# GOSFORD HIGH SCHOOL

2020
Higher School Certificate
Trial Examination

# Physics

## General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- NESA approved calculators may be used
- A data sheet, formulae sheets and Periodic Table are provided
- For questions in Section II, show all relevant working in questions involving calculations
- Write your student number and/or name at the top of every page

**Total marks – 100**

**Section I** (Pages 2–12)
**20 marks**
- Attempt Questions 1–20
- Allow about 35 minutes for this part

**Section II** (Pages 13–32)
**80 marks**
- Attempt Questions 21–36
- Allow about 2 hours and 25 minutes for this section

**This paper MUST NOT be removed from the examination room**

STUDENT NUMBER/NAME:.....

STUDENT NUMBER/NAME.....

## Section I
**20 marks**

**Attempt Questions 1–20**
**Allow about 35 minutes for this part**

Select the alternative A, B, C or D that best answers the question and indicate your choice with a cross (X) in the appropriate space on the grid below.

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| | A | B | C | D |
|---|---|---|---|---|
| 1 | | | | |
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| | A | B | C | D |
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| 11 | | | | |
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| 20 | | | | |

1 Which variable(s) determine the maximum height of a projectile?

A. Launch elevation angle of 45° only

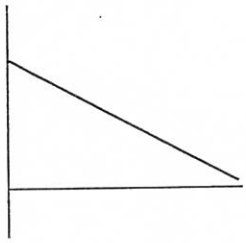
B. Launch speed only

C. Launch speed and launch elevation angle

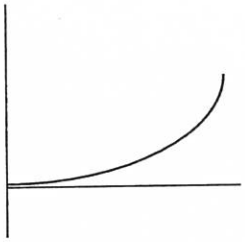
D. Launch speed and range

2 Which graph shows the relationship between the mass and surface gravitational field of planets with the same radius?

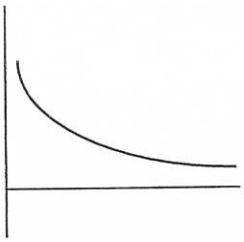
(A)



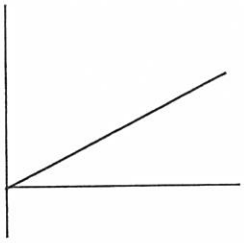
(B)



(C)



(D)



3 Which statement best accounts for the difference between projectile and uniform circular motion?

A. In projectile motion, linear motion is in a constant direction relative to the frame of reference, while in circular motion it is always changing.

B. In projectile motion, the force is in a constant direction relative to the frame of reference, while in circular motion it is always perpendicular to the velocity of the object undergoing circular motion.

C. In projectile motion, the acceleration is in the same direction as the motion, while in circular motion it is always perpendicular to the motion.

D. In projectile motion, the horizontal velocity is constant, while in circular motion the vertical motion is constant.

4 The diagram shows a worker who is having trouble lifting a heavy box using a lever.

How could he use his strength more effectively?

A. By pushing perpendicularly to the lever at the end of the bar

B. By pushing vertically at the end of the bar

C. By pushing perpendicular to the lever closer to the box

D. By pushing vertically closer to the box

5 The escape velocity of Earth is 11 200 m $s^{-1}$ and yet a space craft, moving at much lower speed, can travel away from the Earth and towards distant planets.

Which statement about this is correct?

A. If a space craft turns off its rockets, it will slow down and be pulled back to Earth.

B. To escape the Earth's gravitational field, a space craft will have to accelerate to 11 200 m $s^{-1}$ at some stage during the trip.

C. A space craft in orbit around the Earth could use rockets to accelerate and escape Earth's gravity at a lower speed.

D. The escape velocity depends on the mass of the spacecraft.

6 Which statement about an induction motor is correct?

A. It has no moving parts.

B. It utilises a rotating magnetic field.

C. It is the only type of motor using AC current.

D. It does not have a current-carrying conductor.

7 What happens to the electric field strength between two parallel plates if the voltage between them is doubled and the distance between them is halved?

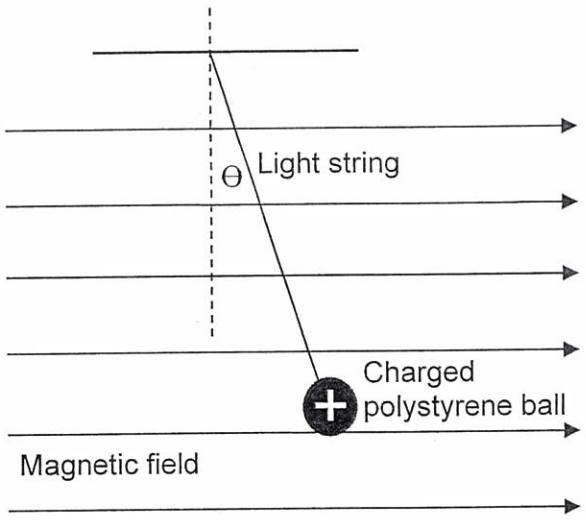
A. Electric field strength stays the same.

B. Electric field strength halves.

C. Electric field strength doubles.

D. Electric field strength becomes four time greater.

8 A student drew a diagram to show what would happen if a charged, very light, polystyrene ball was hung from a fixed point in a strong magnetic field.




Which statement about this situation is correct?

A. The diagram is totally incorrect because a stationary charge in a magnetic field does not experience a force.

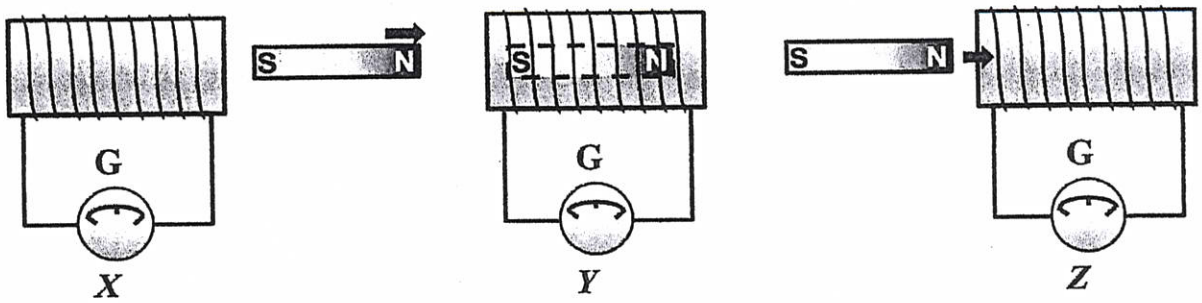
B. The diagram will only be correct for a ball which is charged positively.

C. If the strength of the magnetic field is increased, then the angle Θ will also increase.

D. If the charge on the ball was negative, then it would hang in the opposite direction.

STUDENT NUMBER/NAME.....

9 A magnet moves from left to right at constant speed towards, through and out of the middle coil of wire, as shown in the diagram.




