| Surname | Centre Number | Candidate Number |
|---|---|---|
| Other Names | | 0 |

# GCSE

0247/02

## SCIENCE
## HIGHER TIER
## PHYSICS 3

A.M. WEDNESDAY, 30 January 2013

45 minutes

| For Examiner's use only | | |
|---|---|---|
| **Question** | **Maximum Mark** | **Mark Awarded** |
| **1.** | **5** | |
| **2.** | **9** | |
| **3.** | **7** | |
| **4.** | **7** | |
| **5.** | **4** | |
| **6.** | **8** | |
| **7.** | **10** | |
| **Total** | **50** | |

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**ADDITIONAL MATERIALS**

In addition to this paper you may require a calculator.

**INSTRUCTIONS TO CANDIDATES**

Use black ink or black ball-point pen.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

**INFORMATION FOR CANDIDATES**

The number of marks is given in brackets at the end of each question or part-question.
You are reminded of the necessity for good English and orderly presentation in your answers.
**A list of equations is printed on page 2.** In calculations you should show all your working.

## EQUATIONS

speed = gradient of a distance-time graph

distance travelled = area under a velocity-time graph

acceleration = gradient of a velocity-time graph

speed = $\dfrac{\text{distance}}{\text{time}}$

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|---|---|---|---|
| $v = u + at$ | where | $x$ | = distance |
| | | $u$ | = initial velocity |
| $v^2 = u^2 + 2ax$ | | $v$ | = final velocity |
| $x = ut + \frac{1}{2}at^2$ | | $a$ | = acceleration |
| $x = \frac{1}{2}(u + v)t$ | | $t$ | = time |

| | | | |
|---|---|---|---|
| $\dfrac{V_1}{V_2} = \dfrac{N_1}{N_2}$ | where | $V_1$ | = voltage across the primary coil |
| | | $V_2$ | = voltage across the secondary coil |
| | | $N_1$ | = number of turns on the primary coil |
| | | $N_2$ | = number of turns on the secondary coil |

momentum = mass × velocity

kinetic energy = $\dfrac{mv^2}{2}$, where $m$ = mass, $v$ = velocity or speed

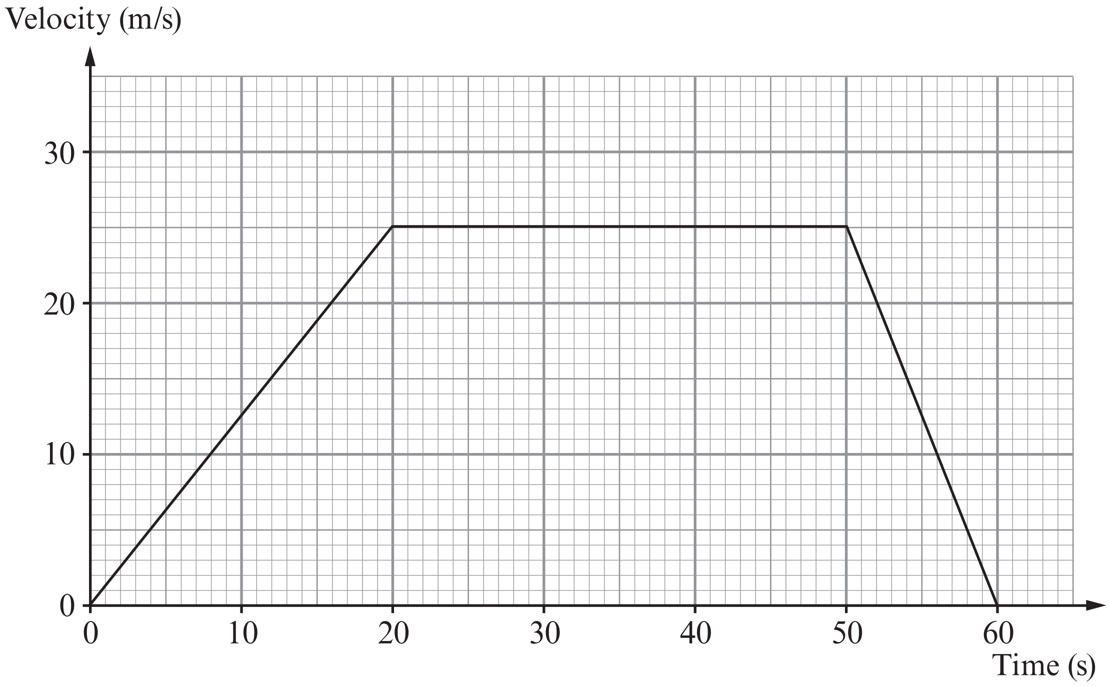
force = $\dfrac{\text{change in momentum}}{\text{time}}$

