Candidate Name	Centre Number	Candidate Number
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GCSE

247/02

SCIENCE PHYSICS

HIGHER TIER

PHYSICS 3

P.M. WEDNESDAY, 10 June 2009

45 minutes

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

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

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 of the examination paper. 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

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

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

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

$$x = \frac{u + v}{2}\, t$$

where x = distance
u = initial velocity
v = final velocity
a = acceleration
t = time

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

where V_1 = voltage across the primary
V_2 = voltage across the secondary
N_1 = number of primary turns
N_2 = number of secondary turns

wave speed = frequency × wavelength

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

momentum = mass × velocity

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

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

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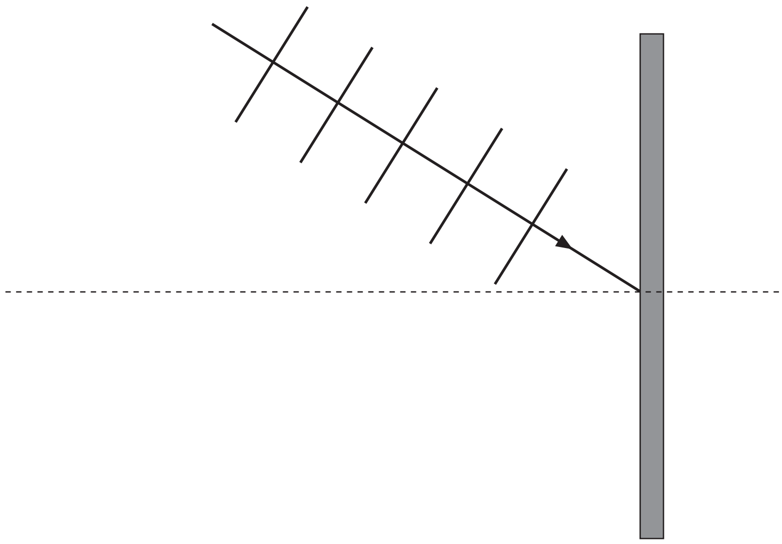
Answer **all** *questions*.

1. The diagram shows water wave fronts hitting a barrier.

The wave fronts are reflected off the barrier.



(i) **Draw** a line with an arrow (⟶) on the diagram to show the direction of the reflected waves. [1]

(ii) **Add** to the diagram to show **four** reflected wave fronts. [2]

3

Examiner only

2. P-waves and S-waves are types of seismic waves produced by earthquakes.

(a) P-waves and S-waves travel at different speeds.

(i) Give **two other** differences between P and S-waves. [2]

1. ....

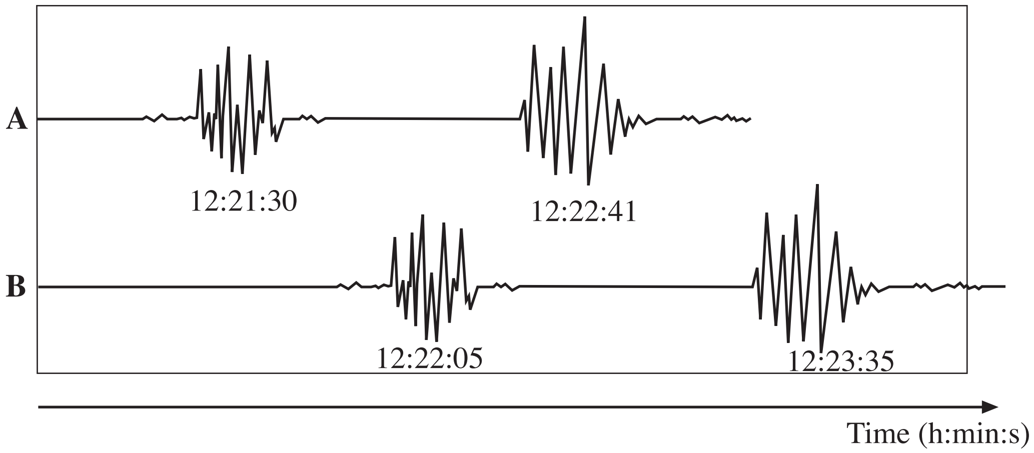
2. ....

(ii) Give **one** difference between transverse and longitudinal waves. [1]

....

....

