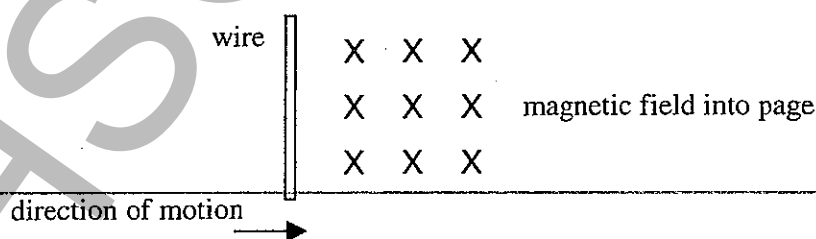


STUDENT NUMBER/NAME: .....

1. An 80 kg astronaut stands on a set of scales on a planet. The scales read 624 N. What is the acceleration due to gravity on this planet?
- (A)  $8.2 \text{ ms}^{-2}$   
 (B)  $7.8 \text{ ms}^{-2}$   
 (C)  $7.1 \text{ ms}^{-2}$   
 (D)  $7.0 \text{ ms}^{-2}$
2. On many overhead power lines the conducting cable is separated from the steel of the support tower by a ceramic material. The main reason for using a ceramic as the separating substance is:
- (A) to insulate the cable from the tower  
 (B) because ceramic is very hard  
 (C) ceramic material is easy to shape  
 (D) ceramic material is a good conductor and so makes electricity distribution cheaper
3. The invention of cathode ray tubes led to the discovery of:
- (A) electrons  
 (B) ions  
 (C) anions  
 (D) semiconductors
4. Why does the conductivity of silicon increase if it is doped with a Group III element?
- (A) the number of free electrons increases  
 (B) the number of positive holes increases  
 (C) the impurity decreases the energy band gap  
 (D) additional electrons are added to the crystal lattice structure
5. A wire is moved in a magnetic field as shown in the diagram below.



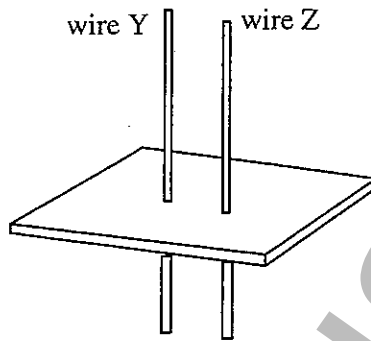
The direction of electron current flow in the wire would be:

- (A) into the page  
 (B) out of the page  
 (C) up the page  
 (D) down the page

6. A cricket ball is hit upwards at  $125 \text{ ms}^{-1}$  and  $50^\circ$  to the horizontal. What is its speed 3 seconds later?

- (A)  $66.4 \text{ ms}^{-1}$
- (B)  $80.4 \text{ ms}^{-1}$
- (C)  $104.2 \text{ ms}^{-1}$
- (D)  $125 \text{ ms}^{-1}$

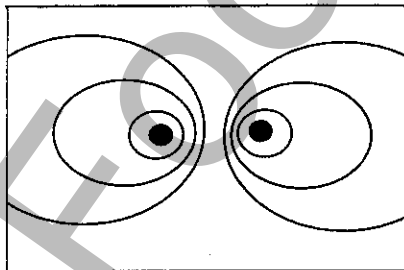
7. Two vertical parallel wires pass through a sheet of thick cardboard as shown.



Iron filings are sprinkled on the card.

When there is an electric current in each conductor, the iron filings form a pattern which indicate the illustrated magnetic field.

viewed from  
above, wire Y  
on left

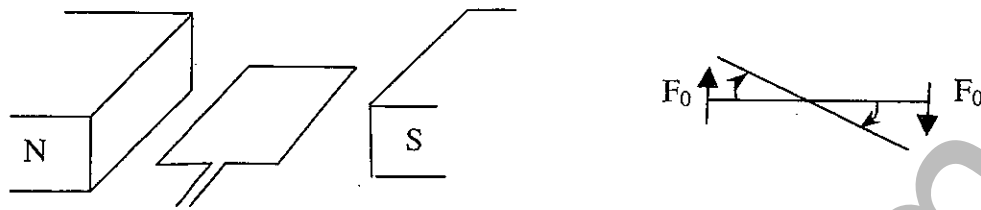


If wire Z is carrying current **downward**, then which of the following alternative statements is correct?

