Student number ....

Cheltenham Girls
High School

2011
Trial Higher School Certificate
Examination

Physics

Total marks – 100

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Write your Student Number at the top of each page you write
- This paper is a Trial Paper only. It follows the structure of the BOS HSC but only examines 9.8.1 of the From Quanta to Quarks Option

Section I Pages 1 – 14

75 marks
This section has two parts, Part A and Part B

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

Part B – 55 marks
- Attempt Questions 21 to 30
- Allow about 1 hour and 40 minutes for this part

Section II Pages 15 - 17
25 marks
- Attempt Questions 31 to 32
- Allow about 45 minutes for this section

Section I
75 marks

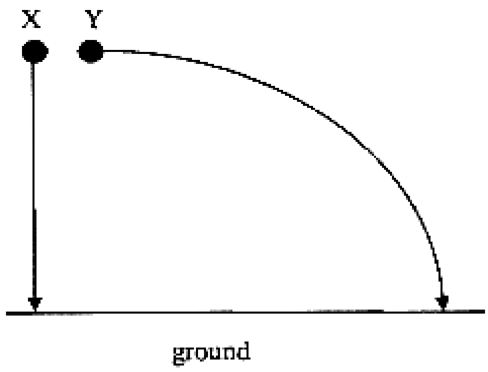
Part A – 20 marks
Attempt Questions 1 – 20
Allow about 35 minutes for this part

Use the multiple-choice answer sheet for Questions 1–20 (remove this sheet from the exam end)

1 An astronaut has a weight of 589 Newtons on Earth. He travels to a distant planet, where his weight is now 1411 Newtons. The acceleration due to gravity on the surface of this planet is:

(A) 2.40 ms^{-2}
(B) 4.10 ms^{-2}
(C) 23.48 ms^{-2}
(D) 143.83 ms^{-2}

2 Two identical metal balls, X and Y, are released at the same time from the same height above horizontal ground. Ball X falls vertically from rest. Ball Y is projected horizontally as shown below. (Air resistance is negligible.)



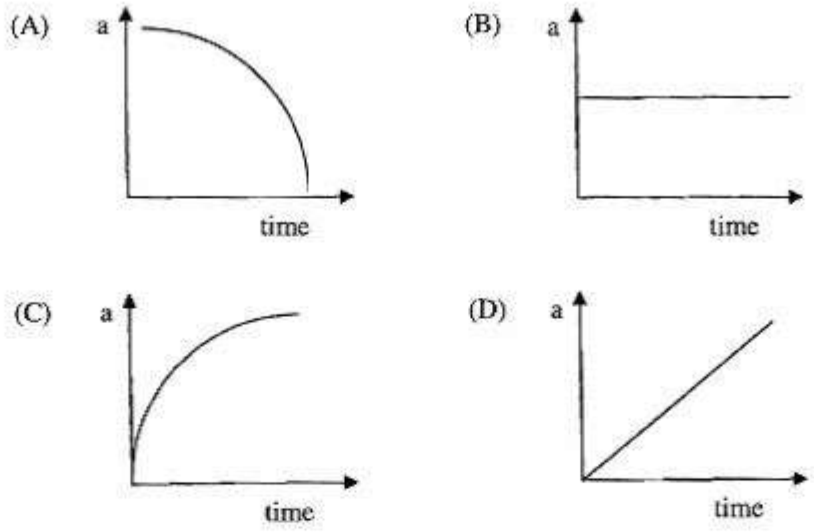
Which of the following statements is correct?

(A) Ball X hits the ground before ball Y because it travels a shorter distance.
(B) Ball Y hits the ground before ball X because its initial velocity is greater.
(C) The balls hit the ground at the same time because horizontal motion does not affect vertical motion.
(D) The balls hit the ground at the same time because they have equal weights.

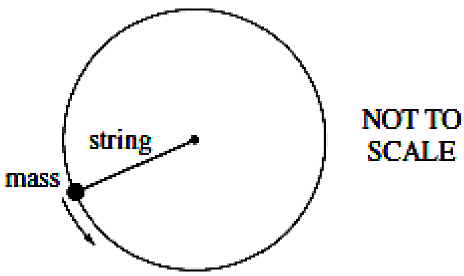
3 On board a spacecraft travelling at 0.5 c relative to the Earth, you measure your craft as being 100 m long. Carrying out this measurement takes you 50 seconds. Observers on Earth with an amazing telescope are watching you. How much time elapses for them, and what is their measurement of your spacecraft?

	Time elapses (s)	Length of your spacecraft(m)
(A)	43.3	86.6
(B)	43.3	115.5
(C)	57.7	86.6
(D)	57.7	115.5

4 Which of the following acceleration versus time graphs best describes the acceleration of a rocket, which is launched with constant thrust motors?



5 A 50 g mass is swung in a horizontal circle as shown. It completes 10 revolutions in 65.2 seconds. The circle has a 50 cm diameter.



Which of the following forces is closest to that required to keep the mass moving in this circle?

