 I.D. Number: _____

Teachers: Mr Coombes, Mr Pitt, Mr Robson

Task Weighting: 15% **Time Allowed: 45 minutes**

This task is marked out of 25 marks **Mark obtained ____ / 25**

INSTRUCTIONS: There are **two** parts **A** and **B** in this task. There is one question in part A, which requires you to carry out a first-hand investigation. You will need to go to where the apparatus is set up in the lab to conduct this investigation. Several stations have been set up for you to do this. You must watch for when the apparatus is free and quietly move to the vacant station to conduct the investigation. It should take you less than 3 minutes to conduct the investigation.

Part B requires you to apply some knowledge and skills to answer the questions without carrying out any first-hand gathering of data. There are seven questions in part B (8 in total).

Read the whole of each question before commencing it, and then record your answers in the spaces provided.

Equations

$$\frac{F}{l} = k\frac{I_1 I_2}{d} \qquad F = BIl\sin\theta \qquad \tau = Fd \qquad \tau = nBIA\cos\theta \qquad \frac{V_p}{V_s} = \frac{n_p}{n_s}$$

Part A

1. Examine the apparatus set up in the lab. The following information may assist you with your observations and conclusions.

   The reading produced on a centre-reading galvanometer is positive, when the current is flowing into the terminal marked positive and out of the one marked negative. When the current flows in the opposite direction, the reading on the meter is negative.

   Connect the apparatus so that you can investigate the production of an electric current using the supplied equipment.

(a) Move the north end of the magnet in and out of each end of the coil in turn.

Describe your observations. (2 marks)

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(b) The following diagram shows a solenoid with the ends short-circuited fixed onto a light trolley. Neglect any effects produced by friction.

Predict the behaviour of the trolley/coil when the magnet is moved towards the end of the coil as shown in the diagram below. (1 mark)

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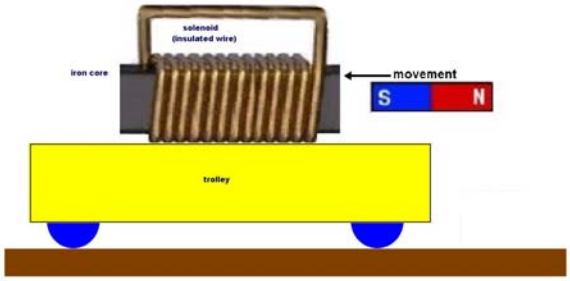

(c) Lenz's law states: "*The effect of an induced emf is such as to oppose the change in magnetic flux that causes the induced emf*." Analyse your prediction in part (b) using Lenz's law. (3 marks)

[Note that the above is a **poor** statement of Lenz's law and it would be better expressed as "*The effect of an induced emf is* ***induce a current that produces a magnetic field*** *that opposes the change in magnetic flux that causes the induced emf*"]

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Part B

2. You have carried out a first-hand investigation of cathode rays using a discharge tube containing a fluorescent display screen.

   Outline the energy conversions that take place in this type of tube. (2 marks)

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3. You have carried out a first-hand investigation of cathode rays using a vacuum tube containing a Maltese cross.

   Draw a labelled diagram of this apparatus that **could** be used to help explain why a "shadow" of the cross is produced in the tube. You are **not required** to provide an explanation. (2 marks)

4. You have performed a first-hand investigation in which you observed the behaviour of cathode rays in a tube containing electric plates.

   (a) Describe the effect of the plates on the cathode rays. (1 mark)

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   (b) Account for the effect described. (2 marks)

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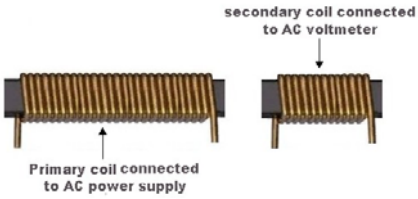
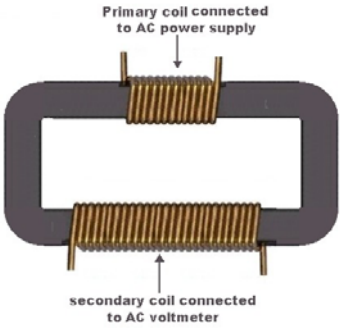
5. Two students wishing to investigate the production of a secondary voltage in a transformer set up the following models.



