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	1·6
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	2747

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

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).

A   B   C   D   E
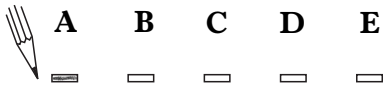
Changing an answer

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**.

A   B   C   D   E
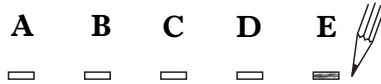
[Turn over

SECTION A

Answer questions 1–20 on the answer sheet.

1. Which of the following is a vector quantity?

   A   Distance

   B   Energy

   C   Speed

   D   Time

   E   Velocity

2. A student walks from X to Y and then from Y to Z.
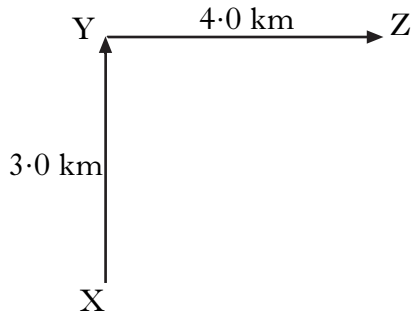
The complete walk takes 2 hours.

Which row in the table shows the average speed and the average velocity for the complete walk?

	Average speed	*Average velocity*
A	2·5 km/h	2·5 km/h at 053
B	2·5 km/h at 053	2·5 km/h
C	3·5 km/h	2·5 km/h at 053
D	3·5 km/h at 053	3·5 km/h
E	3·5 km/h	3·5 km/h at 053

3. A car travelling in a straight line decelerates uniformly from 20 m/s to 12 m/s in 4 seconds. The displacement of the car in this time is

   A   32 m

   B   48 m

   C   64 m

   D   80 m

   E   128 m.

4. An unbalanced force of one newton will make a

   A   0·1 kg mass accelerate at 1 m/s^2

   B   1 kg mass accelerate at 1 m/s^2

   C   1 kg mass accelerate at 10 m/s^2

   D   0·1 kg mass move at a constant speed of 1 m/s

   E   1 kg mass move at a constant speed of 10 m/s.

5. A trolley of mass 0·6 kg is travelling at 5 m/s along a smooth, level track.

The trolley collides with a stationary trolley of mass 0·2 kg.

The magnitude of the total momentum of the trolleys immediately after collision is

   A   0 kg m/s

   B   1·0 kg m/s

   C   2·0 kg m/s

   D   3·0 kg m/s

   E   4·0 kg m/s.

6. A power station has an efficiency of 40%. The input power to the station is 1600 MW.

What is the useful output power?

A   40 MW
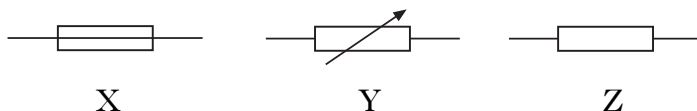
B   640 MW

C   960 MW

D   4000 MW

E   64000 MW

7. A sample of water is at a temperature of $100\,°C$. The sample absorbs $2 \cdot 3 \times 10^4\,J$ of energy.

The specific latent heat of vaporisation of water is $22 \cdot 6 \times 10^5\,J/kg$.

The mass of water changed into steam at $100\,°C$ is

A $0 \cdot 01$ kg

B $5 \cdot 3$ kg

C   100 kg

D $2 \cdot 3 \times 10^4$ kg

E $2 \cdot 3 \times 10^6$ kg.

8. Three circuit symbols X, Y and Z are shown.

X   Y   Z

Which row in the table identifies the symbols X, Y and Z?

	X	Y	Z
A	thermistor	transistor	resistor
B	fuse	variable resistor	thermistor
C	transistor	fuse	variable resistor
D	fuse	variable resistor	resistor
E	variable resistor	resistor	fuse

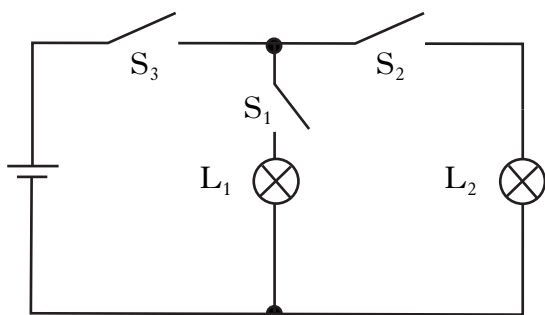**9.** A circuit is set up as shown.
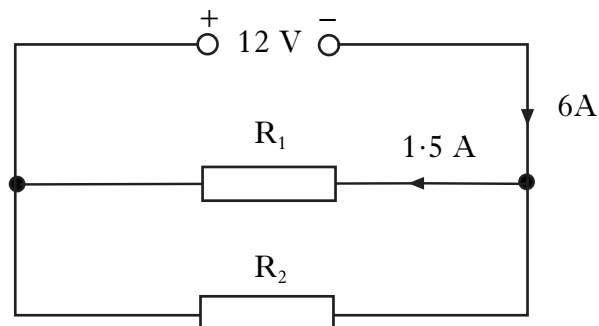
The current from the supply is 6 A. The current in resistor R_1 is $1 \cdot 5$ A.

