X069/201

Read Carefully

1 All questions should be attempted.

Section A (questions 1 to 20)

2 Check that the answer sheet is for Physics Intermediate 2 (Section A).

3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate Number) and **Centre Name** printed on it.

   Do not change any of these details.

4 If any of this information is wrong, tell the Invigilator immediately.

5 If this information is correct, **print** your name and seat number in the boxes provided.

6 Use **black** or **blue ink** for your answers. **Do not use red ink**.

7 There is **only one correct** answer to each question.

8 Any rough working should be done on the question paper or the rough working sheet, **not** on your answer sheet.

9 At the end of the exam, put the **answer sheet for Section A inside the front cover of your answer book**.

10 Instructions as to how to record your answers to questions 1–20 are given on page two.

Section B (questions 21 to 31)

11 Answer the questions numbered 21 to 31 in the answer book provided.

12 Fill in the details on the front of the answer book.

13 Enter the question number clearly in the margin of the answer book beside each of your answers to questions 21 to 31.

14 Care should be taken to give an appropriate number of significant figures in the final answers to calculations.

SECTION A

For questions 1 to 20 in this section of the paper the answer to each question is either **A, B, C, D or E.** Decide what your answer is, then put a horizontal line in the space provided—see the example below.

EXAMPLE

The energy unit measured by the electricity meter in your home is the

    A ampere

    B kilowatt-hour

    C watt

    D coulomb

    E volt.

The correct answer is **B**—kilowatt-hour. The answer **B** has been clearly marked with a horizontal line (see below).
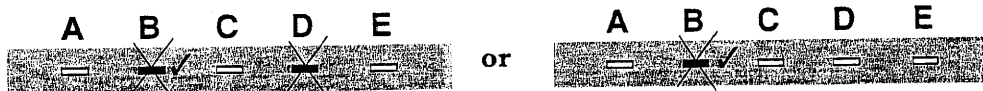

Changing an answer

If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **B**.

If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:
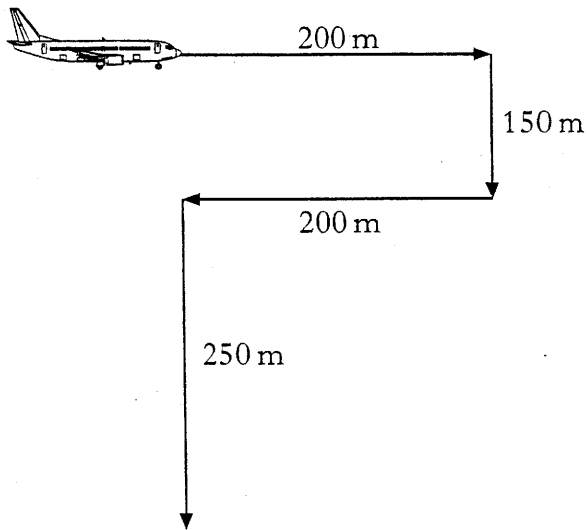
 or

SECTION A

Answer questions 1–20 on the answer sheet.

1. Which of the following is a scalar quantity?

   A Velocity

   B Displacement

   C Acceleration

   D Force

   E Speed

2. At an airport an aircraft moves from the terminal building to the end of the runway.

   Which row shows the total distance travelled and the size of the displacement of the aircraft?

	Total distanced travelled (m)	Size of displacement (m)
A	400	800
B	450	200
C	450	400
D	800	400
E	800	800

3. A seagull, flying horizontally at 8 m/s, drops a piece of food. What will be the horizontal and vertical speeds of the food when it hits the ground 2·5 s later? Air resistance should be ignored.

	Horizontal speed (m/s)	Vertical speed (m/s)
A	0	8
B	8	20
C	8	25
D	25	25
E	33	50

4. A block of mass 4 kg is pulled along a horizontal bench by a force of 16 N.
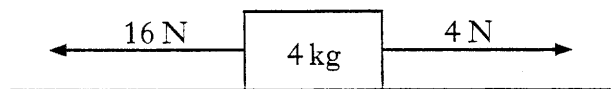
   A constant frictional force of 4 N acts on the block.

   What is the acceleration of the block?

   A $0{\cdot}3\,\text{m/s}^2$

   B $1{\cdot}0\,\text{m/s}^2$

   C $3{\cdot}0\,\text{m/s}^2$

   D $4{\cdot}0\,\text{m/s}^2$

   E $5{\cdot}0\,\text{m/s}^2$

[Turn over

5. Which of the following could be the unit of kinetic energy?

A $N\,m^2$

B $N\,m/s$

C $kg\,m/s$

D N/kg

E $kg\,m^2/s^2$

6. In observing a collision, a student draws the following conclusions.

I Momentum is conserved.

