X069/201

Read Carefully

Reference may be made to the Physics Data Booklet

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   For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.

4   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.

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

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

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 three.

Section B (questions 21 to 31)

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

12   **All answers must be written clearly and legibly in ink**.

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

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

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

DATA SHEET

Speed of light in materials

Material	Speed in m/s
Air	$3 \cdot 0 \times 10^8$
Carbon dioxide	$3 \cdot 0 \times 10^8$
Diamond	$1 \cdot 2 \times 10^8$
Glass	$2 \cdot 0 \times 10^8$
Glycerol	$2 \cdot 1 \times 10^8$
Water	$2 \cdot 3 \times 10^8$

Speed of sound in materials

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

Gravitational field strengths

	Gravitational field strength on the surface in N/kg
Earth	10
Jupiter	26
Mars	4
Mercury	4
Moon	$1 \cdot 6$
Neptune	12
Saturn	11
Sun	270
Venus	9

Specific heat capacity of materials

Material	Specific heat capacity in J/kg °C
Alcohol	2350
Aluminium	902
Copper	386
Glass	500
Ice	2100
Iron	480
Lead	128
Oil	2130
Water	4180

Specific latent heat of fusion of materials

Material	Specific latent heat of fusion in J/kg
Alcohol	$0 \cdot 99 \times 10^5$
Aluminium	$3 \cdot 95 \times 10^5$
Carbon Dioxide	$1 \cdot 80 \times 10^5$
Copper	$2 \cdot 05 \times 10^5$
Iron	$2 \cdot 67 \times 10^5$
Lead	$0 \cdot 25 \times 10^5$
Water	$3 \cdot 34 \times 10^5$

Melting and boiling points of materials

Material	Melting point in °C	Boiling point in °C
Alcohol	−98	65
Aluminium	660	2470
Copper	1077	2567
Glycerol	18	290
Lead	328	1737
Iron	1537	2737

Specific latent heat of vaporisation of materials

Material	Specific latent heat of vaporisation in J/kg
Alcohol	$11 \cdot 2 \times 10^5$
Carbon Dioxide	$3 \cdot 77 \times 10^5$
Glycerol	$8 \cdot 30 \times 10^5$
Turpentine	$2 \cdot 90 \times 10^5$
Water	$22 \cdot 6 \times 10^5$

Radiation weighting factors

| Type of radiation	Radiation weighting factor
alpha	20
beta	1
fast neutrons	10
gamma	1
slow neutrons	3

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, using your pencil, 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 kilowatt-hour

  B ampere

  C watt

  D coulomb

  E volt.

The correct answer is **A**—kilowatt-hour. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).
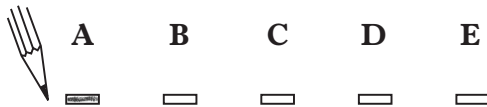
Changing an answer

If you decide to change your answer, carefully erase your first answer and, using your pencil, fill in the answer you want. The answer below has been changed to **E**.

<div align="right">

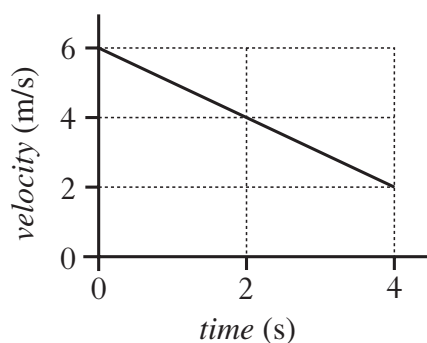**[Turn over**

</div>
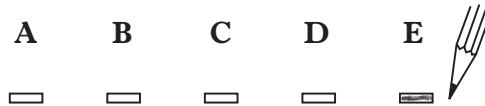
1. During training an athlete sprints 30 m East and then 40 m West.

    Which row shows the distance travelled and the displacement from the starting point?

	Distance travelled	Displacement
A	10 m	10 m East
B	10 m	10 m West
C	10 m	70 m East
D	70 m	10 m West
E	70 m	10 m East

2. The graph shows how the velocity of a ball changes with time.

    The acceleration of the ball is

    A $-8 \, \text{m/s}^2$

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

    C $1 \, \text{m/s}^2$

    D $8 \, \text{m/s}^2$

    E $24 \, \text{m/s}^2$.

3. A ball of mass 2 kg moves along a horizontal surface at 4 m/s.

    Which row shows the momentum and kinetic energy of the ball?