Which choice correctly shows the relationship between the readings on galvanometer *X* as the magnet moves away from coil *X*, on galvanometer *Y* when the magnet is completely inside the coil and on galvanometer *Z* as the magnet moves towards its coil?

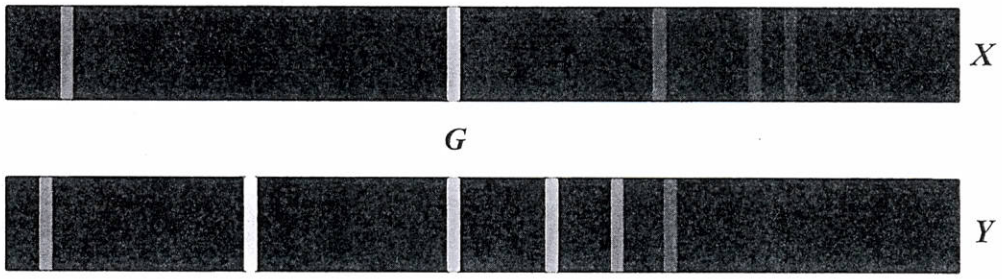
| | *Galvanometer X (Magnet moves away from coil X)* | *Galvanometer Y (Magnet inside coil Y)* | *Galvanometer Z (Magnet moves towards coil Z)* |
|---|---|---|---|
| A. | ↗ | ↗ | ↗ |
| B. | ↖ | ↑ | ↖ |
| C. | ↖ | ↑ | ↗ |
| D. | ↑ | ↗ | ↑ |

10 **The transformer for an electric guitar tuner has an input voltage of 230 V and an output voltage of 6 V.**

**Which of the following options could achieve this transformation?**

| | **Number of turns Primary** | **Number of turns Secondary** |
|---|---|---|
| **(A)** | **690** | **12** |
| **(B)** | **12** | **690** |
| **(C)** | **2760** | **72** |
| **(D)** | **72** | **2760** |

**11** The diagram shows the atomic spectra of two different elements *X* and *Y*.




Given that atomic spectra are "fingerprints" used to identify elements, which choice best accounts for the fact that these two elements have a spectral line at point *G*?

A. The diagram must be incorrect as every element will have completely different spectral lines.

B. Coincidentally, there is an electron transition, with a very similar energy value in both elements.

C. The orbital levels in elements often have the same energy values as the same orbital levels in other elements.

D. The energy levels of the orbits in elements are directly proportional to the number of the electron orbit.

**12** How did Newton's particle theory of light explain refraction?

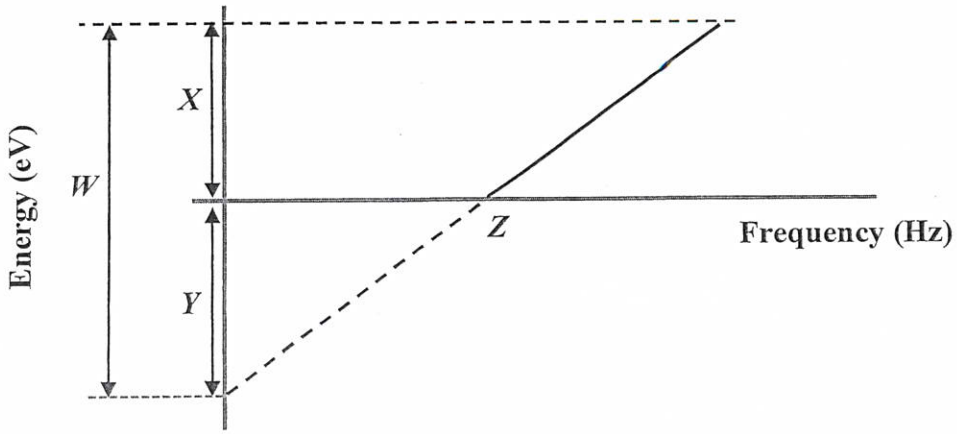
A. Stronger forces within the refracting medium changed the direction of travel of the light particles as they entered the medium.

B. Because the refracting medium was so dense compared to air, the light particles were forced to slow down.

C. The light particles scattered in the medium because the medium particles were closer together than air particles.

D. Newton's particle theory of light could not explain refraction.

**13** The graph shows information about the emission of photoelectrons from a metal.




Which choice correctly identifies the sections labelled W, *X*, *Y* and *Z*?

| | *W* | *X* | *Y* | *Z* |
|---|---|---|---|---|
| A. | Energy of incident photon | Work function of emitter | Kinetic energy of emitted photoelectron | Threshold frequency |
| B. | Kinetic energy of emitted photoelectron | Energy of incident photon | Threshold frequency | Work function of emitter |
| C. | Threshold energy | Kinetic energy of emitted photoelectron | Energy of incident photon | Work function of emitter |
| D. | Energy of incident photon | Kinetic energy of emitted photoelectron | Work function of emitter | Threshold frequency |

STUDENT NUMBER/NAME.....

14 According to Max Planck's black body experiments, which characteristic of an object determined the wavelength of the peak radiation emitted by a hot object?

A. The type of material the object is made of

B. The temperature of the object

C. The type of material and its temperature

D. The temperature of the object and its shape

15. A stationary observer on Earth measures a spaceship travelling at $2.75 \times 10^8$ m s$^{-1}$. When stationary, the spaceship's length is 42 m.

What is the length of the spaceship as seen by the stationary observer?

(A) 16.79 m
(B) 39.21 m
(C) 40.21 m
(D) 45.14 m

16 How long would it take for the radioactivity of a 200 g sample of a radioactive substance with a half-life of 16.2 years, to decay to 15% of its original value?

A. 28.1 years

B. 44.34 years

C. 60.54 years

D. 76.74 years

17 Light from a laser is directed through a pair of slits that are 40 mm apart. If the laser light has a wavelength of 600 nm, calculate the distance between three sequential bright fringes that would be produced if projected onto a screen 1 m from the slits.

