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

Leave blank

General Certificate of Secondary Education
June 2005

# PHYSICS (MODULAR) SPECIFICATION A 3453/H
# HIGHER TIER

Wednesday 22 June 2005 9.00 am to 10.30 am

**H**

**In addition to this paper you will require:**
a ruler.
You may use a calculator.

Time allowed: 1 hour 30 minutes

**Instructions**
- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.
- Show all your working in calculations.

**Information**
- The maximum mark for this paper is 90.
- Mark allocations are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

| For Examiner's Use | | | |
|---|---|---|---|
| Number | Mark | Number | Mark |
| 1 | | 7 | |
| 2 | | 8 | |
| 3 | | 9 | |
| 4 | | 10 | |
| 5 | | 11 | |
| 6 | | 12 | |
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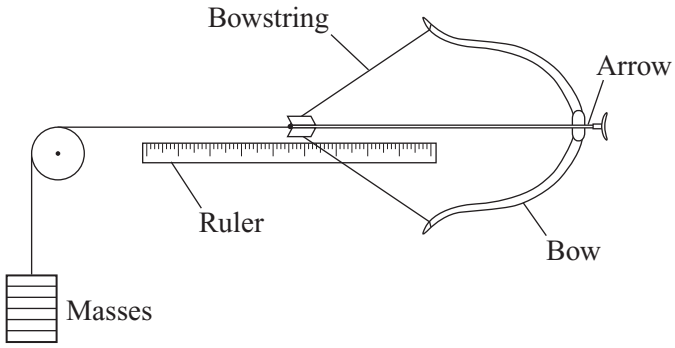
| Total (Column 1) → | | | |
| Total (Column 2) → | | | |
| TOTAL | | | |
| Examiner's Initials | | | |

## FORCES

**1** Some students carried out an investigation with a toy bow and arrow.




The students added masses to bend the bow, as shown in the diagram. They measured the movement of the arrow, using a ruler. From their results the students calculated the energy stored in the bow. To do this, they calculated the work done in bending the bow.

(a) (i) Write down the equation used to calculate the work done.

.....

*(1 mark)*

(ii) The average force applied to pull the arrow back 0.4 m was 20 N.

Calculate the work done and give the unit.

*Show clearly how you work out your final answer.*

.....

.....

.....

.....

Work done.....

*(3 marks)*

(b) The work done is stored as energy.

(i) What type of energy is usefully stored in the bent bow?

.....

*(1 mark)*

(ii) What type of energy does the arrow have when it is released?

.....

*(1 mark)*

6

**2** This question is about the life of stars.

(a) Complete the sentences.

Stars, including the Sun, form when enough ..... and .....

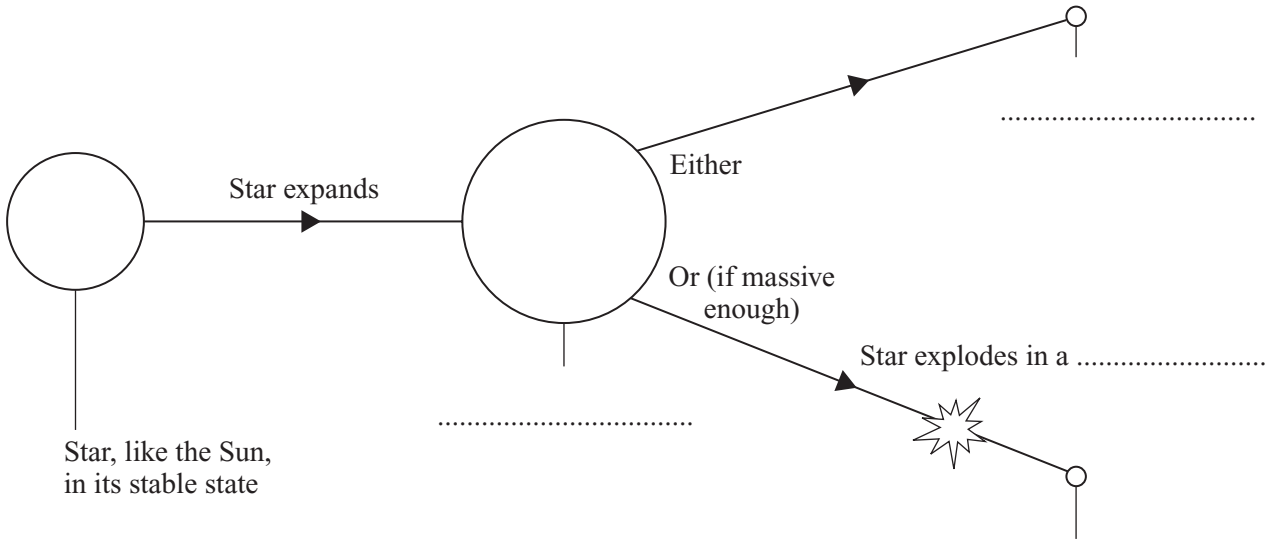
from space is pulled together by ..... attraction.