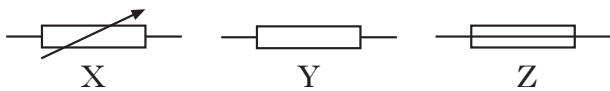 | | Momentum (kg m/s) | Kinetic energy (J) |
    |---|---|---|
    | A | 2 | 4 |
    | B | 4 | 8 |
    | C | 4 | 16 |
    | D | 8 | 8 |
    | E | 8 | 16 |

4. An engine applies a force of 2000 N to move a lorry at a constant speed.

    The lorry travels 100 m in 16 s.

   The power developed by the engine is

    A   0·8 W

    B   12·5 W

    C   320 W

    D   12 500 W

    E   3 200 000 W.

**5.** Which row in the table identifies the following circuit symbols?

	Symbol X	*Symbol Y*	*Symbol Z*
A	fuse	resistor	variable resistor
B	fuse	variable resistor	resistor
C	resistor	variable resistor	fuse
D	variable resistor	fuse	resistor
E	variable resistor	resistor	fuse

6. Which graph shows how the potential difference V across a resistor varies with the current I in the resistor?
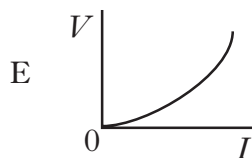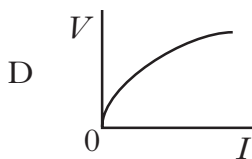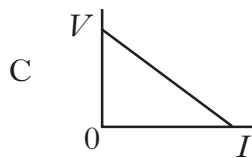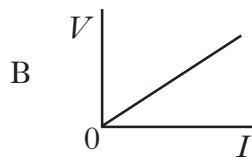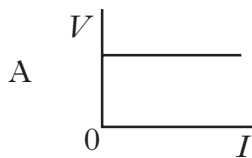
7. A circuit is set up as shown.
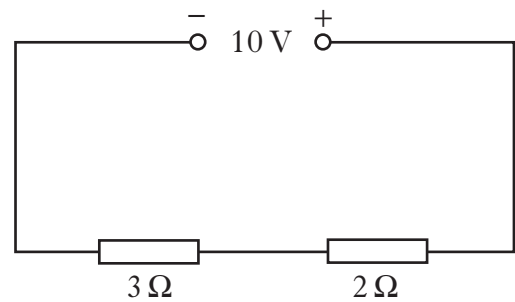
The potential difference across the $2\,\Omega$ resistor is

A   4 V

B   5 V

C   6 V

D   10 V

E   20 V.

8. A student makes the following statements about electrical supplies.
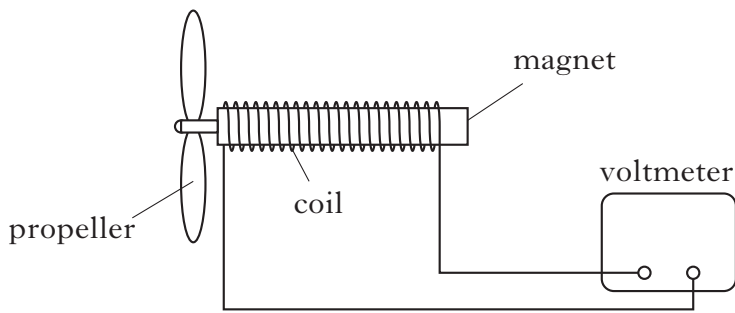
  I The frequency of the mains supply is 50 Hz.

 II The quoted value of an alternating voltage is less than its peak value.

III A d.c supply and an a.c. supply of the same quoted value will supply the same power to a given resistor.

Which of the following statements is/are correct?

A   I only

B   II only

C   III only

D   I and II only

E   I, II and III

9. A wind speed meter is designed as shown.

Air blows across the propeller causing the magnet to rotate. A voltage is induced across the coil.

Which of the following changes will produce an increase in the induced voltage?

  I Replacing the magnet with one of greater field strength.

 II Spinning the propeller faster.

III Reducing the number of turns on the coil.