wave speed = wavelength × frequency

Examiner only

*Answer* **all** *questions.*

**1.** The graph shows part of the motion of an underground train as it travels from one station to the next station.




*(a)* The acceleration/deceleration is the gradient of the appropriate line of a velocity-time graph. Calculate the deceleration of the train. [2]

Deceleration = .................................. $m/s^2$

*(b)* The distance travelled is the area under the line of a velocity-time graph. Calculate the distance travelled when the train was accelerating. [2]

Distance travelled = .................................. m

*(c)* State how the graph shows that the train travelled further in the last 30 s of its motion than in the first 30 s of its motion. [1]

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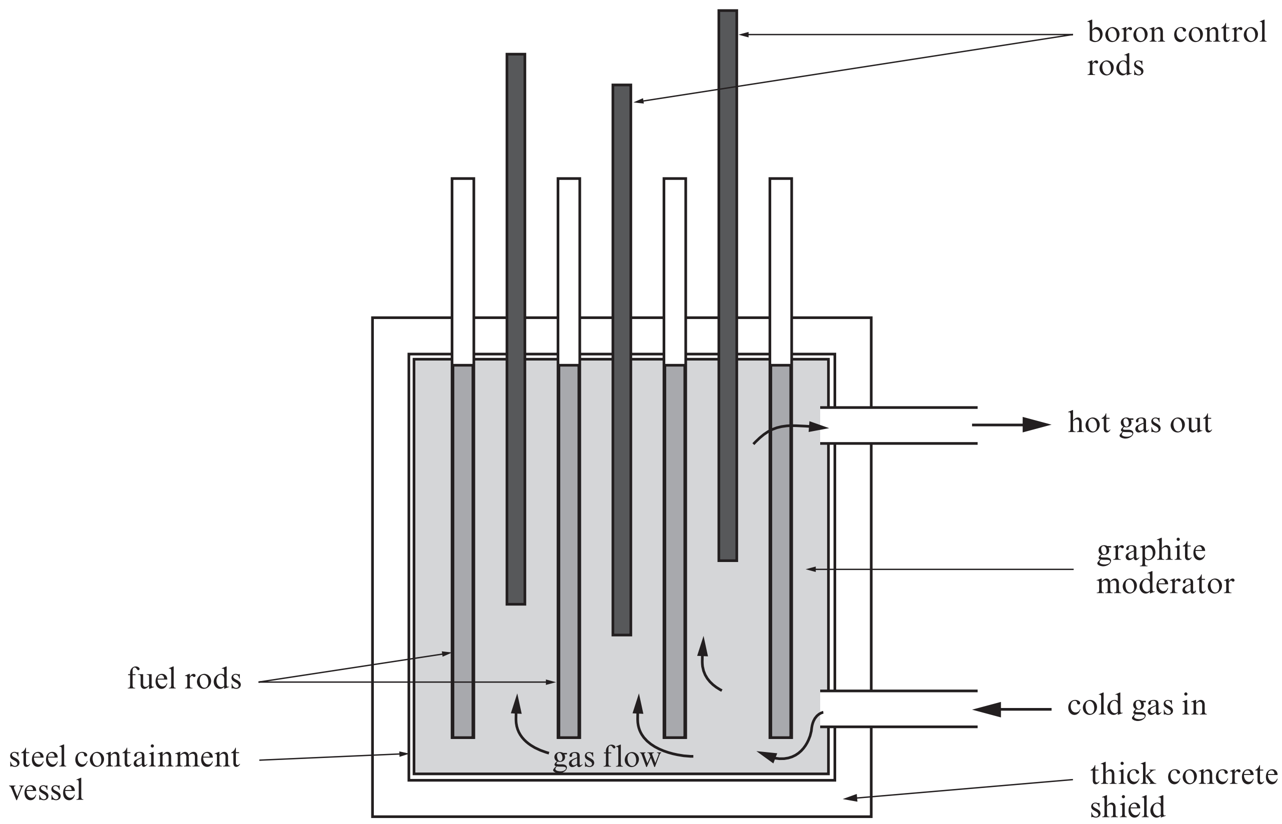
**Turn over.**

