

FOR OFFICIAL USE

| | | | | | |
|--|--|--|--|--|--|
| | | | | | |
|--|--|--|--|--|--|

C

K & U PS

| | |
|--|--|
| | |
|--|--|

Total Marks

3220/402

NATIONAL
QUALIFICATIONS
2003

MONDAY, 19 MAY
10.50 AM - 12.35 PM

PHYSICS
STANDARD GRADE
Credit Level

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth

Day Month Year

| | | | | | | | |
|--|--|--|--|--|--|--|--|
| | | | | | | | |
|--|--|--|--|--|--|--|--|

Scottish candidate number

| | | | | | | | | | |
|--|--|--|--|--|--|--|--|--|--|
| | | | | | | | | | |
|--|--|--|--|--|--|--|--|--|--|

Number of seat

- All questions should be answered.
- The questions may be answered in any order but all answers must be written clearly and legibly in this book.
- Write your answer where indicated by the question or in the space provided after the question.
- If you change your mind about your answer you may score it out and rewrite it in the space provided at the end of the answer book.
- Before leaving the examination room you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.
- Any necessary data will be found in the **data sheet** on page two.



DATA SHEET

Speed of light in materials

| <i>Material</i> | <i>Speed in m/s</i> |
|-----------------|---------------------|
| Air | 3.0×10^8 |
| Carbon dioxide | 3.0×10^8 |
| Diamond | 1.2×10^8 |
| Glass | 2.0×10^8 |
| Glycerol | 2.1×10^8 |
| Water | 2.3×10^8 |

Speed of sound in materials

| <i>Material</i> | <i>Speed in m/s</i> |
|-----------------|---------------------|
| Aluminium | 5200 |
| Air | 340 |
| Bone | 4100 |
| Carbon dioxide | 270 |
| Glycerol | 1900 |
| Muscle | 1600 |
| Steel | 5200 |
| Tissue | 1500 |
| Water | 1500 |

Gravitational field strengths

| | <i>Gravitational field strength on the surface in N/kg</i> |
|---------|--|
| Earth | 10 |
| Jupiter | 26 |
| Mars | 4 |
| Mercury | 4 |
| Moon | 1.6 |
| Neptune | 12 |
| Saturn | 11 |
| Sun | 270 |
| Venus | 9 |

Specific heat capacity of materials

| <i>Material</i> | <i>Specific heat capacity in J/kg °C</i> |
|-----------------|--|
| Alcohol | 2350 |
| Aluminium | 902 |
| Copper | 386 |
| Diamond | 530 |
| Glass | 500 |
| Glycerol | 2400 |
| Ice | 2100 |
| Lead | 128 |
| Water | 4180 |

Specific latent heat of fusion of materials

| <i>Material</i> | <i>Specific latent heat of fusion in J/kg</i> |
|-----------------|---|
| Alcohol | 0.99×10^5 |
| Aluminium | 3.95×10^5 |
| Carbon dioxide | 1.80×10^5 |
| Copper | 2.05×10^5 |
| Glycerol | 1.81×10^5 |
| Lead | 0.25×10^5 |
| Water | 3.34×10^5 |

Melting and boiling points of materials

| <i>Material</i> | <i>Melting point in °C</i> | <i>Boiling point in °C</i> |
|-----------------|----------------------------|----------------------------|
| Alcohol | -98 | 65 |
| Aluminium | 660 | 2470 |
| Copper | 1077 | 2567 |
| Glycerol | 18 | 290 |
| Lead | 328 | 1737 |
| Turpentine | -10 | 156 |

