spaceship pilot travelling through a spaceport observes that it takes 2.00 s to pass through. A person viewing the spaceship from the spaceport records the ship taking 4.39 s. Determine the speed of the ship as a percentage of the speed of light. **3**

(b) Outline an experimental validation of time dilation. **2**

Question 35 (6 marks)

(a) Account for the production of absorption spectra from stars. **2**

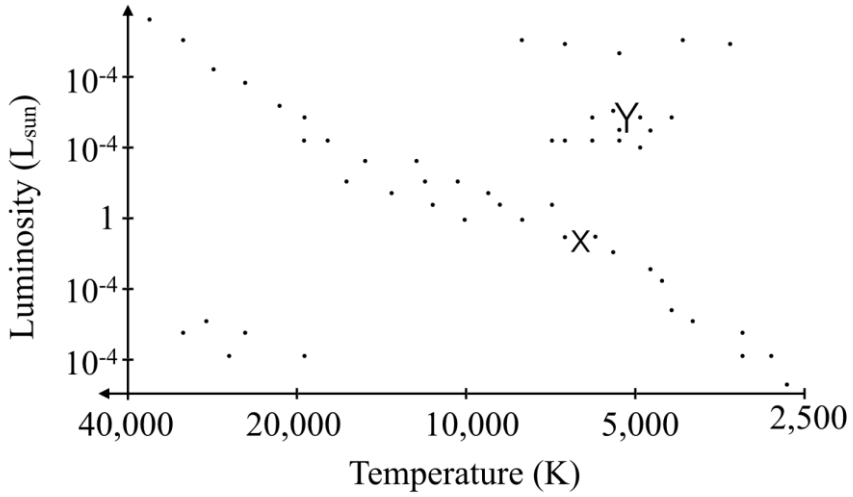
(b) Explain how rotational velocity can be deduced from spectra. **3**

Question 36 (3 marks)

Describe Hubble's justification for an expanding universe. **3**

Question 37 (4 marks)

Identify and outline the most likely dominant nucleosynthesis reactions occurring in the stars marked X and Y in the H-R diagram below. **4**



Question 38 (5 marks)

(a) Outline the insight that Bohr achieved from analysing the emission spectra of hydrogen. **2**

(b) Calculate the second longest wavelength of the Balmer series in hydrogen. **3**

Question 39 (4 marks)

A sample of Iodine-131 has a half-life of 8 days and contains 1.2×10^{13} nuclei.

(a) Calculate the decay constant for Iodine-131. **2**

(b) Determine how many Iodine-131 nuclei will remain after 76 days. **2**

Question 40 (6 marks)

Describe the electromagnetic composition of Baryons. **2**

PEM

2019 Trial HSC Physics Marking Guidelines

Section I, Part A

Multiple-choice Answer Key

Question	Answer
1	B
2	D
3	B
4	A
5	C
6	C
7	B
8	C
9	B
10	D
11	A
12	A
13	C
14	D
15	C
16	A
17	A
18	D
19	D
20	B

Section I, Part B

Question 21

Criteria	Marks
Explains property of orbit and links to use	2
Explains property of orbit or describes use	1

Sample answer:

Because LEO's have a short period, they complete multiple passes off the Earth's surface every day. This makes it ideal for mapping or monitoring of the surface.

Question 22 (a)

Criteria	Marks
Calculates correct mass of the car	2
Attempts to find an expression for centripetal force	1

Sample answer:

$F_c = F_{N_x} = mg \sin\theta$

$3040 = m9.8 \sin 15$

$m = \frac{3040}{9.8 \sin 15}$

$m = 1.2 \times 10^3 \text{ kg}$

Question 22 (b)

Criteria	Marks
Explains in terms of forces the concept of design speed and the consequences of exceeding it on a frictionless surface	3
Explains in terms of forces the concept of design speed	2
Identifies that the horizontal component of the normal force provides a centripetal force	1

Sample answer:

A vehicle travelling at the design speed of a banked track requires no friction to turn because the horizontal component of the normal force creates a sufficient centripetal force to turn the vehicle. If the speed of a vehicle in uniform circular motion is increased a larger centripetal force is required to maintain the same radius of the turn. Beyond the design speed the horizontal component of the normal force will be less than the required centripetal force. Because there is no friction between the tyres and the road the car would slide off.