**2.** Read the information in the passage and look carefully at the diagram before answering the questions that follow.

The diagram shows the important parts of the core of a gas-cooled nuclear reactor.




The fuel rods used in the core of a gas-cooled reactor are made of U-238 (Uranium-238) enriched with 3% of U-235 (Uranium-235). Only U-235 undergoes fission. Its atoms capture slow moving neutrons and split to produce two new radioactive nuclei and up to three new fast moving neutrons.

The fuel rods are surrounded by graphite which slows down the fast moving neutrons to allow more fission to take place.

Boron rods, which readily absorb neutrons, can be raised or lowered into the core and enable the rate of fission to be controlled.

The energy produced is removed by the gas circulating the reactor and is used to generate electricity.

The whole core is encased in a steel lined concrete shield.

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*(a)* (i) What causes U-235 to undergo fission?

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(ii) Explain why graphite is important to the fission process.

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[3]

*(b)* Describe the effect that lowering the boron control rods into the core has on the output from the reactor. [2]

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*(c)* Give **two** reasons why it is important for the core to be encased in a steel lined concrete shield. [2]

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*(d)* The reaction that takes place in the reactor can be represented by the following equation:

$$^{235}_{92}\text{U} + {}^{1}_{0}\text{n} = {}^{143}_{a}\text{X} + {}^{b}_{36}\text{Y} + {}^{1}_{0}\text{n} + {}^{1}_{0}\text{n} + {}^{1}_{0}\text{n} + \text{energy}$$

where $^{1}_{0}\text{n}$ are neutrons and X and Y are radioactive elements.

Balance the equation by identifying the missing numbers *a* and *b*. [2]

*a* = ..........

*b* = ..........