Specific latent heat of vaporisation of materials

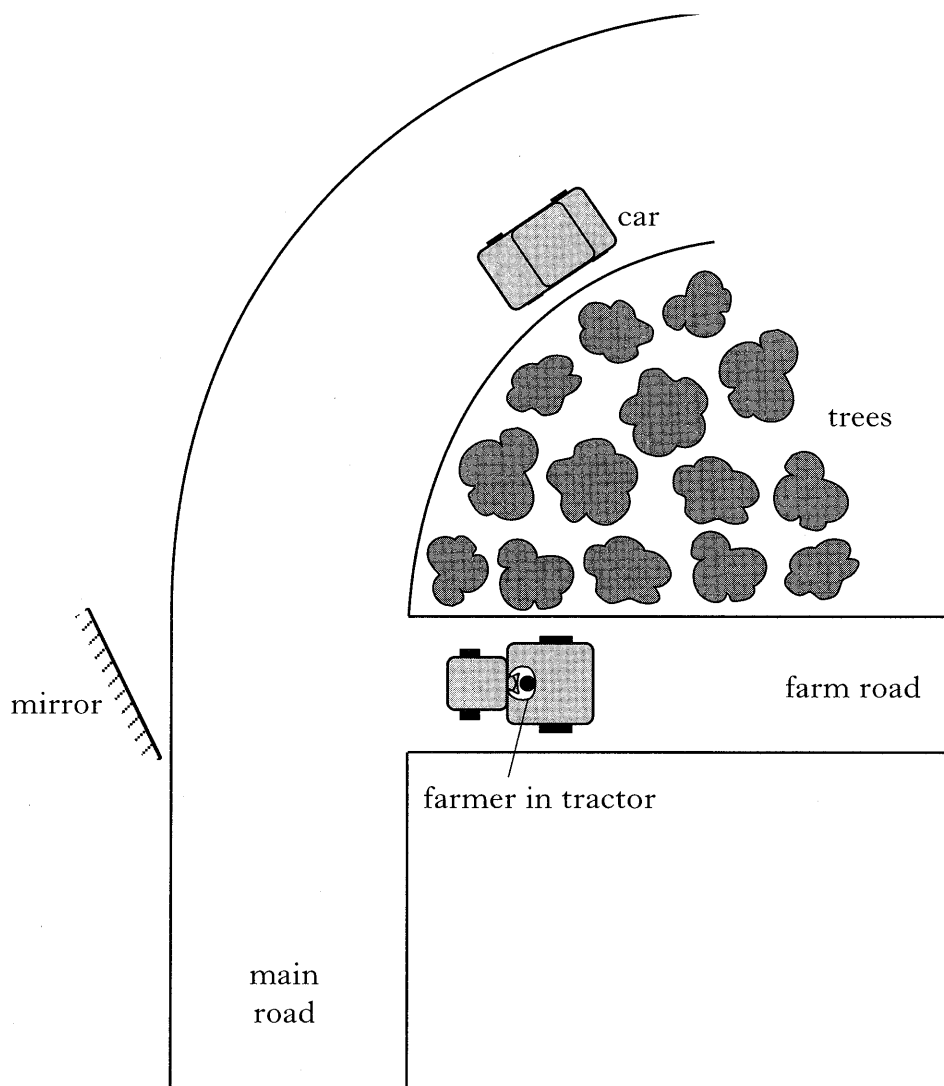
| <i>Material</i> | <i>Specific latent heat of vaporisation in J/kg</i> |
|-----------------|---|
| Alcohol | 11.2×10^5 |
| Carbon dioxide | 3.77×10^5 |
| Glycerol | 8.30×10^5 |
| Turpentine | 2.90×10^5 |
| Water | 22.6×10^5 |

SI Prefixes and Multiplication Factors

| <i>Prefix</i> | <i>Symbol</i> | <i>Factor</i> |
|---------------|---------------|---------------------------|
| giga | G | 1 000 000 000 = 10^9 |
| mega | M | 1 000 000 = 10^6 |
| kilo | k | 1000 = 10^3 |
| milli | m | 0.001 = 10^{-3} |
| micro | μ | 0.000 001 = 10^{-6} |
| nano | n | 0.000 000 001 = 10^{-9} |

Marks

1. A farm road joins a main road at a bend. The farmer has placed a mirror as shown so that he can see when cars are approaching.



- (a) On the diagram, draw rays to show how the farmer in the tractor can see the car by using the mirror.

You must label the angle of incidence and the angle of reflection on your completed diagram.

- (b) State why the driver of the car can **also** see the tractor using the mirror.

.....

.....

| | K&U | PS |
|---|-----|----|
| 3 | | |
| 1 | | |

Marks

| K&U | PS |
|-----|----|
| | |
| | |
| | |
| | |
| | |

2. (continued)

- (c) The students note that there are 5 complete waves in the pool at any time.

Calculate the wavelength of the waves.

Space for working and answer

2

- (d) Explain why “distance divided by time” and “frequency times wavelength” are equivalent for a wave.