A   I only

B   I and II only

C   I and III only

D   II and III only

E   I, II and III

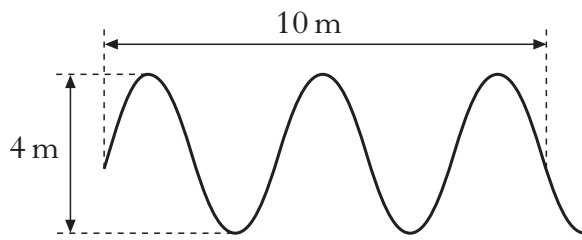**10.** Which of the following is the circuit symbol for an NPN transistor?

11. The input signal to an amplifier is 2 V a.c. at a frequency of 200 Hz. The amplifier has a gain of 8.

Which row shows the output voltage and the output frequency?

	Output voltage (V)	Output frequency (Hz)
A	10	200
B	10	208
C	10	1600
D	16	200
E	16	1600

12. The following diagram gives information about a wave.

10 m

4 m

Which row shows the amplitude and wavelength of the wave?

	Amplitude (m)	Wavelength (m)
A	2	2
B	2	4
C	2	5
D	4	2
E	4	4

13. Sound is a longitudinal wave. When a sound wave travels through air the particles of air

A   vibrate at random

B   vibrate along the wave direction

C   vibrate at 90° to the wave direction

D   move continuously away from the source

E   move continuously towards the source.

14. A signal is transmitted using a curved reflector as shown.

curved reflector
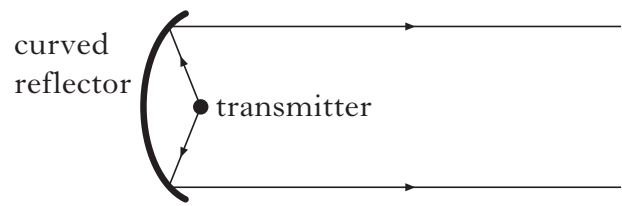
transmitter
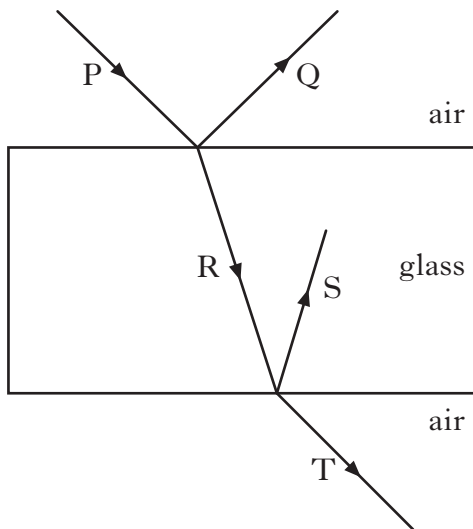
Which of the following statements is/are correct?

  I   The signal meets the curved reflector at an angle called the critical angle.

 II   The transmitter is placed at the focus of the reflector.

III   At the curved reflector, the angle of reflection of the signal is equal to the angle of incidence.

A   I only

B   I and II only

C   I and III only

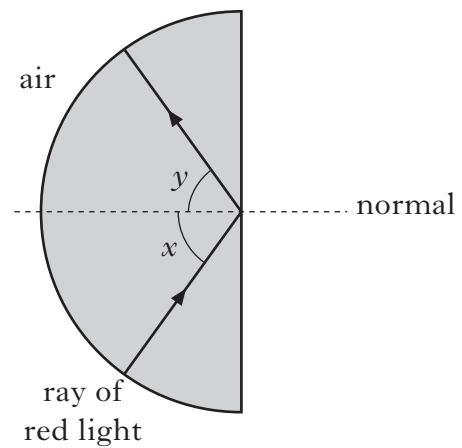D   II and III only

E   I, II and III

[Turn over

15. The diagram shows a ray of light P incident on a rectangular glass block.

Which of the following are refracted rays?

A   Q and R

B   R and S

C   S and T

D   Q and S

E   R and T

16. The diagram shows the path of a ray of red light in a glass block.

A student makes the following statements.

 I Angle x is equal to angle y.

 II Total internal reflection is taking place.

III Angle x is the critical angle for this glass.

Which of the following statements is/are correct?

A   I only

B   II only

C   I and II only

D   II and III only

E   I, II and III

17. Activity and absorbed dose are quantities used in Dosimetry.

Which row shows the unit of activity and the unit of absorbed dose?

	Unit of activity	Unit of absorbed dose
A	gray	becquerel
B	becquerel	sievert
C	becquerel	gray
D	gray	sievert
E	sievert	gray

18. The table shows the count rate of a radioactive source taken at regular time intervals. The count rate has been corrected for background radiation.