Question 23

Criteria	Marks
Describes constant kinetic energy and gravitational potential energy, and relates work to change in energy	3
Describes constant kinetic energy and gravitational potential energy Or Describes constant kinetic energy or gravitational potential energy, and relates work to change in energy	2
Describes constant kinetic energy or gravitational potential energy	1

Sample answer:

When an object is undergoing uniform circular motion its speed is constant, so its kinetic energy is constant. The gravitational potential energy of an object in uniform circular motion on a horizontal plane is always constant because its height above the Earth does not change.

Work done is equal to the energy transferred to the object. Because the total energy of an object in uniform circular motion remains constant, no work is done and thus equal to zero.

Question 24

Criteria	Marks
Defines escape velocity and explains how mass is not a factor in determining its magnitude	3
Equates Kinetic energy with GPE to show escape velocity	2
Identifies escape velocity formula	1

Sample answer:

Escape velocity is defined as the kinetic energy required for a body to escape a gravitational field. Therefore, an escape velocity is reached when the kinetic energy is equal to the gravitational potential energy.

$K = U$

$\frac{1}{2}mv^2 = G\frac{Mm}{r}$

$v^2 = \frac{2GM}{r}$

$v_{esc} = \sqrt{\frac{2GM}{r}}$

By equating the kinetic energy and potential energy of the object, the object's mass has been cancelled and is not a factor in determining escape velocity.

Question 25

Criteria	Marks
Calculates correct distance	2
Uses correct formula	1

Sample answer:

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

$s = (300 \times 10) + \frac{1}{2} \times 25 \times 10^2$

$s = 4250$ m

Question 25

Criteria	Marks
Calculates correct distance of rocket	3
Calculates distance of projectile	2
Calculates time for projectile to fall	1

Sample answer:

$\Delta y = u_y t + \frac{1}{2} a t^2$

$-200 = 0 - \frac{9.8}{2}(t^2)$

$t = 6.39$ s

$v = u + at$

$v = 300 + 25 \times 10$

$v = 550$ m s^{-1}

$\Delta x = u_x t$

$\Delta x = 550 \times 6.39$

$\Delta x = 3513.8$ m

$s_{total} = 4250 + 3513.8$

$s_{total} = 7760$ m

Question 26

Criteria	Marks
Calculates correct period of Saturn	2
Attempts to use Kepler's law of periods	1

Sample answer:

$\frac{r_E^3}{T_E^2} = \frac{r_S^3}{T_S^2}$

$\frac{1}{1} = \frac{9^3}{T^2}$

$T = \sqrt{9^3}$

$T = 27$ Earth years *or* $T = 8.52 \times 10^8$ s

Question 27

Criteria	Marks
States Lenz's law and explains how it prevents a violation of conservation laws	3
States Lenz's law and identifies its affirmation of conservation laws	2
States Lenz's law or identifies its affirmation of conservation laws	1

Sample answer:

Lenz's law states that an induced current will flow in the direction that produces a magnetic field that opposes the change in flux through the conductor.

If it did not oppose the change in flux it would affirm it, creating a larger change in flux which would increase the induced current leading to an infinite source of energy. This would violate the conservation of energy.

Question 28

Criteria	Marks
Explains magnetic flux in primary coil inducing an EMF in the secondary coil that is lower in voltage and identifies the role of the iron core	3
Explains magnetic flux in primary coil inducing an EMF in the secondary coil that is lower in voltage	2
Identifies a step down in voltage	1

Sample answer:

The primary coil supplied with an AC current produces a constantly changing magnetic flux as the current alternates. The soft iron core links the two coils and amplifies the changing flux. The changing flux induces an EMF in the secondary coil. Because there are less turns in the secondary coil a smaller voltage is induced.