II Momentum is a vector quantity.
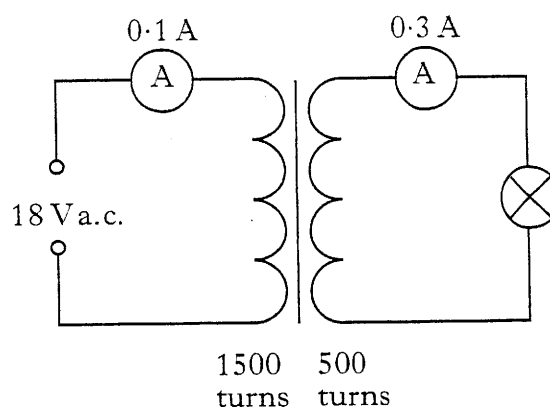
III Momentum is the product of mass and velocity squared.

Which of these conclusions is/are correct?

A I only

B I and II only

C I and III only

D II and III only

E I, II and III

7. An ampere is one

A volt per joule

B joule per second

C joule per coulomb

D coulomb per second

E ohm per volt.

8. The diagram shows a transformer connected to a lamp.

Assuming the transformer to be 100% efficient, what is the resistance of the lamp?

A $20\,\Omega$

B $30\,\Omega$

C $54\,\Omega$

D $60\,\Omega$

E $180\,\Omega$

9. The charge passing a point in a conductor when a current of $4\,mA$ flows for $1000\,s$ is

A $0.25\,C$

B $0.4\,C$

C $4\,C$

D $250\,C$

E $4000\,C$.

10. Which row shows the frequency and voltage of the mains supply?

	Frequency (Hz)	Quoted voltage (V)	Peak voltage (V)
A	10	110	230
B	50	230	230
C	50	230	325
D	60	230	162
E	230	50	50

11. Which of the following devices converts electrical energy to kinetic energy?
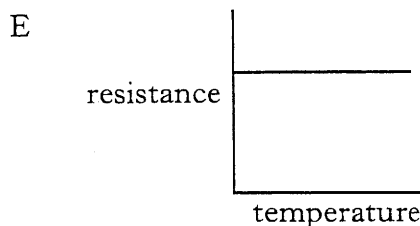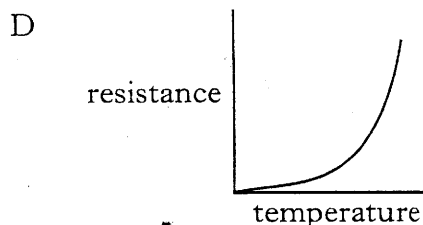
A   Motor

B   Lamp

C   LED

D   LDR

E   Microphone

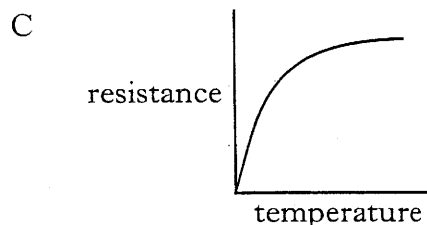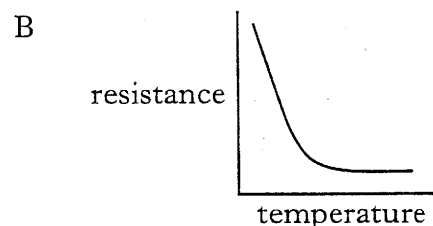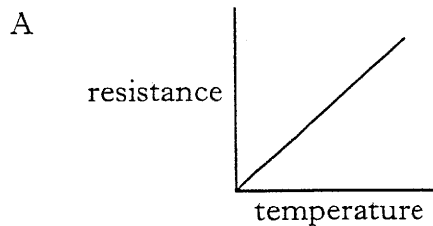**12.** The diagram shows a transverse wave.
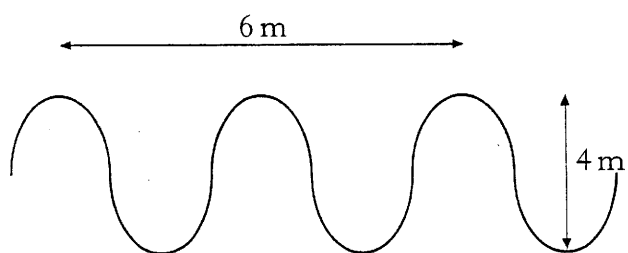
The amplitude of the wave is

A   2 m

B   3 m

C   4 m

D   6 m

E   8 m.

**13.** Which graph shows how the resistance of most thermistors varies with temperature?

A

B

C

D

E

[Turn over

14. An electric kettle is rated at $2 \cdot 76 \, \text{kW}$ for use on a $230 \, \text{V}$ supply. Which of the following statements is/are correct?

   I The kettle uses energy at the rate of $2 \cdot 76$ joules per second.

  II The current through the element of the kettle is $12 \, \text{A}$.

 III 230 coulombs of charge flow through the element every second.