(b) The diagram shows signals received from an earthquake at two monitoring stations **A** and **B**.



(i) Explain why each monitoring station receives two signals at different times. [1]

....

....

(ii) Give a reason why the signals are received at station **A** before station **B**. [1]

....

(iii) The lag time can be used to calculate the distance of a monitoring station from the epicentre of the earthquake using the formula

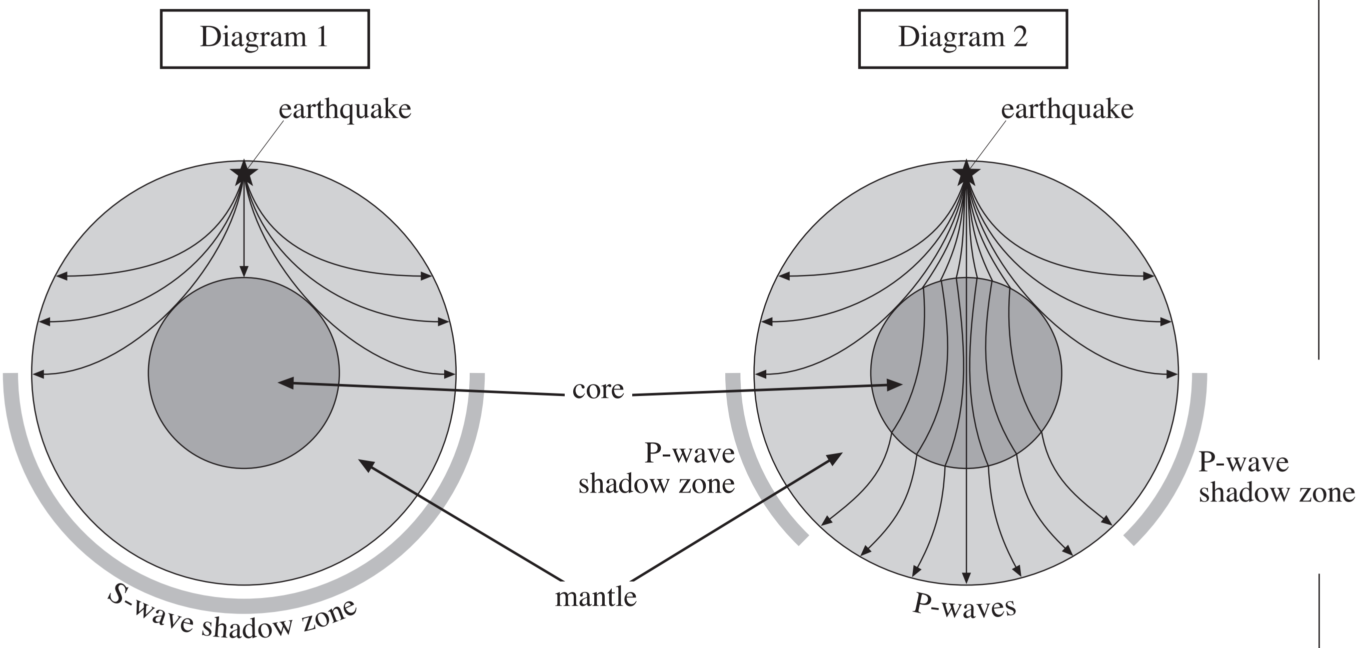
$$\text{Distance (km)} = \frac{\text{lag time (s)}}{5} \times 60$$

Calculate the distance from the epicentre to monitoring station **A**. [2]

Distance = ... km

Examiner only

(c) The diagrams show the paths of seismic waves through the Earth.
Diagram 1 shows S-waves and diagram 2 shows P-waves.



Explain, in terms of the properties of the mantle and the core:

(i) why the S-waves follow the paths shown in diagram 1 and there is a shadow zone where S-waves are not detected;

....

....

....

....

(ii) why the P-waves follow the paths shown in diagram 2.

....

....

....

....

[3]

10

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3. Read the following passage and answer the questions that follow.