Which row in the table shows the potential difference across resistor R_2 and the current in resistor R_2?

	Potential difference across R_2 (V)	Current in R_2 (A)
A	12	$1 \cdot 5$
B	6	$1 \cdot 5$
C	12	$4 \cdot 5$
D	6	$4 \cdot 5$
E	12	$7 \cdot 5$

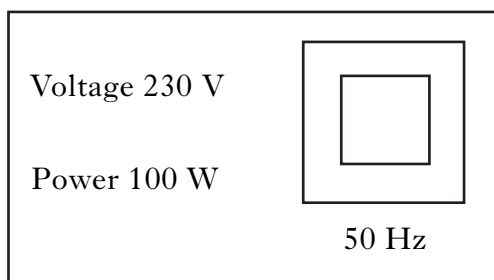**[Turn over**

10. A circuit is set up as shown.

Which switch or switches must be closed to light lamp L_1 **only**?

A S_1 only

B S_2 only

C S_1 and S_2 only
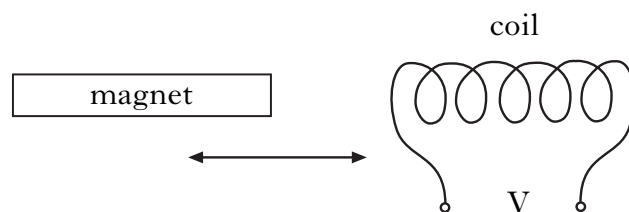
D S_1 and S_3 only

E S_2 and S_3 only

11. The information shown is for an electric food mixer.

Voltage 230 V

Power 100 W

50 Hz

The resistance of the mixer is

A   0·43 Ω

B   2·3 Ω

C   4·6 Ω

D   529 Ω

E   23 000 Ω.

12. When a magnet is pushed into or pulled out of a coil of wire, a voltage is induced across the ends of the coil.

Which of the following produces the greatest induced voltage?

	Strength of magnet	Speed of magnet	Number of turns in a coil
A	weak	slow	20
B	weak	fast	40
C	strong	slow	20
D	strong	fast	20
E	strong	fast	40

13. A manufacturer states that an amplifier has a voltage gain of 15. This means that

A   the output frequency is 15 times the input frequency

B   the input frequency is 15 times the output frequency

C   the output voltage is 15 times the input voltage

D   the input voltage is 15 times the output voltage
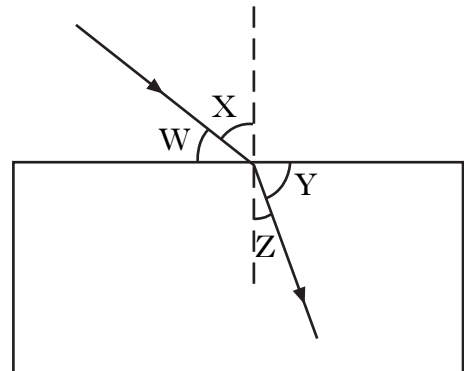
E   the input voltage is 15 V.

14. The following diagram shows a wave.
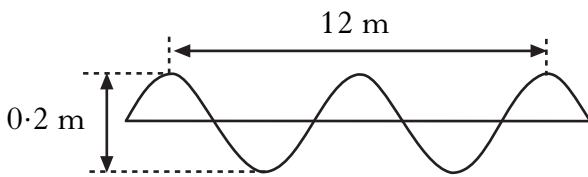
Which row in the table gives the wavelength and amplitude of the wave?

	Wavelength (m)	Amplitude (m)
A	4	0·2
B	6	0·1
C	6	0·2
D	12	0·1
E	12	0·2

15. A ray of light passes from air into a glass block as shown.

Which row in the table shows the angle of incidence and the angle of refraction?

	Angle of incidence	Angle of refraction
A	W	Z
B	W	Y
C	X	Z
D	X	Y
E	Z	X

16. A student wears glasses fitted with concave lenses. Which of the following statements is/are correct?

I The student is short sighted.

II Concave lenses are converging lenses.

III The glasses help the student to see near objects clearly.

A I only

B II only

C III only

D I and II only

E I, II and III

[Turn over

17. Which row in the table describes an alpha particle, a beta particle and a gamma ray?

	Alpha particle	*Beta particle*	*Gamma ray*
A	neutron	helium nucleus	electromagnetic radiation
B	helium nucleus	electron	electromagnetic radiation
C	hydrogen nucleus	electromagnetic radiation	electron
D	helium nucleus	electromagnetic radiation	neutron
E	hydrogen nucleus	electron	electromagnetic radiation

18. For a particular radioactive source, 1800 atoms decay in a time of 3 minutes. The **activity** of this source is

   A   10 Bq

   B   600 Bq

   C   1800 Bq

   D   5400 Bq

   E   324 000 Bq.