Question 29 (a)

Criteria	Marks
Calculates correct power loss	2
Uses correct power loss formula	1

Sample answer:

$P_{loss} = \frac{{v_{drop}}^2}{r}$

$P_{loss} = \frac{50^2}{20 \times 0.01}$

$P_{loss} = 12500 \text{ W}$

Question 29 (b)

Criteria	Marks
Calculate the correct voltage	2
Calculates current	1

Sample answer:

$P_{loss} = I^2R = 12500$

$I = \sqrt{\frac{12500}{20 \times 0.01}}$

$I = 250$ A

$P = VI$

$150 \times 10^6 = V \times 250$

$V = 600$ kV

Question 30 (a)

Criteria	Marks
Calculates correct torque	2
Attempts to use torque formula	1

Sample answer:

$\tau = nIAB \sin\theta$

$\tau = 8 \times 3 \times 0.0144 \times 2.5 \times 10^4 \times \sin 50$

$\tau = 6620$ Nm

Question 30 (b)

Criteria	Marks
Calculates correct change in flux	3
Calculates a value for change in flux with incorrect final angle of coil	2
Determines correct final angle of coil or identifies the formula for change in flux	1

Sample answer:

$\Delta\Phi = \Phi_f - \Phi_i$

$\Delta\Phi = \text{BA}\cos\theta_f - \text{BA}\cos\theta_i$

$\Delta\Phi = (2.5 \times 10^4 \times 0.0144 \times \cos 10) - (2.5 \times 10^4 \times 0.0144 \times \cos 40)$

$\Delta\Phi = 78.8$ W

Question 31 (a)

Criteria	Marks
Calculates the net force acting on the electron	2
Calculates the force acting on the electron by the plates	1

Sample answer:

$E = \frac{V}{d}$

$E = \frac{200}{0.01}$

$E = 20000$ Vm^{-1}

$\Sigma F = qE + mg$

$\Sigma F = 3.2 \times 10^{-15}$ N

Question 31 (b)

Criteria	Marks
Calculates correct time	3
Calculate correct acceleration and attempts to find time	2
Calculate correct acceleration	1

Sample answer:

$a = \frac{\Sigma F}{m}$

$a = \frac{3.2\times10^{-15}}{9.109\times10^{-31}}$

$a = 3.52 \times 10^{15}$ m s^{-2}

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

$0.5 = 0 + \frac{1}{2}3.52 \times 10^{15} \times t^2$

$t = 1.7 \times 10^{-8}$ s

Question 32

Criteria	Marks
Describes Maxwell's major contributions and how they developed our understanding of EMR	5-6
Describes Maxwell's major contributions	3-4
Describes some of Maxwell's major contributions	1-2

Sample answer:

Maxwell quantitatively unified electricity and magnetism through his equations. These two fields of study were previously investigated and studied separately. This unification led the way for major breakthroughs in the understanding of EMR. This deep clarification enabled scientists to properly understand what they were studying.

Maxwell further predicted electromagnetic waves and described many of their properties, most importantly the speed at which they propagated. This calculation so closely matched the measured values of the speed of light that he suggested light was a form of EMR. This eventually led to the unification of a third field of physics, optics.

Maxwell also proposed that light was only a small part of a larger electromagnetic spectrum. This was incredibly important for future discoveries, such as Hertz's discovery of radio waves. This allowed Hertz's discovery to be identified as a further component of the electromagnetic spectrum. The investigations into the range of the electromagnetic spectrum opened a wealth of scientific knowledge and discovery.

Question 33 (a)

Criteria	Marks
Outlines Newtons and Huygens models of light and describes the respective supporting evidence	3-4
Outlines Newtons or Huygens models of light and describes the respective supporting evidence	1-3

Sample answer:

Newton proposed that light consists of very tiny particles known as 'corpuscles'. The corpuscles on emission from the source travel in straight lines with high velocity. Evidence to support this theory was that light travelled in straight lines exactly like objects with mass falling. Waves on the other hand were shown to bend around objects.

Huygens proposed a transverse wave model of light. Because light refracted, diffracted and caused interference patterns supported this idea. Poisson's spot was a clear example of light causing inference patterns as a result of diffraction.