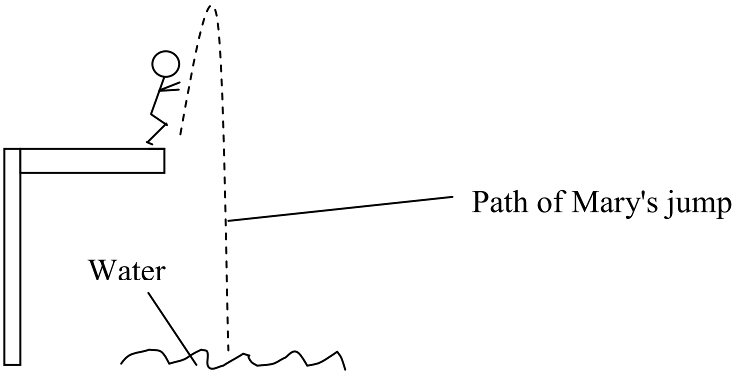
(A) 4.25 N
(B) 8.50 N
(C) 4251.04 N
(D) 8502.08N

6 The acceleration due to gravity on a planet is determined by the mass of the planet and its radius.
Use the information in the table below to determine which planet has the largest acceleration due to gravity.

Planet	*Radius (m)*	*Mass (kg)*
Planet P	6.38×10^{6}	6.0×10^{24}
Planet Q	3.40×10^{6}	6.6×10^{23}
Planet R	2.45×10^{6}	3.6×10^{23}
Planet S	2.48×10^{7}	1.0×10^{26}

(A) Planet P
(B) Planet Q
(C) Planet R
(D) Planet S

7 Mary was on a diving board above the water ready to jump. She jumped with an initial vertical speed of 17.1 ms^{-1} up before landing in the water.



If Mary was in the air for 4.0 s, how high, to the nearest metre, was the diving board from the water?

(A) 5.0 m
(B) 10.0 m
(C) 15.0 m
(D) 20.0 m

8 In a DC motor, a current carrying conductor rotates in a magnetic field.
While a voltage is supplied to the motor and the motor is rotating which would be a correct observation?

(A) The net emf would increase.
(B) The supply emf would decrease.
(C) The current in the coil would be greater while it is stationary than when it was turning.
(D) An induced current would be generated in the same direction to the supply current.

9 Why are high voltages used to transmit electrical energy from power stations over large distances?

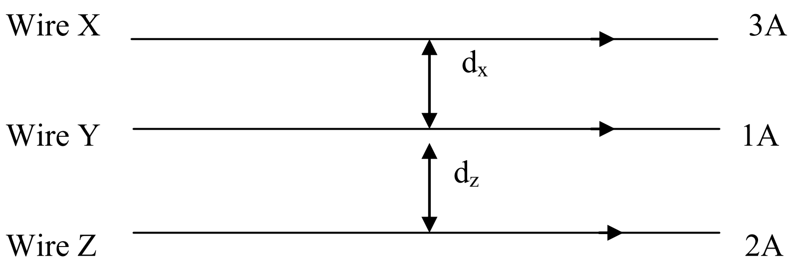
(A) High voltages can be transformed down to any required value.
(B) It minimises the effects of the electrical resistance of the wires.
(C) Transformers operate with less heat production if high voltages are used.
(D) It ensures that, even with voltage losses, 240 V will still reach the user.

10 Electricity for a power plant whose power input is 330 MW is generated at 25 kV then increased to 330 kV.

What is the current in the secondary coil if the transformer is 100% efficient?

(A) 1 A
(B) 25 A
(C) 100 A
(D) 1000 A

11 Three long parallel wires X, Y and Z are positioned in the same plane and conduct different currents in the same direction as shown. The current in wire X is 3 A, in wire Y is 1 A and in wire Z is 2 A. Wires X and Y are separated by a distance d_x and wires Y and Z are separated by a distance d_z.



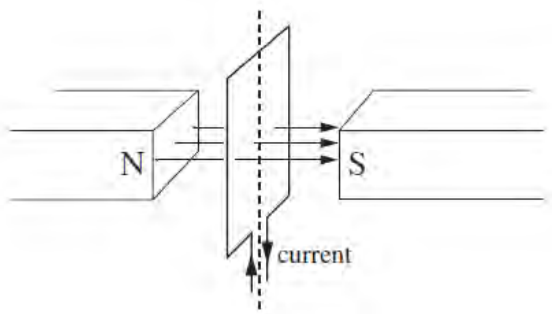
What is the relationship between the distances if the force on wire Y is zero?

(A) $d_x = d_z$
(B) $2d_x = 3d_z$
(C) $3d_x = 2d_z$
(D) $3d_x = 4d_z$

12 A direct current (DC) simple motor is connected to a battery by means of two leads. What is the role of the motor's commutator?

(A) To allow the motor to produce a torque in a constant direction
(B) To prevent overheating due to too large a current in the coil of the motor
(C) To reverse the direction of current in the leads from the power supply to the commutator
(D) To ensure the direction of current in the coil of the motor is constant relative to the magnetic field

13 An electric motor is set up as shown. The coil is placed at 90^{o} to the magnetic field.



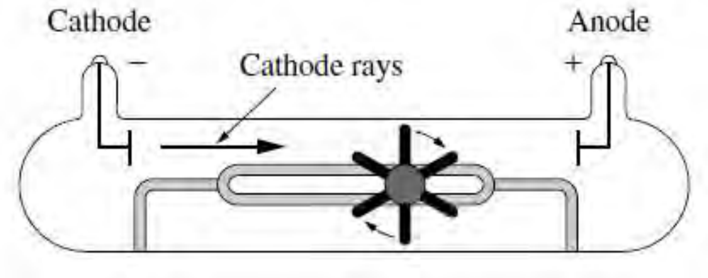
When current is supplied, what will happen to the coil?