Space for working and answer

2

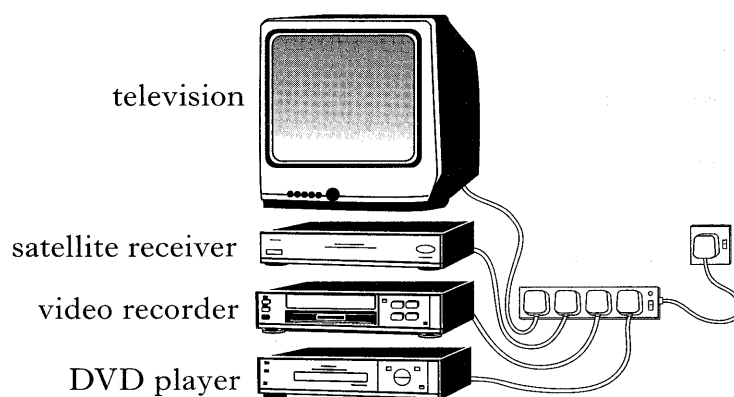
[Turn over

Marks

3. A home entertainment centre consists of four appliances. The table gives the power rating of each appliance.

| <i>Appliance</i> | <i>Power rating (W)</i> |
|--------------------|-------------------------|
| television | 110 |
| video recorder | 22 |
| satellite receiver | 20 |
| DVD player | 18 |

To operate properly, each appliance must be connected to mains voltage. The appliances are connected to the mains using a multiway adaptor.



- (a) (i) State the value of the operating voltage of the appliances.
 1
- (ii) The connections in the multiway adaptor are arranged to ensure that each appliance is connected to mains voltage.
 State how the connections in the multiway adaptor are arranged to achieve this.
 1
- (b) Calculate the current from the mains when all four appliances are operating at the power ratings shown in the table.
 (You must use an appropriate number of significant figures in your answer to this question.)

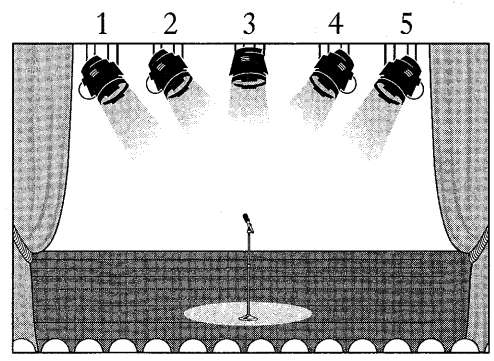
Space for working and answer

| K&U | PS |
|-----|----|
| | |
| | |
| | |
| | |
| | |
| | |

3

Marks

4. A show uses five spotlights of equal brightness, pointing at the same place on the stage.



The spotlights can be turned on and off individually. The colour of light from each spotlight is shown in the table.

| Spotlight | Colour |
|-----------|--------|
| 1 | green |
| 2 | blue |
| 3 | red |
| 4 | blue |
| 5 | green |

(a) State **three** spotlights that could be on to produce white light on the stage.

.....

1

(b) One scene requires yellow light.
 State **two** spotlights that could be on to produce yellow light on the stage.

.....

1

(c) Another scene requires **pale** green light. This needs **four** of the spotlights to be on.
 State **one** spotlight that could be **off** so that the other four produce pale green light.

.....

1

| Marks | K&U | PS |
|-------|-----|----|
| | | |
| 1 | | |
| 1 | | |
| 1 | | |

Marks

| K&U | PS |
|-----|----|
| | |
| | |
| | |
| | |

5. A textbook has three diagrams showing how an eye lens changes when looking at objects that are different distances away. The diagrams below are copies of these three diagrams, with parts omitted.

Diagrams 1 and 3 are not complete.