Smaller masses may also form and be attracted by stars to become ..... .

*(4 marks)*

(b) The diagram shows part of the life of a star.

Complete the labelling on the diagram.




*(4 marks)*

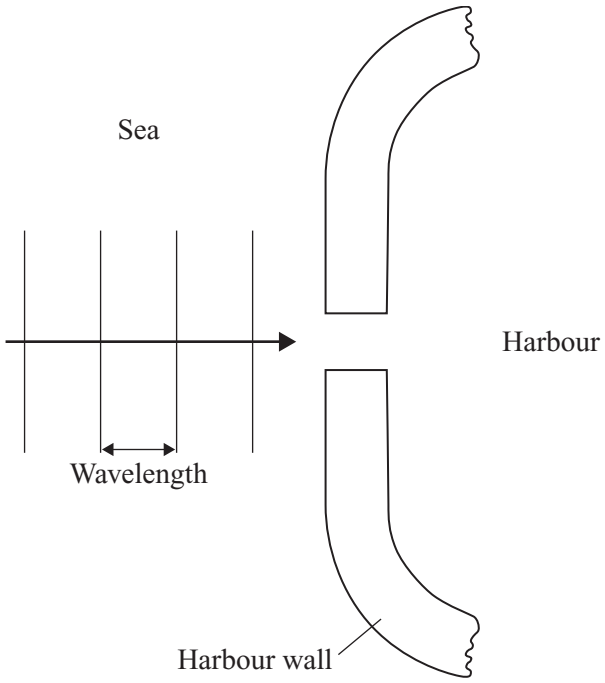
8

**TURN OVER FOR THE NEXT QUESTION**

## WAVES AND RADIATION

**3** The diagram shows some waves approaching a harbour.

(a) (i) Complete the diagram to show what happens to the waves after they pass through the harbour entrance.




*(2 marks)*

(ii) What is the name of the effect that you have drawn?

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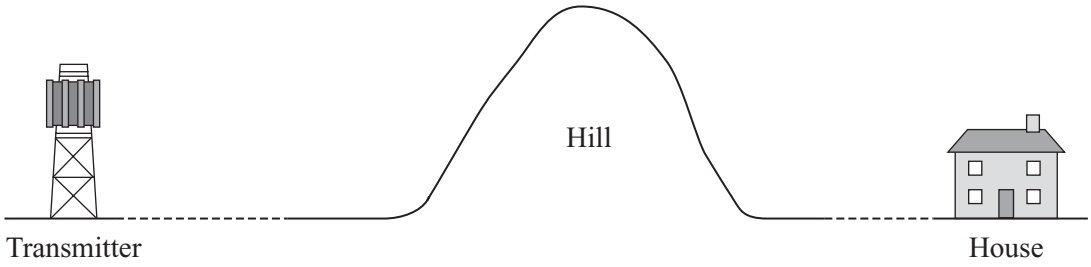
*(1 mark)*

(b) The diagram shows a transmitter for radio and television signals.