   A   I only

   B   II only

   C   I and II only

   D   II and III only

   E   I, II and III

15. The diagram shows a girl standing at a fireworks display. There is a tall building nearby.

tall building
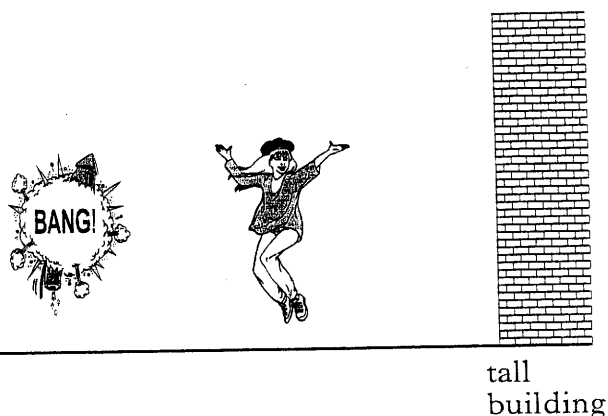
When a firework explodes, the girl hears two bangs $0 \cdot 5 \, \text{s}$ apart.

The speed of sound is $340 \, \text{m/s}$.

How far is the girl from the building?

   A $42 \cdot 5 \, \text{m}$

   B $85 \cdot 0 \, \text{m}$

   C $170 \, \text{m}$

   D $340 \, \text{m}$

   E $680 \, \text{m}$

16. The diagrams show a light ray passing through a semi-circular glass block.

In each case one angle has been marked.

In which diagram is this angle the critical angle?
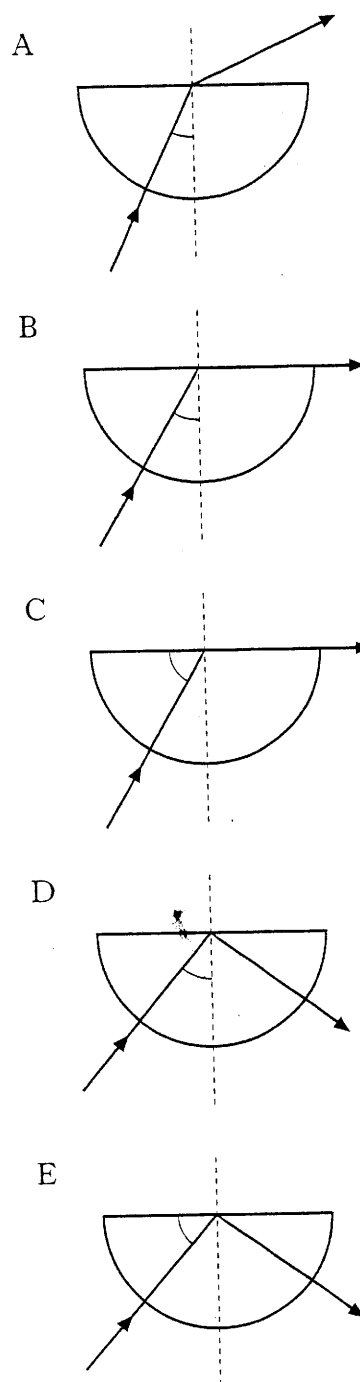
17. Which row correctly describes alpha, beta and gamma radiations?

	α	β	γ
A	electrons from the nucleus	helium nucleus	electro-magnetic radiation
B	electro-magnetic radiation	helium nucleus	electrons from the nucleus
C	helium nucleus	electro-magnetic radiation	electrons from the nucleus
D	helium nucleus	electrons from the nucleus	electro-magnetic radiation
E	electro-magnetic radiation	electrons from the nucleus	helium nucleus

18. Which of the following increases the dose equivalent from a radioactive source?

A Increasing distance

B Handling with tongs

C Standing beside it for a long time

D Storing in a lead container

E Storing under water

19. A radioactive source emits α, β and γ radiations in a beam as shown.

Radioactive source   Sheet of paper   5 mm aluminium
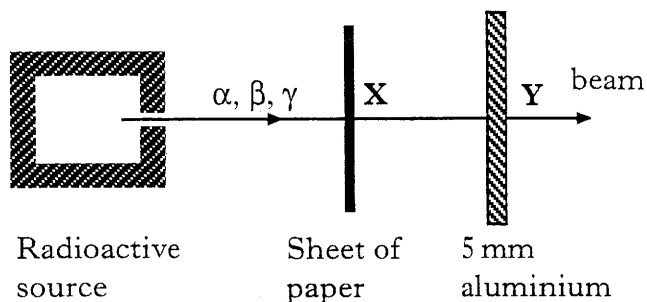
The main radiation(s) in the beam at **X** and **Y** are

	Position **X**	*Position* **Y**
A	α and β	β
B	β and γ	β
C	α and γ	γ
D	α and β	α
E	β and γ	γ

20. The following is an extract from a student's notes on nuclear fission.

   I The nucleus splits into two parts.

   II Neutrons are emitted.

   III Two nuclei join together.

Which of the statements is/are correct?