19. One gray is equal to

   A   one becquerel per kilogram

   B   one sievert per second

   C   one joule per second

   D   one sievert per kilogram

   E   one joule per kilogram.

20. A student makes the following statements about nuclear reactors.

   I Fission takes place in the fuel rods.

  II The material in the control rods slows down neutrons.

 III The material in the moderator absorbs neutrons.

Which of the statements is/are correct?

   A   I only

   B   I and II only

   C   I and III only

   D   II and III only

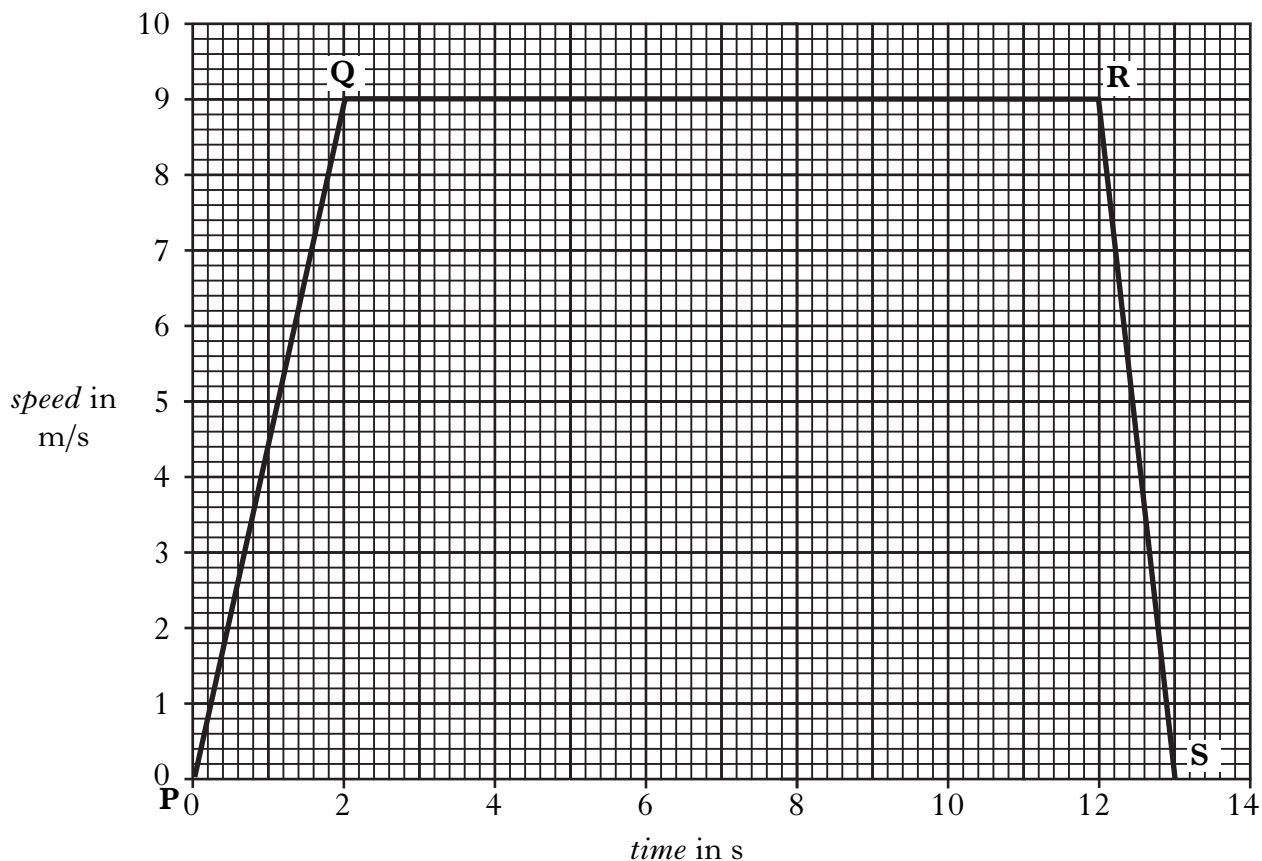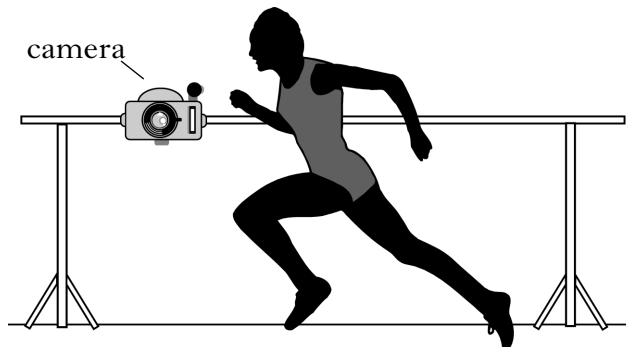   E   I, II and III

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

All answers must be written clearly and legibly in ink.