	Direction of current in wire Y	Direction of force between conductors
(A)	up	attraction
(B)	up	repulsion
(C)	down	repulsion
(D)	down	attraction

8. The Russian space station that was orbiting the Earth for many years eventually crashed into the Earth. This occurred mainly because of:
- (A) a reduction in its orbital velocity due to friction from the magnetosphere.
  - (B) a reduction in its orbital velocity due to friction from the atmosphere.
  - (C) an increase in its orbital velocity due to a stronger gravitational force.
  - (D) a reduction in its orbital velocity causing the gravitational force to decrease.
9. An electric field of strength  $E$  is produced between two charged plates. If the arrangement is changed so that the distance between the plates is one quarter of the original and the voltage between the plates is three times the original, what is the new electric field strength in terms of the old?
- (A)  $12 E$
  - (B)  $3 E$
  - (C)  $0.125 E$
  - (D)  $48 E$
10. Two light globes are able to be switched on simultaneously even though they are separated by a large distance. According to Einstein's theory about the relativity of simultaneity, which of the following statements is a correct description of what can happen when the lights are switched on?
- (A) all observers will see both globes light up at the same time
  - (B) one observer may see one of the globes contract and the other globe expand while another observer may see no change in the size of the globes
  - (C) no observers can see both globes light up at the same time
  - (D) one observer may see the two globes light up at the same time while another observer may see one globe light up after the other
11. Which one of the following statements is **NOT** true in regards to a hole in semiconductor theory?
- (A) holes act as a positive charge
  - (B) holes can be bound to an atomic nucleus
  - (C) holes are repelled by electrons
  - (D) holes have a drift velocity
- 
12. A geostationary satellite that orbits the Earth in a direction from west to east in the equatorial plane will:
- (A) hover over one spot on the Earth's surface
  - (B) be orbiting in the opposite direction to the Earth's rotation
  - (C) continually move over different parts of the Earth's surface
  - (D) move over different parts of the Earth's surface but only those parts that lie on the equator

13. A rectangular coil is placed in the uniform magnetic field between two large magnets.



In the original position, a force  $F_0$ , acts on each side of the coil, producing a torque  $\tau_0$  which causes the coil to start rotating.

The coil rotates through an angle of  $30^\circ$  and is still within the uniform magnetic field.

The statement which correctly describes the new situation for force  $F$  and torque  $\tau$  is:

- (A)  $F < F_0$  and  $\tau = \tau_0$   
 (B)  $F < F_0$  and  $\tau < \tau_0$   
 (C)  $F = F_0$  and  $\tau < \tau_0$   
 (D)  $F < F_0$  and  $\tau > \tau_0$
14. If the current in a metallic conductor was kept constant, then the drift velocity of electrons could be increased by:
- (A) increasing the length of the wire  
 (B) decreasing the length of the wire  
 (C) increasing the cross-sectional area of the wire  
 (D) decreasing the cross-sectional area of the wire
15. If you were supplied with a small unlabelled model of an AC electric motor and a similar small DC motor without being told which was which, the easiest way to distinguish them would be:
- (A) the AC motor would have commutator while the DC motor would not  
 (B) DC motors are double insulated while AC motors are not  
 (C) the DC motor would have slip rings while the AC motor would not  
 (D) the DC motor would have a commutator while the AC motor would not

Section I - continued

**Part B**

**Total marks (60)**

**Attempt questions 16 – 26**

**Allow about 1 hour 45 minutes for this part**

Answer the questions in the spaces provided

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**Question 16 (8 marks)**

**Marks**

Science is based on experimental evidence. Theories will ultimately be supported by experimental results, or new theories that support the experimental data will replace them.

- (a) Galileo's analysis of projectile motion included one component of motion that had constant acceleration. Describe an investigation you carried out that showed that this one component did have constant acceleration.

**2**

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- (b) Michelson and Morley attempted to measure via experiment the relative velocity of the Earth with respect to the 'aether' (ether).

**4**

- (i) Describe this experiment and its results.

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- (ii) Use Einstein's theory of relativity to explain the results of this experiment.

**2**

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**Question 17 (7 marks)**

**Marks**

A simple electric motor can be used as a generator and a generator could be used as an electric motor. Both these machines essentially consist of a coil of wire able to turn in a magnetic field.

- (a) Who is credited with the discovery of the law that accounts for the situations outlined above?

**1**

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- (b) Describe with the aid of a diagram how EITHER of these situations could be demonstrated in the laboratory. Clearly state which situation you are describing.