A I only
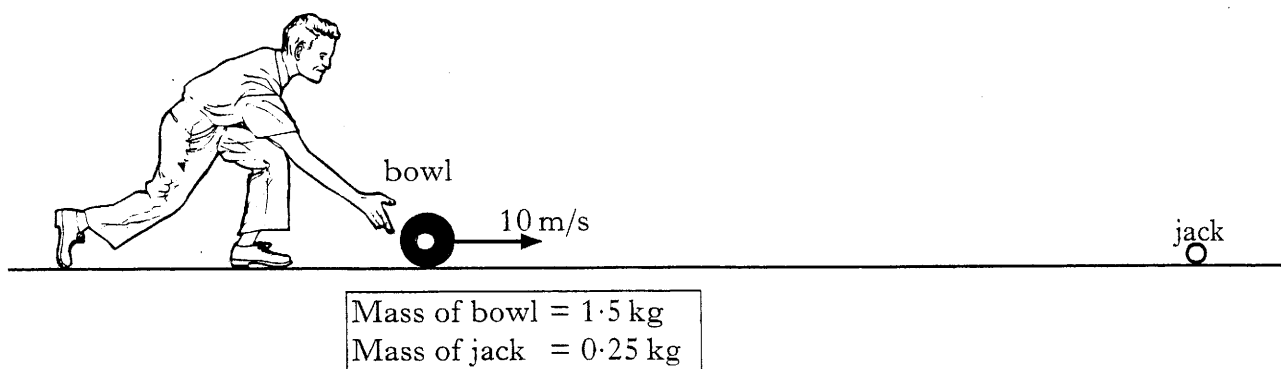
B II only

C III only

D I and II only

E I, II and III

[Turn over

Write your answers to questions 21–31 in the answer book.

21. In a game of bowls, a bowler moves a bowl through a horizontal distance of 1·5 m from rest before releasing it with a velocity of 10 m/s.

bowl

10 m/s

jack

Mass of bowl = 1·5 kg
Mass of jack = 0·25 kg

(a) Show that the kinetic energy of the bowl when it is released is 75 J.   2

(b) Calculate the force the bowler applies to the bowl.   2

(c) The bowl has a speed of 2 m/s when it hits the stationary jack.

After the collision the speed of the bowl is 1·2 m/s.

Calculate the speed of the jack after the collision.   2

(d) Describe a method to find the average speed of the bowl from the moment it is released until it hits the jack.

Your answer should include:

• the apparatus required

• the measurements taken

• how the average speed is calculated.   3

(9)

22. A sky-diver of mass 90 kg drops from a stationary balloon. The speed-time graph shows how the vertical speed of the sky-diver varies until she reaches the ground. She falls 3000 m before opening her parachute.
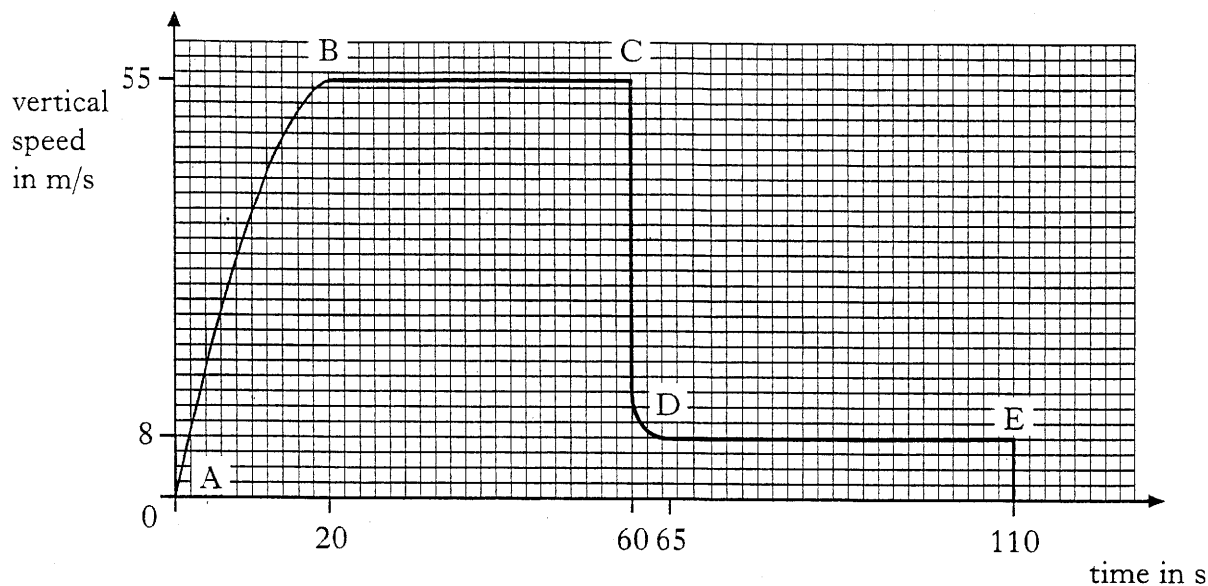
(*a*) At what point does the sky-diver:

    (i)   open her parachute;   **1**

    (ii) reach the ground?   **1**

(*b*) Sketch a diagram showing the forces acting on the sky-diver between B and C.