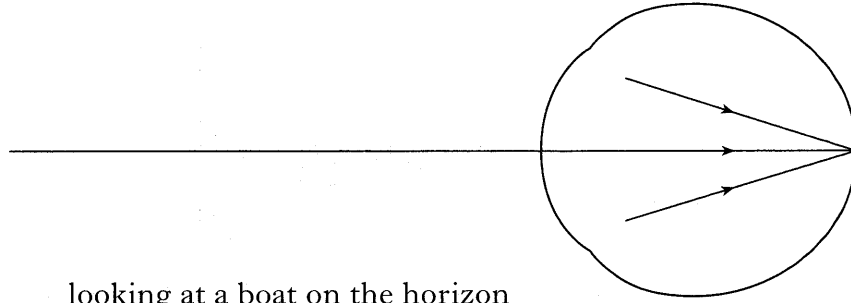


Diagram 1 looking at a boat on the horizon

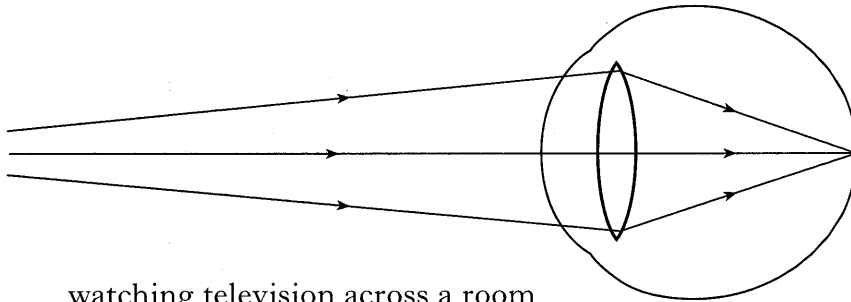


Diagram 2 watching television across a room

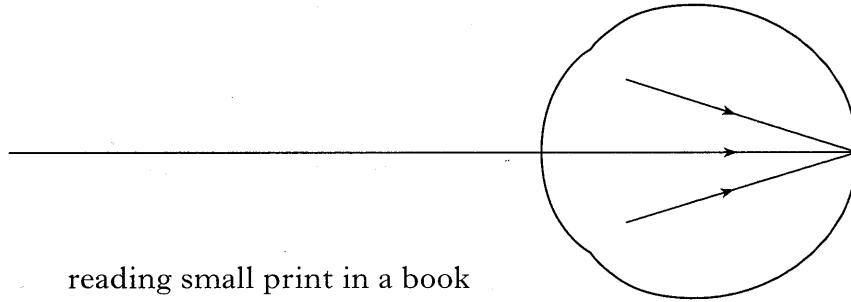


Diagram 3 reading small print in a book

- (a) On diagrams 1 **and** 3:
- draw two rays to show light coming from each object to the eye;
 - draw a lens to show how the shape of the eye lens is different from the shape of the lens in diagram 2.
- (b) The focal length of an eye lens system (the cornea and the eye lens together) is 2.5 cm.

Calculate the power of this eye lens system.

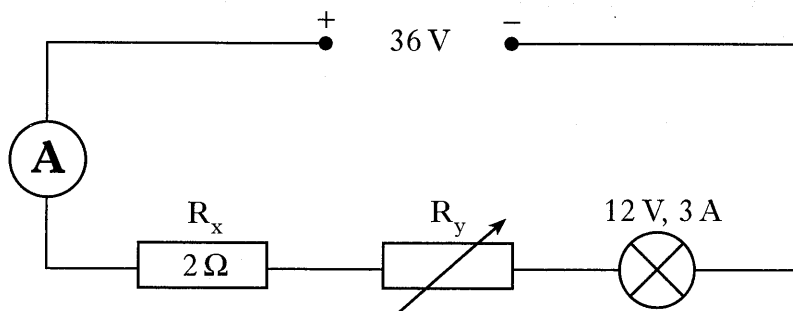
Space for working and answer

4

2

Marks

6. A student designs the circuit shown to operate a 12 V, 3 A lamp from a 36 V supply.



- (a) What is the reading on the ammeter when the lamp is operating at its correct power rating?

.....

1

- (b) The resistance of R_x is $2\ \Omega$.

Calculate the voltage across R_x when the lamp is operating correctly.

Space for working and answer

2

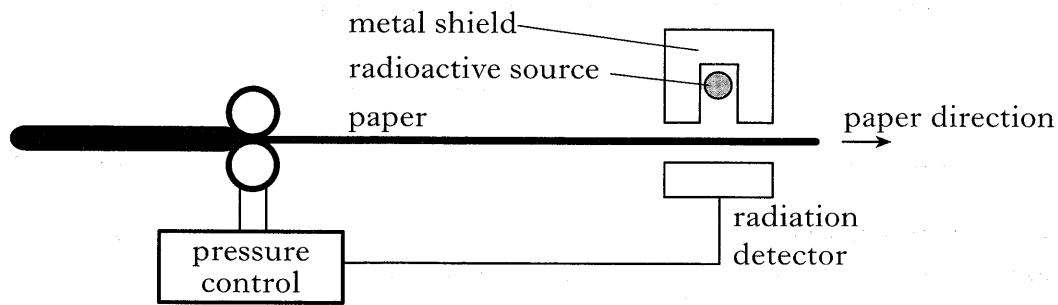
- (c) Calculate the resistance of R_y when the lamp is operating correctly.

