X069/201

NATIONAL QUALIFICATIONS 2010

FRIDAY, 28 MAY
1.00 PM – 3.00 PM

PHYSICS
INTERMEDIATE 2

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 30)

11 Answer the questions numbered 21 to 30 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 30.

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

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

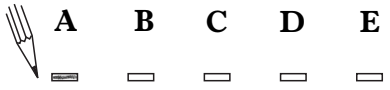
B ampere

C watt

D coulomb

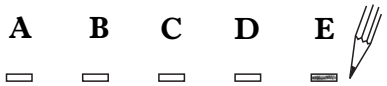
E volt.

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**.



[Turn over

SECTION A

Answer questions 1–20 on the answer sheet.

1. Which of the following is a scalar quantity?

A Force

B Acceleration

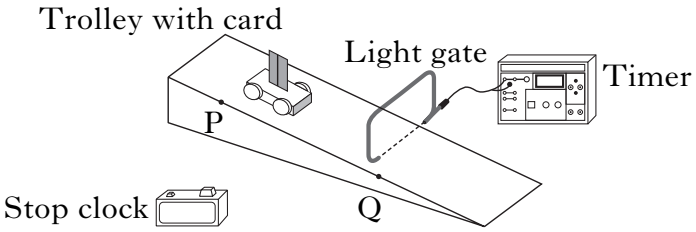
C Momentum

D Velocity

E Energy

2. A student investigates the speed of a trolley as it moves down a slope.

The apparatus is set up as shown.



The following measurements are recorded.

distance from P to Q = 1·0 m
length of card on trolley = 0·04 m
time taken for trolley to travel from P to Q = 2·5 s
time taken for card to pass through light gate = 0·05 s

The speed at Q is

A 0·002 m/s

B 0·016 m/s

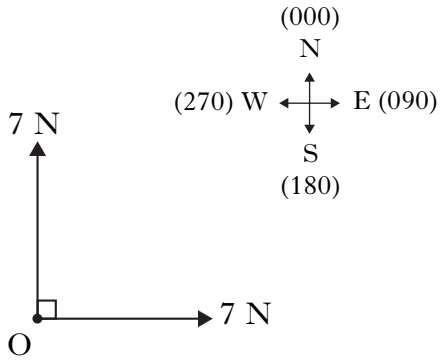
C 0·40 m/s

D 0·80 m/s

E 20 m/s.

3. Two forces, each of 7 N, act on an object O.

The forces act as shown.



The resultant of these two forces is

A 7 N at a bearing of 135

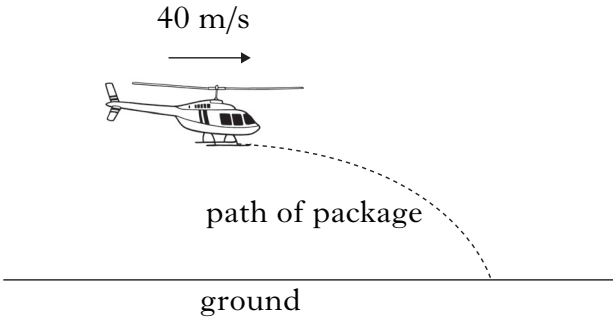
B 9·9 N at a bearing of 045

C 9·9 N at a bearing of 135

D 14 N at a bearing of 045

E 14 N at a bearing of 135.

4 A package is released from a helicopter flying horizontally at a constant speed of 40 m/s.



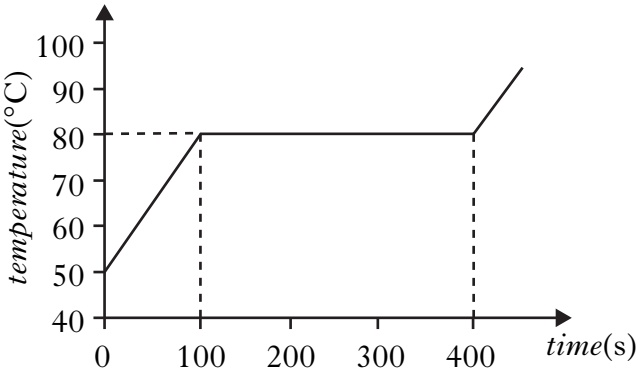
The package takes 3·0 s to reach the ground.

