Physics

General Instructions
• Reading time – 5 minutes
• Working time – 2 hours
• Board-approved calculators may be used
• Write using blue or black pen
• Draw diagrams using pencil
A Data Sheet and Periodic Table, and Formulae Sheets are provided at the back of this paper.

Total marks (60)
This section has two parts, Part A and Part B

Part A
Total marks (15)
• Attempt Questions 1 – 15
• Allow about 30 minutes for this part

Part B
Total marks (45)
• Attempt Questions 16-24
• Allow about 1 hour and 30 minutes for this part
Part A
Total marks (15)
Allow about 30 minutes for this part

Use the multiple choice answer sheet.
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9
A □ B □ C □ D □

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A □ B □ C □ D □

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word correct and drawing an arrow as follows:

A □ B □ correct □ C □ D □

Outcomes Assessed

H1 evaluates how major advances in scientific understanding and technology have changed the direction or nature of scientific thinking
H2 analyses the ways in which models, theories and laws in physics have been tested and validated
H3 assesses the impact of particular advances in physics on the development of technologies
H5 identifies possible future directions of physics research
H6 explains events in terms of Newton’s Laws, Law of Conservation of Momentum and relativity
H7 explains the effect of energy transfers and transformation
H8 analyses wave interactions and explains the effects of those interactions
H9 explains the effects of electric, magnetic and gravitational fields
H10 describes the nature of electromagnetic radiation and matter in terms of the particles
H11 justifies the appropriateness of a particular investigation plan
H12 evaluates ways in which accuracy and reliability could be improved in investigations
H14 assesses the validity of conclusions from gathered data and information
Question 1

When a rocket experiences weight, we can tell that

(a) it is in a gravitational field.
(b) it experiences an acceleration.
(c) it has mass.
(d) all of the above.

Question 2

Below is the value of gravity on the surface of several planets:

<table>
<thead>
<tr>
<th>Planet</th>
<th>Xenos</th>
<th>Orion A3</th>
<th>Kanthus</th>
<th>Sirius B2</th>
<th>Jupiter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of gravity (zergs/dak²)</td>
<td>4.6</td>
<td>5.3</td>
<td>1.2</td>
<td>3.6</td>
<td>4.5</td>
</tr>
</tbody>
</table>

What is some information that can be determined from the above data?

(a) Xenos is about the same size as Jupiter.
(b) Kanthus is three times smaller than Sirius B2.
(c) Orion A3 is more massive than Sirius B2.
(d) There is not enough information to determine any relationships.

Question 3

A rocket is launched at an angle of 30° as shown below.

What is the component of gravity acting on the rocket while it is on the plane?

(a) 0 ms⁻²
(b) 4.91 ms⁻²
(c) 8.50 mm⁻²
(d) 9.81 ms⁻²

Question 4

This question refers to the table below:

<table>
<thead>
<tr>
<th>Moon</th>
<th>Period (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europa</td>
<td>3.6</td>
</tr>
<tr>
<td>Callisto</td>
<td>16.7</td>
</tr>
<tr>
<td>Io</td>
<td>1.8</td>
</tr>
<tr>
<td>Ganymede</td>
<td>7.2</td>
</tr>
</tbody>
</table>

On the basis of Kepler’s Laws, the order of the moons from Jupiter starting with the closest to the planet is:

(a) Callisto, Ganymede, Europa, Io
(b) Io, Europa, Ganymede, Callisto
(c) Europa, Io, Callisto, Ganymede
(d) Io, Callisto, Europa, Ganymede
Question 5

A small atmospheric “window” exists for safe re-entry for spacecraft to the earth. The windows is determined by

(a) the size of the spacecraft.
(b) a combination of landing site, geography and weather conditions.
(c) the hole in the ozone layer.
(d) a compromise between generating too much heat and keeping within safe “g” forces.

Question 6

Which of the following has the greatest effect on microwave communications with satellites in low earth orbit?

(a) The ozone layer.
(b) Sunspots.
(c) The van Allen radiation belt.
(d) Electrical storms.

Question 7

XX. The Michelson-Morley experiment was set up to measure

(a) the speed of light through the aether.
(b) the relative motion of the earth through the aether.
(c) the vibratory nature of the aether.
(d) the particulate nature of light.