**21.** Athletes in a race are recorded by a TV camera which runs on rails beside the track.

camera

The graph shows the speed of the camera during the race.

(*a*) Calculate the acceleration of the camera between **P** and **Q**. **2**

(*b*) The mass of the camera is 15 kg.

Calculate the unbalanced force needed to produce the acceleration between **P** and **Q**. **2**

(*c*) How far does the camera travel in the 13 s? **2**

(*d*) The camera lens has a focal length of 200 mm.

Calculate the power of the lens. **2**

(8)

22. A fairground ride uses a giant catapult to launch people upwards using elastic cords.

800 N   800 N

90°

elastic cord   elastic cord
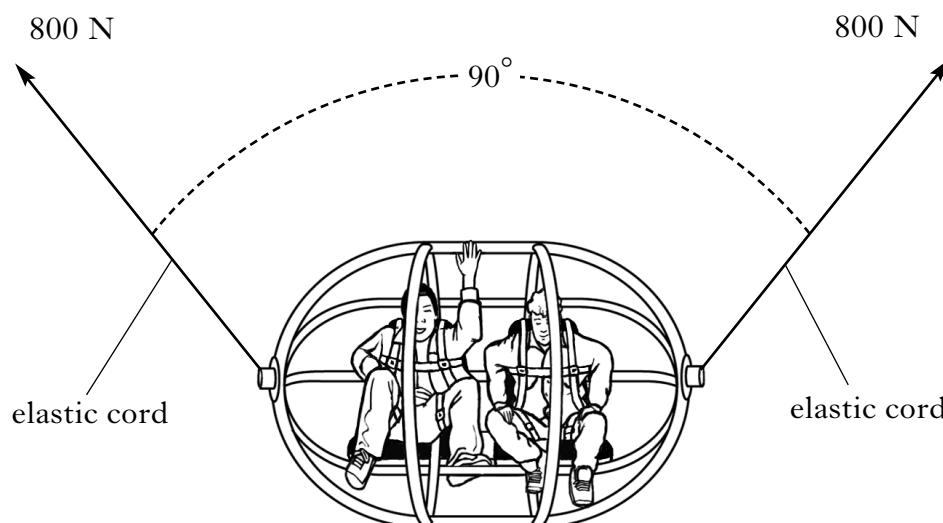
(*a*) Each cord applies a force of 800 N and the cords are at 90° as shown. Using a scale diagram, or otherwise, find the size of the resultant of these two forces.   **2**

(*b*) The cage is now pulled further down before release. The cords provide an upward resultant force of 2700 N. The cage and its occupants have a total mass of 180 kg.

  (i) Calculate the weight of the cage and occupants.   **2**

  (ii) Calculate the acceleration of the cage and occupants when released.   **3**

(7)

23. One type of exercise machine is shown below.
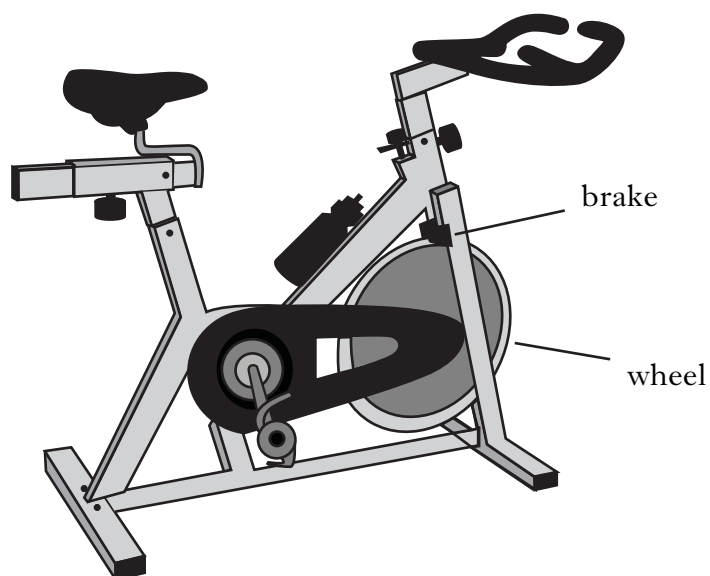
(*a*) A person using this machine pedals against friction forces applied to the wheel by the brake.

A friction force of 300 N is applied at the edge of the wheel, which has a circumference of 1·5 m.

   (i) How much work is done by friction in one turn of the wheel?   **2**

  (ii) The person turns the wheel 500 times in 5 minutes.

     Calculate the average power produced.   **3**

(*b*) The wheel is a solid aluminium disc of mass 12·0 kg.