Design A



Design B

(a) Choose the design most appropriate to this investigation and justify your choice. (2 marks)

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(b) The input to a transformer was 6 V and the required output was 30 volts. Calculate the number of turns that would be required on the secondary coil if the primary coil had 50 turns on it. (1 mark)

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6. Outline how a mathematical model is validated in physics. (2 marks)

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7. A student modelled an AC induction motor by balancing an aluminium pie dish on a vertical needle on a stand and then moving a magnet above the dish around its circumference about 1 cm away from the dish. The student observed that the dish rotated in the same direction as that in which the magnet was moving and that the faster the magnet was moved, the faster the dish rotated. The investigation was repeated using a plastic dish similar in size and shape to the aluminium dish. The student observed that movement of the magnet had no effect on the plastic dish.

   The student concluded from this investigation that it is necessary for the rotor of an AC induction motor to be made of a conductor.

   Assess the validity of the student's conclusion. (2 marks)

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8. Assess the following statement. (5 marks)

   A lamp that is connected to a step-down transformer produces less power than that which is applied to the primary coil. A lamp that is connected to a step-up transformer produces more power than that which is applied to the primary coil.

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End of Task

First-hand investigations

- perform an investigation to model the generation of an electric current by moving a magnet in a coil or a coil near a magnet
- plan, choose equipment or resources for, and perform a first-hand investigation to predict and verify the effect on a generated electric current when:
  - the distance between the coil and magnet is varied
  - the strength of the magnet is varied
  - the relative motion between the coil and the magnet is varied
- plan, choose equipment or resources for, and perform a first-hand investigation to demonstrate the production of an alternating current
- perform an investigation to model the structure of a transformer to demonstrate how secondary voltage is produced
- solve problems and analyse information about transformers using:

$$\frac{V_p}{V_s} = \frac{n_p}{n_s}$$

- perform an investigation to demonstrate the principle of an AC induction motor

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- perform an investigation and gather first-hand information to observe the occurrence of different striation patterns for different pressures in discharge tubes
- perform an investigation to demonstrate and identify properties of cathode rays using discharge tubes:
  - containing a Maltese cross
  - containing electric plates
  - with a fluorescent display screen
  - containing a glass wheel
- analyse the information gathered to determine the sign of the charge on cathode rays

Outcomes assessed in this task

H2. analyses the ways in which models, theories and laws in physics have been tested and validated
H7. explains the effects of energy transfers and energy transformations
H9. explains the effects of electric, magnetic and gravitational fields
H11. justifies the appropriateness of a particular investigation plan
H12. evaluates ways in which accuracy and reliability could be improved in investigations
H13. uses terminology and reporting styles appropriately and successfully to communicate information and understanding
H14. assesses the validity of conclusions from gathered data and information
H15. explains why an investigation is best undertaken individually or by a team

Marking Criteria for Year 12 Prac/Process Task 3 2005

Part A

1. Examine the apparatus set up in the lab. The following information may assist you with your observations and conclusions.

   The reading produced on a centre-reading galvanometer is positive, when the current is flowing into the terminal marked positive and out of the one marked negative. When the current flows in the opposite direction, the reading on the meter is negative.

   Connect the apparatus so that you can investigate the production of an electric current using the supplied equipment.

(a) Move the north end of the magnet in and out of each end of the coil in turn.

Describe your observations. (2 marks)

Question 1 (a) Criteria	Marks
Describes the movement of the needle (or flow of induced current) in opposite directions when the north end of the magnet is inserted into opposite ends of the coil AND Describes the movement of the needle (or flow of induced current) in opposite directions when the north end of the magnet is inserted into and removed from one end of the coil	2
Describes ONE of the above	1

(b) The following diagram shows a solenoid with the ends short-circuited fixed onto a light trolley. Neglect any effects produced by friction.

Predict the behaviour of the trolley/coil when the magnet is moved towards the end of the coil as shown in the diagram below. (1 mark)

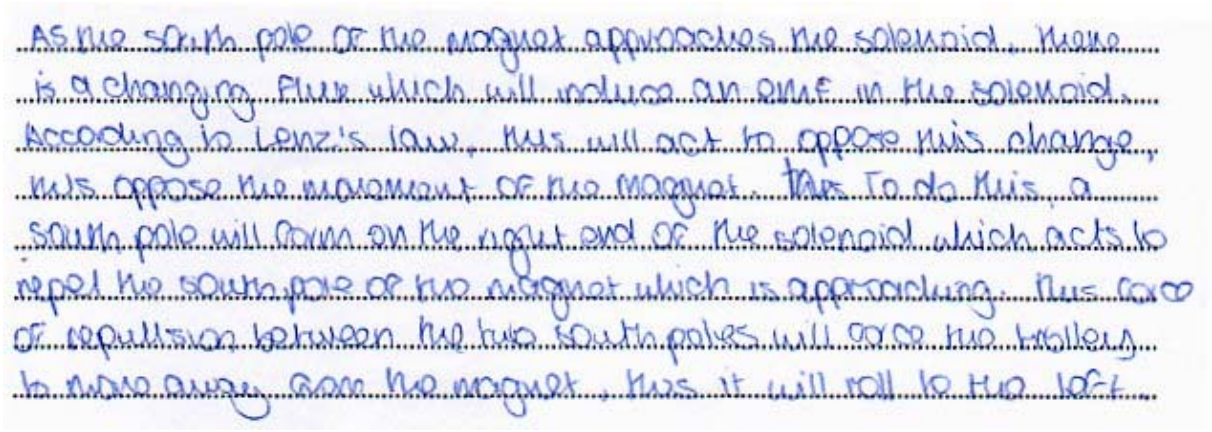
Question 1 (b) Criteria	Marks
Predicts the repulsion of the coil / trolley as the magnet is moved towards the coil (or states that the coil / trolley moves to the left)	1