Question 8

Two wires P and Q, separated by (d) metres, exert a force per unit of length of F Newtons/metre. If the separation between the lines is reduced to \( \frac{d}{2} \) metres, the force per unit length is now

(a) \( \frac{F}{4} \)
(b) \( \frac{F}{2} \)
(c) \( 2F \)
(d) \( 4F \)
Question 9

The south pole of a magnet is brought towards a circular metal ring that hangs freely from a vertical string. Looking towards the ring,

(a) a current is induced in a clockwise direction setting up a North pole on the side of the ring closest to the South pole of the magnet.
(b) a current is induced in a clockwise direction setting up a South pole on the side of the ring closest to the South pole of the magnet.
(c) a current is induced in an anticlockwise direction setting up a North pole on the side of the ring closest to the South pole of the magnet.
(d) a current is induced in an anticlockwise direction setting up a South pole on the side of the ring closest to the South pole of the magnet.

Question 10

When the North pole of a magnet is pushed into the end of an air core solenoid a North pole is induced at the end of the solenoid, this is a direct consequence of

(a) Fleming’s rule.
(b) the right hand screw rule.
(c) Oersted’s law.
(d) the law of conservation of energy.

Question 11

Calculate the maximum torque produced by a single coil of wire 10 cm long and 5 cm wide when placed in a magnetic field of 5 T, if a current of 2A flows through the wire.

(a) 500 Nm.
(b) 5 Nm.
(c) 0.5 Nm.
(d) 0.05 Nm.

Question 12

Transformers use soft iron cores to

(a) transfer the alternating current directly from the primary to secondary circuits.
(b) intensify the magnetic field.
(c) decrease eddy currents.
(d) provide structural support to the wiring.
Question 13

The main components of an AC motor are

(a) rotor, stator, armature, commutator.
(b) rotor, stator, armature, induction coil.
(c) rotor, armature, induction coil, commutator.
(d) stator, armature, induction coil, commutator.

Question 14

AC motors are often low power because

(a) the rotor is incapable of sustaining high currents.
(b) the frequency of the motor is normally too high.
(c) induction motors are too inefficient at high power.
(d) eddy currents prevent high power applications.

Question 15

Cross-country cables transmit electrical power at relatively high voltage and low current because

(a) this reduces heat losses due to high currents.
(b) it is easier to generate high AC voltages at low current.
(c) DC voltages cannot be transmitted very far.
(d) this is less dangerous than low voltage and high current.
Section I

Part B
Total marks (60)
Attempt Questions 16 – 26
Allow about 1 hour and 30 minutes for this part

Answer Questions 16 – 18 in the Part B1 Answer Booklet.

Show all relevant working in questions involving calculations.

Part B1 – Answer this section in the booklet provided.

Question 16 (9 marks)
During the HSC course, you have gathered information to determine a value for the acceleration due to gravity.

(a) Briefly describe one technique used to determine the value of gravity.  
    Marks

(b) In the technique described in part (a), explain two possible sources of variation from the accepted value of gravity.  
    Marks

(c) Explain how one of the variables is controlled throughout the experiment.  
    Marks

(d) Evaluate the design showing how it could be improved to reduce the source of error discussed in (b) above.  
    Marks

Question 17 (9 marks)
A rocket is launched vertically and attains a speed of 45 m/s after 15 seconds. At this time the first stage is ejected and a second stage is activated and further accelerates the rocket to 80 m/s in another 30 seconds. The total mass of the rocket is 5.6 \times 10^4 kg and the mass of the first stage is 2.1 \times 10^4 kg. The mass of fuel in the first stage is 1.8 \times 10^4 kg.

(a) Calculate the average acceleration of the rocket in the first 15 seconds.  
    Marks

(b) Find the velocity of the rocket just after the first stage is ejected and before the second stage ignites.  
    Marks

(c) Evaluate if this rocket is suitable for astronauts and discuss what equipment will be required  
    Marks

(d) At some point in the rocket’s course, it changes direction from a vertical climb to a more easterly trajectory. Discuss why this course change is necessary when the rocket wants to move from a lower to a higher orbit.  
    Marks
**Question 18 (4 marks)**

A spacecraft is accelerated to 90% of the speed of light. Its rest mass is $5.0 \times 10^8$ kg and its rest length is 134 m.