You must name these forces and show their directions.   **2**

(*c*) Calculate the force of friction acting on the sky-diver between B and C.   **3**

        (7)

23. A new hydro-electric power station is being planned for the Highlands.
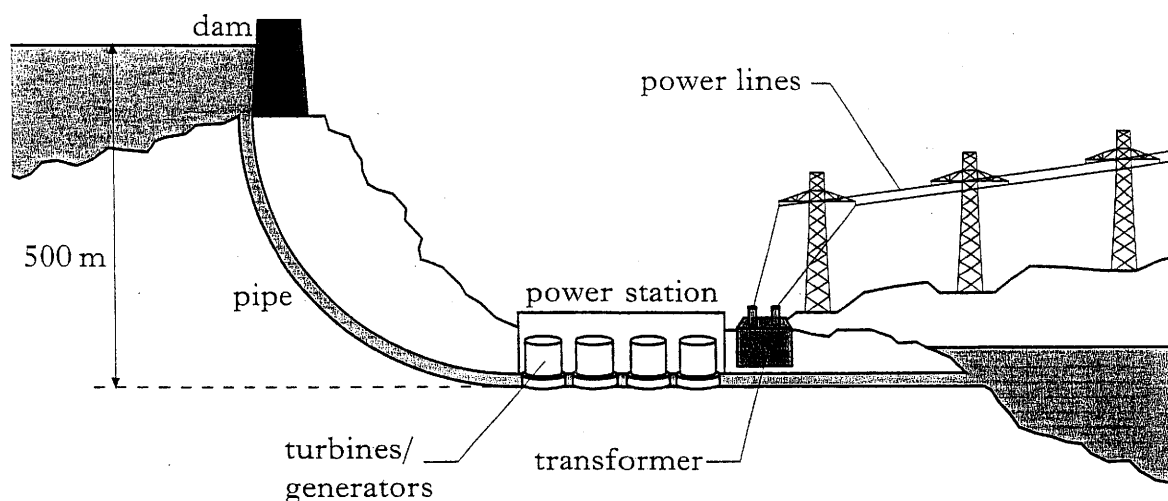
(a) Water is stored in a reservoir at a vertical height of 500 m above the power station. Each second 8000 kg of water flows through the power station.

   (i) Show that the water loses 40 MJ of gravitational potential energy each second.   2

   (ii) Assuming no energy losses in the pipe, state the input power to the station.   1

   (iii) Calculate the electrical output power of the station if it is 80% efficient.   2

(b) The output current from the power station is 1280 A at a voltage of 25 kV.

The voltage is stepped-up to 400 kV by a transformer.

Assuming no energy losses in the transformer, calculate the current in the power lines.   2
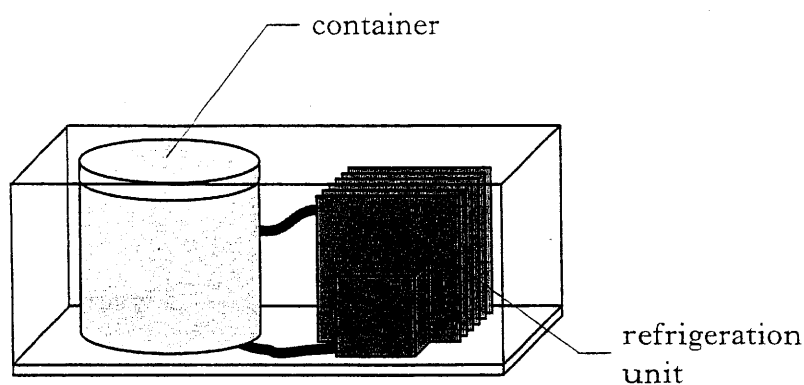
   (7)

24. An ice cream maker has a refrigeration unit which can remove heat at 120 J/s. Liquid ice cream, of mass 0·6 kg at a temperature of 20 °C, is added to the container.

container

refrigeration unit

(a) Calculate how much energy must be removed from the mixture to cool it to its freezing point of –16 °C.
(Specific heat capacity of ice cream = 2100 J/kg °C)

2

(b) Calculate how much heat energy must be removed to freeze the ice cream at this temperature.
(Specific latent heat of fusion of ice cream = $2·34 \times 10^5$ J/kg)

2

(c) (i) Calculate the time taken to cool and freeze the ice cream.

3

(ii) What assumption have you made in carrying out this calculation?

1

(8)

[Turn over

25. (*a*) A student connects two resistors in series with a power supply set at 20 V.
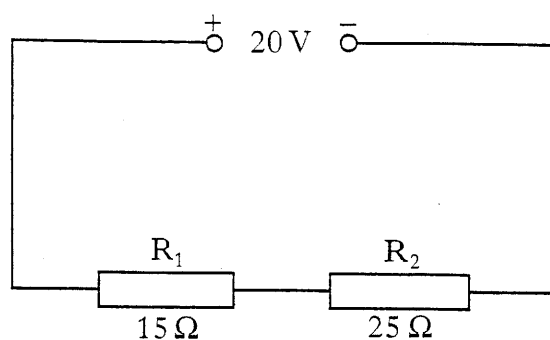

    (i) Calculate the current in the circuit.   3

    (ii) Calculate the potential difference across resistor R_1.   2

    (iii) Redraw the above circuit diagram showing meters correctly connected to measure the quantities in (i) and (ii) above.   2

(*b*) R_1 is now replaced by a 4 V lamp and the supply voltage is reduced to 12 V.