   (i) All the work done by friction is converted to heat in the disc.

     Calculate the temperature rise after 500 turns.   **2**

  (ii) Explain why the actual temperature rise of the disc is less than calculated in (*b*) (i).   **1**

                                                               (8)

[Turn over

24. An early method of crash testing involved a car rolling down a slope and colliding with a wall.

In one test, a car of mass 750 kg starts at the top of a 7·2 m high slope.

7·2 m
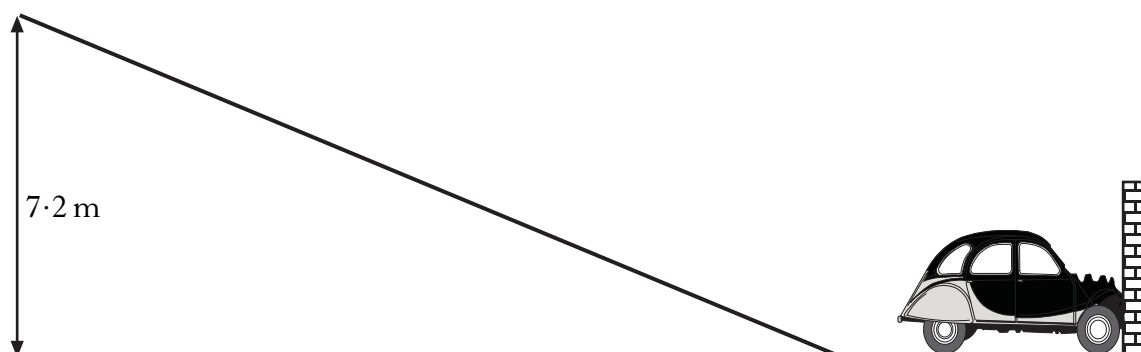
(*a*) Calculate the gravitional potential energy of the car at the top of the slope. **2**

(*b*) (i) State the value of the kinetic energy of the car at the bottom of the slope, assuming no energy losses. **1**

(ii) Calculate the speed of the car at the bottom of the slope, before hitting the wall. **2**

(5)

25. Some resistors are labelled with a power rating as well as their resistance value. This is the maximum power at which they can operate without overheating.
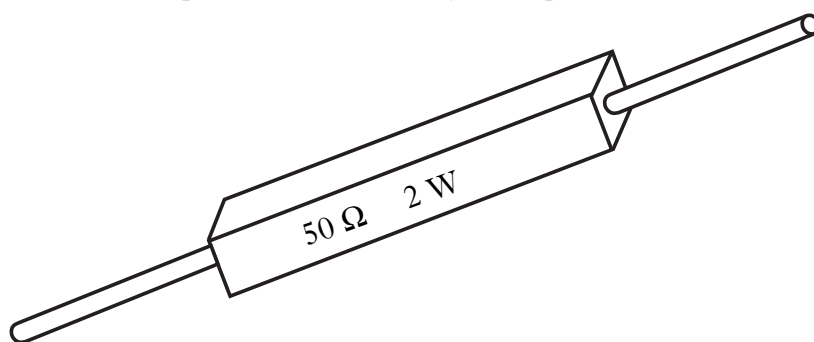
(*a*) A resistor is labelled 50 Ω, 2 W.

Calculate the maximum operating current for this resistor.　　**2**

(*b*) Two resistors, each rated at 2 W, are connected in parallel to a 9 V d.c. supply.

They have resistances of 60 Ω and 30 Ω.
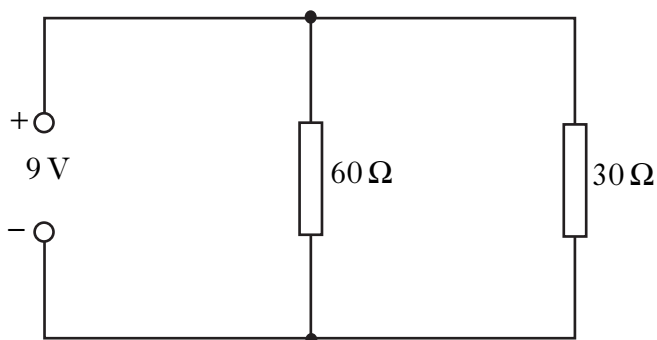
(i)　Calculate the total resistance of the circuit.　　**2**

(ii)　Calculate the power produced in each resistor.　　**3**

(iii)　State which, if any, of the resistors will overheat.　　**1**

(*c*) The 9 V **d.c.** supply is replaced by a 9 V **a.c.** supply.