(A) The coil will turn clockwise.
(B) The coil will turn anti-clockwise.
(C) The coil will not turn.
(D) The coil will turn clockwise 180^{o} and then turn anti-clockwise.

14 The minimum amount of energy needed for photosynthesis in green plants is 3.0 x10^{-19} J. What is the maximum wavelength of incident light that can be shone on the plant surface in order to carry out photosynthesis?

(A) 1.36 10^{23} m
(B) 4.53 x 10^{14} m
(C) 6.62 x 10^{-7} m
(D) 2.21 x 10^{-15} m

15 The diagram below shows one of the evacuated glass tubes that were originally invented by Sir William Crookes to determine the properties of what were called cathode rays.



Which of the following properties of cathode rays was this tube designed to show?

(A) Cathode rays are streams of electrons.
(B) Cathode rays travel in straight lines.
(C) Cathode rays carry a negative charge.
(D) Cathode rays possess kinetic energy.

16 Photons of wavelength λ are incident on a metallic surface in a vacuum. Each second there are 10 photons incident on the metallic surface, but no electrons are emitted from the surface.

Which of the following actions is most likely to cause electrons to be emitted from the metallic surface?

(A) Decrease the frequency of the incident light.
(B) Decrease the wavelength of the incident light.
(C) Increase the number of photons per second incident on the surface.
(D) Move the metallic surface to the air.

17 Which of the following is an advantage of solid state devices over thermionic devices?

(A) Solid state devices can tolerate a higher voltage than thermionic devices.
(B) Solid state devices can last forever and will not break down.
(C) Thermionic devices need a very low temperature to work but solid devices does not.
(D) Solid state devices consume less electrical power than thermionic devices.

18 If a superconductor is above its transition temperature,

(A) the lattice vibration will break up the Cooper Pairs as fast as they can form.
(B) the lattice distortions will attract electrons to form Cooper Pairs.
(C) the Meissner Effect can levitate a magnet.
(D) the "holes" in a doped lattice allow electrons to "tunnel".

19 In the experiment used by the Braggs to determine crystal structure, the radiation used was:

(A) x-rays
(B) radio waves
(C) ultra-violet rays
(D) visible light

20 JJ Thomson's famous cathode ray experiment was able to get a value for:

(A) the mass of the electron.
(B) the strength of crossed electric and magnetic fields
(C) the electric charge of an electron.
(D) the charge to mass ratio of the electron.

(End of Part A)

Section I (continued)
Part B – 55 marks
Attempt Questions 21 to 30.
Allow about 1 hour and 40 minutes for this part.
Answer the questions in the spaces provided.

Mark

Question 21 (5 marks)
Two students are 130 m apart. One holds a paint ball gun on the ground level and fires a paint ball at the other. The ball leaves the gun at 40 ms^{-1} at an angle of elevation of 20^o.

(a) Calculate the maximum height of the paint ball above its firing position. **2**

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(b) Determine whether or not the ball hits the second student. **3**

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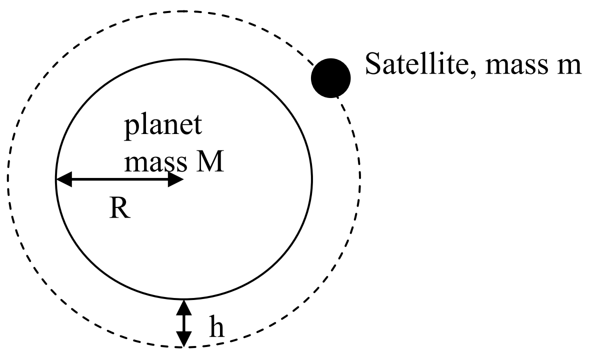
Question 22 (5 marks)
A spherical planet has radius R and mass M. A satellite of mass m orbits the planet with constant orbital speed v at a height h above the planet's surface, as shown below (not to scale).



(a) Outline why, although the satellite is moving with constant speed, the net force on it is not zero. **1**

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Mark

(b) Why does a person experience weight on the Earth but feel weightless orbiting the Earth in a satellite? **2**

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(c) A second satellite, mass 2M is placed into the same orbit. What will be its orbital speed compared to the first satellite? Justify your answer using Physics equations. **2**

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Question 23 (8 marks)
The Chinese have an ambitious space program, hoping to land Taikonauts (Chinese space travellers) on the Moon by 2019. A student hopes to be in one of their future space shuttles, designed to achieve an altitude of 260 km after a 3 minute launch.

(a) Explain the issues associated with getting Taikonauts into orbit in terms of launching rockets. Address the following issues in your answer: **3**
- the forces acting on the space shuttle; and
- the effect of forces on the astronauts.

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(b) What is the orbital velocity of a Chinese shuttle in circular orbit at an altitude of 260 km (radius of the earth = 6.38×10^6 m) **3**

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Mark

(c) On one such future taikonaut mission an observation satellite may be launched from orbit. What is the radius of the satellite orbit if its period is 14 hours? **2**

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Question 24 (6 marks)

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One of Einstein's first "thought experiments" was as follows:

"Suppose I am sitting on a train that is travelling at the speed of light. If I hold up a mirror in front of me and look at it, will I see my own reflection?"