The lamp is operating at its stated voltage.
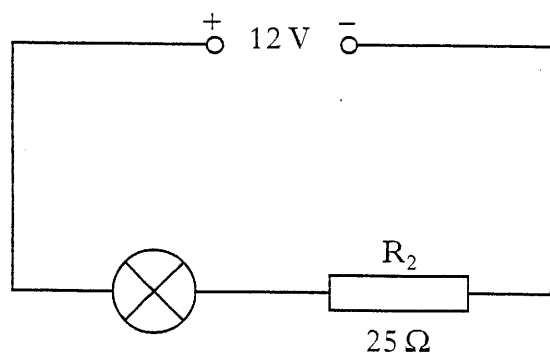
Calculate the rate at which electrical energy is converted to heat energy in resistor R_2.   3

                                      (10)

26. A student makes a device to measure the speed of moving air.

plastic cups

metal rod

magnet

iron core

N   S

a.c. voltmeter

coil
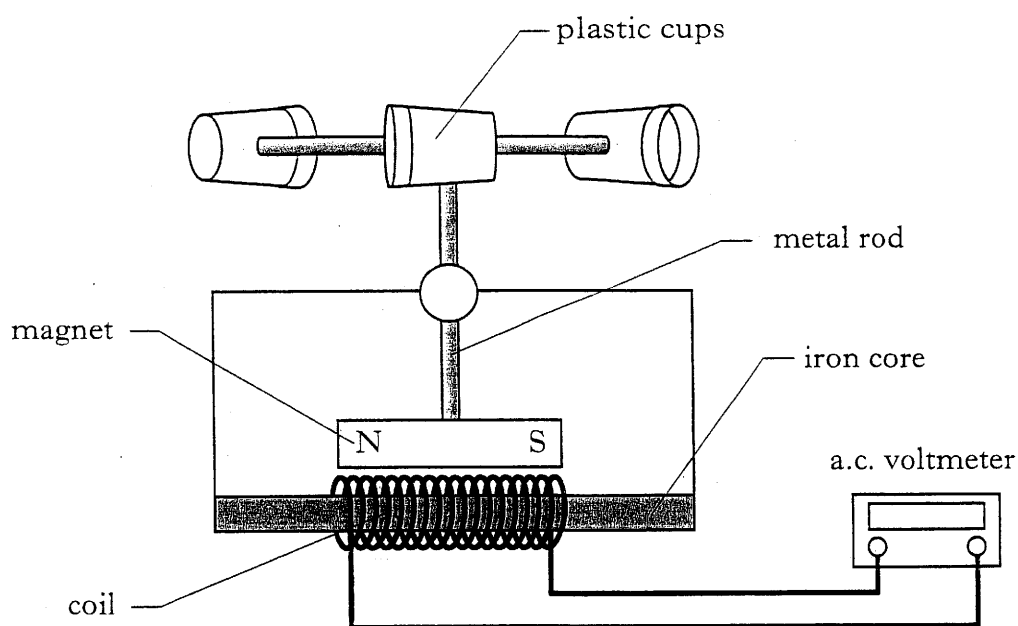
Moving air pushes the plastic cups round and this turns the metal rod.

A bar magnet is attached to the rod as shown in the diagram.

(*a*) Explain why a reading is shown on the voltmeter when the cups move.   2

(*b*) What happens to the voltmeter reading when the air speed increases?   1

(*c*) Suggest **two** changes which could be made **to the apparatus** to give a
bigger reading on the voltmeter.   2

(*d*) Explain, in terms of electron flow, what is meant by a.c.   1

(6)

[Turn over

27. A circuit diagram of an electronic system is shown below.

The system is designed to sound a warning when the light intensity falls below a certain level.
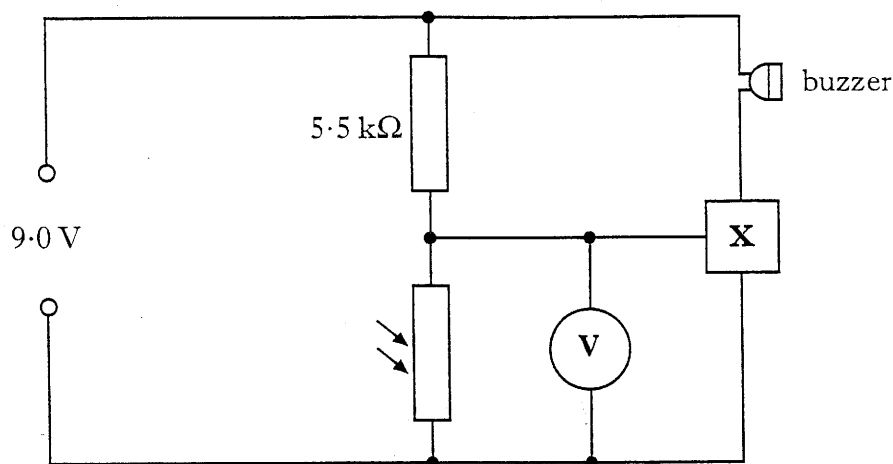
(a) Component X is a transistor.