(c) Lenz's law states: "*The effect of an induced emf is such as to oppose the change in magnetic flux that causes the induced emf*." Analyse your prediction in part (b) using Lenz's law. [Note that this is a **poor** statement of Lenz's law and it would be better expressed as "*The effect of an induced emf is* ***induce a current that produces a magnetic field*** *that opposes the change in magnetic flux that causes the induced emf*"] (3 marks)

Question 1 (c) Criteria	Marks
Identifies the key components – the change in flux produced by the moving magnet and the force of repulsion produced between the magnet and the coil AND Describes the **relationship** between the components – the current induced in the coil produces a magnetic field that opposes the cause of the flux change – the movement of the south end of the magnet towards the coil. Demonstrates a clear understanding that this description is consistent with Lenz's law.	3
Identifies the key components – the change in flux produced by the moving magnet and the force of repulsion produced between the magnet and the coil BUT fails to demonstrate a clear understanding of the connection between them in terms of Lenz's law.	2
Identifies that the end of the solenoid closest to the magnet is a south pole OR States that the changing magnetic flux (due to movement of magnet) induces an emf.	1

H2. analyses the ways in which models, theories and laws in physics have been tested and validated

Sample answer



Part B

2. You have carried out a first-hand investigation of cathode rays using a discharge tube containing a fluorescent display screen.

   Outline the energy conversions that take place in this type of tube. (2 marks)

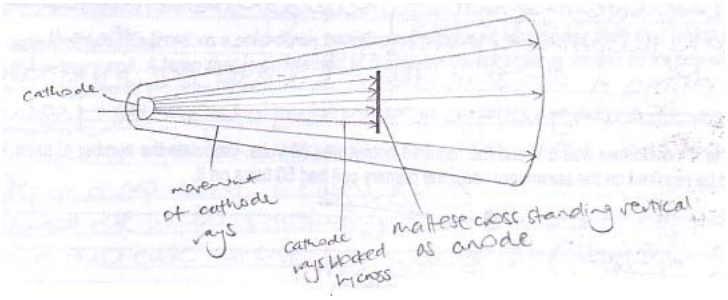
Question 2 Criteria	Marks
Outlines the conversion electrical potential energy (due to the potential difference between the cathode and anode) to kinetic energy of electrons in the cathode ray and the subsequent conversion of this kinetic energy into light (or electromagnetic) energy when the electrons strike the atoms in the fluorescent display screen.	2
Outlines the conversion of the kinetic energy of electrons in the cathode ray into light (or electromagnetic) energy when the electrons strike the atoms in the fluorescent display screen.	1½
Identifies one of the forms of energy – kinetic or light – and correctly associates it with either the electrons or the behaviour of the fluorescent screen respectively.	1

H7. explains the effects of energy transfers and energy transformations

3. You have carried out a first-hand investigation of cathode rays using a vacuum tube containing a Maltese cross.

   Draw a labelled diagram of this apparatus that **could** be used to help explain why a "shadow" of the cross is produced in the tube. You are **not required** to provide an explanation. (2 marks)

Question 3 Criteria	Marks
Draws a labelled diagram, showing the cathode, anode (may be the cross itself or a separate electrode between the cross and the cathode), electrons between the cathode and the end of the tube beyond the Maltese cross (or shows the path of electrons – labelled)	2
Draws a labelled diagram, showing the cathode, anode (may be the cross itself or a separate electrode between the cross and the cathode)	1
Poor diagram – too small, careless, unclear	− ½ mark



4. You have performed a first-hand investigation in which you observed the behaviour of cathode rays in a tube containing electric plates.