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- (c) With reference to either the galvanometer or the loudspeaker, describe (using a suitable diagram) how the motor effect is used.

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**Question 18** (4 marks)

**Marks**

(a) How could we distinguish between moving electrons and gamma rays?

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(b) Calculate the energy of an X-ray that has a wavelength of  $4 \times 10^{-11}$  m.

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**Question 19** (3 marks)

List THREE factors that cause the acceleration due to gravity on the surface of the Earth to vary.

3

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**Question 20** (3 marks)

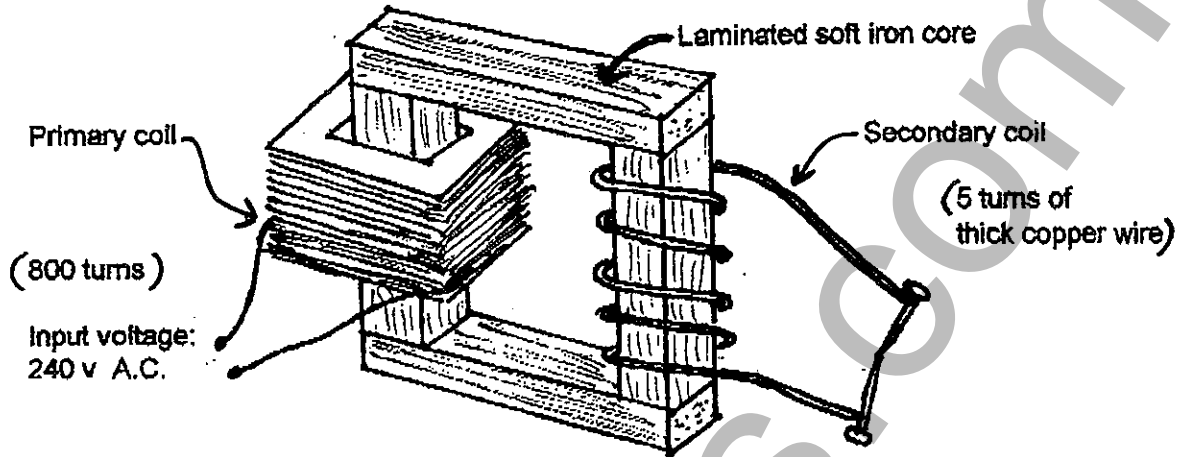
Outline how Einstein explained the effect of frequency on the photo current produced in the photoelectric effect.

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**Question 21 (6 marks)**

A step-down transformer is constructed with 800 turns on the primary coil and connected to 240 V A.C. The secondary coil has 5 turns as shown:



- (a) Clearly showing your method, determine the output voltage. 2

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- (b) The above arrangement produces a small secondary voltage, but in spite of this, the secondary current can be so large it heats up the wiring so much that it can weld together two nails. Assuming the transformer is "ideal" (100% efficient), explain how such a small output voltage can produce such a large output current. 2

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- (c) Real transformers are always less than ideal, but the laminated core helps improve the operating efficiency.

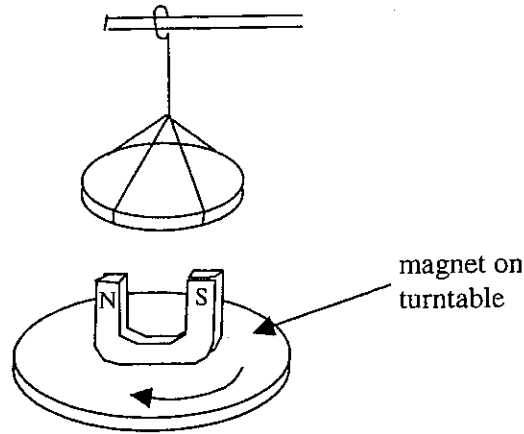
Describe the structure of the laminated core and explain how it helps to reduce energy losses. 2

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**Question 22** (3 marks)

A thick aluminium disc is suspended over a strong magnet. The magnet is mounted on a turntable, which rotates as shown.



- (a) Describe what happens to the aluminium disc when the turntable rotates. 1

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- (b) Use Lenz's law to explain this observation. 2

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**Question 24** (4 marks)

**Marks**

(a) What are the van Allen belts?

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(b) Describe how sunspot activity can affect the van Allen belts.

**1**

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(c) Explain how these changes further affect communication with geostationary satellites.