> At the moment, nuclear reactors use nuclear fission to generate power.
>
> In nuclear fission, you get energy from splitting one atom into two different atoms. In a nuclear reactor, high-energy neutrons split heavy atoms of uranium, producing large amounts of energy, radiation and radioactive waste.
>
> In the future, reactors may use nuclear fusion to generate power.
>
> In nuclear fusion, large amounts of energy are produced when two atoms join together to form one larger atom.
>
> One type of fusion reaction involves deuterium. Deuterium is a hydrogen isotope. It is not radioactive and can be obtained from seawater. Two deuterium atoms under certain conditions combine to form an isotope of helium and a neutron and a large amount of energy. This fusion reaction does not produce high-level nuclear waste.
>
> When atoms fuse, the nuclei must come together. A very high temperature is needed to overcome the repulsion between the positive protons. A high pressure is also needed to squeeze the atoms together so they can fuse.

(a) (i) Explain how nuclear fission is different from nuclear fusion. [2]

....

....

....

(ii) Explain why in the future, nuclear fusion reactors would be more environmentally friendly than nuclear fission reactors. [2]

....

....

....

(iii) Give a reason why there is an unlimited supply of fuel for a fusion reactor. [1]

....

(iv) Name the products formed when two deuterium atoms fuse. [2]

....

(b) Explain why it is difficult to achieve controlled nuclear fusion on Earth. [2]

....

....

....

9

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4. Cars are road tested while they accelerate from 0 to 27 m/s (60 mph).

(i) A car reaches a speed of 27 m/s in 6 s.

Write down an equation as it appears on page 2, and use it to calculate the acceleration of the car during this time and state the unit for your answer.

Equation: ....

.... [1]

Calculation: [3]

Acceleration = ... unit = ...

(ii) Another car reaches a velocity of 27 m/s from rest in 8 s.

Write down an equation as it appears on page 2, and use it to calculate the distance travelled by the car during this time.

Equation: ....

.... [1]

Calculation: [2]

Distance = ... m

7

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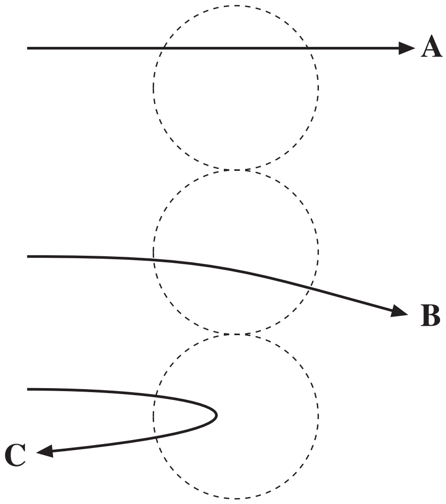
5. (i) In the early 20th Century, scientists observed the paths of alpha particles passing through very thin gold foil. The diagram shows the paths of three alpha particles in the experiment.



Most alpha particles followed path **A**, some followed path **B**, and very few followed path **C**.

Explain how the three alpha particle paths led Rutherford to propose a model of the atom. [3]

....

....

....

....

(ii) This model was further developed by Bohr. **With the aid of a diagram** explain how the Bohr model accounts for atomic spectra. [3]

....

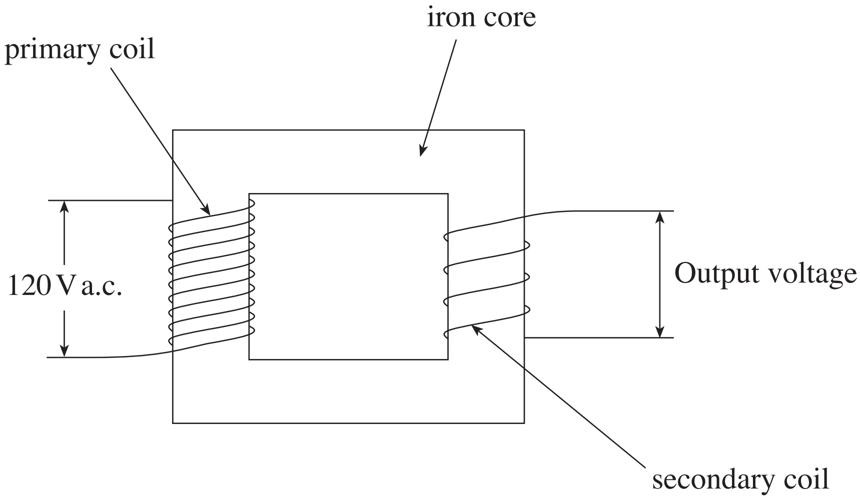
....