Two types of transistor are suitable for this system, an NPN transistor and an n-channel enhancement MOSFET.

Draw and name the circuit symbol for each transistor.　　　　2

(b) What is the purpose of the transistor in this system?　　　　1
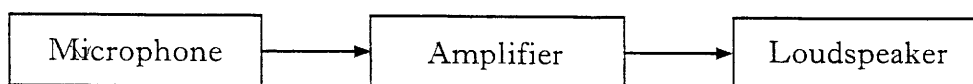
(c) A MOSFET is used at position X.

When the light intensity falls, the voltmeter reading rises to 2·4 V and the buzzer sounds.

Calculate the resistance of the LDR when this happens.　　　　3

　　　　(6)

28. A student is investigating an amplifier system.

```
┌─────────────┐      ┌─────────────┐      ┌─────────────┐
│  Microphone │─────▶│  Amplifier  │─────▶│ Loudspeaker │
└─────────────┘      └─────────────┘      └─────────────┘
```

(a) The student whistles into the microphone at a frequency of 400 Hz.

Calculate the wavelength of the sound emitted by the loudspeaker.
(The speed of sound in air is 340 m/s.)

2

(b) The student obtains the following information about the system.

Output voltage of the microphone   = 2 mV
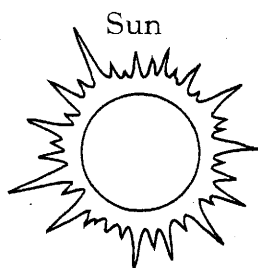Resistance of loudspeaker   = 16 Ω
Current in loudspeaker   = 25 mA

Calculate the voltage gain of the amplifier.

3

(5)

[Turn over

29. The sun is $1 \cdot 5 \times 10^{11}$ m from the Earth. The sun emits all radiations in the electromagnetic spectrum. All these radiations travel through space at 3×10^8 m/s.

Sun

Earth

(a) What do all waves transfer? 1

(b) Calculate the time taken for sunlight to reach Earth. 2

(c) The diagram below shows the electromagnetic spectrum in order of increasing frequency.

One part has been missed out.

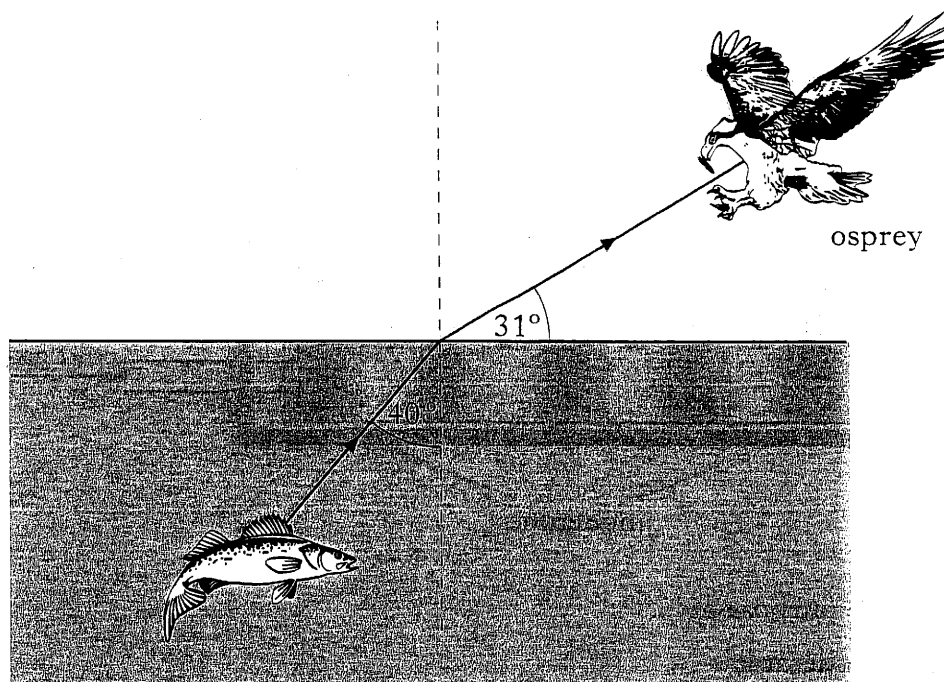| Radio & TV		Infrared	Visible light	Ultraviolet	X-rays	Gamma rays

(i) Name the missing radiation. 1

(ii) Name an ionising radiation from the spectrum. 1

(iii) What is meant by *ionisation*? 1

(6)

30. (*a*) An osprey sees a fish in a loch.