The effects of air resistance can be ignored.

Which row in the table shows the horizontal speed and vertical speed of the package just before it hits the ground?

	Horizontal speed (m/s)	*Vertical speed* (m/s)
A	0	30
B	30	30
C	30	40
D	40	30
E	40	40

5. 100 g of a solid is heated by a 50 W heater. The graph of temperature of the substance against time is shown.



The specific latent heat of fusion of the substance is

A $1{\cdot}3 \times 10^3$ J/kg

B $1{\cdot}5 \times 10^3$ J/kg

C $3{\cdot}0 \times 10^3$ J/kg

D $1{\cdot}5 \times 10^5$ J/kg

E $1{\cdot}9 \times 10^5$ J/kg.

[Turn over

6. A crate of mass 200 kg is pushed a distance of 20 m across a level floor.

The crate is pushed with a force of 150 N.

The force of friction acting on the crate is 50 N.

The work done in pushing the crate across the floor is

A 1000 J

B 2000 J

C 3000 J

D 4000 J

E 20 000 J.

7. A student makes the following statements about electrical circuits.

I The sum of the potential differences across components connected in series is equal to the supply voltage.

II The sum of the currents in parallel branches is equal to the current drawn from the supply.

III The potential difference across components connected in parallel is the same for each component.

Which of the statements is/are correct?

A I only

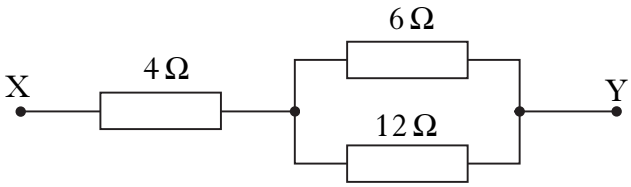
B III only

C I and II only

D II and III only

E I, II and III

8. Three resistors are connected as shown



The total resistance between X and Y is

A 2 Ω

B 4 Ω

C 8 Ω

D 13 Ω

E 22 Ω.

9. The resistance of a wire is 6 Ω.

The current in the wire is 2 A.

The power developed in the wire is

A 3 W

B 12 W

C 18 W

D 24 W

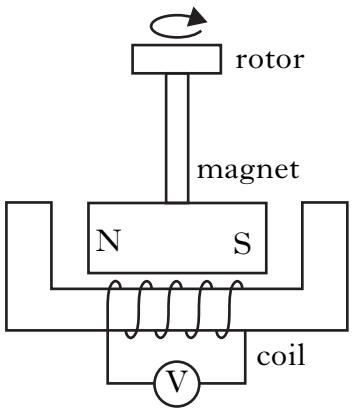
E 72 W.

10. The voltage of the mains supply in the UK is 230 V a.c.

Which row in the table shows the peak voltage and frequency of the mains supply in the UK?

	peak voltage (V)	*frequency* (Hz)
A	175	50
B	175	60
C	230	50
D	325	50
E	325	60

11. The diagram shows a model bicycle dynamo.



When the rotor is turned the magnet rotates, inducing a voltage in the coil. The induced voltage can be decreased by

A increasing the number of turns on the coil

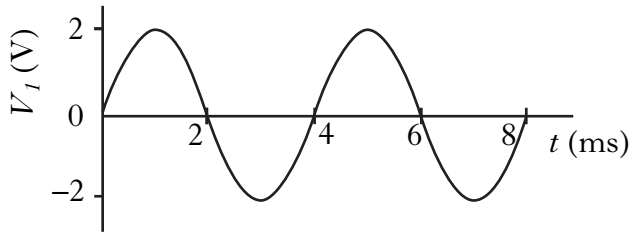
B decreasing the number of turns on the coil

C using a stronger magnet

D turning the rotor faster

E reversing the direction of rotation of the magnet.