Analyse this thought experiment and discuss the relationship between thought and reality.

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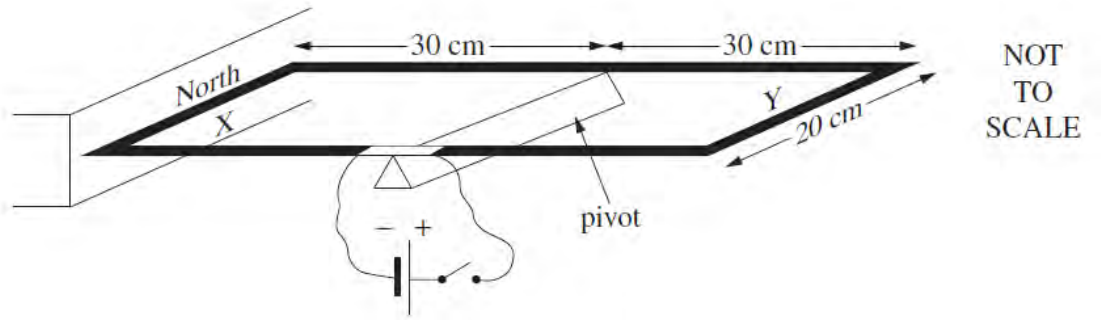
Mark

Question 25 (6 marks)

A rectangular wire loop is connected to a DC power supply. Side X of the loop is placed next to a magnet. The loop is free to rotate about a pivot.



When the power is switched on, a current of 20 A is supplied to the loop. To prevent rotation, a mass of 40 g can be attached to either side X or side Y of the loop.

(a) On which side of the loop should the mass be attached to prevent rotation? **1**

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(b) Calculate the torque provided by the 40 g mass. **2**

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(c) Calculate the magnetic field strength around side X. **3**

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Mark

Question 26 (6 marks)

In the distribution of electricity, the overall energy losses between the power plant and users can easily be between 8% and 15%, which suggests that there is still some room to improve efficiency. **6**

Analyse this statement. In your analysis, you must refer to existing sources of energy loss, and a possible new technology to minimise such loss.

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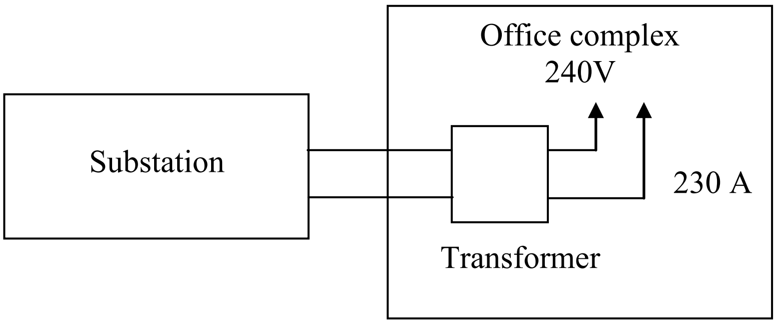
Student number ....

Mark

Question 27 (6 marks)

An electricity substation delivers a current of 10 A at a voltage of 6 kV to an office complex. The office complex uses a transformer to provide a current of 230 A at a voltage of 240 V.



(a) Explain why AC is preferable to DC as an input current for transformers. **2**

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(b) Outline possible causes of energy loss in the transformer. **2**

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(c) Calculate the energy lost by the transformer in eight hours. **2**

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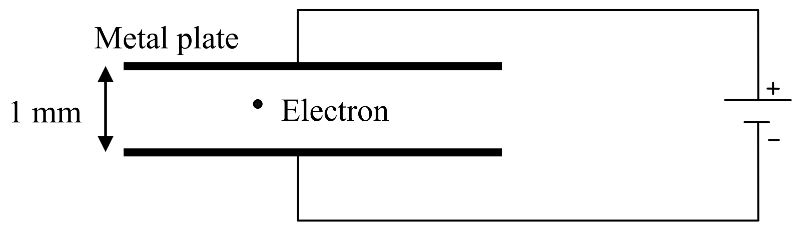
Mark

Question 28 (5 marks)
An electron was placed in the middle of two charged parallel horizontal metal plates as shown in the diagram below.



(a) Identify the two forces acting on the electron. **2**

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(b) What voltage should be applied between the two parallel metal plates if the electron is suspended motionless between the plates? **3**

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Question 29 (3 marks)
In an experiment some physics students were using ultraviolet light (wavelength 300 nm) to see if they could produce photoelectrons.

(a) Calculate the energy of a photon of ultraviolet light. **2**

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(b) State how this photon could produce a photoelectron. **1**

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Student number ....

Mark

Question 30 (5 marks)

(a) Compare the suitability of germanium and silicon as semiconductor materials **2**

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(b) Account for the occurrence of "holes" in "doped" semiconductors and their involvement in the flow of current in semiconductors. **3**

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Section II
25 marks
Attempt Questions 31 to 32 – From Quanta to Quarks.
Allow about 45 minutes for this section.

Answer the questions on the paper provided.

Mark

Question 31 (16 marks)
Rutherford discovered the atomic nucleus and suggested one of the earliest atomic models.