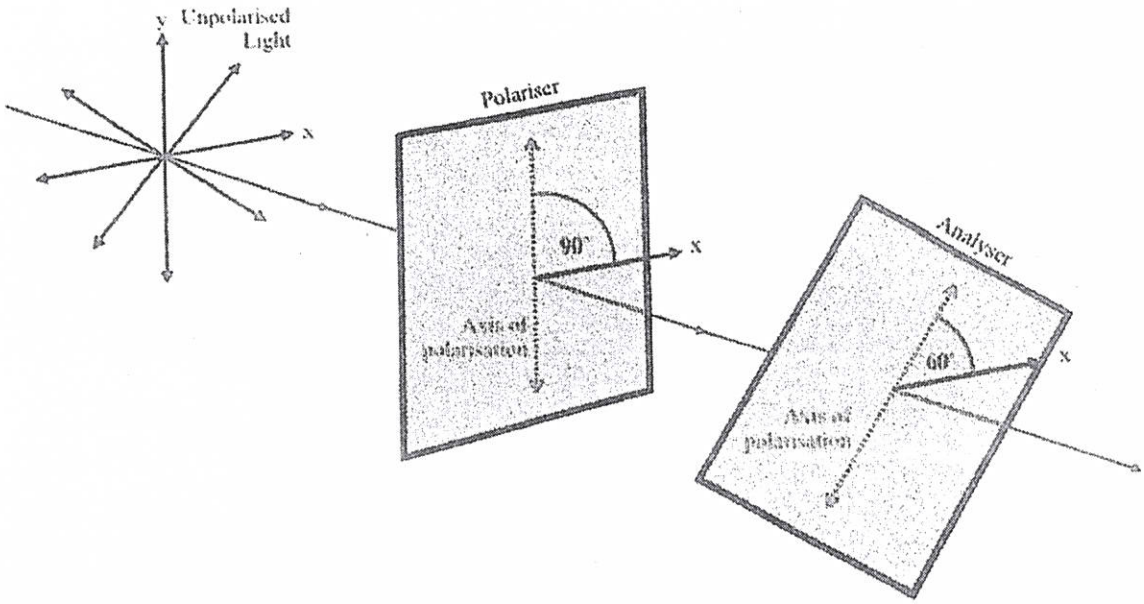
(A) 0.003cm

(B) 0.0015cm

(C) 0.005cm

(D) 0.001cm

18 Unpolarised light is passed through a polariser followed by an analyser as shown in the diagram below.




Calculate the intensity of the light transmitted by the analyser.

(A) 0.125 $I_o$

(B) 0.375 $I_o$

(C) 0.25 $I_o$

(D) 0.75 $I_o$

**19** What is the relationship between binding energy and mass defect in a spontaneous nuclear reaction?

A. The mass defect is the equivalent of the binding energy of the products.

B. The mass defect is the equivalent of the binding energy of the reactant.

C. The mass defect is the equivalent of the binding energy loss of the products compared to the reactants.

D. The mass defect is the equivalent of the binding energy gain of the products compared to the reactants.

**20** What was Schrodinger's main contribution to the current model of the atom?

A. Schrodinger performed diffraction experiments verifying the wave properties of electrons.

B. Schrodinger's work was the basis of Bohr's model of the atom.

C. Schrodinger's wave equations were very important in the development of modern quantum mechanics.

D. Schrodinger was the first to apply quantum ideas to the understanding of the atom.

## Section II

**80 marks**
**Attempt Questions 21–36**
**Allow about 2 hours 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.

Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

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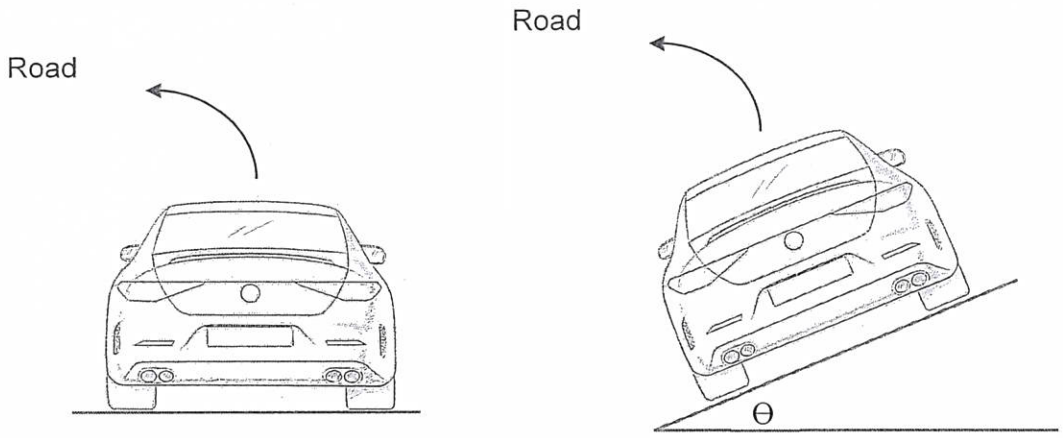
**Question 21** (4 marks) **Marks**

The diagram shows identical cars on rough road surfaces, one on a curved horizontal road and one on a curved road banked at $\Theta°$. Both roads curve towards the left, with the curves part of the same radius circle. **4**




With the help of additions to the diagram above, explain why the car can safely take the banked curve at a higher speed than the identical car driving on the horizontal curved road.

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**Question 22** (9 marks) **Marks**

A stroboscopic photograph was taken of student competing a long jump event. The distance between the student in the first and last images is 2.2 m. The camera used to take the pictures took one frame every 0.1 s.

(a) Calculate, using projectile motion equations, the maximum height of the student above the ground. Identify any assumptions made in your calculation **5**

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**Question 22 continues on the next page**

Question 22 (continued) **Marks**

(b) At what velocity did the student launch upwards? **4**

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**End of Question 22**

**Question 23** (3 marks)

**Marks**

The total energy of a satellite is equal to the sum of its gravitational potential energy and its orbital kinetic energy. However, the work done to put that satellite into orbit is less than this. **3**

Explain how this does not contravene the law of conservation of energy.

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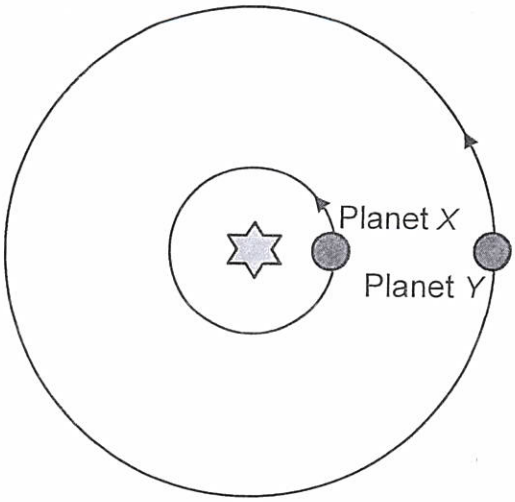
**Question 24** (3 marks) **Marks**

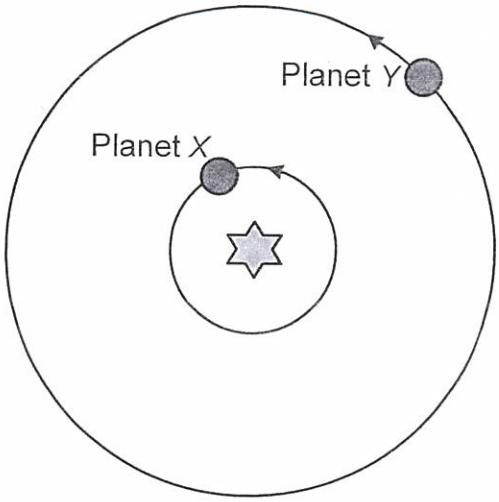
Two planets $X$ and $Y$ travel anticlockwise in circular orbits about a star, as seen in the diagram. The radii of the orbits $X$ and $Y$ are in the ratio 2:5. **3**

The planets are shown below at a time interval of 5 years. Initially they were aligned, making a straight line with the star. Five years later, planet $X$ has rotated through 120°, as shown.