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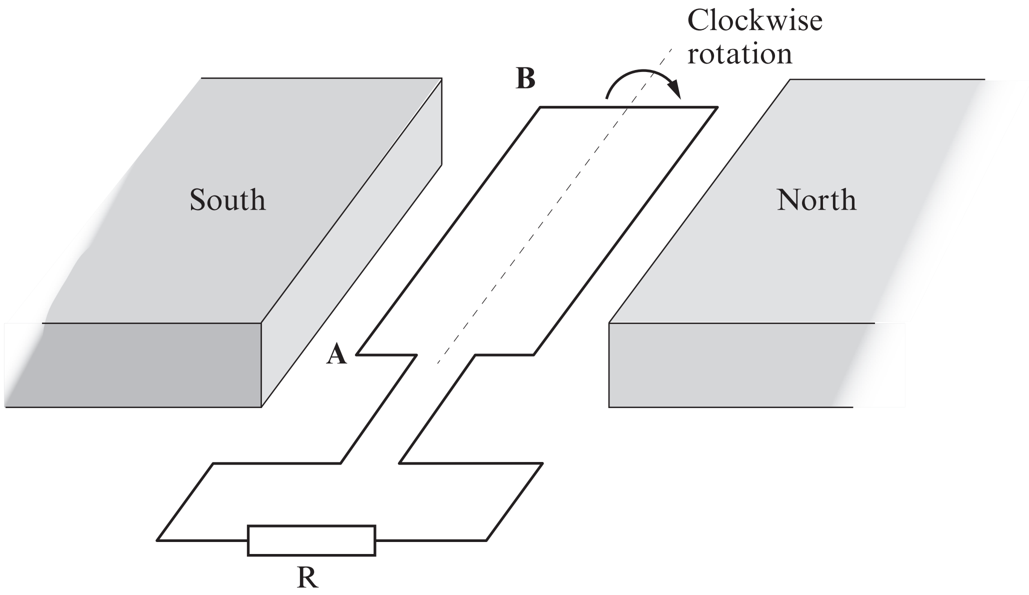
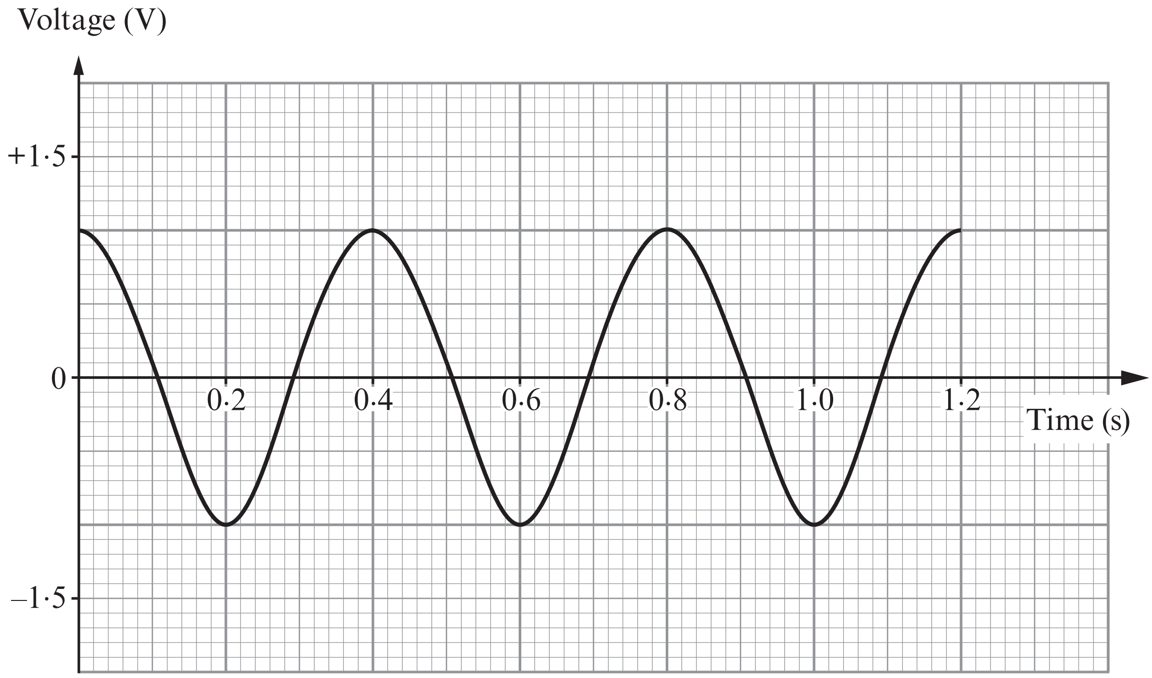
**3.** The diagram shows a simple a.c. generator. It consists of a single coil which is rotated at constant speed in a magnetic field.




As the coil rotates, it 'cuts through' the magnetic field lines producing a voltage which drives an alternating current through the coil and the resistor R.

The graph below shows how this voltage varies with time.