(a) Describe Rutherford's atomic model with the help of a labelled diagram. **4**

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(b) Explain why Rutherford's model was criticised by scientists at the time. **2**

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(c) Rutherford's atomic model was refined and extended by Bohr. Define Bohr's postulates. **3**

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(d) Even Bohr's model had serious shortcomings. Outline the key deficiencies of Bohr's model. **3**

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(e) Describe Planck's contribution to the development of the atomic model and explain how his work was critical in allowing the development of the Bohr model. **4**

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Mark

Question 32 (9 marks)
The emission spectra of excited atomic hydrogen atoms can be predicted using the equation:

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

(a) Use this equation to calculate the wavelength of the H_β spectral line for hydrogen, given that H_β light is associated with an electron transition from the $n = 4$ state to the $n = 2$ state in a hydrogen atom. **2**

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(b) Use the wave equation and Plank's equation to find the amount of energy carried by one photon of the H_β spectral line. **4**

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(c) According to Bohr, what does this amount of energy represent within a hydrogen atom? **1**

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(b) Explain how energy is conserved when an electron makes a transition from one stationary state to another in an atom. **2**

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End of paper

Cheltenham Girls High School
2011 HSC Physics Trail Exam
Marking Guidelines

Section I - Part A

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

Section I - Part B

21(a)

Marking Criteria	Marks
Correctly calculate the maximum height	2
Provide correct equation and substitution of values, but makes an error in the calculation.	1

Sample answer:

$U_y = U\sin\theta = 40 \times \sin 20^o = 13.68\ ms^{-1}$

$V_y{}^2 = U_y{}^2 + 2a_y\Delta y$

$0 = 13.68\ ms^{-1} + 2 \times (-9.81\ ms^{-2})\ \Delta y$

$\Delta y = 13.68^2 / (2 \times 9.81) = 9.55\ m$

OR

$V_y = U_y + a_y t$

$0 = 40 \sin 20^o + (-9.81)\ t$

$t = 1.396\ s$

$\Delta y = U_y t + ½\ a_y t^2$

$\Delta y = 40 \sin 20^o \times 1.396 + ½\ (-9.81)(1.396)^2 = 9.55\ m$

21(b)

Marking Criteria	Marks
Correctly calculate the time and the horizontal distance Correctly find out whether the ball will hit the second student or not	3
Any 2 of above	2
Any 1 of above	1

Sample answer:

$\Delta y = U_y t + 1/2\ a_y\ t^2$

$0 = 13.68\ t + 1/2\ (-9.8)\ t^2$

$t = 13.68 / 4.9 = 2.80\ s$

$\Delta x = U_x\ t = 40 \cos 20^o \times 2.80 = 105.5m$

The ball will not hit the second student who is at 130 m away.

OR

$V_y = U_y + a_y t$

$0 = 13.68 - 9.81 \times t$

$t = 1.396\ s$

Total time = 2t =2.80 s

$\Delta x = U_x\ t = 40 \cos 20^o \times 2.80 = 105.5m$

The ball will not hit the second student who is at 130 m away.

22(a)

Marking Criteria	Marks
States direction of gravitational force or acceleration in relation to its velocity.	1

Sample answer:
Satellite is accelerating towards the centre, it has gravitational force acting on it at 90^o to its direction of motion, therefore undergoes uniform circular motion.

OR

The satellite undergoes centripetal acceleration as its direction is constantly changing.

22(b)

Marking Criteria	Marks
Explains sensation of weight and lack of weight in satellite due to common acceleration.	2
Explains sensation of weight OR lack of weight in satellite due to common acceleration.	1

Sample answer:
Weight is experienced when our body is in contact with the ground (or other surface) which pushes on us in the opposite direction to the gravitational force. In space circling the Earth or in 'freefall' all parts of our body accelerate at the same rate as the satellite towards Earth due to the gravitational force and no contact forces are exerted on us, hence no sensation of weight.

22(c)

Marking Criteria	Marks
Provides correct answer and provides equation to justify same orbital speed.	2
Provides correct answer OR provides equation to justify same orbital speed.	1

Sample answer:
Same orbital speed.
$GMm/r^2 = mv^2/r$
Since mass of satellite m cancels, orbital speed is independent of mass of the satellite. Therefore speed will be the same for all satellites at the same radius.
(OR use Kepler's law of periods to explain.)

23(a)

Marking Criteria	Marks
Uses cause and effect in terms of conservation of momentum on the shuttle to explain why the shuttle moves off the launch pad AND ONE effect of force on the astronauts during launch using a numerical example	3
Qualitatively states ONE effect of conservation of momentum on the shuttle AND ONE effect of force on the astronauts during launch.	2
Qualitatively states ONE effect of conservation of momentum on the shuttle OR ONE effect of force on the astronauts during launch.	1

Sample answer:
When launching a rocket with live Taikonauts, there are several issues to address. One of these is that the total momentum of the system is zero, thus to move the shuttle forward a thrust with equal and opposite momentum must be thrown backwards. As more fuel is used and thrown out as fast as possible, the mass of the shuttle gets lighter resulting in higher speeds due to p = mv.

However, this acceleration can produce nasty effects on the Taikonauts, especially if the acceleration exceeds more than 10 g for a few seconds. Because the launch takes 3 minutes, a lesser acceleration of 3-4 g is more acceptable for this time range, as the body can sustain this force for a length of time.