The reception of signals at the house varies as shown in the table.

| Programme | Wavelength | Reception |
|---|---|---|
| TV | 0.5 metres | very poor |
| VHF radio | 3 metres | poor |
| LW radio | 1500 metres | very good |

Use the information in the table to help you to explain why reception is best for LW radio.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

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*(4 marks)*

7

**TURN OVER FOR THE NEXT QUESTION**

**4** Part of a newspaper article is shown below.

> **Farmed salmon may contain radioactive waste**
>
> Fears have been raised about the safety of farmed salmon after the discovery of traces of *radioactive* waste in some salmon.
>
> Technetium–99, a by-product of nuclear reprocessing, was found in the fish.

(a) What is meant by *radioactive*?

.....

.....

*(1 mark)*

(b) Technetium–99 can also be written $^{99}_{43}\mathrm{Tc}$.

One of the two numbers is the atomic (proton) number.

The other number is the mass (nucleon) number.

(i) How many protons are present in the nucleus of any technetium atom?

.....

(ii) How many neutrons are present in the nucleus of a technetium–99 atom?

.....

*(2 marks)*

(c) Technetium–99 emits beta (β) radiation and has a *half-life* of 4 200 000 years.

(i) What is meant by *half-life*?

.....

.....

*(1 mark)*

(ii) Why is beta (β) radiation more dangerous than alpha (α) radiation when the source of the radiation is outside the body?

.....

.....

.....

*(2 marks)*

(iii) Why is alpha ($\alpha$) radiation more dangerous than beta ($\beta$) radiation when the source of the radiation is inside the body?

.....

.....

*(1 mark)*

7

**TURN OVER FOR THE NEXT QUESTION**

## FORCES AND MOTION

**5** (a) At one time, people believed that the main features of the Earth's surface were the result of the shrinking of the Earth's crust.

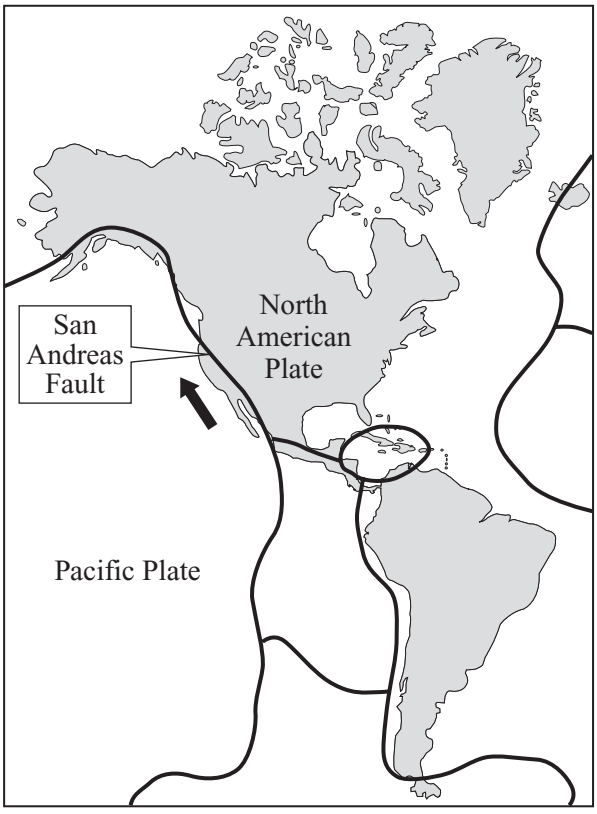
What did they think caused the Earth's crust to shrink?

.....

.....

*(1 mark)*

(b) We now believe that the Earth's lithosphere is cracked into a number of large pieces called tectonic plates.
Along the coast of California, the San Andreas fault separates the Pacific plate from the North American plate.