Time (minutes)	10	20	30	40	50
Count rate (counts per minute)	800	630	500	400	315

What is the half-life in minutes of the isotope?

A   10

B   15

C   20

D   30

E   40

19. In the following passage some words have been replaced by letters X and Y.

In a nuclear reactor, fission is caused by X bombardment of a uranium nucleus. This causes the nucleus to split releasing neutrons and Y.

Which row gives the words for X and Y?

	X	Y
A	neutron	energy
B	proton	energy
C	electron	protons
D	neutron	protons
E	electron	energy

20. Control rods in a nuclear reactor

A   absorb neutrons

B   contain uranium

C   produce neutrons

D   remove heat from the reactor

E   slow down neutrons.

Candidates are reminded that the answer sheet for Section A MUST be placed INSIDE the front cover of the answer book.
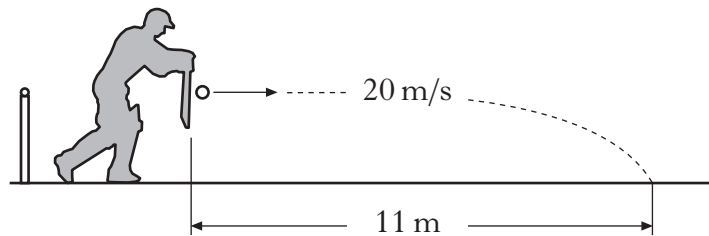
[Turn over

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

**All answers must be written clearly and legibly in ink.**

21. A cricketer strikes a ball. The ball leaves the bat horizontally at 20 m/s. It hits the ground at a distance of 11 m from the point where it was struck.


Assume that air resistance is negligible.

(*a*) Calculate the time of flight of the ball.   **2**

(*b*) Calculate the vertical speed of the ball as it reaches the ground.   **2**

(*c*) Sketch a graph of vertical speed against time for the ball. Numerical values are required on both axes.   **2**

(*d*) Calculate the vertical distance travelled by the ball during its flight.   **2**

                                                                                                                    (8)

22. A satellite moves in a circular orbit around a planet. The satellite travels at a constant speed whilst accelerating.
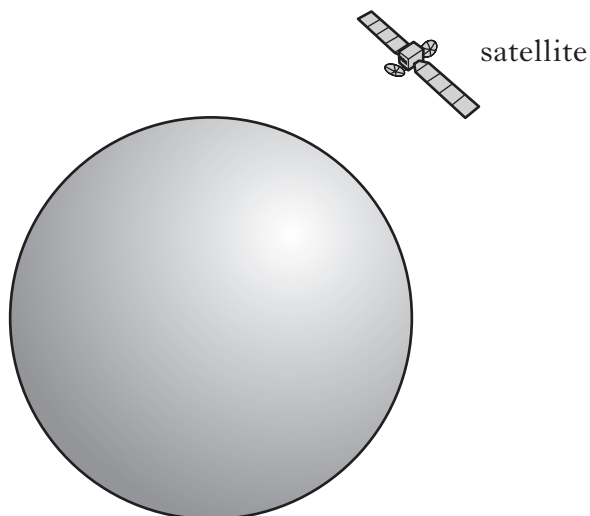
(*a*) (i) Define the term *acceleration*. **1**

  (ii) Explain how the satellite can be accelerating when it is travelling at a constant speed. **1**

(*b*) At one particular point in its orbit the satellite fires two rockets. The forces exerted on the satellite by these rockets are shown on the diagram.
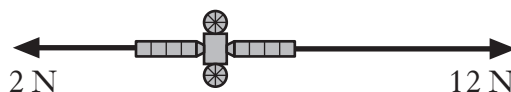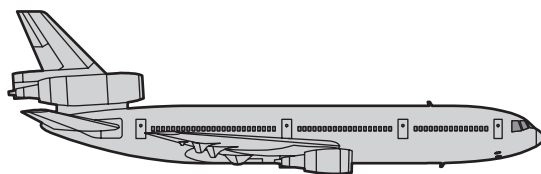

The satellite has a mass of 50 kg. Calculate the resultant acceleration due to these forces. **3**

(5)

[Turn over

23. An aircraft is flying horizontally at a constant speed.

(*a*) The aircraft and passengers have a total mass of 50 000 kg. Calculate the total weight. **2**

(*b*) State the magnitude of the upward force acting on the aircraft. **1**

(*c*) During the flight, the aircraft's engines produce a force of 4.4×10^4 N due North. The aircraft encounters a crosswind, blowing from west to east, which exerts a force of 3.2×10^4 N.