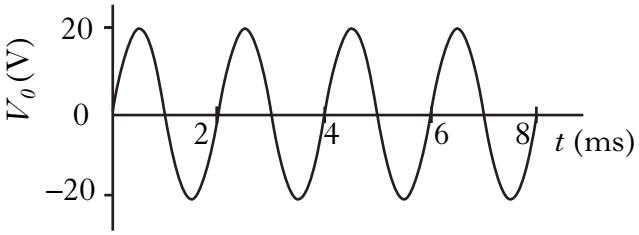
12. The graph below shows how the input voltage V_1 to an amplifier varies with time t.



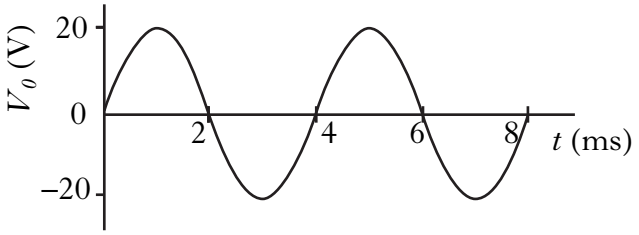
The amplifier has a voltage gain of 10.

Which graph shows how the output voltage V_0 of the amplifier varies with time t?

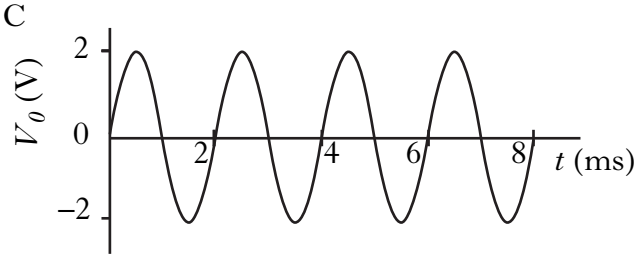
A



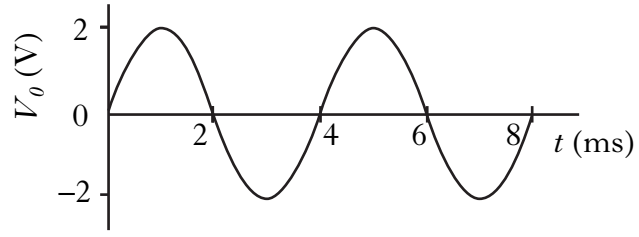
B



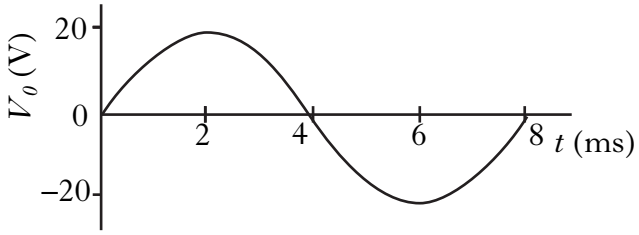
C



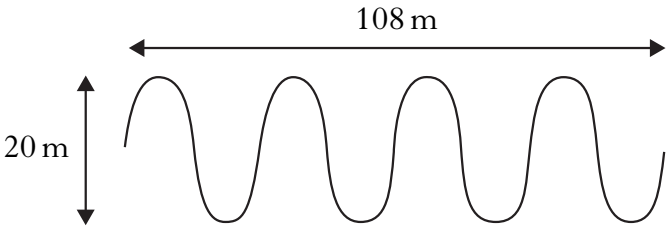
D



E



13. The diagram gives information about a wave.



The time taken for the waves to travel 108 m is 0·5 s.

A student makes the following statements about the waves.

I The wavelength of the waves is 27 m.

II The amplitude of the waves is 20 m.

III The frequency of the waves is 8 Hz.

Which of the statements is/are correct?

A I only

B II only

C I and III only

D II and III only

E I, II and III

14. The diagram shows members of the electromagnetic spectrum in order of increasing wavelength.

Gamma rays	P	Ultraviolet radiation	Q	Infrared radiation	R	TV & radio waves

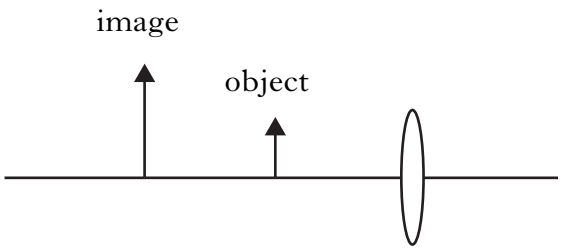
increasing wavelength →

Which row in the table identifies the radiations represented by the letters P, Q and R?