(a) Calculate the spacecraft’s apparent length at 0.9 of light speed.  
(b) Evaluate the following paradox:

“If an astronaut within the spacecraft shines a torchlight so that it faced forwards, an observer at rest outside the spacecraft reports that the light beam from the torchlight travels at the same speed as one that is shone at rest outside the spacecraft.”

**Part B2 – Answer this section in the booklet provided.**

**Question 19 (6 marks)**

A rectangular coil ABCD of 100 turns of wires lies in a plane to a magnetic field of 10 Tesla. A current of 2.0 Amperes flow from a battery to the path ABCD

(a) What is the direction of the force on the sides AB and CD?  
(b) Calculate the magnitude of the force acting on the sides AB, BC and CD, if BC is 2.0 cm long and AB is 4.0 cm long  
(c) Calculate the maximum torque acting on the coil and determine the direction in which the coil rotates.

**Question 20 (2 marks)**

A magnet moves relative to a solenoid as shown below:

(a) State the law that determines the direction of the induced current.  
(b) Apply the law you stated in part (a) to draw on the diagram the induced poles on the solenoid and the direction of the induced current in the solenoid.
**Question 21** (3 marks)  
Assess available evidence about the physiological effects on humans living near high voltage power lines.  

**Question 22** (5 marks)  
Transformers are widely used in both domestic and industrial circuits.  

(a) In your answer book, sketch a simple transformer and clearly label the primary coil, the secondary coil and the soft iron core.  

(b) Given that a transformer has 100 turns on the primary coil and 500 turns on the secondary coil, calculate the output when it has an input voltage of 20V.  

(c) Discuss at least one problem associated with the development of eddy currents in the soft iron core.  

(d) List one method used to reduce the size of eddy currents produced in transformers and explain how this method limits the eddy currents that develop.  

**Question 23** (3 marks)  
Explain the advantages of induction motors over synchronous motors.  

**Question 24** (4 marks)  
Electromagnetic induction is used in many areas.  

(a) Describe how electromagnetic induction is used in cooktops in electric ranges.  

(b) Explain how electromagnetic braking works in such things as amusement park rides and triple beam balances.  

End of Exam – Check your answers.
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample  \[ 2 + 4 = \] (A) 2 (B) 6 (C) 8 (D) 9

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

\[ \text{correct} \]
Answer Questions 16 – 21 in this Answer Booklet.

16. (a) ________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

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(b) ________________________________________________________________

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(c) ________________________________________________________________

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(d) ________________________________________________________________

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_____________________________________________________________________
17. (a) 

(b) 

c) ______________________________________________________________________________ 
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

(d) ______________________________________________________________________________ 
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
18. (a)

(b) ____________________________________________________________
Name / Number: _________________________________

Answer Questions 19 – 24 in this Answer Booklet.

19. (a) 

(b) 

(c)
20. (a) 

(b) 

21. 

22. (a) 

(b) 

(c) 


HSC Physics Half Yearly Exams 2001 Mapping Grid

For each question in the exam please map the content area, the syllabus outcome and the targeted performance band. This mapping grid must be stored along with the planning grid with exam paper in the Faculty assessment folder.