Initial position of planets




Position of planets 5 years later




Determine how long it takes planet $Y$ to orbit the star.

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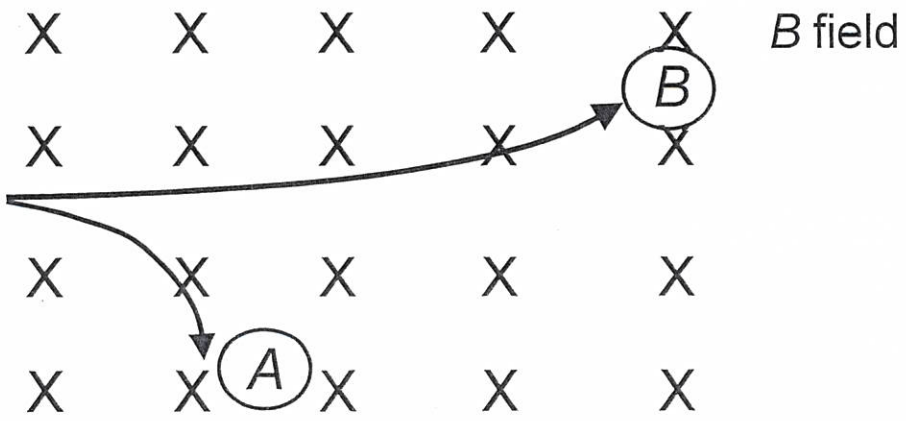
**Question 25** (4 marks) **Marks**

Charged particles *A* and *B* move into a magnetic field and move along different circular paths.




(a) What *must be different* about particles *A* and *B*? Justify your answer. **1**

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(b) What *might be different* about particles *A* and *B*? Justify your answer. **3**

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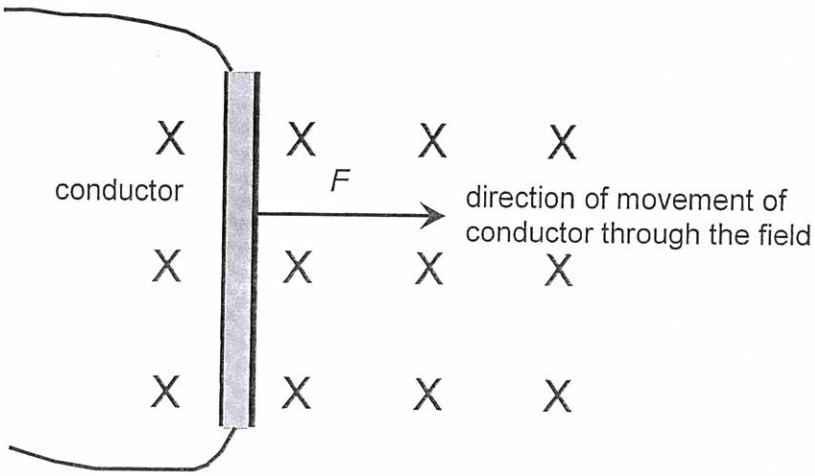
**Question 26** (4 marks)

**Marks**

A conductor which is connected to a galvanometer is moved by a force $F$ through a magnetic field, as shown below. **4**




In terms of the principles of physics involved, predict the direction of the induced current in the conductor and explain why it *must* be in this direction.

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**Question 27** (4 marks) **Marks**

The old definition of the ampere stated:

> *The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed one metre apart in vacuum, would produce between these conductors a force equal to $2\times10^{-7}$ newtons per metre of length.*

Explain how this definition of the ampere relates to Newton's Third Law and calculate the size of the force between two parallel current carrying wires, each 0.65 metres long, carrying 0.375 amperes each, and separated by a distance of 13.5 mm **4**

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**Question 28** (9 marks) **Marks**

The table shows the results of an experiment on the relationship between the rotational speed of a motor coil and the net voltage across the coil. The motor was connected to a 12 V power supply. Assume that there is no load attached and frictional effects are zero.

| *Speed of coil (rpm)* | *Voltage across coil (V)* |
|---|---|
| 0 | 12.0 |
| 1000 | 11.3 |
| 2000 | 10.1 |
| 3000 | 9.8 |
| 4000 | 9.3 |
| 5000 | 8.7 |
| 6000 | 7.6 |

(a) Graph this data on the axes below. 2

**Question 28 continues on the next page**

Question 28 (continued) **Marks**

(b) Explain, in terms of the principles of physics involved, why the net voltage across the coil is decreasing and predict its minimum value when the motor reaches its maximum operating speed. **4**

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(c) On the basis of his graph the student concluded that the net voltage across motor coils is directly proportional to the speed of the coil. **3**

Evaluate the student's conclusion.

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**End of Question 28**

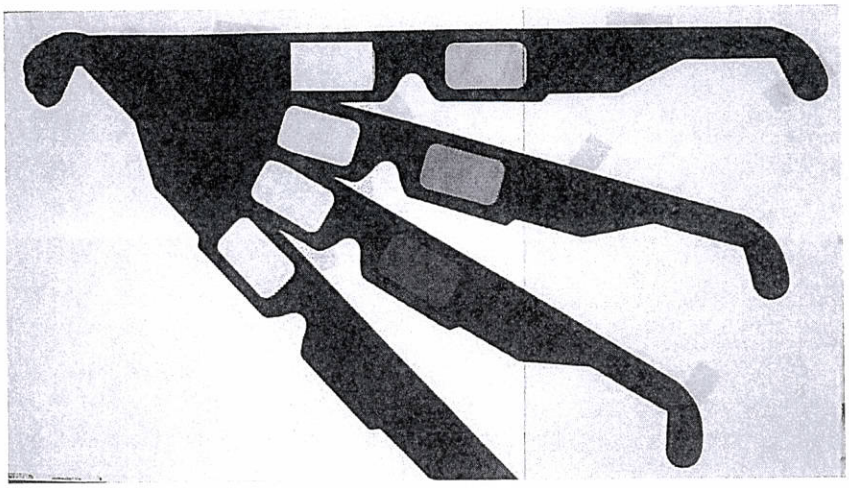
**Question 29** (5 marks)

(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 30** (4 marks) **Marks**

The photograph below shows the two lenses of a pair of glasses in front of the same light source. The arm of the glasses is pivoted on the left-hand side so that the angle of the arm relative to the light source can be changed. The photograph shows the two lenses at four different positions. **4**



In terms of the principles of physics involved, account for the lack of change in the light passing through the left-hand lens compared to the changing amount of light passing through the right-hand lens as the angle of inclination of the lenses is increased.

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**Question 31** (4 marks) **Marks**

Compare the structure and function of a DC generator and a DC motor. 4

**Question 32** (5 marks) **Marks**

Einstein's Special Theory of Relativity is widely accepted as making excellent predictions even though these predictions are not readily observed in everyday situations 3

(a) Describe evidence that supports predictions made by Einstein's special relativity of theory.