	P	*Q*	*R*
A	X-rays	visible light	microwaves
B	X-rays	microwaves	visible light
C	microwaves	visible light	X-rays
D	visible light	microwaves	X-rays
E	visible light	X-rays	microwaves

15. An object is placed in front of a converging lens as shown.

The position of the image formed by the lens is also shown.



The focal length of the lens is 100 mm.

The distance between the lens and the object is

A 50 mm

B 100 mm

C 150 mm

D 200 mm

E 250 mm.

16. A converging lens has a focal length of 50 mm.

The power of the lens is

A +0·02 D

B +0·2 D

C −0·2 D

D +20 D

E −20 D.

17. A student makes the following statements about a carbon atom.

I The atom is made up only of protons and neutrons.

II The nucleus of the atom contains protons, neutrons and electrons.

III The nucleus of the atom contains only protons and neutrons.

Which of the statements is/are correct?

A I only

B II only

C III only

D I and II only

E I and III only

18. Human tissue can be damaged by exposure to radiation.

On which of the following factors does the risk of biological harm depend?

I The absorbed dose.

II The type of radiation.

III The body organs or tissue exposed.

A I only

B I and II only

C II only

D II and III only

E I, II and III

[Turn over

19. Information about a radioactive source is given in Table 1.

Table 1

Activity	*Energy absorbed per kilogram of tissue*	*Radiation weighting factor*
500 MBq	0·2 μJ	10

Which row in Table 2 gives the correct information for the radioactive source?

Table 2

	Absorbed Dose	*Equivalent Dose*
A	0·2 μGy	2 μSv
B	500 MGy	10 Sv
C	10 Gy	0·2 μSv
D	20 μGy	50 MSv
E	2 μGy	0·2 μSv

20. In a nuclear reactor a chain reaction releases energy from nuclei.

Which of the following statements describes the beginning of a chain reaction?

A An electron splits a nucleus releasing more electrons.

B An electron splits a nucleus releasing protons.

C A proton splits a nucleus releasing more protons.

D A neutron splits a nucleus releasing electrons.

E A neutron splits a nucleus releasing more neutrons.

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

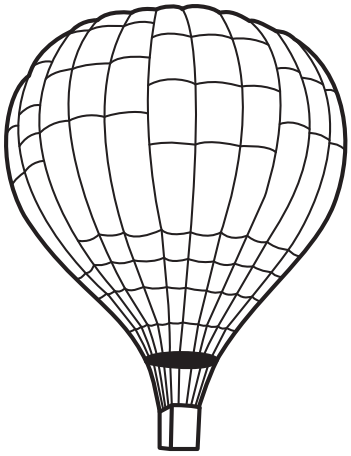
SECTION B

Marks

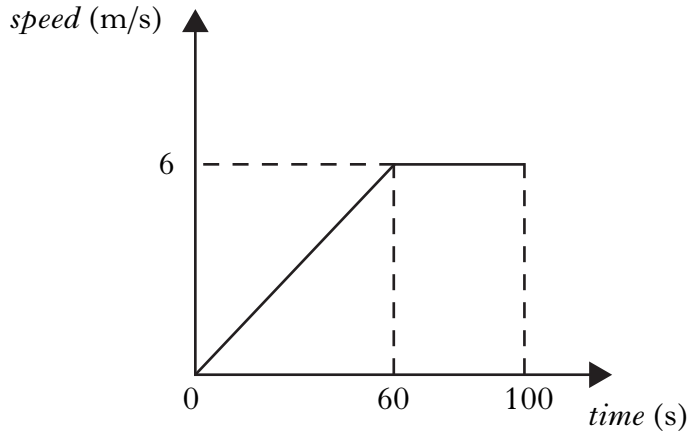
Write your answers to questions 21–30 in the answer book.

All answers must be written clearly and legibly in ink.

21. A balloon of mass 400 kg rises vertically from the ground.



The graph shows how the vertical speed of the balloon changes during the first 100 s of its upward flight.