What effect, if any, would this have on your answers to part (*b*) (ii)?　　**1**

(9)

[Turn over

26. A karaoke machine consists of a microphone, amplifier, loudspeaker, DVD player and screen.
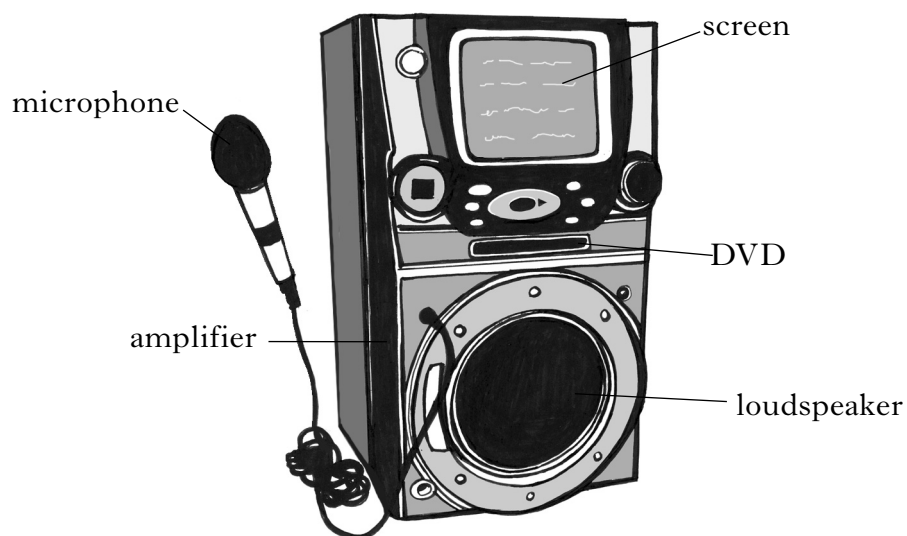
(a) What energy change takes place in the microphone? **1**

(b) The amplifier processes the signal from the microphone.

What effect does the amplifier have on the signal's

(i) frequency; **1**

(ii) amplitude? **1**

(c) A singer produces a note of frequency 850 Hz. The speed of sound in air is 340 m/s.

Calculate the wavelength of this note in air. **2**

(d) The DVD player contains a laser.

Light from this laser enters a small glass prism as shown.
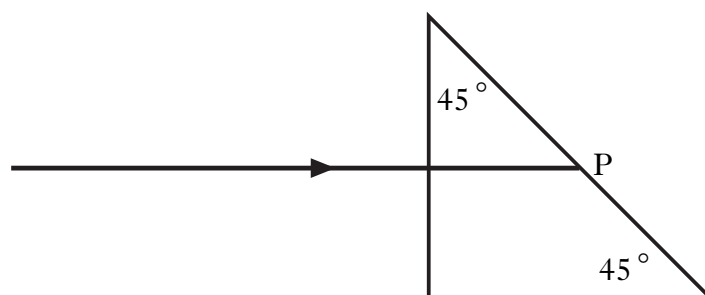
The glass has a critical angle of 40°.

(i) Explain what is meant by the term "critical angle". **1**

(ii) Copy and complete the diagram to show the path of the ray after it strikes point P. **2**

(8)

27. An office has an automatic window blind that closes when the light level outside gets too high.

The electronic circuit that operates the motor to close the blind is shown.
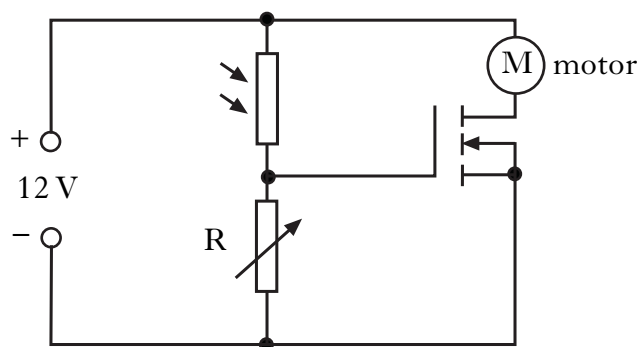
(*a*) The MOSFET switches on when the voltage across variable resistor R reaches 2·4 V.
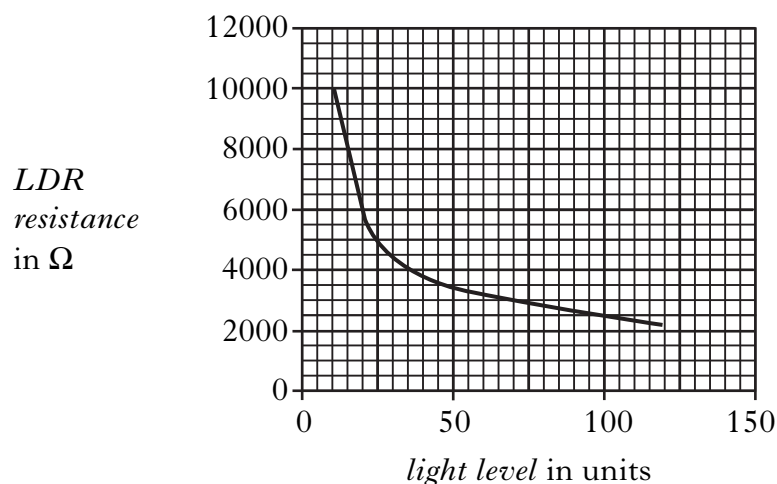
  (i) Explain how this circuit works to close the blind.   **3**

 (ii) What is the purpose of the variable resistor R?   **1**

(*b*) The graph shows how the resistance of the LDR varies with light level.