Question 33 (b)

Criteria	Marks
Describes the wave models predicted effects contrasting to the observed results	2
Identifies the observed results that could not be explained	1

Sample answer:

The wave theory of light suggests that the photoelectric effect should occur at all frequencies of light because the surface electrons in the material would gradually absorb enough energy to break away from the material. Experiments revealed that below a particular frequency no photoemission of electrons occurred.

Question 34 (a)

Criteria	Marks
Calculates the speed of the ship as a percentage of the speed of light	3
Calculate the speed of the ship	2
Attempts to use the correct formula	1

Sample answer:

$$t = \frac{t_0}{\sqrt{\left(1-\frac{v^2}{c^2}\right)}}$$

$$4.39 = \frac{2}{\sqrt{\left(1-\frac{v^2}{1^2}\right)}}$$

$$v = 0.890$$

The ship is travelling at 89% the speed of light.

Question 34 (b)

Criteria	Marks
Outline an experimental validation of time dilation	2
Identifies an experimental validation of time dilation	1

Sample answer:

Muons in the upper atmosphere have a very short resting lifetime. So short that they would not be able to reach the surface of the Earth after their creation. However, because they reach relativistic speeds, their lifetimes are dilated long enough to be detected on the surface. This provides evidence for Einstein's time dilation.

Question 35 (a)

Criteria	Marks
Identifies absorbed light as corresponding to absorption pattern and identifies light passing through gasses as the cause.	2
• Identifies absorbed light as corresponding to absorption pattern Or • identifies light passing through gasses as the cause	1

Sample answer:

Absorption spectra are produced when a continuous spectrum of light passes through a cloud of cool gas, such as in stars. Atoms in the gas absorb photons of wavelength corresponding to the quanta of energy involved in possible transitions of electrons to higher energy levels. The wavelengths correspond to the dark lines of the absorption spectrum.

Question 35 (b)

Criteria	Marks
• Describes rotation as having one side approaching and one side receding from observational perspective. • Describes Red and blue shift observed for the two different sides • Describes how the colour shift manifests in the spectra – broadening.	3
• Describes rotation as having one side approaching and one side receding from observational perspective. • Describes red and blue shift observed for the two different sides	2
• Describes red and blue shift observed for the two different sides	1

Sample answer:

As an object such as a star rotates, one side moves towards the observer and the other side moves away simultaneously to produce a rotation. As a result of the Doppler effect, a blue shift will occur on the side that is approaching and a red shift will occur on the side that is receding. This results in the absorption lines within the emission spectrum being both red and blue shifted simultaneously, so that they appear broader than expected. Careful measurement of the amount of broadening, along with a stars size can lead to the calculation of the rotational velocity of a star.

Question 36

Criteria	Marks
Describes the results of a comparison of relative spectral lines and an application of the Doppler effect	3
Outlines redshifted galaxies or nebulae and relates to expansion of universe	2
Identifies redshifted galaxies or nebulae	1

Sample answer:

Hubble carefully compared the wavelengths of spectral lines of hydrogen from other nebulae to the wavelengths of the same spectral lines observed in the laboratory. This allowed the relative speed of these nebulae to Earth to be deduced. He found that most nebulae produced wavelengths that were red-shifted, which according to the doppler effect indicates a receding source. Hubble deduced from this data that because the galaxies were moving away from each other that the universe must be expanding.

Question 37

Criteria	Marks
Correctly identifies and outlines the correct nucleosynthesis reactions occurring in both stars	4
Correctly identifies the correct nucleosynthesis reactions occurring in both stars and outlines one of these reactions	3
Correctly identifies the correct nucleosynthesis reactions occurring in both stars Or Correctly identifies and outlines the correct nucleosynthesis reactions occurring in star X or Y	2
Correctly identifies the correct nucleosynthesis reactions occurring in star X or Y	1

Sample answer:

The star marked X is a main-sequence star. The dominant nuclear reaction occurring in this star is exclusively the fusion of hydrogen into helium nuclei, most likely through the proton-proton chain pathway. The PP chain takes four hydrogen nuclei and creates one helium nucleus.