(*a*) Calculate the acceleration of the balloon during the first 60 s. **2**

(*b*) Calculate the distance travelled by the balloon in 100 s. **2**

(*c*) Calculate the average speed of the balloon during the first 100 s. **2**

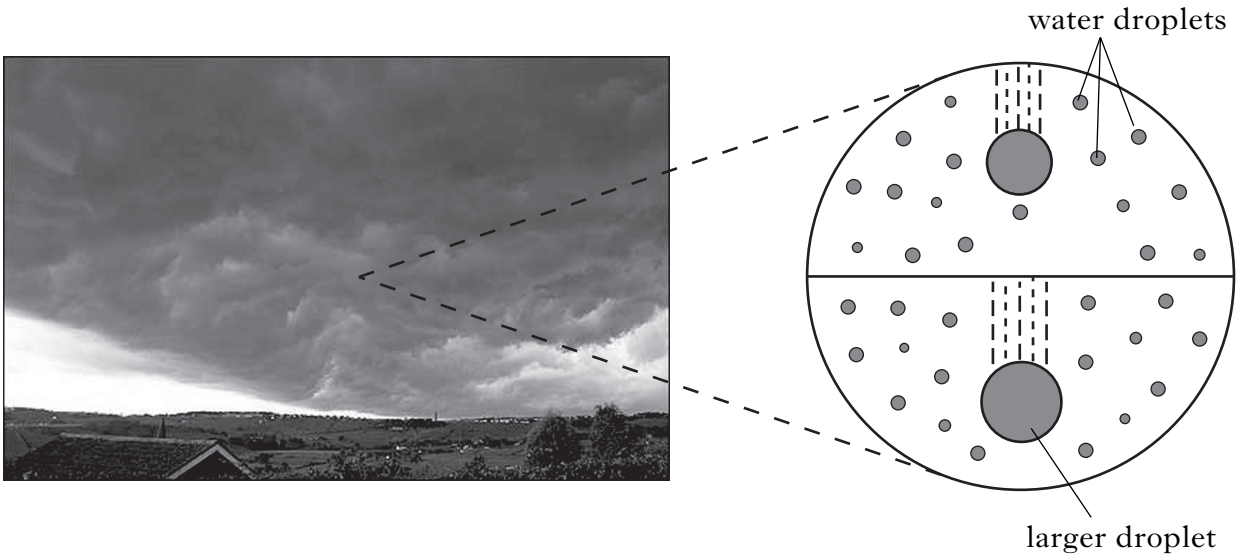
(*d*) Calculate the weight of the balloon. **2**

(*e*) Calculate the total upward force acting on the balloon during the first 60 s of its flight. **3**

(11)

Marks

22. Inside a storm cloud water droplets move around and collide with each other.



(*a*) A water droplet of mass 2·0 g moving at a speed of 4·0 m/s collides with a stationary water droplet of mass 1·2 g. The two droplets join together to form a larger droplet.

Calculate the speed of this larger droplet after the collision. **2**

(*b*) Another water droplet within the cloud is falling with a constant speed. Draw a diagram showing the forces acting on this droplet.

Name these forces and show their directions. **2**

(*c*) The motion of water droplets in the cloud causes flashes of lightning. One lightning flash transfers 1650 C of charge in 0·15 s.

Calculate the electric current produced by this flash. **2**

(*d*) Why does an observer, standing 3 km from a thunder cloud, see a lightning flash before he hears the thunder? **1**

(7)

Marks

23. On the planet Mercury the surface temperature at night is –173 °C. The surface temperature during the day is 307 °C. A rock lying on the surface of the planet has a mass of 60 kg.

(*a*) The rock absorbs $2{\cdot}59 \times 10^7$ J of heat energy from the Sun during the day.

Calculate the specific heat capacity of the rock. **2**

(*b*) Heat is released at a steady rate of 1440 J/s at night.

Calculate the time taken for the rock to release $2{\cdot}59 \times 10^7$ J of heat. **2**

(*c*) Energy from these rocks could be used to heat a base on the surface of Mercury.

How many 60 kg rocks would be needed to supply a 288 kW heating system? **2**

(*d*) Using information from the data sheet, would it be **easier**, **the same** or **more difficult** to lift rocks on Mercury compared to Earth?