The diagram shows the path of a light ray from the fish to the osprey.

osprey

31°

(i) State the size of the angle of incidence. 1

(ii) State the size of the angle of refraction. 1

(*b*) A bird watcher is using a telescope to watch the osprey.

The eyepiece of the telescope acts as a magnifying lens.

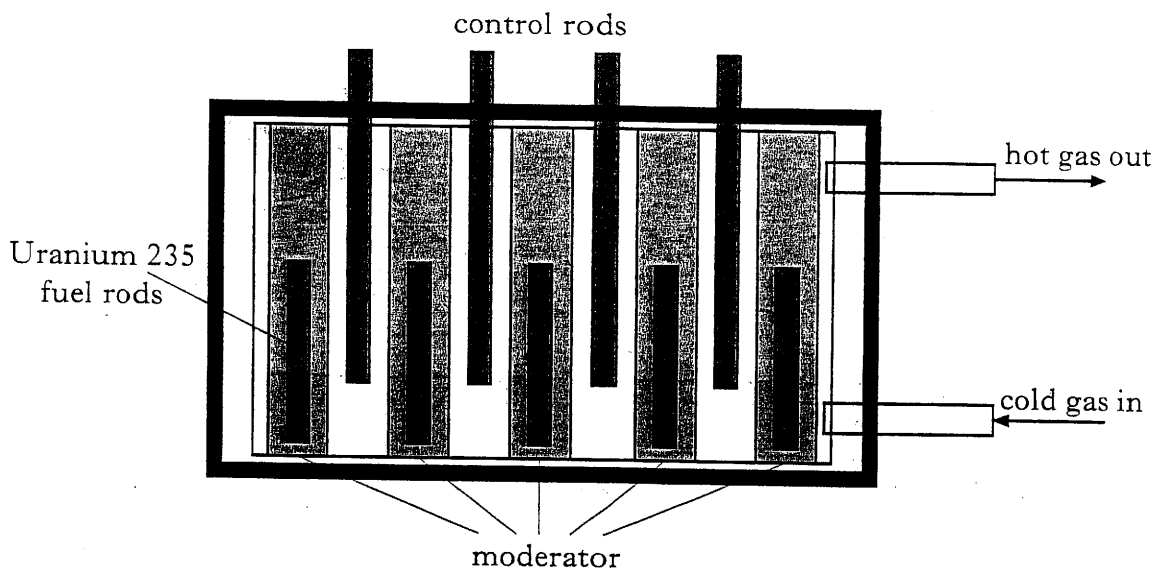(i) On the square paper provided, copy the diagram below.

Complete your diagram to show the size and position of the image formed by the lens. 2

object

10 mm

F

30 mm

50 mm

F
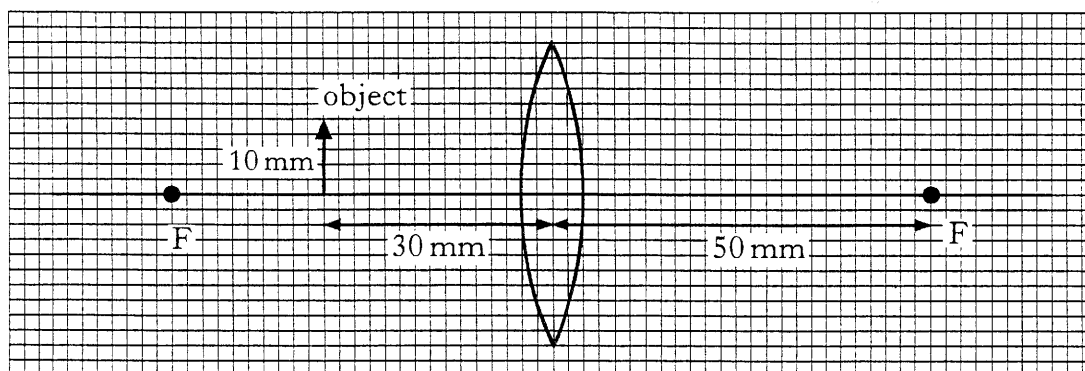
(ii) The focal length of this lens is 50 mm. Calculate the power of this lens. 2

(6)

[Turn over for Question 31 on *Page eighteen*

31. A diagram of the core of a gas cooled nuclear reactor is shown below.

(a) Explain the purpose of

    (i)   the moderator

    (ii) the control rods.

1

1

(b) One of the waste products produced in the nuclear reactor is caesium.

The caesium in the waste products removed from the reactor has an activity of 16×10^{12} Bq.

Caesium has a half-life of 30 years.

    (i)   State what is meant by the activity of a radioactive source.

    (ii) State what is meant by the half-life of a radioactive source.

    (iii) Calculate the activity of the caesium 150 years after its removal from the reactor.

1

1

2

(c) A worker at the nuclear power station has a mass of 90 kg and receives a dose equivalent of 276 µSv from slow neutrons. The quality factor for slow neutrons is 2·3.

    (i)   What does the quality factor tell us about a radiation?

    (ii) How much energy has the worker absorbed from the slow neutrons?

1

3

(10)

[END OF QUESTION PAPER]