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*(a)* Use the graph to find the time taken to make one complete rotation of the coil. [1]

Time = .................................... s

*(b)* Use Fleming's right hand rule to **mark on the diagram** the direction of the current through **AB** when the coil is moving through the position shown. [1]

*(c)* Complete the table below to state the effect, if any, the following separate changes would have on the output voltage. Parts of the table have been completed for you. [3]

| Change | Effect on the maximum voltage | Effect on the time for one rotation of the coil |
|---|---|---|
| Increasing the strength of the magnetic poles and turning the coil at the same speed | Increased | No change |
| Turning the coil at a slower speed | ............................................................ | Increased |
| Increasing the number of coils and turning the coil at a faster speed | ............................................................ | ............................................................ |

*(d)* State **two** differences, apart from size, between industrial a.c. generators used in power stations and the simple a.c. generator shown in the diagram on the opposite page. [2]

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**4.** P and S waves are seismic waves. P waves are longitudinal waves and S waves are transverse waves.

*(a)* Explain, in terms of particle movement, the difference between longitudinal and transverse waves. [2]

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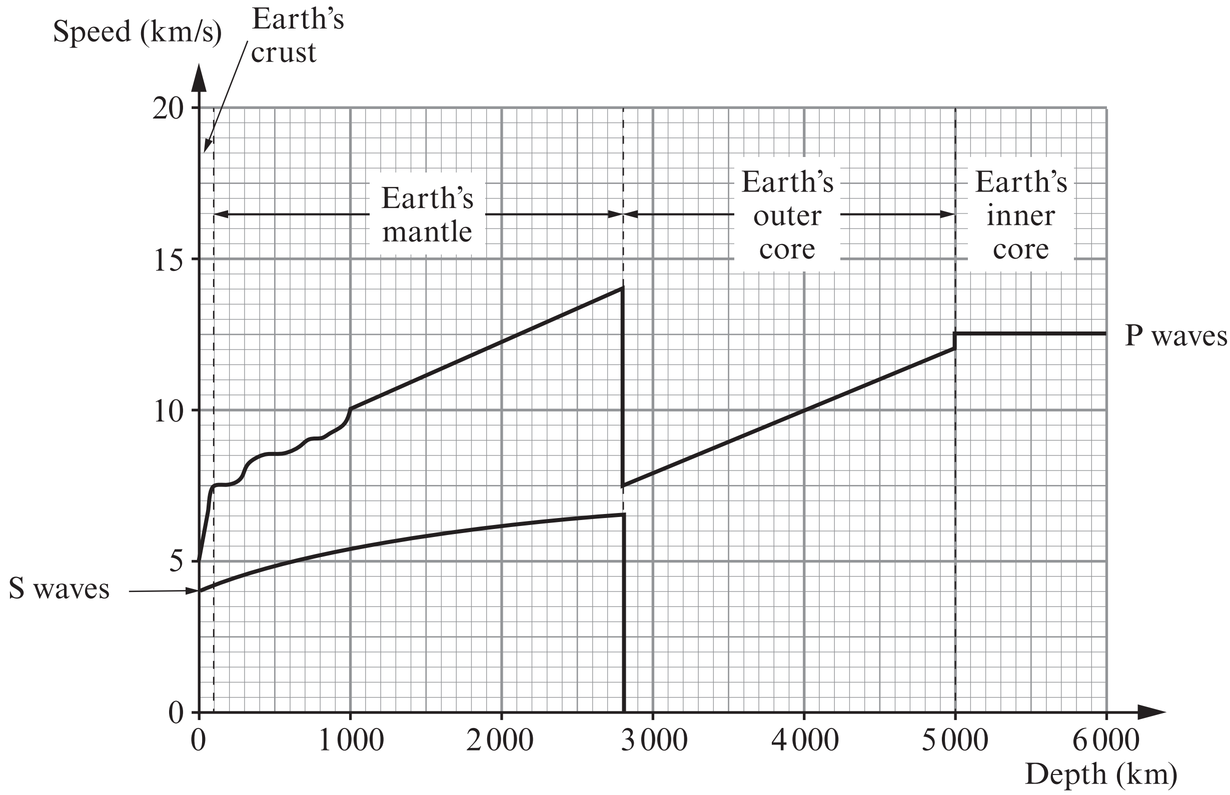
The graphs show how the speed of P and S waves change with depth inside the Earth.