<table>
<thead>
<tr>
<th>Question</th>
<th>Mark</th>
<th>Content</th>
<th>Syllabus Outcomes</th>
<th>Targeted Performance Band</th>
<th>Correct Answer</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td>9.2.1.1</td>
<td>H6, H9</td>
<td>2</td>
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<td>H4, H6, H9</td>
<td>5</td>
<td>C</td>
</tr>
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<td>H4, H7</td>
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<td>H2, H4, H9</td>
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<td>H7, H9</td>
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<td>16(a)</td>
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<td>H4, H6, H9</td>
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<td>16(b)</td>
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<td>H4, H6, H9, H12</td>
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<td>A</td>
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<td>16(c)</td>
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<td>H4, H6, H7</td>
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<td>H4, H6, H7</td>
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<td>H4, H6, H9</td>
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<td>A</td>
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<tr>
<td>18(b)</td>
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<td>9.2.3.6</td>
<td>H4, H6, H9</td>
<td>5-6</td>
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<td>H7, H9</td>
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<td>19(b)</td>
<td>3</td>
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<td>H7, H9</td>
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<td>A</td>
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<tr>
<td>19(c)</td>
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<td>9.3.1.6</td>
<td>H7, H9</td>
<td>5</td>
<td>A</td>
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<td>H7, H9</td>
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<td>20(b)</td>
<td>1</td>
<td>9.3.2.5</td>
<td>H7, H9</td>
<td>4</td>
<td>A</td>
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<tr>
<td>21</td>
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<td>9.3.3.5</td>
<td>H4, H6, H7</td>
<td>6</td>
<td>A</td>
</tr>
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<td>22(a)</td>
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<td>9.3.4.2</td>
<td>H4, H7, H9</td>
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<td>A</td>
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<td>22(b)</td>
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<td>H4, H7, H9</td>
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<td>H4, H7, H9</td>
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<td>A</td>
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<tr>
<td>22(d)</td>
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<td>9.3.4.6</td>
<td>H4, H7, H9</td>
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<td>24(b)</td>
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<td>9.3.2.6</td>
<td>H4, H6, H7</td>
<td>3-4</td>
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</table>
Question 16 (9 marks)

During the HSC course, you have gathered information to determine a value for the acceleration due to gravity.

(a) Briefly describe one technique used to determine the value of gravity.  

**MARKING GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Accurately describes one method for measuring gravity</td>
<td>1</td>
</tr>
</tbody>
</table>

Sample answer:
One method is to use a pendulum. The length and period of the pendulum is measured and an equation is used to calculate the value of gravity from these variables.

(b) In the technique described in part (a), explain two possible sources of variation from the accepted value of gravity.  

**MARKING GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Correctly explains two sources of error / variation.</td>
<td>2</td>
</tr>
</tbody>
</table>

Sample answer:
Using the pendulum technique, the value of gravity obtained can depend on the location of the experiment (different rocks under the surface can change the value slightly) and there are inaccuracies in the measurement of the period in particular the measurement of time if it is done by hand.

(c) Explain how one of the variables is controlled throughout the experiment.

**MARKING GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Identifies and describes how one variable is controlled.</td>
<td>2</td>
</tr>
</tbody>
</table>

Sample answer:
The length of the pendulum is one variable that is controlled. This is done by securing the pendulum to a fixed point, such as a boss head on a retort stand.

(d) Evaluate the design showing how it could be improved to reduce the source of error discussed in (b) above.

**MARKING GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Suggests the best strategies on the basis of a comparison of others.</td>
<td>4</td>
</tr>
<tr>
<td>• Compares different strategies that can be employed to reduce the errors mentioned in part (b)</td>
<td>2-3</td>
</tr>
<tr>
<td>• Identifies changes that can be made to the experiment.</td>
<td>1</td>
</tr>
</tbody>
</table>

Sample answer:
In order to improve the accuracy of the timing of the pendulum, different methods can be used. One is to use a data logger triggered by a light switch, although this will introduced other errors as there is a time delay in the computer processing the value. Another way would be to use a dedicated timer. This will probably be more accurate as errors in timing are minimised in the manufacture of the device.
Question 17 (9 marks)

A rocket is launched vertically and attains a speed of 45 m/s after 15 seconds. At this time the first stage is ejected and a second stage is activated and further accelerates the rocket to 80 m/s in another 30 seconds. The total mass of the rocket is 5.6 X 10^4 kg and the mass of the first stage is 2.1 X 10^4 kg. The mass of fuel in the first stage is 1.8 X 10^4 kg

(a) Calculate the average acceleration of the rocket in the first 15 seconds.

**MARKING GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Correctly calculates the acceleration</td>
<td>1</td>
</tr>
</tbody>
</table>

Sample answer:

\[ a = \frac{v - u}{t} = \frac{45 - 0}{15} = 3 \text{ ms}^{-2} \]

(b) Find the velocity of the rocket just after the first stage is ejected and before the second stage ignites.

**MARKING GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Calculates the correct velocity after the stage is ejected.</td>
<td>2</td>
</tr>
<tr>
<td>• Identifies and applies correct equations to use.</td>
<td>1</td>
</tr>
</tbody>
</table>

Sample answer:

Momentum before the first stage is ejected \( m_1v_1 = (5.6 - 1.8) \times 10^4 \text{ kg} \times 45 \text{ m/s} = 1.71 \times 10^6 \text{ Ns} \)

Thus total momentum after the first stage is ejected \( 1.71 \times 10^6 \text{ Ns} \).