Space for working and answer

3

Marks

7. A paper mill uses a radioactive source in a system to monitor the thickness of paper.



The count rate detected by the radiation detector changes as the thickness of the paper varies. The radiation detector sends signals to the pressure control to maintain an even thickness of paper. The radioactive source emits a type of radiation that is partly absorbed by the paper. The source also has a half-life that allows the mill to run continuously, for several days.

- (a) What is meant by the term “half-life”?

.....

1

- (b) The following radioactive sources are available.

| <i>Source</i> | <i>Half-life</i> | <i>Radiation emitted</i> |
|---------------|------------------|--------------------------|
| P | 500 years | alpha |
| Q | 20 hours | beta |
| R | 450 years | beta |
| S | 300 years | gamma |

- (i) Explain why source P cannot be used in this system.

.....

1

- (ii) Which source should be used? Explain your answer.

.....

2

Marks

| K&U | PS |
|-----|----|
| | |
| | |
| | |
| | |
| | |

7. (continued)

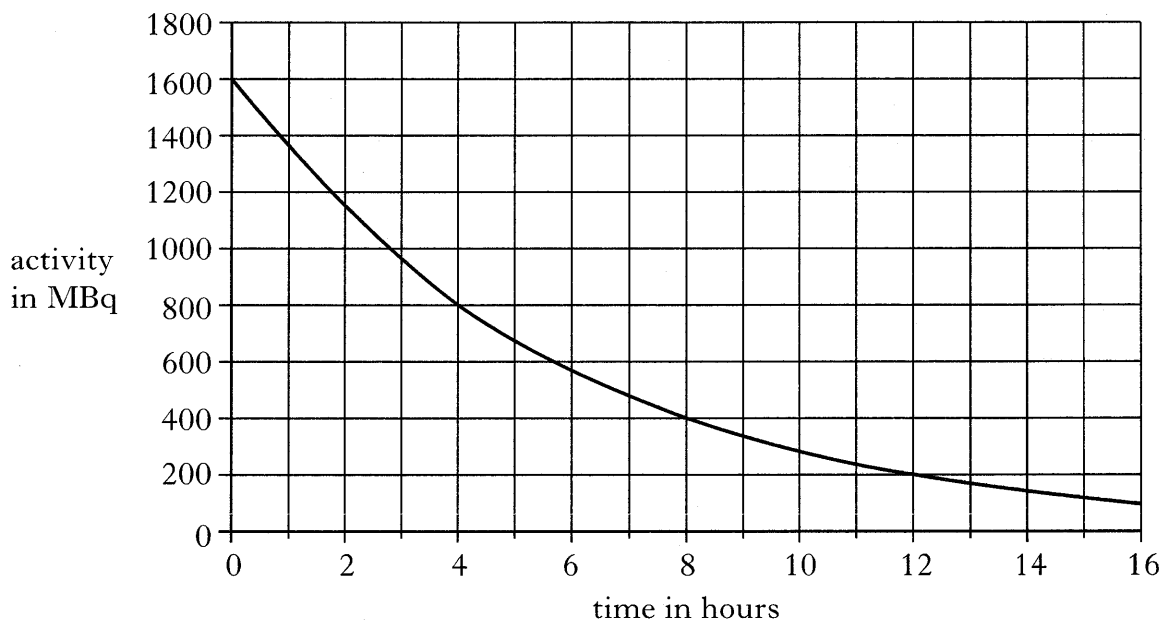
(c) Why does the radioactive source in the paper mill have a metal shield?

.....

.....

1

(d) Another radioactive source emits gamma radiation. The graph shows how the activity of this source decreases with time.



Calculate the half-life of this radioactive source.