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(b) Calculate relativistic momentum of a proton moving at 0.8 c. 2

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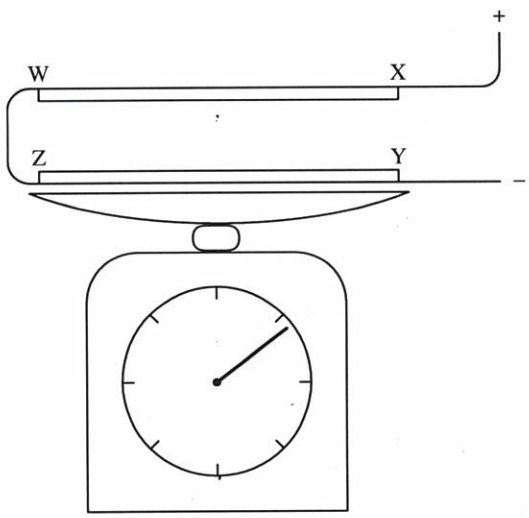
**Question 33** (4 marks)

A teacher demonstrates the forces on two parallel identical copper conductors, as shown in the diagram. **4**




The top conductor WX is fixed, while the bottom conductor ZY lies on top of a balance. The distance between the conductors is 5 mm, and each conductor is 29 cm in length. Initially, the balance reads 4.5 grams for conductor ZY. When the current is switched on, the teacher records a reading of 4.56 grams.

Calculate the magnitude of the current.

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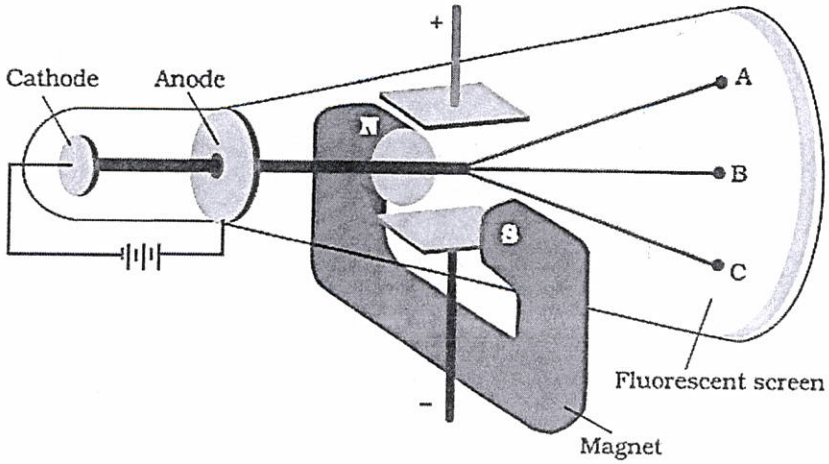
**Question 34** (8 marks) **Marks**

The diagram shows apparatus similar to that used by J J Thomson in early cathode ray tube experiments. **8**




Explain how Thomson used this apparatus to determine the nature of cathode rays and outline how his interpretation of the results contributed to our understanding of the structure of matter.

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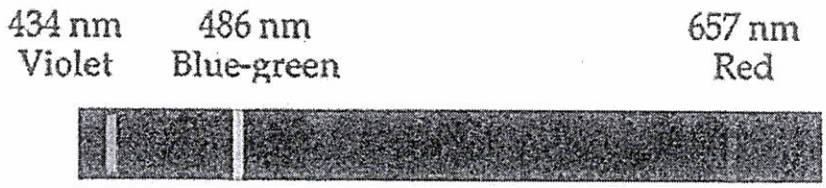
**Question 35 (3 marks)** **Marks**

When an excited electrons falls from n = 4 to n = 2, the transition emits a blue-green colour. Calculate the energy involved in this transition in Joules and eV. 3



**Question 36** (7 marks)

**Marks**

Analyse how conservation laws relate to the structure of the atom. 7

**Extra writing space**

# TRIAL EXAMS – 2020
# PHYSICS – TRIAL HSC EXAMINATION
# MARKING GUIDELINES

**Section I**

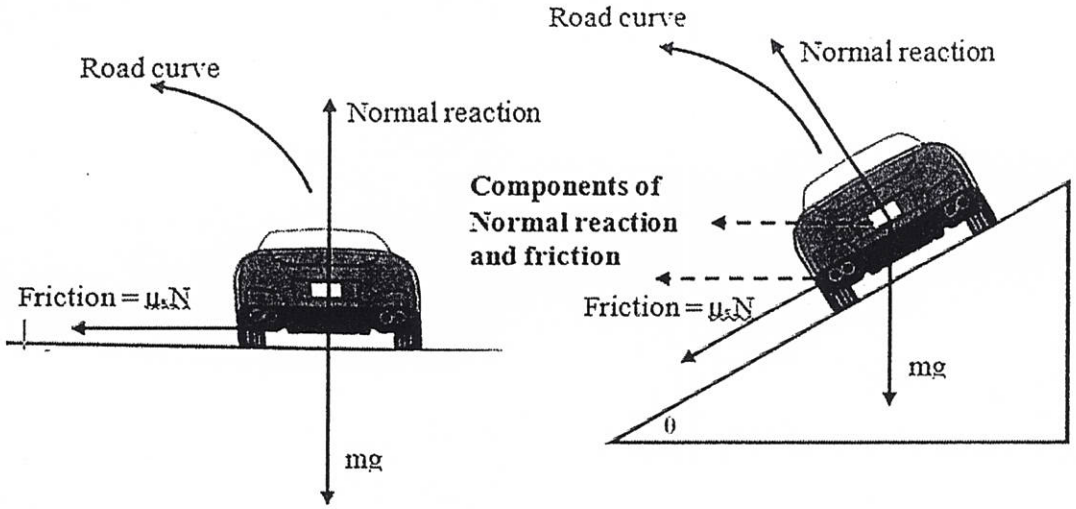
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | D | B | A | C | B | D | A | C | C | B | A | D | B | A | B | A | D | D | C |

**Section II**

**Q21**

| Criteria | Marks |
|---|---|
| • Identifies ALL forces acting, draws components of forces on diagram and compares the magnitudes of their contribution to centripetal force | 4 |
| • Identifies all forces acting and draws components of forces on diagram contributing to centripetal force | 3 |
| • Identifies the contribution of the normal reaction component to centripetal force | 2 |
| • Provides some relevant information | 1 |

*Sample answer:*




On the horizontal road, the friction alone provides the centripetal force to hold car in curve. On the banked road, only a component of the frictional force is acting horizontally but the horizontal component of the normal reaction force contributes. This is significantly larger than the reduction in the frictional force towards the centre of the motion. Therefore, the net centripetal force is larger and since mass and radius of curvature are the same, the car can go faster around the banked curve.