Mass of rocket after first stage is ejected \( m_2 = 5.6 \times 10^4 - 2.1 \times 10^4 \text{ kg} = 3.5 \times 10^4 \text{ kg} \).

Thus velocity after ejection of first stage \( v_2 = \frac{p}{m} = \frac{1.71 \times 10^6}{3.5 \times 10^4} = 48.0 \text{ m/s} \).

(c) Evaluate if this rocket is suitable for astronauts and discuss what equipment will be required

**MARKING GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Justifies why equipment used is necessary to astronaut survival.</td>
<td>3</td>
</tr>
<tr>
<td>• Discusses how astronauts can tolerate accelerations up to 3W and states some equipment needed for the astronauts.</td>
<td>2</td>
</tr>
<tr>
<td>• Mentions that the acceleration is sufficiently low for astronauts to survive.</td>
<td>1</td>
</tr>
</tbody>
</table>

Sample answer:

Since an acceleration of 3 ms\(^{-2}\) is lower than the 3W that is cited as the maximum tolerance level of astronauts, the acceleration is safe for astronauts. They will require life support systems such as oxygen bottles and perhaps food and water for longer voyages. The couch that the astronaut is strapped into must support and cushion the reaction force that the astronaut experiences as the rocket accelerates.
(d) At some point in the rocket’s course, it changes direction from a vertical climb to a more easterly trajectory. Discuss why this course change is necessary when the rocket wants to move from a lower to a higher orbit.

3

**MARKING GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Describes the slingshot effect and how it is used to place the projectile into a higher orbital.</td>
<td>2-3</td>
</tr>
<tr>
<td>• Mentions how the rocket needs to go into a circular orbit.</td>
<td>1</td>
</tr>
</tbody>
</table>

Sample answer:
The easterly course is necessary to put the rocket into a circular orbit around the Earth. Once in a circular orbit, no more energy is needed to maintain the rocket (ignoring air resistance). This manoeuvre is also necessary when performing a slingshot into a higher orbit. Using the earth’s rotational energy, the rocket can “borrow” some of this energy found along the equator to boost its own speed to move it into a higher orbit. Hence the easterly course is essential to produce this effect.

**Question 18 (4 marks)**

A spacecraft is accelerated to 90% of the speed of light. Its rest mass is \(5.0 \times 10^8\) kg and its rest length is 134 m.

(a) Calculate the spacecraft’s apparent length at 0.9 of light speed.

1

**MARKING GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Correctly calculates the length at 0.9c</td>
<td>1</td>
</tr>
</tbody>
</table>

Sample answer:

\[
L_v = L_0 \sqrt{1 - \frac{v^2}{c^2}} = 134 \times \sqrt{1 - \frac{0.9c^2}{c^2}} = 42.4 \text{ metres.}
\]

(b) Evaluate the following paradox:

“If an astronaut within the spacecraft shines a torchlight so that it faced forwards, an observer at rest outside the spacecraft reports that the light beam from the torchlight travels at the same speed as one that is shone at rest outside the spacecraft.”

3

**MARKING GUIDELINES**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Explains how length and time dilation causes the moving observer to measure the same value as a “stationary” observer.</td>
<td>3</td>
</tr>
<tr>
<td>• Makes note of the relative velocity between the moving object and the observer.</td>
<td>2</td>
</tr>
<tr>
<td>• Makes a statement about the constancy of the speed of light such as “light always travels at the speed of light irregardless of the surrounding conditions”.</td>
<td>1</td>
</tr>
</tbody>
</table>

Sample answer:
Both observers agree on the speed of light because they are in different frames of reference. The astronaut inside the spacecraft does not feel it move and so everything within the spacecraft appears stationary, hence a beam of light will travel inside the spacecraft at \(c\). The “stationary” observer will also measure light as \(c\). If the observer at rest were to measure the light beam in the spacecraft, due to length and time dilation the length will shorten and the time measured increased such that the ratio of length to time will still equal \(c\).
Question 19 (6 marks) A rectangular coil ABCD of 100 turns of wires lies in a plane to a magnetic field of 10 Tesla. A current of 2.0 Amperes flows from a battery to the path ABCD