23(b)

Marking Criteria	Marks
Obtains correct answer, showing substitution and working	3
Identifies correct equation AND substitutes values in.	2
Realises and sets gravity as the producing force for the centripetal force i.e. $Gm_1m_2/r^2 = m_1v^2/r$ OR Identifies ONE correct equation	1

Sample answer:

$$\frac{G\,m_1m_2}{r^2} = \frac{m_1v^2}{r} \quad \therefore v=\sqrt{(Gm_e/r)} \quad = \sqrt{\frac{6.67\text{x}10^{-11}\text{x}6.0\text{x}10^{24}}{6.38\text{x}10^{6} + 260 \text{ x } 10^{3}}} = 7.76 \text{ x } 10^{3} \text{ ms}^{-1}$$

23(c)

Marking Criteria	Marks
Obtains correct answer	2
Identifies the need for Kepler's Law of Periods	1

Sample answer:

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2} \quad \therefore r^3 = \frac{GMT^2}{4\pi^2} = \frac{6.67\text{x}10^{-11} \text{ x } 6.0\text{x}10^{24} \text{ x } (14\text{x}60\text{x}60)^2}{4\pi^2} \quad \therefore r = 2.95 \text{ x } 10^{7} \text{ m}$$

24

Marking Criteria	Marks
• analysis includes a discussion of the dilemma in the TWO possible answers, and their implications AND • Einstein's reconciliation of the answer • clear discussion of the relationship between thought and reality	5-6
• discussion of the dilemma in the TWO possible answers, and their implications OR • Einstein's reconciliation of the answer OR • discussion of the relationship between thought and reality	3-4
• identifies ONE of the TWO possible answers OR • Einstein's reconciliation of the answer	1-2

Sample answer:

In this particular thought experiment there are two possible answers, both of which contained a dilemma for the scientific community of the time that believed in the aether model:

1. No, a reflection will not appear. This is the result predicted by the aether model, since light can only travel at a set speed through the aether. If the train is travelling at that speed then the light cannot catch the mirror and return as a reflection. Unfortunately, this violates the principle of relativity, which states that in an inertial frame of reference you cannot perform any experiment to tell that you are moving.
2. Yes, the reflection will be seen, because according to the principle of relativity, it would not be possible for the person in the train to do anything to detect the constant motion with which he or she is moving.

Einstein decided that:

- the reflection will be seen as normal, because he believed that the principle of relativity should always hold true

- the person at the side of the track sees the light travelling normally. But this means that time passes differently for you on the train and for the person at the side of the track
- the aether model has nothing to do with it, Einstein decided it was superfluous.

A limitation of thought experiments is that what you imagine as the outcome is based upon your common sense, that is, your collective experiences of the way things normally happen. Einstein used thought experiments to investigate situations that could not be tested in reality. In some cases, that inability to test, stems from limitations in current technology.

25(a)

Marking Criteria	Marks
Identifies correct side of loop	1

Sample answer:
Side X

25(b)

Marking Criteria	Marks
Substitutes correctly to calculate torque	2
Uses formula correctly, but makes an error in substitution	1

Sample answer:
$\tau = Fd = mgd = 40 \times 10^{-3} \times 9.8 \times 30 \times 10^{-2} = 1.176 \times 10^{-1}$ Nm

25(c)

Marking Criteria	Marks
• Manipulates equations to calculate the value of magnetic field strength	3
Equates two appropriate equations, AND EITHER • Makes an error in rearranging the equations OR • Makes an error in substitution	2
• Identifies an appropriate equation • Attempts to calculate magnetic field strength	1

Sample answer:

F = BIL sinθ and F = mg
BIL sinθ = mg

$$B = \frac{mg}{IL\sin\theta} = \frac{40 \times 10^{-3} \times 9.8}{20 \times 20 \times 10^{-2} \times \sin 90^{\circ}} = 9.8 \times 10^{-2}\ \text{T}$$

OR

τ = BIA cosθ and τ = mgd (you can use the answer from Q.25b)

$$B = \frac{mgd}{IA\cos\theta} = \frac{1.176 \times 10^{-1}}{20 \times 20 \times 10^{-2} \times 30 \times 10^{-2} \times \cos 0^{\circ}} = 9.8 \times 10^{-2}\ \text{T}$$

26

Marking Criteria	Marks
• Demonstrates a thorough knowledge of how energy losses occur in transmission • Describes present techniques to reduce energy losses and relates to energy losses in transmission • Identifies a new technology to reduce energy loss and relates to how this technology could minimise energy losses in a source • Demonstrates coherence and logical progression	6
• Demonstrates a sound knowledge of how energy losses occur in transmission • Describes present techniques to reduce energy losses • Identifies a new technology to reduce energy loss and provides a feature of this technology • Communicates some scientific principles and ideas in a clear manner	4-5
• Demonstrates a knowledge of how energy is lost in transmission and identifies a new technology to reduce the losses • Communicates ideas in a basic form using general scientific terms OR • Demonstrates a sound knowledge about how energy is lost in transmission and states how such loss is minimised • Communicates ideas in a basic form using general scientific terms	2-3
• Communicates simple ideas AND EITHER • States how energy is lost through a source OR • Identifies a new technology to reduce energy losses OR • Identifies how an energy loss is presently minimised OR • Identifies two sources of energy loss	1

Sample answer:

Energy losses essentially come about in transformers and cables. The efficiency of large transformers in step up and step down substations is quite high and may reach 99%, by including features such as laminated iron cores to reduce eddy currents but for medium and low voltages the efficiency is much less even when techniques such as the above are used.