Examiner only

*(b)* Explain how **evidence from the graphs** can be used to deduce the physical properties of the mantle and the core. [5]

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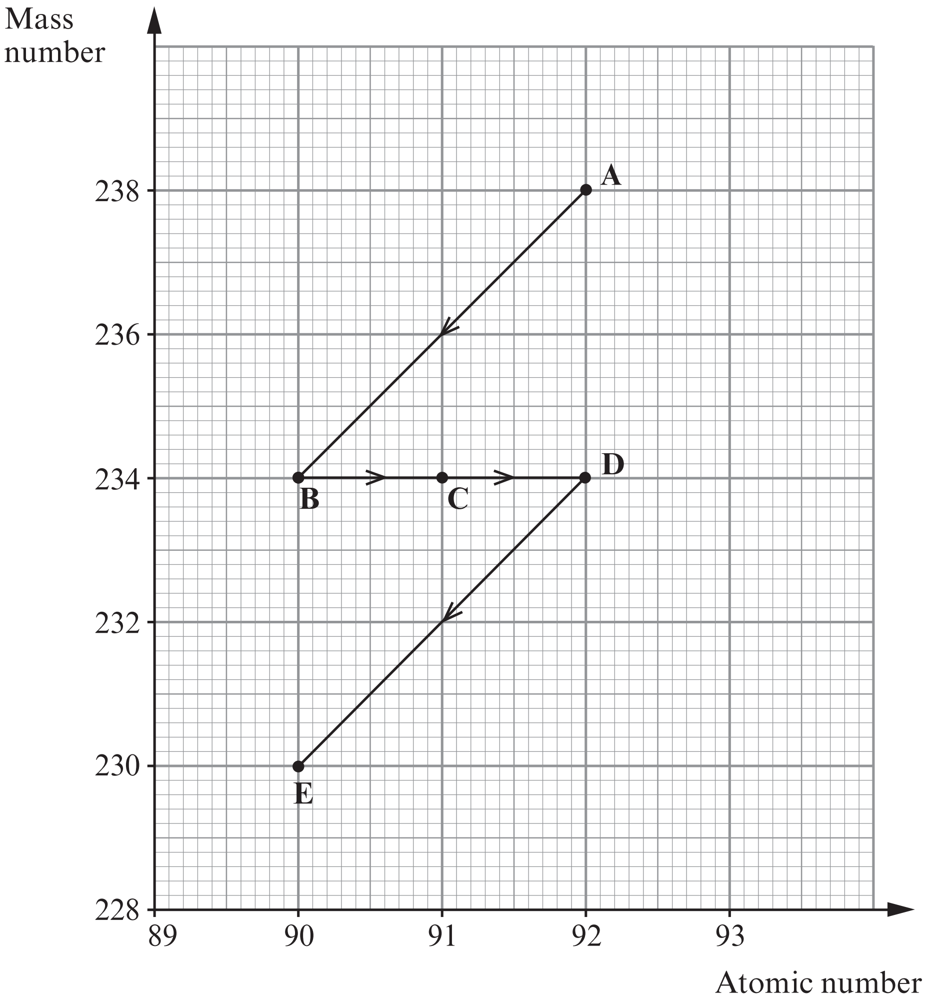
Examiner only

**5.** The graph below represents a radioactive decay series in which nucleus **A** decays to nucleus **B**. Further decays eventually produce nucleus **E**.




*(a)* Name the radiation emitted in the change: [2]

(i) **A** to **B** ..........................................................................

(ii) **C** to **D** ..........................................................................

*(b)* Calculate the number of neutrons contained in nucleus **E**. ........................................................ [1]

*(c)* Nucleus **D** is a uranium nucleus. State which *other* nucleus is an isotope of uranium.