(a) What is the direction of the force on the sides AB and CD? 1

MARKING GUIDELINES

<table>
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<tr>
<th>Criteria</th>
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</thead>
<tbody>
<tr>
<td>• Correct direction identified</td>
<td>1</td>
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</tbody>
</table>

Sample answer:
The direction that AB and CD will turn is anticlockwise (ie AB goes down and CD goes up)

(b) Calculate the magnitude of the force acting on the sides AB, BC and CD, if BC is 2.0 cm long and AB is 4.0 cm long 3

MARKING GUIDELINES

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>• Correctly calculates the force on all three sections of the coil.</td>
<td>3</td>
</tr>
<tr>
<td>• Identify that BC is parallel to the magnetic field and hence experiences no force</td>
<td>1-2</td>
</tr>
</tbody>
</table>

Sample answer:
\[ F_{AB} = \frac{B I}{\sin \theta} = 10 \times 2 \times 0.04 = 0.8 \text{ N} \]
\[ F_{BC} = 0 \text{ since the current is parallel to the magnetic field.} \]
\[ F_{CD} = \frac{B I}{\sin \theta} = 10 \times 2 \times 0.04 = 0.8 \text{ N} \]

(c) Calculate the maximum torque acting on the coil and determine the direction in which the coil rotates. 2

MARKING GUIDELINES

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>• Identifies the correct equation and applies it appropriately to derive the correct answer.</td>
<td>1-2</td>
</tr>
</tbody>
</table>

Sample answer:
\[ \tau = n I B A \cos \theta = 100 \times 2 \times 10 \times (0.02 \times 0.04) \times \cos 90^\circ = 1.6 \text{ Nm.} \]
The torque is anticlockwise according the right palm rule.
Question 20 (2 marks)

A magnet moves relative to a solenoid as shown below:

(a) State the law that determines the direction of the induced current.  

MARKING GUIDELINES

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>Correctly states law.</td>
<td>1</td>
</tr>
</tbody>
</table>

Sample answer:
Lenz’s Law.

(b) Apply the law you stated in part (a) to draw on the diagram the induced poles on the solenoid and the direction of the induced current in the solenoid.  

MARKING GUIDELINES

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correctly applies Lenz’s law to the situation.</td>
<td>1</td>
</tr>
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</table>

Sample answer:

Question 21 (3 marks)

Assess available evidence about the physiological effects on humans living near high voltage power lines.  

MARKING GUIDELINES

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>States that most current evidence is epidemiological and conclusive proof is yet to emerge.</td>
<td>2-3</td>
</tr>
<tr>
<td>Links leukemias and brain function to studies of electric fields in humans.</td>
<td></td>
</tr>
<tr>
<td>Mentioned some possible effects of electric fields on humans.</td>
<td>1</td>
</tr>
</tbody>
</table>

Sample answer:
To date there is no firm evidence linking the effects of high voltage power lines to physiological effects on humans. Some studies have shown an increased risk of certain leukemias and other cancers while studies done on mobile phones suggest that brain function can be compromised. However, these studies do not provide a mechanism for these effects, although in 2001 a study showed that some charged metal particles originating from power lines can be inhaled by humans. The effect of such particles is still unknown.
Transformers are widely used in both domestic and industrial circuits.

(a) In your answer book, sketch a simple transformer and clearly label the primary coil, the secondary coil and the soft iron core.

MARKING GUIDELINES

Criteria | Marks
--- | ---
Correctly sketches the transformer and labels all three features | 1

Sample answer:

![Transformer Sketch](image)

(b) Given that a transformer has 100 turns on the primary coil and 500 turns on the secondary coil, calculate the output when it has an input voltage of 20V.

MARKING GUIDELINES

Criteria | Marks
--- | ---
Correctly calculates the output voltage | 1

Sample answer:

\[
\frac{n_p}{n_s} = \frac{V_p}{V_s} \Rightarrow V_s = V_p \times \frac{n_s}{n_p} = 20 \times \frac{500}{100} = 100 \text{ V}
\]

(c) Discuss at least one problem associated with the development of eddy currents in the soft iron core.