  (i) What is the resistance of the LDR when the light level is 70 units?   **1**

 (ii) R has a value of 600 Ω. Calculate the voltage across R when the light level is 70 units.   **2**

(iii) State whether or not the blinds will close when the light level is 70 units.
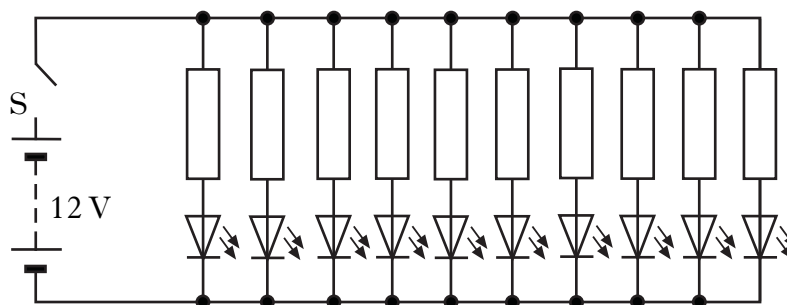
Justify your answer.   **2**

   (9)

[Turn over

28. The rear light of a car is made up of a row of 10 **identical** red LEDs. Each LED requires 2 V and 20 mA to operate correctly.

(*a*) The circuit for this is shown.

(i) Why does each LED need a resistor in series? **1**

(ii) The voltage of the car battery is 12 V.

Calculate the value of each resistor. **3**

(iii) Calculate the total current, **in amperes**, from the battery when the rear light is operating correctly. **2**

(*b*) Some car headlights require 84 V to operate. Electronic circuits are needed to convert the car battery voltage.
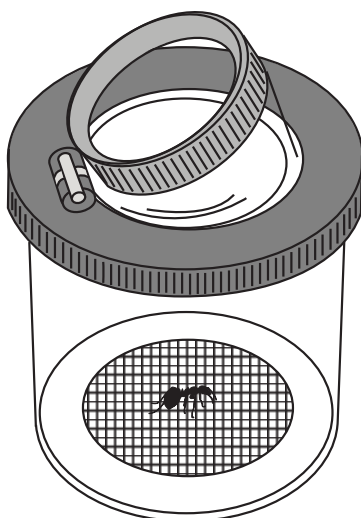
Part of the circuit contains a transformer as shown.
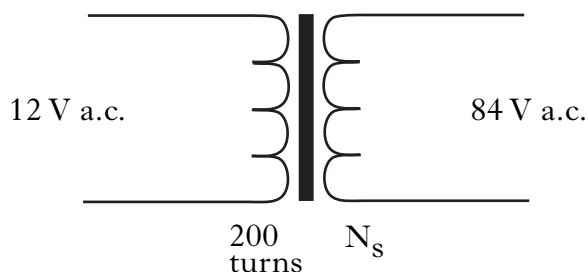
The primary coil of the transformer has 200 turns.

Calculate the number of turns, N_S, in the secondary coil. **2**

(8)

29. A "bug viewer" has a plastic chamber with a lens in the lid. It is used to get a magnified view of small insects placed on the base of the chamber.
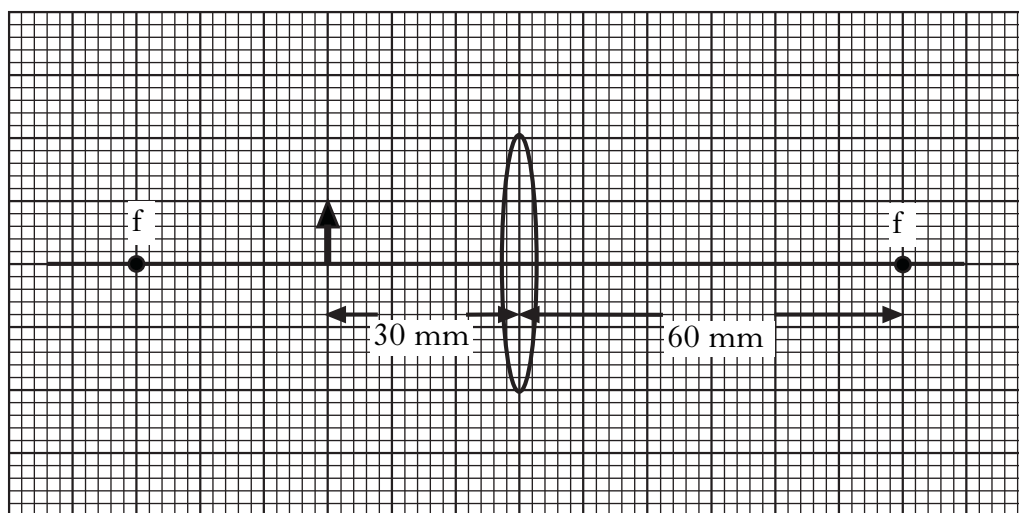

(*a*) What type of lens should be used?