The Pacific plate is moving roughly north-westwards relative to the North American plate.

(i) Complete the sentence.

The approximate speed of the plates relative to each other is a few ..... every year.

*(1 mark)*

(ii) Describe what causes the movement of tectonic plates.

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*(3 marks)*

(c) (i) Where, in relation to tectonic plates, are earthquakes and volcanoes most likely to occur?

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*(1 mark)*

(ii) In California, small tremors occur every day.
Scientists monitor the position and intensity of the tremors.

Give **one** reason why it is difficult to predict when a large earthquake will occur.

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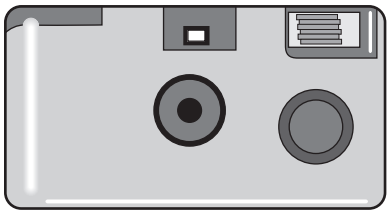
*(1 mark)*

7

**TURN OVER FOR THE NEXT QUESTION**

## QUESTIONS RELATING TO PREVIOUSLY TESTED MODULES

**6** (a) The converging lens in a camera produces a real image.



Explain the difference between a real image and a virtual image.

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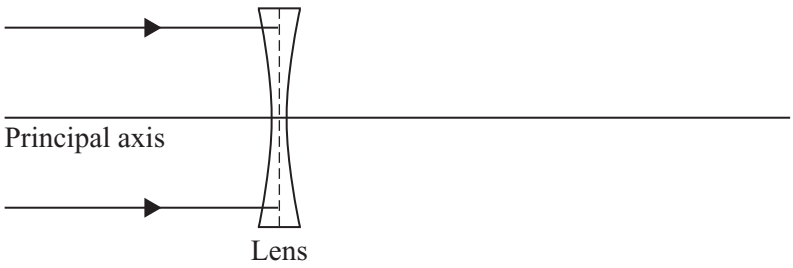
*(3 marks)*

(b) Complete the diagram to show what happens to the **two** rays of light after they enter the lens shown below. Put an **F** on the ray diagram to label the focus of the lens.




*(3 marks)*

6

## FORCES

**7** (a) Explain, as fully as you can, how a star generates the energy which it radiates.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

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*(4 marks)*

(b) Explain why scientists believe that the solar system was formed from the material produced when earlier stars exploded.

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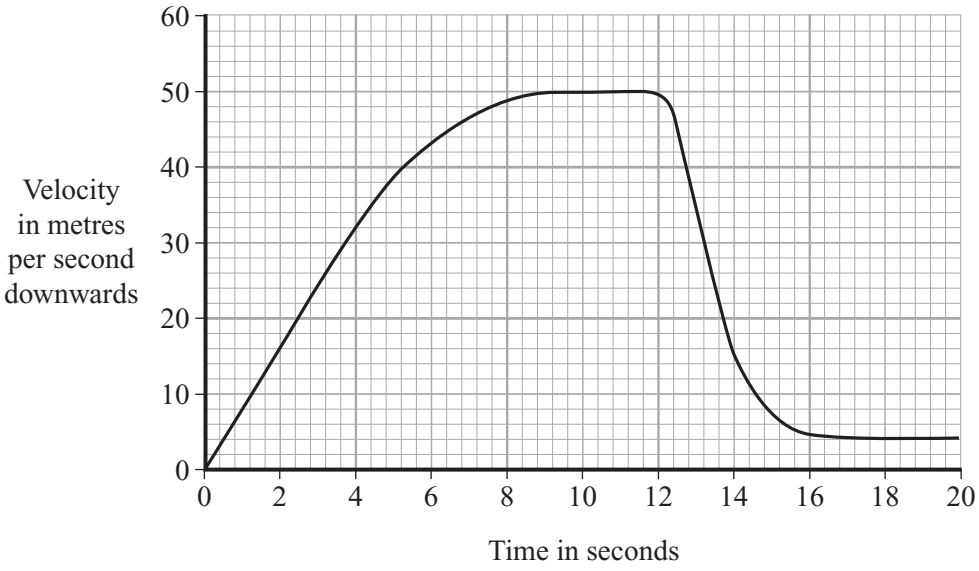
*(3 marks)*