....

6

Examiner only

6. The diagram shows one type of transformer.



(a) Explain how a transformer produces an output voltage from an alternating voltage applied to the primary coil. [3]

....

....

....

....

....

(b) The input voltage is 120 V. The output voltage is 6 V. The secondary coil contains 40 turns of wire.
Write down an equation as it appears on page 2, and use it to calculate the number of turns in the primary coil.

Equation: ....

.... [1]

Calculation: [2]

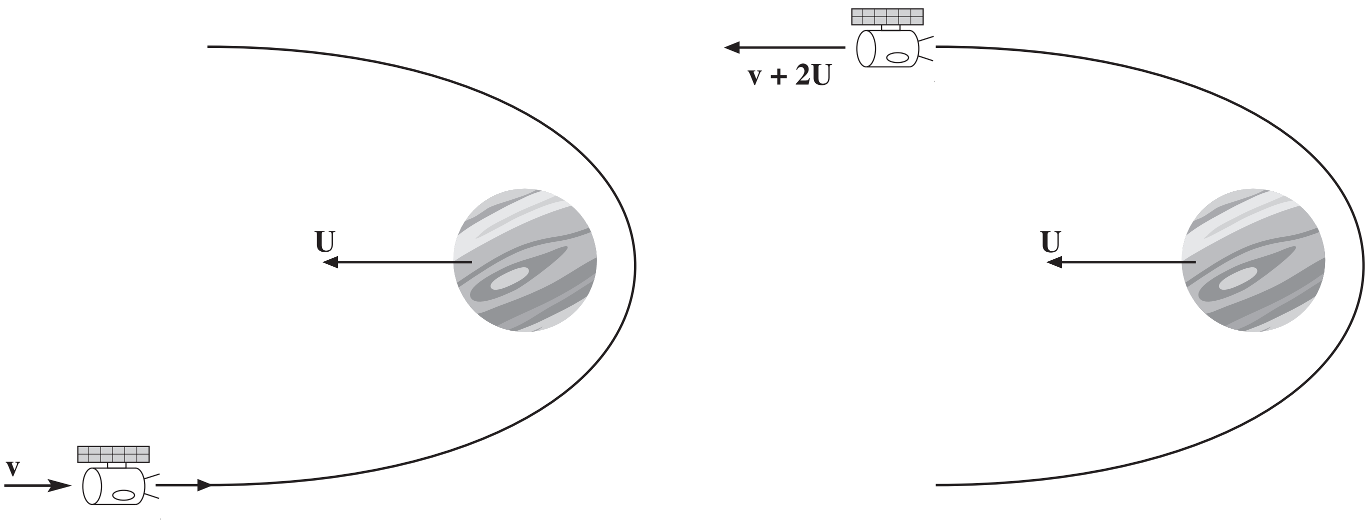
Number of turns on primary coil = ...

6

Turn over.

7. If we want a 100 kg space probe to travel outwards in the Solar System against the Sun's gravity, it needs a lot of energy. The space probe can fly past a planet in a 'slingshot orbit' and in doing so it picks up energy.

The diagrams show what happens to the speed and direction of the space probe in such an orbit.



The velocity of approach of the space probe, **v**, is 20 000 m/s. The velocity of the planet, **U**, is 15 000 m/s. After the 'slingshot', the speed of the probe is **v + 2U**.

(a) Calculate the velocity of the space probe as it moves away from the planet. [1]

Velocity = ... m/s

(b) The 'slingshot orbit' increases the kinetic energy of the space probe.

(i) Use the equation

$$\text{kinetic energy} = \frac{\text{mass} \times \text{velocity}^2}{2}$$

to calculate the kinetic energy of the space probe after moving through the 'slingshot orbit'. [2]

Increase in kinetic energy = ... J

(ii) Explain how the conservation of energy applies in a 'slingshot orbit'. [2]

....

....

....

(c) The force acting on the probe during the 'slingshot orbit' changes the momentum of the probe.

(i) Explain in terms of force, why the space probe follows the 'slingshot orbit'. [1]

....

....

(ii) Use the equation

$$\text{momentum} = \text{mass} \times \text{velocity}$$

to calculate the change in momentum of the space probe as a result of moving through the 'slingshot orbit'. [3]

Change in momentum = ... kg m/s

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