........................................................ [1]

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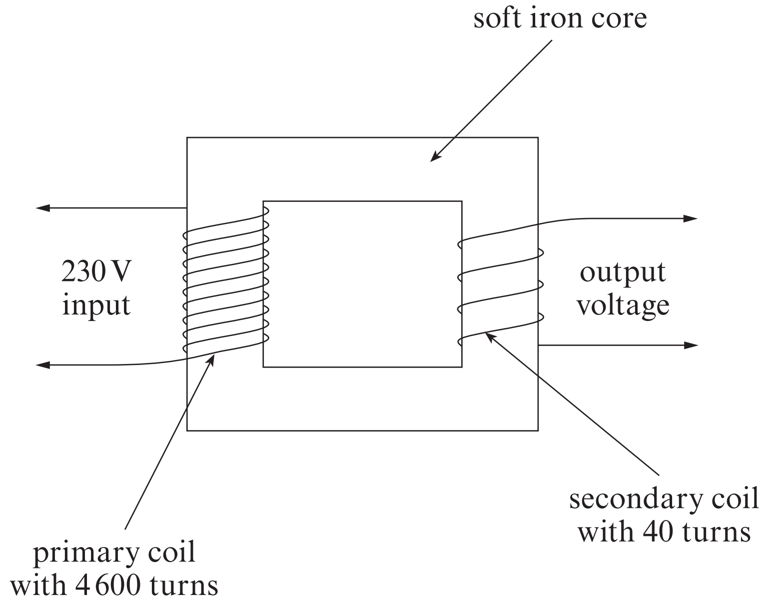
**6.** The diagram shows the primary and secondary coils of a transformer, wound on a soft iron core.




When the input alternating voltage of 230 V is applied to the primary coil an output alternating voltage is produced in the secondary coil.

*(a)* (i) Explain what part the iron core plays in producing the output voltage.

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(ii) Explain why the output voltage is less than the input voltage for this transformer.

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[3]

Examiner only

*(b)* Give a reason why the output voltage is zero when a d.c. voltage is applied to the primary coil. [1]

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*(c)* Select an equation from page 2 and use it together with data shown on the diagram to calculate the output voltage.

Equation: .......................................................................................................... [1]

Calculation:

Output voltage = ............................................ V [3]

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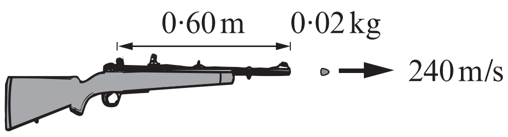
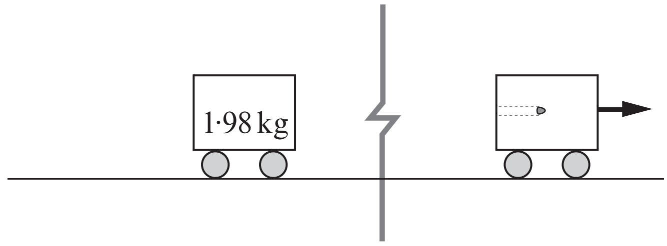
Examiner only

**7.** A bullet is fired from a rifle. It strikes a target mounted on wheels which then starts to move freely.




*(a)* Choose from these equations to answer the questions that follow.

$$a = \frac{v-u}{t}$$

$$v^2 = u^2 + 2ax$$

$$x = ut + \frac{1}{2}at^2$$

$$x = \frac{1}{2}(u+v)t$$

(i) Calculate the mean acceleration of the bullet during its travel along the 0·60 m barrel of the rifle. [2]

Acceleration = .................................................... $m/s^2$

(ii) Calculate the time taken by the bullet to travel the length of the barrel. [2]

Time = .................................................... s

Examiner only

*(b)* Use the equation: momentum = mass × velocity

together with the law of conservation of momentum to find the velocity of the target and bullet after impact. [2]

Velocity = .................................................... m/s

*(c)* (i) Select an equation from page 2 to find the total kinetic energy before impact. [2]

Kinetic energy = .................................................... J

(ii) Most often kinetic energy is lost on impact. Explain how you can account for the loss of energy. [2]

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**END OF PAPER**