1

(*b*) The lens used has a focal length of 60 mm and the base of the chamber is 30 mm from the lens.

Copy and complete this diagram by adding rays to show where the image of the bug will be formed.

2

Use the squared ruled paper provided (small squares side).

(*c*) How would the shape of this lens have to be altered to give it a longer focal length?

1

(*d*) Name the eye defect which this type of lens could correct.

1

(5)

[Turn over

30. When welders join thick steel plates it is important that the joint is completely filled with metal. This ensures there are no air pockets in the metal weld, as this would weaken the joint.

One method of checking for air pockets is to use a radioactive source on one side of the joint. A detector placed as shown measures the count rate on the other side.
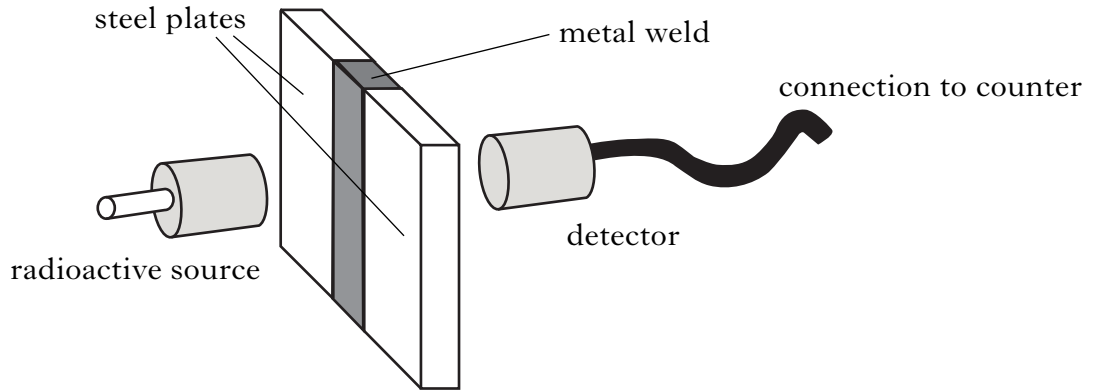
View from above
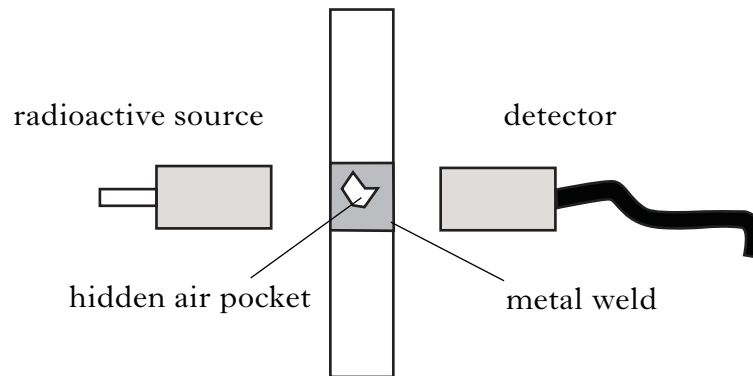
(*a*) The radioactive source and detector are moved along the weld. How would the count rate change when the detector moves over an air pocket?

Explain your answer. **2**

(*b*) Which of the radiations alpha, beta or gamma must be used?

Explain your answer. **2**

(*c*) X-rays are sometimes used to detect air pockets.

How does the wavelength of X-rays compare with gamma rays? **1**

(5)

31. Gold-198 is a radioactive source that is used to trace factory waste which may cause river pollution.

A small quantity of the radioactive gold is added into the waste as it enters the river. Scanning the river using radiation detectors allows scientists to trace where the waste has travelled.

Gold-198 has a half-life of 2·7 days.

(*a*) What is meant by the term "half-life"?   **1**

(*b*) A sample of Gold-198 has an activity of 64 kBq when first obtained by the scientists.

Calculate the activity after 13·5 days.   **2**

(*c*) Describe two precautions taken by the scientists to reduce the equivalent dose they receive while using radioactive sources.   **2**

(*d*) A scientist receives an absorbed dose of 10 mGy of alpha radiation.

  (i) Calculate the equivalent dose received.   **2**

  (ii) The risk of biological harm from radiation exposure depends on the absorbed dose and the type of radiation. Which other factor affects the risk of biological harm?   **1**

                                                                          (8)

[*END OF QUESTION PAPER*]

ACKNOWLEDGEMENTS