4.4×10^4 N

North

3.2×10^4 N
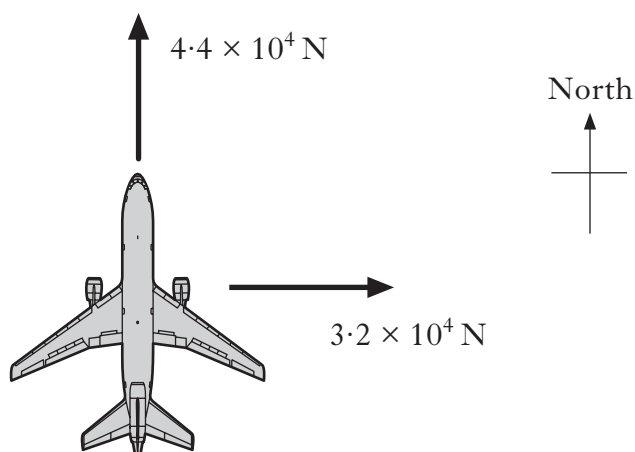
Calculate the resultant force on the aircraft. **3**

(*d*) During a particular flight, a pilot receives an absorbed dose of $15 \, \mu$Gy from gamma rays. Calculate the equivalent dose received due to this type of radiation. **2**

(*e*) Gamma radiation is an example of radiation which causes *ionisation*. Explain what is meant by the term *ionisation*. **1**

(9)

24. An experiment was carried out to determine the specific heat capacity of water. The energy supplied to the water was measured by a joulemeter.
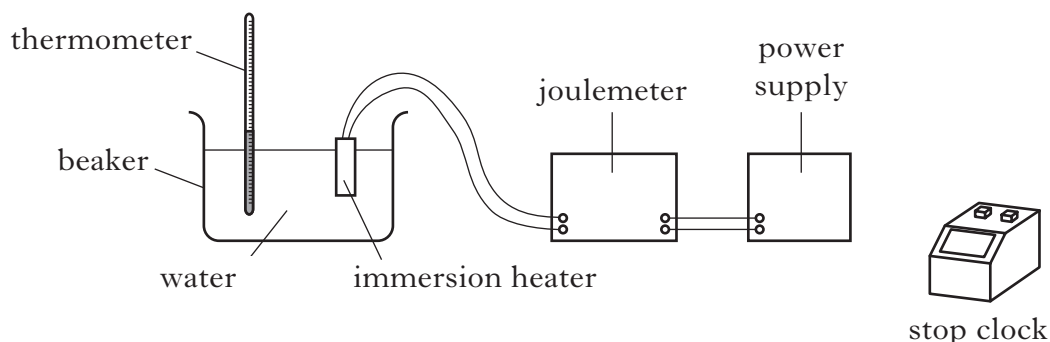

The following data was recorded.

Initial temperature of the water = 21 °C.
Final temperature of the water = 33 °C.
Initial reading on the joulemeter = 12 kJ.
Final reading on the joulemeter = 120 kJ.
Mass of water = 2·0 kg.
Time = 5 minutes.

(*a*) (i) Calculate the change in temperature of the water.   **1**

(ii) Calculate the energy supplied by the immersion heater.   **1**

(iii) Calculate the value for the specific heat capacity of water obtained from this experiment.   **2**

(*b*) (i) The accepted value for the specific heat capacity of water is quoted in the table in the Data Sheet. Explain the difference between the accepted value and the value obtained in the experiment.   **2**

(ii) How could the experiment be improved to reduce this difference?   **1**

(*c*) Calculate the power rating of the immersion heater.   **2**

    (9)

[Turn over

25. Part of a circuit is shown below.
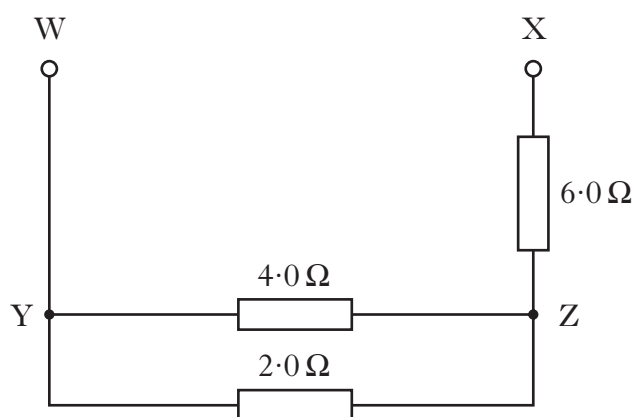
(*a*) Calculate the total resistance between points Y and Z. **2**