**Q22(a)**

| Criteria | Marks |
|---|---|
| • Calculates the maximum height and makes clear TWO assumptions | 5 |
| • Calculates the maximum height and makes clear ONE assumption<br>OR<br>• Provides maximum height calculation with ONE error and TWO assumptions | 4 |
| • Calculates the maximum height<br>OR<br>• Provides maximum height calculation with ONE error and ONE assumption | 3 |
| • Provides maximum height calculation with ONE error | 2 |
| • Provides some relevant information | 1 |

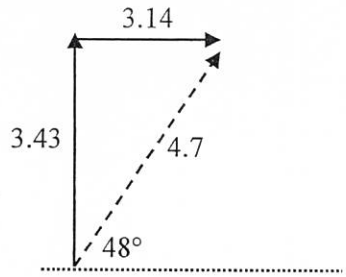
*Sample answer*: The number of spaces in the photograph = 7, therefore the time of flight = 0.7 s
Time to rise to top of path = half time of flight = 0.35 s  Vertical velocity at top = 0
$v_{top} = u + at \quad 0 = u - 9.8 \times 0.35$
Therefore $u_{vertical} = 3.43$ m s$^{-1}$ upwards
From $v_{top}^2 = u_v^2 + 2a\Delta y$, $0 = 3.43^2 - 19.6\Delta y$
Maximum height = 0.60 m

It must be assumed that the jumper is in the air for precisely 7 intervals but the first and last intervals may have been less. The jumper is not a point object so the answer would apply to the centre of mass of the jumper. Therefore, his feet would have been closer to the ground than 0.6 m. Also, the rotation of parts of the body may have applied forces apart from gravity affecting the height of the centre of mass.

**Q22(b)**

| Criteria | Marks |
|---|---|
| • Calculates launch speed and direction | 4 |
| • Calculates launch speed and direction using vectors with ONE error | 3 |
| • Calculates launch speed using vectors with ONE error | 2 |
| • Provides some relevant information | 1 |

*Sample answer*: Initial horizontal speed is = 2.2 m/0.7 = 3.14 m s$^{-1}$
Launch speed = vector sum of horizontal and vertical velocities




Launch speed = 4.7 m s$^{-1}$ at 48° to the horizontal

**Q23**

| Criteria | Marks |
|---|---|
| • Explains clearly how energy is conserved | 3 |
| • Identifies the difference in gravitational potential energy in relation to definition | 2 |
| • Identifies the difference in gravitational potential energy | 1 |

*Sample answer*: The work done to provide the orbital kinetic energy is given by the formula $1/2mv^2$. Because gravitational potential energy is calculated based on distance from the centre of the Earth, the work done to raise the satellite to its orbital position is the difference in the gravitational potential energy between the orbit position and the surface of the Earth. The satellite also had kinetic energy at launch due to the Earth's rotation.

The total energy of the satellite in orbit is the gravitational potential energy at the Earth's surface plus the work done to provide its kinetic energy plus the work done to increase the potential energy to that of the orbit which is less than the orbital potential energy. The law of conservation of energy is not contravened.

**Q24**

| Criteria | Marks |
|---|---|
| • Calculates period of planet Y | 3 |
| • Calculates period of planet X and correctly substitutes into Kepler's law of periods | 2 |
| • Calculates period of planet X<br>OR<br>• Correctly substitutes into Kepler's law of periods | 1 |

*Sample answer*: Planet X travels 120/360 = 0.33 rotation in 5 years
Therefore, X travels one rotation in 5/0.33 = 15 years
Kepler's law of periods states that $(T_Y^2)/(R_Y)^3 = (T_X^2)/(R_X)^3$
Hence $(T_Y^2)/(T_X^2) = (R_Y)^3/(R_X)^3$
$(T_Y^2)/(T_X^2) = 5^3/2^3$ $T_Y^2 = 15^2 \times 5^3/2^3$ $T_Y = 59$ years

**Q25(a)**

| Criteria | Marks |
|---|---|
| • Identifies sign of charge | 1 |

*Sample answer*: The signs must be different (A is negative and B is positive) because they curve in opposite directions within the field.

**Q25(b)**

| Criteria | Marks |
|---|---|
| • Identifies THREE detailed possibilities and reason | 3 |
| • Identifies TWO detailed possibilities and reason<br>OR<br>• Three detailed possibilities | 2 |
| • Identifies TWO possibilities | 1 |

*Sample answer*: In a magnetic field, the force on a charge moving at right angles to the field equals Bqv. Hence $Bqv = mv^2/r$ and $r = mv/Bq$. The radii of curvature of B is larger than A, therefore the mass of A could be smaller, the velocity of B could be larger, the charge of A be larger than B or a combination of these variables could apply.

**Q26**

| Criteria | Marks |
|---|---|
| • Provides a correct prediction and a well-reasoned explanation identifying TWO physics principles | 3-4 |
| • Provides a correct prediction based on conservation of energy | 2 |
| • Provides a correct prediction | 1 |

*Sample answer*: The induced current in the conductor will be towards the top of the page. It must be in this direction in order to obey Lenz's law, based on the law of conservation of energy which states that energy cannot be created or destroyed, only changed from one form to another. If the current was down the page, then according to the motor effect, the magnetic field it induced would interact with the applied magnetic field (the field into the page) to produce a force on the conductor to the right as given by the right-hand palm rule. This would increase the movement to the right and increase its kinetic energy without the need to continue to apply the external force, F.

**Q27**

| Criteria | Marks |
|---|---|
| • Applies Newton's Third law to the ampere definition and calculates the force between the two wires | 4 |
| • Applies Newton's Third law to the ampere definition and shows some correct working when calculating the force between the two wires | 3 |
| • Applies Newton's Third law to the ampere definition<br>OR<br>• Calculates the force between the two wires | 2 |
| • Provides some correct information | 1 |

*Sample answer*: In the definition the conductors exert equal and opposite forces on each other according to Newton's Third Law. The force on conductor 1 by conductor 2 (action) is equal in size but opposite in direction to the force on conductor 2 by conductor 1 (reaction). The forces may pull the conductors together or push the conductors apart.

The size of the force is given by:

$$\frac{F}{l} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r}$$

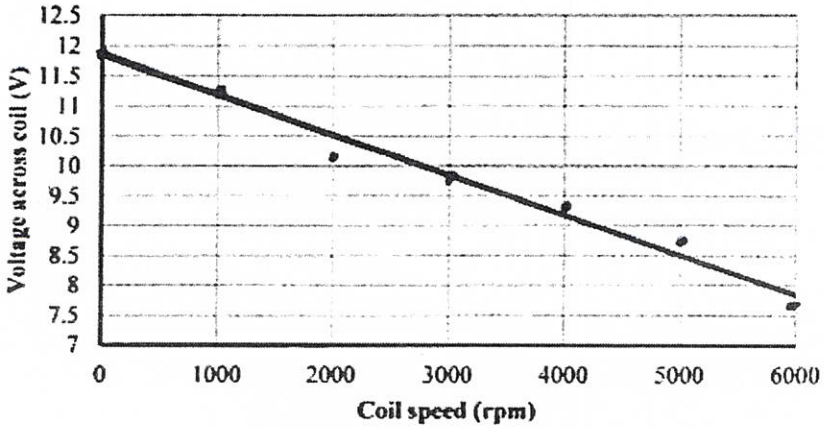
$F = 2 \times 10^{-7} \times (0.375)^2 / (13.5 \times 10^{-3})$

