Please write clearly in block capitals.

Centre number ____________________________  Candidate number ____________________________

Surname ____________________________

Forename(s) ____________________________

Candidate signature ____________________________

---

GCSE PHYSICS
Higher Tier  Unit Physics P3

Friday 17 June 2016  Morning  Time allowed: 1 hour

Materials
For this paper you must have:
• a ruler
• a calculator
• the Physics Equations Sheet (enclosed).

Instructions
• Use black ink or black ball-point pen.
• Fill in the boxes at the top of this page.
• Answer all questions.
• You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
• Do all rough work in this book. Cross through any work you do not want to be marked.

Information
• The marks for questions are shown in brackets.
• The maximum mark for this paper is 60.
• You are expected to use a calculator where appropriate.
• You are reminded of the need for good English and clear presentation in your answers.
• Question 1(b) should be answered in continuous prose.
  In this question you will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Advice
• In all calculations, show clearly how you work out your answer.
Electromagnets are often used at recycling centres to separate some types of metals from other materials.

Give one reason why an electromagnet would be used rather than a permanent magnet.

[1 mark]

_____________________________________________________________________________________
_____________________________________________________________________________________

1 (b) In this question you will gain marks for using good English, organising information clearly and using scientific words correctly.

Some students want to build an electromagnet.

The students have the equipment shown in Figure 1.

Figure 1

- Insulated wire
- Iron nail
- Power supply
- Connecting leads
- Steel paperclips
- Wooden clamp and stand
Describe how the students could build an electromagnet. Include in your answer how the students should vary and test the strength of their electromagnet. 

[6 marks]
2 Figure 2 shows the structure of a traditional transformer.

**Figure 2**

- Primary coil
- Secondary coil
- 230 V
- Iron core

2 (a) There is an alternating current in the primary coil of the transformer.

State what is produced in the iron core. [2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________

2 (b) A transformer has only **one** turn of wire on the secondary coil.

The potential difference across the secondary coil is 11.5 V
The potential difference across the primary coil is 230 V

Calculate the number of turns on the primary coil.

Use the correct equation from the Physics Equations Sheet. [2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

Number of turns on the primary coil = ______________

Question 2 continues on the next page

Turn over ▶
2 (c) In most transformers, the power output is less than the power input. State why. [1 mark]

_____________________________________________________________________________________
_____________________________________________________________________________________

2 (d) Two students investigated how magnets can be used to produce a potential difference. The students held a coil of wire above a magnet. The students quickly lowered the coil so that the magnet was inside the coil, as shown in Figure 3.

Figure 3

Coil of wire

Voltmeter

Magnet

The students recorded the maximum potential difference for coils with different numbers of turns of wire. The results are shown in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Number of turns of wire in the coil</th>
<th>Maximum potential difference in volts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Results from student 1</td>
</tr>
<tr>
<td>5</td>
<td>0.09</td>
</tr>
<tr>
<td>10</td>
<td>0.20</td>
</tr>
<tr>
<td>15</td>
<td>0.31</td>
</tr>
<tr>
<td>20</td>
<td>0.39</td>
</tr>
<tr>
<td>25</td>
<td>0.51</td>
</tr>
</tbody>
</table>
2 (d) (i) State the resolution of the voltmeter.

Give one reason why the resolution of the voltmeter is suitable for this investigation. [2 marks]

Resolution _____________________

Reason _____________________________________________________________________________
_____________________________________________________________________________________

2 (d) (ii) The two students used exactly the same equipment to carry out their investigations. Both students recorded their results correctly.

Give the reason why student 2 got different results from student 1. [1 mark]
_____________________________________________________________________________________
_____________________________________________________________________________________

2 (d) (iii) The students decided that even though the results were different, there was no need to repeat the investigation.

How do the results show that the investigation is reproducible? [1 mark]
_____________________________________________________________________________________
_____________________________________________________________________________________

2 (d) (iv) State the name of the process which causes the potential difference to be produced in this investigation. [1 mark]
_____________________________________________________________________________________

2 (e) A transformer has been developed that can be used with many different devices.

Suggest one advantage of having a transformer that can be used with many different devices. [1 mark]
_____________________________________________________________________________________
_____________________________________________________________________________________
3 X-rays and ultrasound can both be used for scanning internal organs.

3 (a) Ultrasound is used to scan unborn babies but X-rays are not used to scan unborn babies.

Explain why. [3 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

3 (b) The behaviour of ultrasound waves when they meet a boundary between two different materials is used to produce an image.

Describe how. [2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
3 (c) **Figure 4** shows two pulses from a scan of an unborn baby. The emitted pulse is labelled A. The returning pulse picked up by the receiver is labelled B.

![Figure 4]

The closest distance between the unborn baby and the mother’s skin is 4.0 cm. Use information from **Figure 4** to calculate the average speed of the pulse.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

Average speed = ___________ m/s

**Question 3 continues on the next page**
3 (d) **Figure 5** shows an X-ray of an arm with a broken bone.

![Figure 5](image)

3 (d) (i) Describe how X-rays are able to produce an image of bones. [3 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

3 (d) (ii) Complete the following sentence.

X-rays are able to produce detailed images because their wavelength is very ____________________ . [1 mark]
Figure 6 shows a ray of light going from air into an optical fibre and then travelling through part of the optical fibre.

**Figure 6**

4 (a) Which one of the following pairs of angles correctly identifies the angle of incidence and the angle of refraction?

Tick (✓) one box.