The star marked Y is a red giant. The dominant nuclear reaction occurring in the star is the fusion of Helium into Carbon through the triple alpha process. In this process three helium nuclei combine to form carbon.

Question 38 (a)

Criteria	Marks
Describes electrons inhibiting energy shells and emitting corresponding wavelengths when falling from higher to lower shells	2
Describes electrons inhibiting energy shells or emitting corresponding wavelengths when falling from higher to lower shells	1

Sample answer:

Bohr was able to develop the atomic model to encompass energy shells in which electrons could inhabit. He further explained that when an electron moved from a higher energy shell to a lower energy shell it released energy that corresponded to the levels of energy that it fell. Those specific energies were released as the specific wavelengths of lights detected in the spectra.

Question 38 (b)

Criteria	Marks
Calculates the correct wavelength	3
Uses the correct values in the equation	2
Uses the correct equation	1

Sample answer:

$$\frac{1}{\lambda} = R\left(\frac{1}{{n_f}^2} - \frac{1}{{n_i}^2}\right)$$

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right)$$

$\lambda = 486.2$ nm or 4.862×10^{-7} m

Question 39 (a)

Criteria	Marks
Calculates correct decay constant	2
Attempts to use correct formula	1

Sample answer:

$\lambda = \frac{\ln(2)}{t_{1/2}}$

$\lambda = \frac{\ln(2)}{8}$

$\lambda = 0.087 \text{ day}^{-1}$

Question 39 (b)

Criteria	Marks
Calculates correct number of atoms	2
Attempts to use correct formula	1

Sample answer:

$N_t = N_0 e^{-\lambda t}$

$N_t = 1.2 \times 10^{13} \times e^{-0.087 \times 76}$

$N_t = 1.6 \times 10^{10}$ nuclei

Question 40

Criteria	Marks
Identifies the composition of protons and neutrons in terms of quarks and associated charges	2
Identifies the composition of protons and neutrons in terms of quarks or associated charges Or Identifies the composition of protons or neutrons in terms of quarks and associated charges	1

Sample answer:

Proton composition:

$up + up + down = proton$

$\left(+\frac{2}{3}\right) + \left(+\frac{2}{3}\right) + \left(-\frac{1}{3}\right) = 1$

Neutron composition:

$down + down + up = neutron$

$\left(-\frac{1}{3}\right) + \left(-\frac{1}{3}\right) + \left(+\frac{2}{3}\right) = 0$

Physics

2019 Trial HSC Examination Mapping Grid

Part A

Question	Marks	Outcome
1	1	PH12-12
2	1	PH12-12
3	1	PH12-12
4	1	PH12-12
5	1	PH12-14
6	1	PH12-12
7	1	PH12-13
8	1	PH12-13
9	1	PH12-13
10	1	PH12-15
11	1	PH12-15
12	1	PH12-13
13	1	PH12-14
14	1	PH12-14
15	1	PH12-14
16	1	PH12-14
17	1	PH12-15
18	1	PH12-15
19	1	PH12-14
20	1	PH12-14

Part B

Question	Marks	Outcome
21	2	PH12-12
22 (a)	2	PH12-12
22 (b)	3	PH12-12
23	3	PH12-12
24	3	PH12-12
25 (a)	2	PH12-12

Question	Marks	Content
25 (b)	3	PH12-12
26	2	PH12-12
27	3	PH12-13
28	3	PH12-13
29 (a)	2	PH12-13
29 (b)	2	PH12-13
30 (a)	2	PH12-13
30 (b)	3	PH12-13
31 (a)	2	PH12-13
31 (b)	3	PH12-12, PH12-13
32	6	PH12-13
33 (a)	4	PH12-14
33 (b)	2	PH12-14
34 (a)	3	PH12-14
34 (b)	2	PH12-14
35 (a)	2	PH12-15
35 (b)	3	PH12-14
36	3	PH12-15
37	4	PH12-15
38 (a)	2	PH12-15
38 (b)	3	PH12-15
39 (a)	2	PH12-15
39 (b)	2	PH12-15
40	2	PH12-15