$= 2.08 \times 10^{-6}$ N

**Q28(a)**

| Criteria | Marks |
|---|---|
| • Correctly plots points and draws a ruled line of best fit | 2 |
| • Correctly plots some points<br>OR<br>• Draws a ruled line of best fit | 1 |

*Sample answer*:




**Q28(b)**

| Criteria | Marks |
|---|---|
| • Explains the change in voltage in terms of physics principles and justifies the predicted minimum value | 4 |
| • Identifies the cause of the change in voltage and correctly predicts the minimum value | 3 |
| • Explains the change in voltage in terms of physics principles<br>OR<br>• Justifies the predicted minimum value | 2 |
| • Identifies induction as the cause of the change in voltage<br>OR<br>• Correctly predicts the minimum value | 1 |

*Sample answer*: The voltage is decreasing because the movement of the sides of the coil through the magnetic field will induce a back emf in the coil (Faraday's law of induction). The direction of this emf must be such that it opposes the motion of the coil (Lenz's Law) so as not to contravene the law of conservation of energy.

When the motor reaches its operating speed, the voltage across it will be zero and the back emf will equal the supply voltage.

**Q28(c)**

| Criteria | Marks |
|---|---|
| • Judges conclusion incorrect based on TWO requirements for inversely proportional graph and application to other motors | 3 |
| • Judges conclusion incorrect based on TWO requirements for inversely proportional graph<br>OR<br>• Judges conclusion incorrect based on ONE requirement for inversely proportional graph and application to other motors | 2 |
| • Judges conclusion incorrect based on ONE requirement for inversely proportional graph<br>OR<br>• Judges conclusion incorrect based on application to other motors | 1 |

*Sample answer*: The student's statement is incorrect – the decrease in the net voltage is a linear function of the speed of the rotor but not directly proportional, requiring a straight line through the origin with a positive gradient. Having made only one set of measurements and used only one type of motor, any conclusion could only apply to this motor and would not be valid for all motors.

**Question 29a**

| 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: The ship is travelling at 89% the speed of light

**Question 29b**

| Criteria | Marks |
|---|---|
| Calculates the speed of escape velocity from Earth | 2 |
| A relevant step involved | 1 |

Sample answer: $v = \sqrt{2GM/r}$

Q30

| Criteria | Marks |
|---|---|
| • Identifies light source and lens as polarised and the light through the right lens depends on the angle between the planes of polarisation<br>OR<br>• Applies Malus's law | 4 |
| • Identifies light source and lens as polarised and the light through the right lens depends on the angle between the planes of polarisation | 3 |
| • Identifies light source and lens as polarised | 2 |
| • The light is polarised<br>OR<br>• The right lens is polarised | 1 |

*Sample answer*: Because the light intensity through the right-hand lens changes, the incident light from the back must be polarised as well as the right-hand lens material. Because the angle of inclination of this lens changes, the angle between the polarisation planes changes and according to Malus's Law, the intensity of light through the lens changes. This varies as $\cos^2\Theta$ where $\Theta$ is the angle between the two planes of polarisation. In the last position, the angle is 90°.

The intensity of the light passing through the left-hand lens does not change because that lens is not polarised.

**Question 31**

| Criteria | Marks |
|---|---|
| Compares both structure and function in terms of both similarities and differences | 4 |
| Compares both structure and/or function in terms of similarities and/or differences | 3 |
| 2 relevant points in terms of comparing structure and/or function | 2 |
| 1 relevant point in terms of comparing structure and/or function | 1 |

Sample answer:

Similarities in structure

- Both very similar as both have coil in a magnetic field as well as a split ring commutator and brushes

Differences in structure

- Motor has power supply whereas generator has power output terminals

Similarities in function

- Both convert energy from one form to another

Differences in function

- Motor converts electrical energy → mechanical energy whereas generator converts mechanical energy → electrical energy

**Question 32a**

| Criteria | Marks |
|---|---|
| Outlines in detail an experimental validation of time dilation | 3 |
| Outlines simply 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.

Q32(b)

| Criteria | Marks |
|---|---|
| • Calculates relativistic momentum correctly | 2 |
| • Calculates relativistic momentum based on incorrect relativistic mass calculation | 1 |

*Sample answer*:

At 0.8c, the gamma factor $= \frac{1}{\sqrt{1 - v^2/c^2}} = \frac{1}{0.6} = 1.67$

Therefore, the relativistic mass of the proton $= 1.673 \times 10^{-27} \times 1.67 = 2.79 \times 10^{-27}$ kg

So, relativistic momentum of the proton $= 2.79 \times 10^{-27} \times 0.8 \times 3 \times 10^{8} = 6.7 \times 10^{-19}$ kg m s$^{-1}$

**Question 33**

| Criteria | Marks |
|---|---|
| Calculates the correct force of repulsion rearranges equation to find current AND states that the current is the same for both conductors AND states the current for both conductors AND states the correct magnitude of the current | 4 |
| Any three of the above points | 3 |
| Any two of the above points | 2 |
| Any one of the above points | 1 |

Sample answer:

force of repulsion $= mg$

$= 0.06 \times 10^{-3} \times 9.8$

$= 5.88 \times 10^{-4}$ N

$$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$$

$$I = \sqrt{\frac{F \times 2\pi r}{l \times \mu_0}}$$

Since the current is the same for both conductors, the magnitude of the current will be:

$$I = \sqrt{\frac{5.88 \times 10^{-4} \times 2\pi \times 5.00 \times 10^{-3}}{29.0 \times 10^{-2} \times 4\pi \times 10^{-7}}}$$

$= 7.12$ A

Q34

| Criteria | Marks |
|---|---|
| • Describes the deflection of cathode rays in electric field and its importance in the debate about the nature of cathode rays<br>• Provides a comprehensive description of use of magnetic field as well as electric to determine charge/mass ratio<br>• Outlines basis for identifying the cathode rays as a charged subatomic particle | 7–8 |
| • Describes the deflection of cathode rays by electric fields<br>• Outlines how the charge/mass ratio was found<br>• Identifies cathode rays as negatively charged particles | 5–6 |
| • Describes the deflection of cathode rays by electric fields<br>• Outlines how the charge/mass ratio was found | 3–4 |
| • Provides some relevant information | 1–2 |

*Sample answer:* In his experiment Thomson used an extended cathode ray tube with a slot in the anode to produce a focussed beam of cathode rays. He first deflected the cathode rays with an electric field to position A. This result provided strong evidence for cathode rays being negatively charged particles (waves cannot be charged) and settled the debate that had been ongoing for years as to whether they were waves or particles. This debate had raged because although the cathode rays were deflected by magnetic fields, the electric fields used had not been strong enough to produce a visible deflection, so it was thought the cathode rays might be uncharged, and therefore possibly waves.