(*b*) Calculate the total resistance between points W and X. **2**

(*c*) Calculate the voltage across the 2·0 Ω resistor when the current in the 4·0 Ω resistor is 0·10 A. **2**

(6)

26. A student has two electrical power supplies. One is an a.c. supply and the other is a d.c. supply.
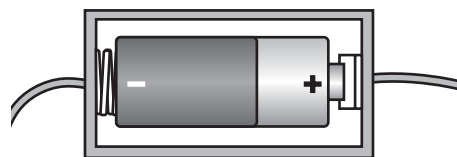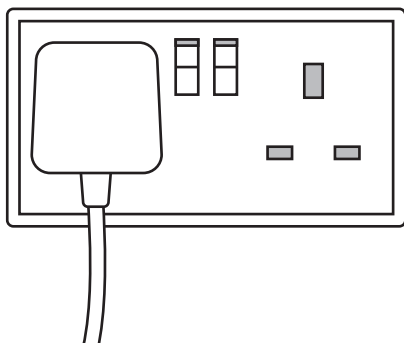

(*a*) Explain a.c and d.c. in terms of electron flow in a circuit.   **2**

(*b*) The student uses **one** of the supplies to operate a transformer.

   (i) Which power supply should be used to operate the transformer?   **1**

  (ii) What is the purpose of a transformer?   **1**

 (iii) A transformer with an efficiency of 30% is used in a computer. Calculate the output power when the input power is 50 W.   **2**

                  (6)

[Turn over

**27.** Light emitting diodes (LEDs) are often used as on/off indicators on televisions and computers.

An LED is connected in a circuit with a resistor R.
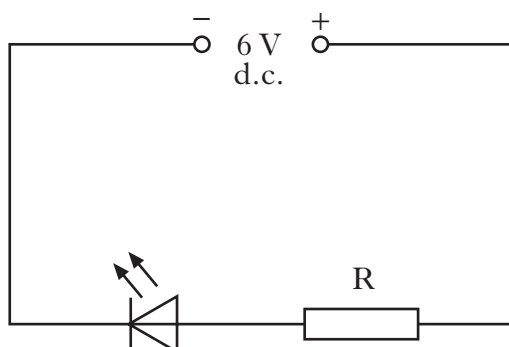
(*a*) What is the purpose of resistor R?   **1**

(*b*) The LED is rated at 2 V, 100 mA. Calculate the resistance of resistor R.   **3**

(*c*) Calculate the power developed by resistor R when the LED is working normally.   **2**

(6)

28. A solar cell is tested for use in a buggy.
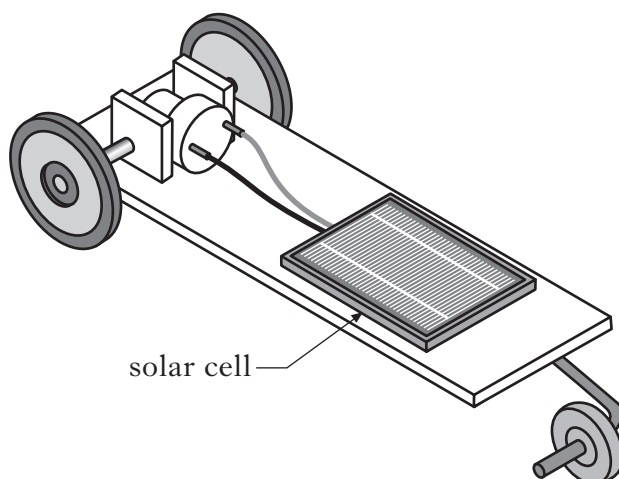
solar cell

The solar cell produces a voltage of 0·5 V and a current of 0·4 mA.