7

**TURN OVER FOR THE NEXT QUESTION**

**8** The graph shows how the velocity of a parachutist changes with time during the first 20 seconds of a jump.




(a) Use information from the graph to calculate:

(i) the acceleration of the parachutist during the first 3 seconds of the jump;

*Show clearly how you work out your final answer.*

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

*(3 marks)*

(ii) the distance fallen by the parachutist during the first 3 seconds.

*Show clearly how you work out your final answer.*

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Distance fallen = ..... m

*(3 marks)*

(b) The last 3 seconds on the graph show that the parachutist reaches a constant velocity.

Explain why this happens.

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*(3 marks)*

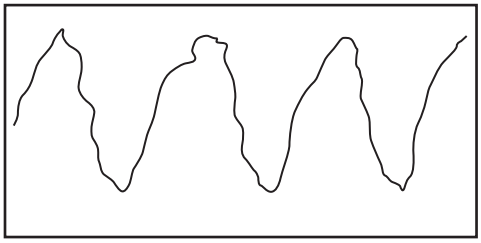
9

**TURN OVER FOR THE NEXT QUESTION**

## WAVES AND RADIATION

**9** Email is sent using digital signals.

(a) An analogue signal is shown in **Box 1**.
Sketch a digital signal in **Box 2**.



**Box 1**

**Box 2**

*(1 mark)*

(b) As signals travel, they pick up *noise*.

What is *noise*?

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.....

*(1 mark)*

(c) As signals travel, they become weaker and need to be amplified.
An amplified digital signal will be a near perfect copy of the original signal.
An amplified analogue signal will have deteriorated compared with the original signal.

Explain why.

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*(4 marks)*

6

**TURN OVER FOR THE NEXT QUESTION**

**10** The radioisotope potassium–40 is present in certain igneous rocks. Potassium–40 decays to argon–40 which is a stable isotope of the gas argon.
The argon gas which is formed can become trapped in the rock.
The age of the rock can be estimated by comparing the proportions of potassium–40 and argon–40 in a sample of rock.

(a) Potassium–40 emits beta (β) radiation and gamma (γ) radiation.

(i) What is beta radiation?

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*(2 marks)*

(ii) What happens to the nucleus of a potassium–40 atom which leads to the emission of beta radiation?

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*(1 mark)*

(iii) What is gamma radiation?

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.....

*(2 marks)*

(b) The half-life of potassium–40 is 1.3 billion years.
A sample of igneous rock is found to contain seven times more argon–40 atoms than potassium–40 atoms.

Estimate the age of the rock.

*Show clearly how you work out your answer.*

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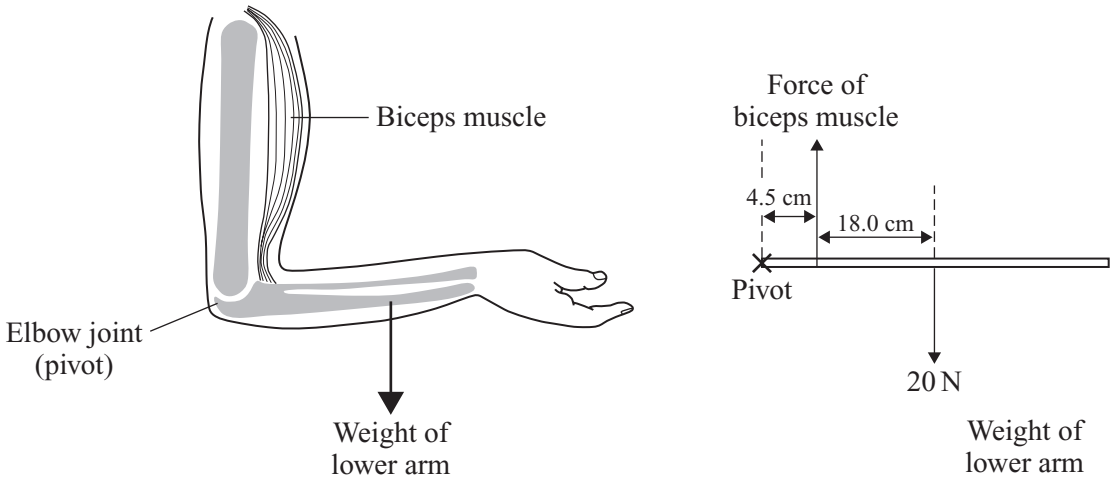
*(3 marks)*