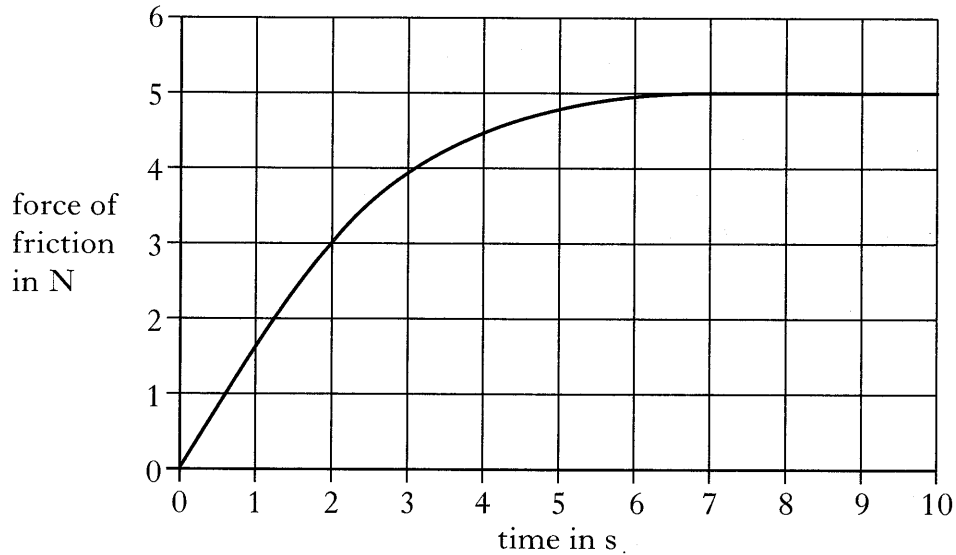
Space for working and answer

1

[Turn over

Marks

11. A model motor boat of mass 4 kg is initially at rest on a pond. The boat's motor, which provides a constant force of 5 N, is switched on. As the boat accelerates, the force of friction acting on it increases. A graph of the force of friction acting on the boat against time is shown.



- (a) (i) State the force of friction acting on the boat 2 s after the motor is switched on.

.....

1

- (ii) Calculate the acceleration of the boat at this time.

Space for working and answer

3

- (b) Describe and explain the movement of the boat after 7 s.

.....

2

| | K&U | PS |
|---|-----|----|
| 1 | | |
| 3 | | |
| 2 | | |

12. A battery charger with an input voltage of 230 V is used to recharge a car battery. The charger contains a transformer that has an output voltage of 13.8 V.

(a) What type of transformer does the battery charger contain?

.....

(b) There are 4000 turns in the primary coil of the transformer.

Assuming the transformer is 100% efficient, calculate the number of turns in the secondary coil.

Space for working and answer

(c) (i) When charging the battery, the current in the secondary coil is 4.7 A.

(A) Calculate the power output of the transformer.

Space for working and answer

(B) In practice, the transformer is only 94% efficient. Calculate the current in the primary coil.

Space for working and answer

(ii) State and explain **one** reason why a transformer is not 100% efficient.

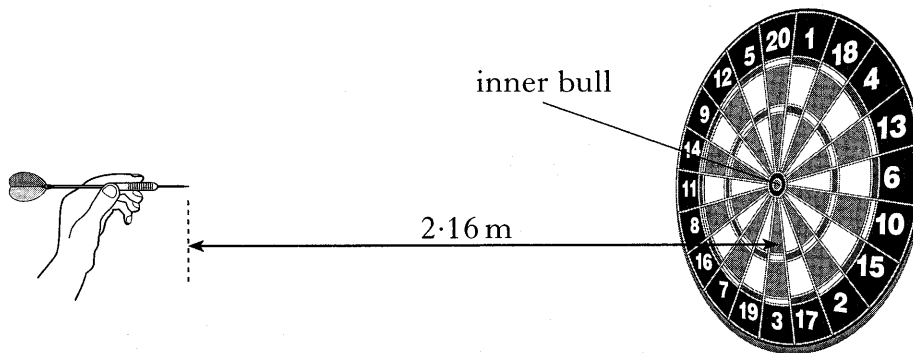
.....
.....
.....

| Marks | K&U | PS |
|-------|-----|----|
| | | |
| 1 | | |
| 2 | | |
| 2 | | |
| 3 | | |
| 2 | | |

Marks

| K&U | PS |
|-----|----|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

15. A darts player throws a dart horizontally at the centre of the inner bull. The dart leaves the player's hand at a distance of 2.16 m from the dartboard and with a horizontal speed of 12.0 m/s.



- (a) Calculate the time taken for the dart to travel from the hand to the board.

Space for working and answer

2

- (b) Explain why the dart follows a curved path in its flight to the board.

.....

.....

.....

2

- (c) The average vertical speed of the dart during its flight to the board is 0.9 m/s.

How far below the centre of the inner bull does the dart hit the board?

Space for working and answer

2

[END OF QUESTION PAPER]

| K&U | PS |
|-----|----|
| | |

YOU MAY USE THE SPACE ON THIS PAGE TO REWRITE ANY ANSWER YOU HAVE DECIDED TO CHANGE IN THE MAIN PART OF THE ANSWER BOOKLET. TAKE CARE TO WRITE IN CAREFULLY THE APPROPRIATE QUESTION NUMBER.