MARKING GUIDELINES

Criteria | Marks
--- | ---
Mentions one problems created by the development of eddy currents. | 1

Sample answer:

Eddy currents reduce the total magnetic energy available to create the secondary voltage, hence reducing the efficiency of the transformer.

(d) List one method used to reduce the size of eddy currents produced in transformers and explain how this method limits the eddy currents that develop.

MARKING GUIDELINES

Criteria | Marks
--- | ---
Accurately explains how the method can reduce eddy currents. | 2

Sample answer:

Lamination of the soft iron core can reduce the total effect of eddy currents by divided the current into smaller elements that cause less losses than a single large eddy current.
Question 23 (3 marks)

Explain the advantages of induction motors over synchronous motors.  

<table>
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<tr>
<th>MARKING GUIDELINES</th>
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<tbody>
<tr>
<td>Criteria</td>
</tr>
<tr>
<td>• Compares the advantages of induction motors to synchronous motors.</td>
</tr>
<tr>
<td>• Lists some advantages of induction motors.</td>
</tr>
</tbody>
</table>

Sample answer:
Induction motors in general are more efficient due to less friction between rotor and stator components; the ability to be sealed allowing a lubricant such as oil to be used; less complex mechanisms need to be used compared to the timing circuits needed in synchronous motors; and they can attain relatively high speeds compared to similar synchronous motors.

Question 24 (4 marks)

Electromagnetic induction is used in many areas.

(a) Describe how electromagnetic induction is used in cooktops in electric ranges.  

<table>
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<tr>
<th>MARKING GUIDELINES</th>
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<tbody>
<tr>
<td>Criteria</td>
</tr>
<tr>
<td>• Explains how induction cooking works.</td>
</tr>
<tr>
<td>• Briefly explains the principles of magnetic induction.</td>
</tr>
</tbody>
</table>

Sample answer:
In induction cooktops, a large AC current is run through coils underneath the cook top surface. Any metal pan placed on top of the cook top has eddy currents induced in it according to Lenz’s law. These eddy currents have no where to go so they dissipate their energy as heat, which warms up the food.

(b) Explain how electromagnetic braking works in such things as amusement park rides and triple beam balances.  

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<tbody>
<tr>
<td>Criteria</td>
</tr>
<tr>
<td>• Applies Lenz’s law to the slowing down of the object in the presence of an external magnetic field.</td>
</tr>
<tr>
<td>• Briefly describes Lenz’s law or similar.</td>
</tr>
</tbody>
</table>

Sample answer:
Electromagnetic braking is a passive system where a moving conductor in a magnetic field has a voltage induced in it due to Lenz’s law. This voltage in turn creates eddy currents that attempt to oppose their production. Since the induced voltage is caused by the movement of the conductor in the magnetic field, the eddy current’s magnetic field oppose the external field in an attempt to slow down the conductor, hence braking the system.
General Instructions. What is this form? To help the government fight financial crime, Federal regulation requires certain financial institutions to obtain, verify, and record information about the beneficial owners of legal entity customers. Continental Lawyers Title Insurance Company - is hereby designated as escrow holder (the "Escrow Holder"). In addition to these general instructions, which contain general information concerning Forms 1096, 1097, 1098, 1099, 3921, 3922, 5498, and W-2G, we provide specific form instructions separately. Get the instructions you need for completing a specific form from the following list of separate instructions. • Instructions for Form 1097-BTC. • Instructions for Form 1098. • Instructions for Form 1098-C. • Instructions for Forms 1098-E and 1098-T. • Bassersdorf, Switzerland Document code Unit General instructions and common functions Instruction Manual Document Type Document title Page 2 of 169 Table of contents 1 ORGANIZATION OF THE HW4 MANUALS . 5 2 OVERVIEW . AND common functions Instruction Manual Document Type Document title 9 Page 3 of 169 SEARCHING FOR DEVICES WITH HW4 . RPF Constable General Instructions are provided to familiarize the candidates with the different policies and regulations of the Examination, Examination center and in general about the Do’s and Don’ts in the recruitment process. This chapter covers the instructions pertaining to but not limited to: what kind of stationery items to be carried inside the examination hall, particulars to be noted, during the examination, end of the examination, proof of identity to be submitted etc.