In further experiments, the beam of electrons was passed through a magnetic field perpendicular to the electrons' velocity, produced by current carrying coils on each side of tube. The deflection of the beam in magnetic field was measured at the end of the tube and used to calculate the radius of the curved (circular) path of electrons in magnetic field, B. The electric field E perpendicular to the magnetic field was then adjusted so that the forces deflecting the beam due to E and B fields cancelled. From his measurements and the size of the electric and magnetic field applied, Thomson calculated the charge to mass ratio of the cathode ray particles.

It is at this point that Thomson used his results as the basis for a brilliant assumption: that the charge on cathode ray particles was similar in size to that on a hydrogen ion and then calculated their mass. (His value was close to the value accepted today). He further assumed they were the same as the particles predicted by George Stoney in 1894 to be part of an atom and responsible for dynamic (flowing) electricity. He gave them Stoney's name, "*electrons*". Thomson's work provided evidence for the first subatomic particles to be discovered.

**Question 35**

| Criteria | Marks |
|---|---|
| Calculates the energy in Joules and eV correctly | 3 |
| Calculates the energy in Joules or eV correctly | 2 |
| A relevant step included | 1 |

Sample answer:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$ where $1.097 \times 10^7 m^{-1}$

$\lambda$ = 486nm (486.17nm)

$c = f\lambda$ SO $f = 6.172839506 \times 10^{14} Hz$

$E = hf$ so $E = 4.090123457 \times 10^{-19} J$ or $E = 4.1 \times 10^{-19} J$ and $E = 2.556 eV$

**Question 36**

| Criteria | Marks |
|---|---|
| Clear and logical analysis of how conservation laws have been used over time to enable scientists to determine the structure of the atom. | 7 |
| An analysis of how conservation laws have been used over time to enable scientists to determine the structure of the atom. | 6 |
| Identifying how conservation laws have been used over time and how they have determined the structure of the atom. | 5 |
| Identifying how conservation laws have been used over time or how they have determined the structure of the atom. | 4 |
| Three relevant pieces of information included in answer | 3 |
| Two relevant pieces of information included in answer | 2 |
| A relevant piece of information included in answer | 1 |

Sample answer:

Clear and logical analysis

Define conservation laws :

Relate to the structure of the atom: Chadwick, Bohr ????

# NSW INDEPENDENT TRIAL EXAMS – 2020
# PHYSICS – TRIAL HSC EXAMINATION – MAPPING GRID

| Question | Marks | Content module | Syllabus Outcomes (PH) | Targeted performance bands |
|---|---|---|---|---|
| **Section I** | | | | |
| **1** | 1 | 5 Projectile Motion | 12-6, 12-12 | 2-3 |
| **2** | 1 | 5 Motion in a Gravitational Field | 12-5, 12-12 | 3-4 |
| **3** | 1 | 5 Projectile Motion<br>Circular motion | 12-6, 12-12 | 2-3 |
| **4** | 1 | 5 Circular Motion | 12-6, 12-12 | 2-3 |
| **5** | 1 | 5 Projectile Motion | 12-6, 12-12 | 3-4 |
| **6** | 1 | 6 Applications of the Motor Effect | 12-6, 12-13 | 2-3 |
| **7** | 1 | 6 Charged Particles, Conductors and Electric and Magnetic Fields | 12-6, 12-13 | 3-4 |
| **8** | 1 | 6 Charged Particles, Conductors and Electric and Magnetic Fields | 12-6, 12-13 | 3-4 |
| **9** | 1 | 6 Electromagnetic Induction | 12-6, 12-13 | 4-5 |
| **10** | 1 | 6 Electromagnetic Induction | 12-6, 12-13 | 2-3 |
| **11** | 1 | 7 Electromagnetic Spectrum | 12-6, 12-14 | 3-4 |
| **12** | 1 | 7 Light: Wave Model | 12-6, 12-14 | 3-4 |
| **13** | 1 | 7 Light: Quantum Model | 12-6, 12-14 | 4-5 |
| **14** | 1 | 7 Light: Quantum Model | 12-6, 12-14 | 3-4 |
| **15** | 1 | 7 Light and Special Relativity | 12-6, 12-14 | 3-4 |
| **16** | 1 | 8 Properties of the Nucleus | 12-6, 12-15 | 4-5 |
| **17** | 1 | 8 Origins of the Elements | 12-6, 12-15 | 3-4 |
| **18** | 1 | 8 Quantum Mechanical Nature of the Atom | 12-6, 12-15 | 4-5 |
| **19** | 1 | 8 Properties of the Nucleus | 12-6, 12-15 | 4-5 |
| **20** | 1 | 8 Deep inside the Atom | 12-6, 12-15 | 2-3 |
| **Section II** | | | | |
| **21** | 4 | 5 Circular Motion | 12-6, 12-7, 12-6, 12-12 | 3-5 |
| **22(a)** | 5 | 5 Projectile Motion | 12-4, 12-5, 12-12 | 3-4 |
| **22(b)** | 4 | 5 Projectile Motion | 12-6, 12-12 | 4-5 |
| **23** | 3 | 5 Motion in a Gravitational Field | 12-6, 12-7, 12-12 | 4-6 |
| **24** | 3 | 5 Motion in a Gravitational Field | 12-6, 12-12 | 3-5 |
| **25(a)** | 1 | 6 Charged Particles, Conductors and Electric and Magnetic Fields | 12-7, 12-13 | 3-4 |
| **25(b)** | 3 | 6 Charged Particles, Conductors and Electric and Magnetic Fields | 12-7, 12-13 | 4-5 |
| **26** | 4 | 6 Electromagnetic Induction | 12-7, 12-13 | 3-4 |
| **27** | 4 | 6 The Motor Effect | 12-13 | 3-4 |
| **28(a)** | 2 | 6 Applications of the Motor Effect | 12-4 | 2-3 |
| **28(b)** | 4 | 6 Applications of the Motor Effect | 12-7, 12-13 | 4-5 |
| **28(c)** | 3 | 6 Applications of the Motor Effect | 12-5, 12-13 | 2-3 |
| **29** | 8 | 7 Electromagnetic Spectrum | 12-7, 12-14 | 3-6 |
| **30** | 4 | 7 Light: Wave Model | 12-6, 12-14 | 4-5 |
| **31** | 4 | 7 Light: Quantum Model | 12-5, 12-6, 12-14 | 4-5 |
| **32(a)** | 2 | 7 Light and Special Relativity | 12-7, 12-14 | 3-4 |
| **32(b)** | 2 | 7 Light and Special Relativity | 12-6, 12-14 | 3-4 |
| **33(a)** | 2 | 8 Properties of the Nucleus | 12-7, 12-15 | 2-3 |
| **33(b)** | 2 | 8 Properties of the Nucleus | 12-6,12-15 | 3-4 |
| **34** | 8 | 8 Structure of the Atom | 12-7, 12-15 | 3-6 |
| **35** | 3 | 8 Quantum Mechanical Nature of the Atom | 12-7, 12-15 | 3-4 |
| **36** | 5 | 8 Deep inside the Atom | 12-7, 12-15 | 3-5 |