(a) Describe the effect of the plates on the cathode rays. (1 mark)

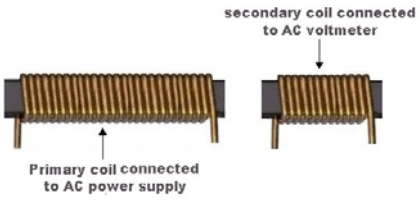
Question 4 (a) Criteria	Marks
Describes the deflection of the cathode rays towards the positive plate (or in the opposite direction to the electric field between the plates)	1

(b) Account for the effect described. (2 marks)

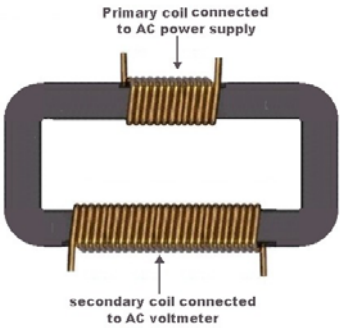
Question 4 (b) Criteria	Marks
Gives a reason for the deflection described in 4 (a) because of the electric field that is produced by the voltage between the plates resulting in a force on the negatively charged electrons that is towards the positive plate.	2
States that a force acts on the electrons (or cathode ray)	1

H9. explains the effects of electric, magnetic and gravitational fields

5. Two students wishing to investigate the production of a secondary voltage in a transformer set up the following models.



Design A



Design B

(a) Choose the design most appropriate to this investigation and justify your choice. (2 marks)

H11. justifies the appropriateness of a particular investigation plan

Question 5 (a) Criteria	Marks
Identifies design B as the best choice AND supports this choice by stating that the flux linkage between the primary and secondary coils is better in design B because of the continuous iron core that passes through both coils.	2
Identifies design B as the best choice and supports this choice with an argument relating to the fact that it is a step-up transformer and that [depending on the magnitude of the input voltage] the output voltage, which is greater would be easier to measure accurately	1

(b) The input to a transformer was 6 V and the required output was 30 volts. Calculate the number of turns that would be required on the secondary coil if the primary coil had 50 turns on it. (1 mark)

Question 5 (b) Criteria	Marks
Substitutes correctly into the equation $\frac{V_p}{V_s} = \frac{n_p}{n_s}$ **OR** has the correct answer only 250 turns	1

6. Outline how a mathematical model is validated in physics. (2 marks)

Question 6 Criteria	Marks
Outlines the need to conduct an investigation in which one of the variables between which a relationship is to be validated is changed, keeping all other identified variables constant, and observing the effect on the other variable.	2
Outlines a procedure needed to establish a connection between a dependent and independent variable.	1

H2. analyses the ways in which models, theories and laws in physics have been tested and validated

7. A student modelled an AC induction motor by balancing an aluminium pie dish on a vertical needle on a stand and then moving a magnet above the dish around its circumference about 1 cm away from the dish. The student observed that the dish rotated in the same direction as that in which the magnet was moving and that the faster the magnet was moved, the faster the dish rotated. The investigation was repeated using a plastic dish similar in size and shape to the aluminium dish. The student observed that movement of the magnet had no effect on the plastic dish.

   The student concluded from this investigation that it is necessary for the rotor of an AC induction motor to be made of a conductor.

   Assess the validity of the student's conclusion. (2 marks)

Question 7 Criteria	Marks
States that the conclusion is valid because only one variable, the material from which the dish was made, had been changed – the one appropriate to the conclusion that was made.	2
Makes one appropriate statement relevant to good experimental design in relation to this investigation.	1

H14. assesses the validity of conclusions from gathered data and information

8. Assess the following statement. (5 marks)

   A lamp that is connected to a step-down transformer produces less power than that which is applied to the primary coil. A lamp that is connected to a step-up transformer produces more power than that which is applied to the primary coil.

Question 2 Criteria	Marks
States that the first sentence is correct and supported by reasoning that the power output of a transformer is always less than the power input, because some of the electrical energy is transformed into heat in the transformer core. A good answer would relate this to the **law of conservation of energy** …. AND States that the second sentence is incorrect and provides a reason (violates the law conservation of energy…). A good answer would argue additionally that there is an implicit misconception in the statement that voltage is the only variable that affects the power, when in fact power is the product of voltage and current and…	4-5
Identifies that the first statement is correct and supports the statement with a valid argument such as the fact that some of the electrical energy is transformed into heat in the transformer core. OR Presents a clear argument that the second statement violates the law of conservation of energy.	2-3
Makes a correct statement about the change in voltage or the change in current	1

H7. explains the effects of energy transfers and energy transformations
H9. explains the effects of electric, magnetic and gravitational fields
H13. uses terminology … appropriately and successfully to communicate information and understanding