<table>
<thead>
<tr>
<th>Angle of incidence</th>
<th>Angle of refraction</th>
<th>Tick (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>

4 (b) The glass used to make this optical fibre has a refractive index of 1.5.

Calculate the critical angle of the glass.
Give your answer to 2 significant figures.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

Critical angle = ____________ degrees
4 (c) Short pulses of light can carry information through optical fibres.

Each pulse is made of lots of light rays. The light rays refract into the optical fibres at different angles when the pulse is sent.

The paths of two possible rays, A and B, are shown in Figure 7. These rays make up part of the pulse shown in Figure 8.

![Figure 7](image)

A pulse of light entering the optical fibre has changed when it leaves the optical fibre, as shown in Figure 8.

![Figure 8](image)

By considering the paths of rays A and B, explain why the pulse of light shown in Figure 8 changed as it passed through the optical fibre.

[2 marks]

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

6
A drum is hit by a beater attached to a drumstick lever. The drumstick lever is attached to a foot-pedal by a chain, as shown in Figure 9.

5 (a) When the toe is pushed down the force creates a moment on the foot-pedal.

5 (a) (i) State what is meant by the moment of a force.

5 (a) (ii) The foot-pedal is pushed halfway down and held stationary. The toe and the chain both exert a force on the foot-pedal.

Compare the sizes and directions of the moments caused by the force of the toe and the force of the chain on the foot-pedal.

[1 mark]
5 (a) (iii) The drummer’s toe pushes with a 1.5 N force on the foot-pedal. The perpendicular distance from the pivot to the force is 0.12 m. The perpendicular distance from the pivot to the chain is 0.20 m.

Calculate the force of the chain acting on the foot-pedal.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Force = _______________ N

Question 5 continues on the next page
5 (b) The foot-pedal is pushed with different forces to make the beater move at different speeds.

The higher the speed at which the beater hits the drum, the louder the sound the drum makes.

**Figure 10** shows how the length of the drumstick lever affects the speed of the beater for three different forces.

**Figure 10**

![Graph showing the relationship between length of the drumstick lever and speed of the beater for different forces.]

The drummer needs to be able to sometimes play the drum quietly and sometimes loudly.

How does the **length** of the drumstick lever affect the variation in loudness of the sound from the drum when applying:

[2 marks]

a force of 3 N? __________________________________________

_____________________________________________________________________________________

a range of forces from 3 N to 9 N? __________________________________________

_____________________________________________________________________________________
In a balancing game, wooden blocks are used to build a tower. The shape of the tower at the start of the game is shown in Figure 11. During the game, some of the blocks are taken out and put on top of the tower as shown in Figure 12. This causes the centre of mass of the tower to change.

6 (a) (i) State what is meant by the term ‘centre of mass’.

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

6 (a) (ii) Give two reasons why the tower in Figure 12 is less stable than the tower in Figure 11.

1 ___________________________________________________________________________________
_____________________________________________________________________________________

2 ___________________________________________________________________________________
_____________________________________________________________________________________

[1 mark]
[2 marks]
6 (b) **Figure 13** shows a different arrangement for the wooden blocks.

A block was placed in position A and an identical block was placed in position B at the same time.

Explain why the tower did not fall over. You should include reference to moments in your answer.

[2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

Turn over for the next question
7 (a) Some people have an eye defect called long sight.

7 (a) (i) State one cause of long sight. [1 mark]

7 (a) (ii) Long sight can be corrected by surgery. During surgery, the surgeon may need to cut and heat very delicate parts of the eye.

Name the piece of equipment which provides the energy source used to do this. [1 mark]

7 (b) A light bulb is placed between a convex lens and the principle focus of this lens, at position N shown in Figure 14. The light bulb is then moved to position M, a large distance from the lens.

Describe how the nature of the image formed changes as the light bulb is moved from position N to position M. [3 marks]
7 (c) An object, \( O \), is very near to a convex lens, as shown in Figure 15.

Complete Figure 15 to show how rays of light from the object form an image.

[3 marks]

**Figure 15**

---

**Question 7 continues on the next page**
The object distance is the distance from an object to the lens. The image distance is the distance from the lens to the image.

**Figure 16** shows how the image distance changes with the object distance, for two identically shaped convex lenses, A and B. Each lens is made from a different type of glass.

**Figure 16**

![Graph showing object distance vs image distance for lenses A and B.]

7 (d) (i) When the object distance is 4 cm, the image distance for lens A is longer than for lens B.

State why. 

[1 mark]
7 (d) (ii) When the object is moved between lens B and the principal focus, the image size changes. Table 2 shows the magnification produced by lens B for different object distances.

Table 2

<table>
<thead>
<tr>
<th>Object distance in cm</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>1</td>
</tr>
<tr>
<td>5.0</td>
<td>2</td>
</tr>
<tr>
<td>6.7</td>
<td>3</td>
</tr>
<tr>
<td>7.5</td>
<td>4</td>
</tr>
<tr>
<td>8.0</td>
<td>5</td>
</tr>
</tbody>
</table>

Using information from Figure 16 and Table 2, describe the relationship between the image distance and the magnification produced by lens B. [2 marks]

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

7 (d) (iii) A third convex lens, lens C, is made from the same type of glass as lens B, but has a shorter focal length than lens B.

Lens B is shown in Figure 17.

Complete Figure 17 to show how lens C is different from lens B. [1 mark]

Figure 17

[Diagram of lens B and lens C]

END OF QUESTIONS