(*a*)   (i) Calculate the power produced by the solar cell.   **2**

     (ii) The buggy requires 4 mW to operate. Calculate the number of solar cells required to supply this power.   **2**

(*b*) State the energy change in a solar cell.   **1**

(*c*) The solar cell is illuminated by light of frequency $6·7 \times 10^{14}$ Hz. Calculate the wavelength of this light.   **2**

       (7)

[Turn over

29. The Sun produces electromagnetic radiation. The electromagnetic spectrum is shown in order of increasing wavelength. Two radiations P and Q have been omitted.

Gamma rays	X rays	P	Visible light	Infra red	Q	Television and radio rays

Increasing wavelength →

(*a*) (i) Identify radiations P and Q. **2**

   (ii) The planet Neptune is $4 \cdot 50 \times 10^9$ km from the Sun. Calculate the time taken for radio waves from the Sun to reach Neptune. **2**

   (iii) State what happens to the frequency of electromagnetic radiation as the wavelength increases. **1**

(*b*) The Sun produces a *solar wind* consisting of charged particles. In one particular part of the solar wind, a charge of 360 C passes a point in space in one minute. Calculate the current. **2**

(7)

30. A converging lens has a focal length of 30 mm.

(*a*) Calculate the power of the lens. **2**

(*b*) On the graph paper provided, copy and complete the diagram below. Show the size and position of the image formed by the lens.
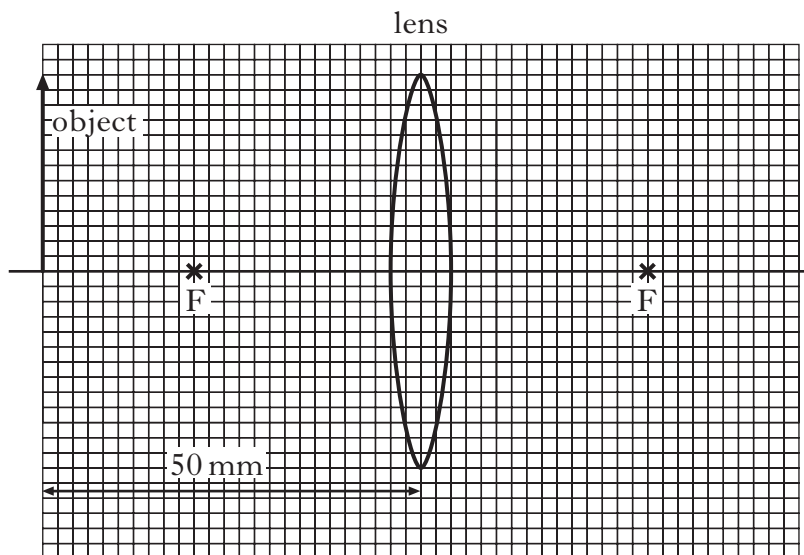
3

(*c*) Name the eye defect which a converging lens can correct. Explain your answer. **2**

(7)

[Turn over for Question 31 on *Page twenty*

31. It is possible to determine the age of a prehistoric wooden boat by measuring the activity of radioactive carbon-14.

The activity of a piece of wood from the boat is $300\,\mu Bq$.

(*a*) How many atoms of carbon-14 decay in 1 day? **2**

(*b*) When the boat was carved, the activity of the piece of wood was $2400\,\mu Bq$ due to carbon-14 atoms. The half-life of carbon-14 is 5730 years. Calculate the age of the boat. **2**

(*c*) Carbon-14 emits beta particles. What is a beta particle? **1**

(*d*) A radioactive source emits alpha particles. What is an alpha particle? **1**

(*e*) How does the ionisation density of alpha particles compare with that of beta particles? **1**

(*f*) (i) A student sets up an experiment as shown.
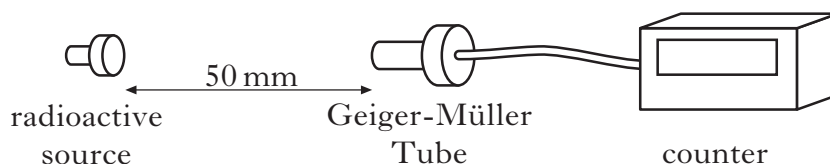
The student places a 3 mm sheet of aluminium between the radioactive source and the Geiger-Müller Tube. The count rate is observed to decrease and the student concludes that the radioactive material is emitting beta radiation.

Suggest **one** reason why her conclusion may be incorrect. **1**

  (ii) State **two** safety precautions that the student must observe when handling radioactive sources. **2**

(10)

[*END OF QUESTION PAPER*]