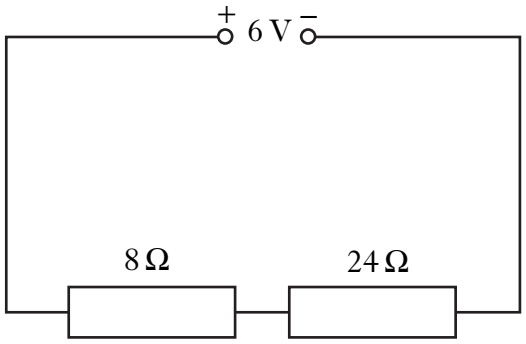
You **must** explain your answer. **2**

(8)

[Turn over

Marks

24. A student sets up the following circuit.



(*a*) Calculate the current in the 8 Ω resistor. **3**

(*b*) Calculate the voltage across the 8 Ω resistor. **2**

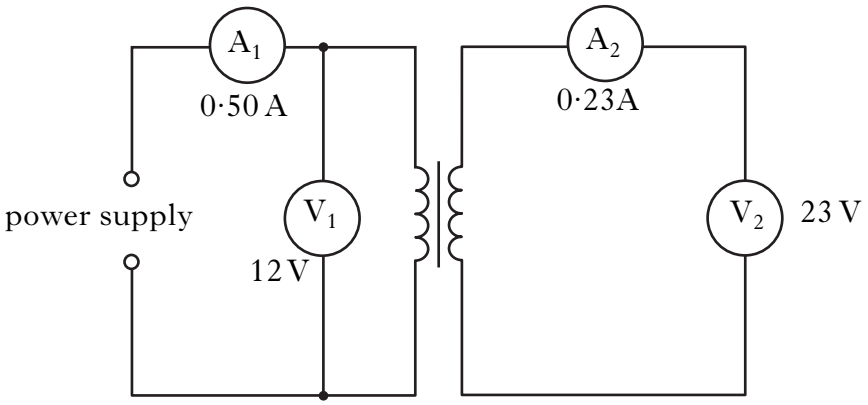
(*c*) The 24 Ω resistor is replaced by one of **greater** resistance. How will this affect the voltage across the 8 Ω resistor?

Explain your answer. **2**

(7)

Marks

25. In a lab experiment a technician builds a transformer and uses electrical meters to take a number of measurements, as shown in the diagram.



(*a*) The technician has a choice of an a.c. or a d.c. power supply. Which power supply should be used?

Explain your answer. **2**

(*b*) Calculate the electrical power in the primary circuit of the transformer. **2**

(*c*) Calculate the electrical power in the secondary circuit of the transformer. **1**

(*d*) Calculate the percentage efficiency of the transformer. **2**

(*e*) Another experiment uses a different transformer. It is 100% efficient. The primary coil has 1500 turns and the secondary coil contains 3000 turns.

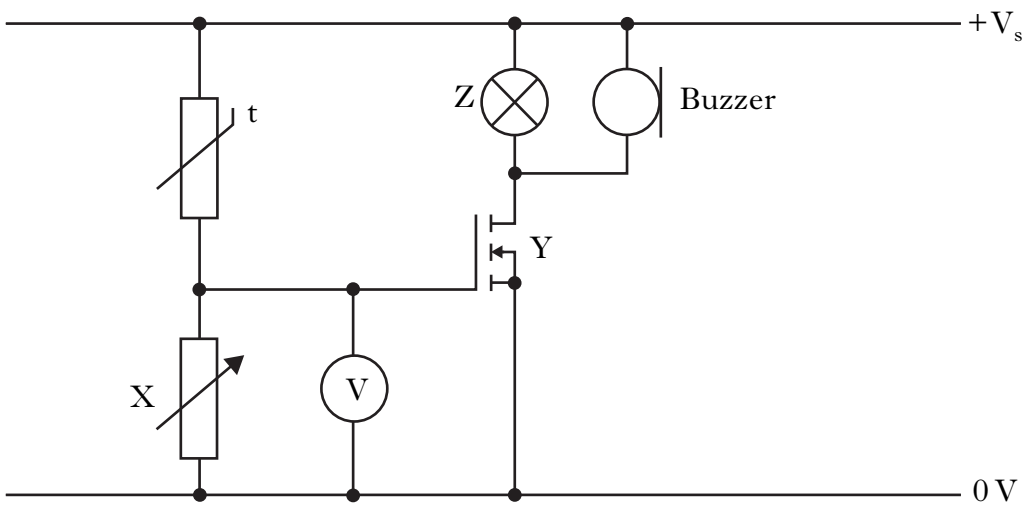
Calculate the secondary voltage when the primary voltage is 12 V. **2**