8

## FORCES AND MOTION

**11** The first diagram shows a human arm.
The second diagram is a simple force diagram for the lower arm.




(a) Calculate the moment, or turning effect, of the weight of the lower arm about the pivot.

Write down the equation that you are going to use.

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*(2 marks)*

*Show clearly how you work out your answer.*

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Moment = ..... Ncm
*(2 marks)*

(b) Calculate the force that the biceps muscle must exert to keep the lower arm balanced.

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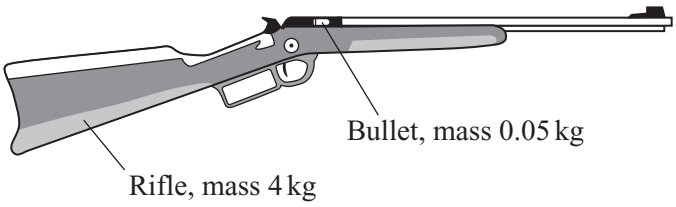
Force = ..... N
*(3 marks)*

7

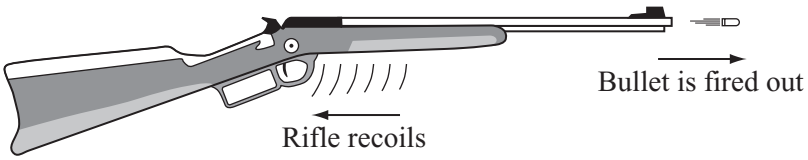
**Turn over ▶**

**12** When someone fires a rifle, they feel the rifle 'kick back', or recoil.

**Before firing**




**As rifle is fired**




(a) Calculate the recoil velocity of a rifle of mass 4 kg that fires a bullet of mass 0.05 kg at a speed of 280 m/s.

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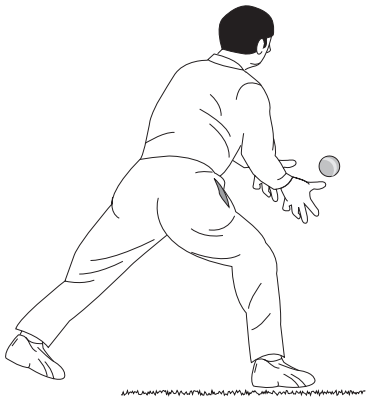
Recoil velocity = ..... m/s

*(3 marks)*

(b) The diagram shows a cricketer catching a cricket ball.



He pulls his hands backwards as he catches the ball.
This reduces the pain that he feels.

Explain why.

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*(3 marks)*

6

**TURN OVER FOR THE NEXT QUESTION**

## QUESTIONS RELATING TO PREVIOUSLY TESTED MODULES

**13** Modern electronic systems include CCTV, mobile phones and the Internet.

Complete the table below to give **one** advantage and **one** disadvantage of each system.

| System | Advantage | Disadvantage |
|---|---|---|
| CCTV | ..... ..... ..... | ..... ..... ..... |
| Mobile phones | ..... ..... ..... | ..... ..... ..... |
| The Internet | ..... ..... ..... | ..... ..... ..... |

*(6 marks)*

6

**END OF QUESTIONS**