**2**

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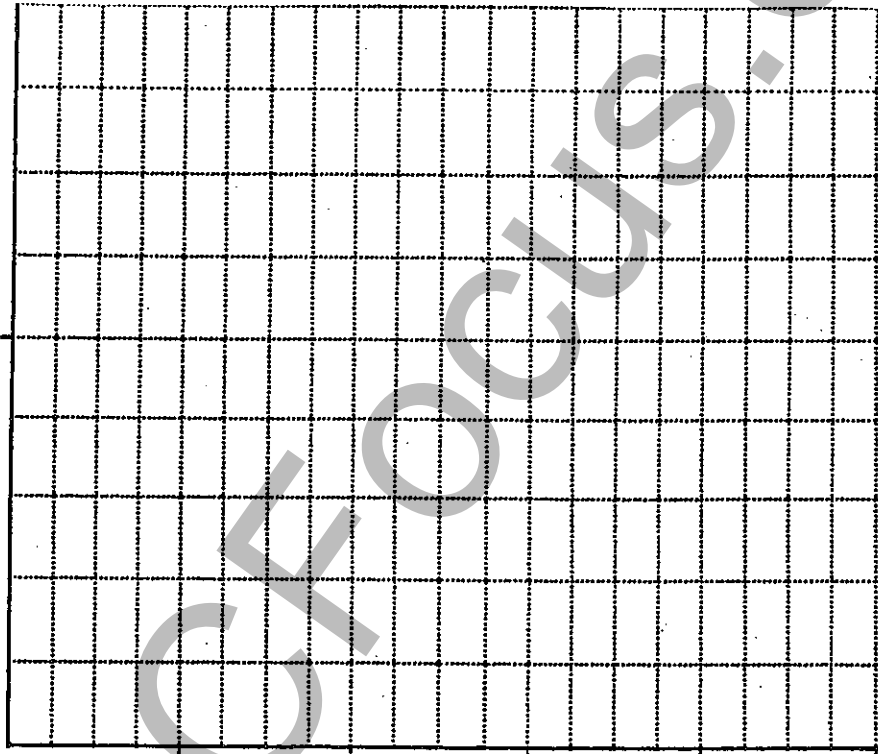
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**Question 25** (4 marks)**Marks**

A student is investigating the effect of the SEPARATION of two long straight parallel wires on the FORCE between the conductors when they are carrying constant electric currents. The following results were obtained:

Separation of wires (mm)	Force per unit length ( $\text{N m}^{-1}$ )
6.0	$8.3 \times 10^{-4}$
8.0	$6.2 \times 10^{-4}$
11.0	$4.5 \times 10^{-4}$
14.0	$3.1 \times 10^{-4}$
20.0	$2.5 \times 10^{-4}$

- (a) Plot a graph of Force per unit length vs Separation of wires

**3**

- (b) Based on the shape of the graph you have drawn, describe the next step which the student should take in order to obtain the relationship between the variables.

**1**

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**Question 26** (5 marks)

**Marks**

The next big leap forward for humans in space travel may see extended space travel across distances outside the solar system.

Discuss the limitations and problems for such journeys on a human crew due to presently achievable speeds and present communication technologies.

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**Question 27** (4 marks)

In your Physics course, you have performed a first hand investigation to demonstrate and identify the properties of cathode rays using discharge tubes.

- (a) Explain how your results demonstrated that:
  - (i) cathode rays travel in straight lines, and
  - (ii) cathode rays transfer energy and do work.

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- (b) Explain one safety precaution necessary when performing this investigation.

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**Question 28** (3 marks)

**Marks**

Explain why a magnet is able to hover above a superconducting material that has reached the temperature at which it is superconducting.

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**Question 32 – From Quanta to Quarks (25 marks)****Marks**

- (a) (i) Calculate the speed of an electron which has a wavelength of  $5 \times 10^{-10}$  m. **1**
- (ii) Outline the application of wave characteristics of electrons in the electron microscope. **2**
- (b) (i) Draw a diagram to show the visible hydrogen spectrum, clearly labelling each line. **1**
- (ii) Account for the existence of a number of lines in the hydrogen spectrum even though the hydrogen atom has only one electron. **3**
- (c) Assess the implication of the contribution of Heisenberg to our knowledge of the atom. **4**
- (d) Discuss the limitations of the Bohr model of the hydrogen atom in terms of its development and its inability to completely explain all experimental results. **6**
- (e) With the aid of a diagram, describe the apparatus used by Rutherford to explore the structure of matter. Discuss the implications of his results. **8**

**End of Question 32**