(9)

[Turn over

Marks

26. Water in a fish tank has to be maintained at a constant temperature. Part of the electronic circuit which controls the temperature is shown.



(*a*) Name components Y and Z. **2**

(*b*) What happens to the resistance of the thermistor as the temperature increases? **1**

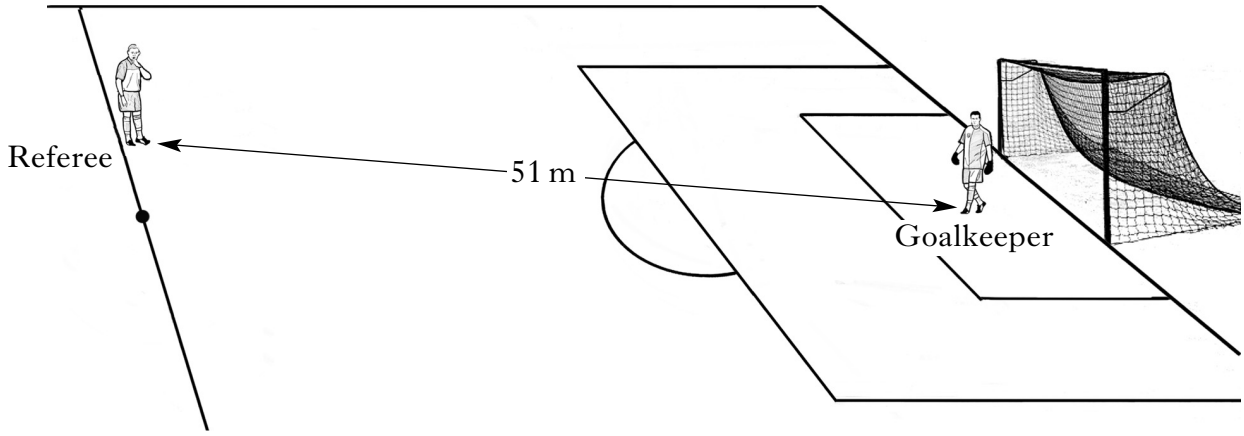
(*c*) When the voltmeter reading reaches 1·8 V component Y switches on. Explain how the circuit operates when the temperature rises. **2**

(*d*) Why is a variable resistor chosen for component X rather than a fixed value resistor? **1**

(6)

Marks

27. At the kick-off in a football match, during the World Cup Finals, the referee blows his whistle. The whistle produces sound waves.



(*a*) Using information from the diagram and the data sheet, calculate the time taken for the sound waves to reach the goalkeeper. **2**

(*b*) (i) Are sound waves transverse or longitudinal waves? **1**

(ii) Describe **two** differences between transverse and longitudinal waves. **2**

(iii) What is transferred by waves? **1**

(*c*) (i) Floodlights in the stadium are switched on. Each lamp has a power rating of 2·40 kW. The operating voltage is 315 V.

Calculate the resistance of a lamp. **2**

(ii) The floodlights consist of 20 lamps connected in parallel.

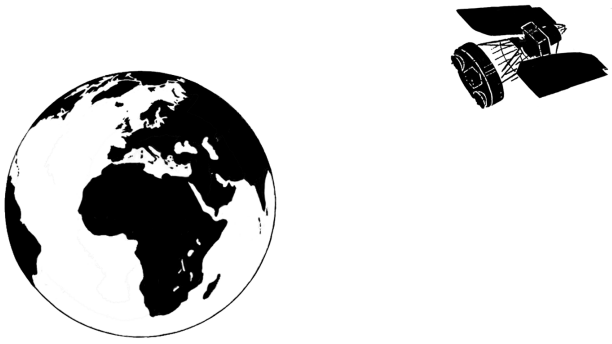
State **two** reasons why the lamps are connected in parallel. **2**

(10)

[Turn over

Marks

28. A satellite sends microwaves to a ground station on Earth.



(*a*) The microwaves have a wavelength of 60 mm.