For cables its contrary, those carrying high current sustain more heating and therefore endure more energy loss. Power loss = I^2R. By carrying large voltages over long distances the energy loss is minimised.

The limitation to this is safety and hence near large populations the electricity must be sent at low voltages sacrificing energy loss for safety. If a new technology such as superconductors was economically viable then these energy losses could be minimised.

It would allow current to be sent with little or no energy losses in the cables and therefore electricity could be sent over large distances at low voltages reducing the need for transformers. It could also be sent as a DC current which would further reduce the energy loss as the constant change in direction of the current.

27(a)

Marking Criteria	Marks
Explains the need for AC current in terms of change in magnetic flux	2
States that transformers will not work with DC current OR Explains the need for AC current with no reference to magnetic flux	1

Sample answer:
A DC current produces a constant magnetic flux, whereas an AC current has a continually changing flux. A transformer needs a changing flux in order to work, so that a current can be induced in the secondary coil, so AC current is needed.

27(b)

Marking Criteria	Marks
Sketches in general terms TWO possible causes of energy loss	2
Sketches in general terms ONE possible cause of energy loss	1

Sample answer:
Any TWO of the following:
- Energy can be lost as heat due to the resistance of the copper of the primary and secondary coils.
- Energy can be lost due to eddy currents within the conductor of the primary and secondary coils.
- Energy can be lost due to eddy currents within the iron core (although this can be minimised by using a laminated core).
- Energy can be lost due to incomplete magnetic coupling between the primary and secondary coils.

27(c)

Marking Criteria	Marks
Correctly states the input and output power. Calculates the power loss and the energy lost in 8 hours	2
Correctly calculates the input OR output power OR States that E = Pt or VIt	1

Sample answer:
Power input $= V_p I_p = 6 \times 10^3$,V x 10A $= 6 \times 10^4$ W
Power output $= V_s I_s = 240$ V x 230 A $= 5.52 \times 10^4$ W
Rate of energy loss $= (6 \times 10^4 - 5.52 \times 10^4) = 4.8 \times 10^3$ W (= J s^{-1})
∴Energy lost in 8 hours = (4.8×10^3) W x (8 x 60 x 60) s
$= 1.3824 \times 10^8$ J
$= 1.4 \times 10^8$ J

28(a)

Marking Criteria	Marks
Correctly identify the two forces	2
Correctly identify any one force	1

Sample answer:
The forces by the gravity and the electric field

28(b)

Marking Criteria	Marks
• Correctly use formula to calculate the weight of the electron • Correctly use formula to show that the forces of the electric field equals to the weight of the electron • Correctly calculate the voltage should be applied	3
Any two of the above	2
Any one of the above	1

Sample answer:
Weight of the electron = mass x gravity =9.109×10^{-31} kg x 9.81 ms^{-2} = 8.94×10^{-30} N
Force of the electric field = E q = V/d x q = V/0.001m x 1.602×10^{-19} C
If the electron is motionless, the force of the electric field = weight of the electron
V/0.001m x 1.602×10^{-19} C = 8.94×10^{-30} N
V =8.94×10^{-30} N x 0.001m / 1.602×10^{-19} C = 5.58×10^{-14} V

29(a)

Marking Criteria	Marks
substitutes into correct equation AND calculates the energy of the photon	2
substitutes into correct equation OR calculates the energy of the photon	1

Sample answer:
λ=300nm = 300×10^{-9} m
E = hf =hc/λ

$$= \frac{6.626 \times 10^{-34} \times 3.00 \times 10^{8}}{300 \times 10^{-9}}$$

= 6.626 x 10-19 J

29(b)

Marking Criteria	Marks
explain how photon produces photoelectron	1

Sample answer:
When the packet of light hits an electron in the outer shells of the metal, it gives all of its energy to the electron. This electron then has enough energy to break away, and leave the surface of the metal atom and kinetic energy to move once released from the surface.

30(a)

Marking Criteria	Marks
Compare two suitability of germanium and silicon as semiconductor	2
Compare one suitability of germanium and silicon as semiconductor	1

Sample answer:
Pure crystal of germanium is easier to obtain than the silicon.
Germanium is a rare element but silicon is one of the most abundant elements on Earth.