(i) Calculate the frequency of the waves. **2**

(ii) Determine the period of the waves. **2**

(*b*) The satellite sends radio waves along with the microwaves to the ground station. Will the radio waves be received by the ground station **before**, **after** or **at the same time** as the microwaves?

Explain your answer. **2**

(*c*) When the microwaves reach the ground station they are received by a curved reflector.

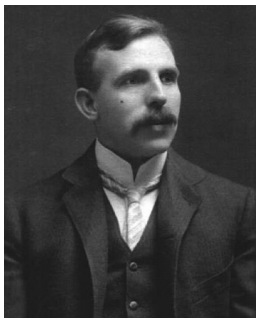
Explain why a curved reflector is used.

Your answer may include a diagram. **2**

(8)

Marks

29. In 1908 Ernest Rutherford conducted a series of experiments involving alpha particles.



(*a*) State what is meant by an alpha particle. **1**

(*b*) Alpha particles produce a greater ionisation density than beta particles or gamma rays. What is meant by the term *ionisation*? **1**

(*c*) A radioactive source emits alpha particles and has a half-life of 2·5 hours. The source has an initial activity of 4·8 kBq.

Calculate the time taken for its activity to decrease to 300 Bq. **2**

(*d*) Calculate the number of decays in the sample in two minutes, when the activity of the source is 1·2 kBq. **2**

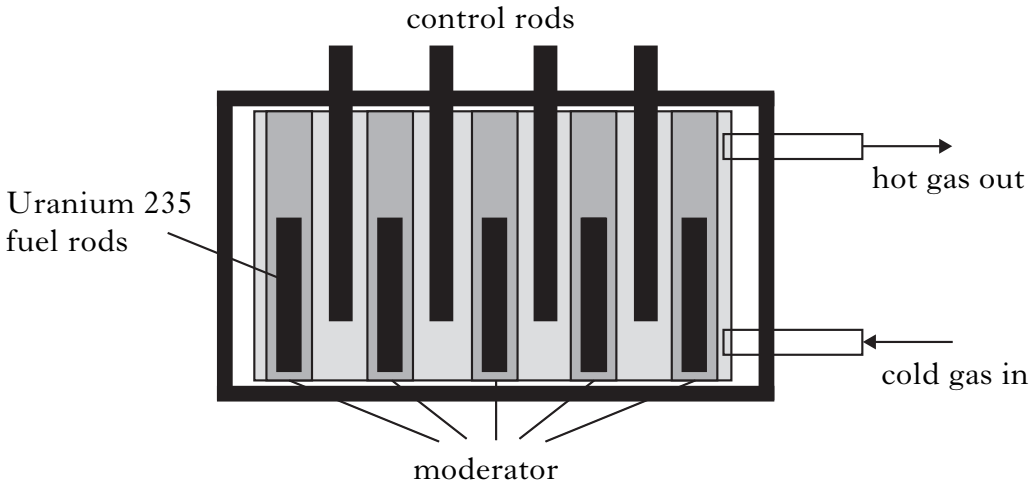
(*e*) Some sources emit alpha particles and are stored in lead cases despite the fact that alpha particles cannot penetrate paper. Suggest a possible reason for storing these sources using this method. **1**

(7)

[Turn over for Question 30 on *Page twenty*

Marks

30. Many countries use nuclear reactors to produce energy. A diagram of the core of a nuclear reactor is shown.



(*a*) State the purpose of:

(i) the moderator; **1**

(ii) the control rods. **1**

(*b*) One nuclear fission reaction produces $2{\cdot}9 \times 10^{-11}$ J of energy. The power output of the reactor is 1·4 GW. How many fission reactions are produced in one hour? **3**

(*c*) State **one advantage** and **one disadvantage** of using nuclear power for the generation of electricity. **2**

(7)

[*END OF QUESTION PAPER*]