30(b)

Marking Criteria	Marks
Fully describe the occurrence of "holes" in "doped" semiconductors and their involvement in the flow of current	3
Partly describe the occurrence of "holes" in "doped" semiconductors and their involvement in the flow of current	1-2

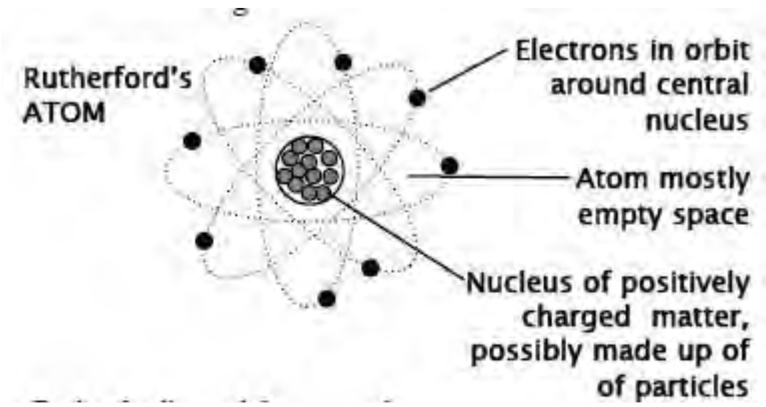
Sample answer:
When a semiconductor is doped with atoms with 3 valence electrons, such as aluminium, this adds extra "holes" to the lattice. The hole is a space that an electron from elsewhere can jump into. An electron flow is form when a sequence of movements in which the next electron in the valence band has enough energy to jump into the hole, leaving its own hole behind. When an electron flows to the right, the hole flows to the left.

Section II

31(a)

Marking Criteria	Marks
Fully describe Rutherford's atomic model with a correct labelled diagram	4
Partly describe Rutherford's atomic model with a labelled diagram	2-3
Partly describe Rutherford's atomic model without a labelled diagram OR a labelled diagram of Rutherford's atomic model without description	1

Sample answer:



Rutherford's model proposed:
- At the centre is a tiny, dense nucleus with a positive electrical charge.
- The negatively charged electrons orbit around the nucleus
- The distance form nucleus to the electron orbits is very large compared to the size of the particles, so the atom is mostly empty space.

Question 31(b)

Criteria	Marks
• A clear explanation of why the model was thought to have been unstable, OR any TWO other criticisms	2
• Incomplete explanation of instability, OR ONE other criticism	1

Suggested answer:
Rutherford's model involved an orbiting electron. Because the electron is accelerating, it should emit electromagnetic radiation, lose energy, and spiral into the nucleus. Rutherford's model also failed to explain the emission or absorption spectra of excited atomic atoms.

Question 31(c)

Criteria	Marks
• An answer that states THREE Bohr's postulates	3

• An answer that states TWO Bohr's postulates	2
• An answer that states ONE Bohr's postulates	1

Suggested answers:

- Electrons revolve only in certain "allowed" orbits.
- Electrons gain or lose energy to "jump" between orbits.
- Electrons in "allowed orbits" have quantised amounts of angular momentum too

Question 31(d)

Criteria	Marks
• An answer that states THREE correct shortcomings	3
• An answer that states TWO correct shortcomings	2
• An answer that states ONE correct shortcoming	1

Suggested answers:

Bohr's model could not adequately explain:

- the relative intensity of spectral lines
- the spectra of atoms larger than hydrogen
- the existence of hyperfine spectral lines
- the Zeeman effect.

31(e)

Marking Criteria	Marks
States TWO of Bohr's postulates which clearly link the model's development to a description of Planck's earlier concept of quantisation	3-4
Describes quantisation as the ability of radiation to be emitted or absorbed in discrete packets	2
Identifies Planck's original idea of quantisation of energy	1

Sample answer:

Planck was the architect of the concept of quantisation, that is, that energy can be emitted or absorbed only in discrete packets or quanta (determined by the equation $E = hf$). Bohr needed to explain why electrons in atomic orbitals did not continually radiate energy (and spiral into the nucleus) and why there were distinct spectral lines present in atomic spectra. He used Planck's ideas in what we today refer to as Bohr's postulates, which can be written as:

1. That electrons move in metastable orbits without radiating energy. Quantisation prohibits continuous radiation.
2. An electron may move from a lower energy orbital to a higher energy orbital by absorbing a quantum of energy ($E=hf$) and from a higher energy orbital to a lower energy orbital by releasing a quantum of energy.

32(a)

Marking Criteria	Marks
Substitutes correctly to calculate wavelength	2
Uses formula correctly, but makes an error in substitution	1

Sample answer:

$1/\lambda = 1.097 \times 10^7 (1/2^2 - 1/4^2)$

$\lambda = 4.86 \times 10^{-7}$ m

32(b)

Marking Criteria	Marks
Substitutes correctly to calculate frequency AND substitutes correctly to calculate energy	4

Uses formula correctly, but makes an error in substitution	1-3

Sample answer:
$c = f\lambda$
$f = c/\lambda = 3 \times 10^{8}\ ms^{-1} / 4.86 \times 10^{-7}\ m = 6.17 \times 10^{14}$ Hz
$E = hf = 6.626 \times 10^{-34}$ Js $\times\ 6.17 \times 10^{14}$ Hz $= 4.09 \times 10^{-19}$ J

32(c)

Marking Criteria	Marks
Correctly state the amount of energy represent within a hydrogen atom	1

Sample answer:
It represents the energy difference between the 2nd and 4th quantum level (or "allowed orbits").

32(d)

Marking Criteria	Marks
Correct answer for emission AND absorption of a photon	2
Correct answer for emission OR absorption of a photon	1

Sample answer:
When an atom absorbs a photon of light, the energy of the photon is added to the energy of the atom. Energy is conserved because the difference in energy between the initial and final state of the electron is equal to the photon energy. When an excited electron in the atom relaxes to a less excited state, energy is conserved because a photon is released with an energy that is equal to the energy difference between the states.

End of Marking Guidelines