

# X069/11/02

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NATIONAL MONDAY, 28 MAY  
QUALIFICATIONS 1.00 PM – 3.00 PM  
2012

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*

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

### *Speed of sound in materials*

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

### *Gravitational field strengths*

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

### *Specific heat capacity of materials*

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

### *Specific latent heat of fusion of materials*

<i>Material</i>	<i>Specific latent heat of fusion in J/kg</i>
Alcohol	$0.99 \times 10^5$
Aluminium	$3.95 \times 10^5$
Carbon Dioxide	$1.80 \times 10^5$
Copper	$2.05 \times 10^5$
Iron	$2.67 \times 10^5$
Lead	$0.25 \times 10^5$
Water	$3.34 \times 10^5$

### *Melting and boiling points of materials*

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

### *Specific latent heat of vaporisation of materials*

<i>Material</i>	<i>Specific latent heat of vaporisation in J/kg</i>
Alcohol	$11.2 \times 10^5$
Carbon Dioxide	$3.77 \times 10^5$
Glycerol	$8.30 \times 10^5$
Turpentine	$2.90 \times 10^5$
Water	$22.6 \times 10^5$

### *Radiation weighting factors*

<i>Type of radiation</i>	<i>Radiation weighting factor</i>
alpha	20
beta	1
fast neutrons	10
gamma	1
slow neutrons	3

SECTION A

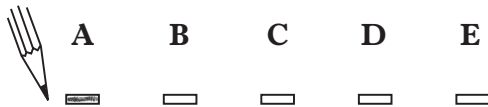
For questions 1 to 20 in this section of the paper the answer to each question is either A, B, C, D or E. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided—see the example below.

EXAMPLE

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

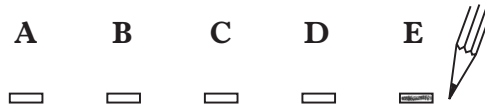
- A kilowatt-hour
- B ampere
- C watt
- D coulomb
- E volt.

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**.

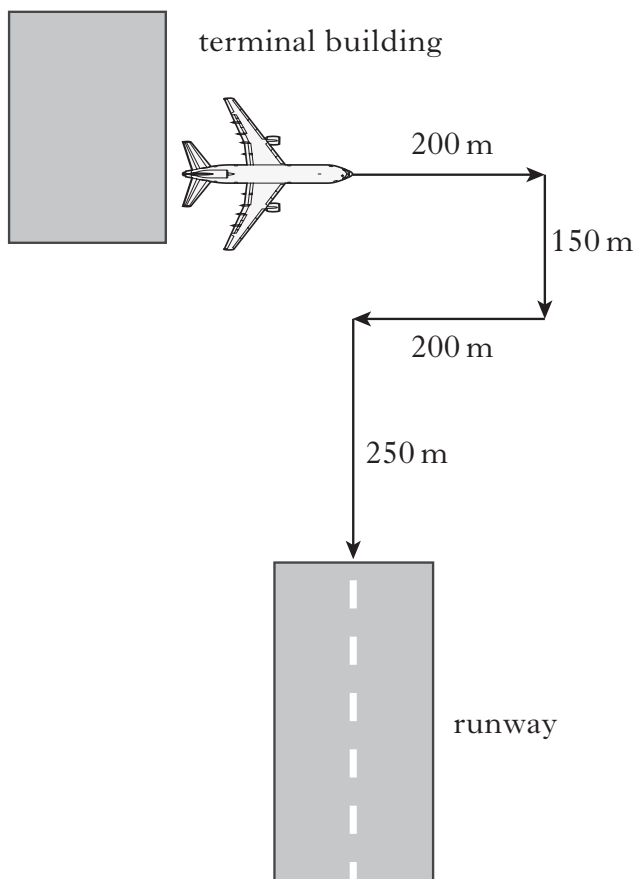


[Turn over

## SECTION A

Answer questions 1–20 on the answer sheet.

1. 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?

	<i>Total distance travelled (m)</i>	<i>Size of displacement (m)</i>
A	400	800
B	450	200
C	450	400
D	800	400
E	800	800

2. Near the Earth's surface, a mass of 6 kg is falling with a constant velocity.

The air resistance and the unbalanced force acting on the mass are:

	<i>air resistance</i>	<i>unbalanced force</i>
A	60 N upwards	0 N
B	10 N upwards	10 N downwards
C	10 N downwards	70 N downwards
D	10 N upwards	0 N
E	60 N upwards	60 N downwards

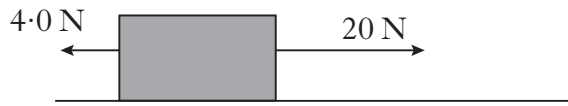
3. Two forces act on an object O in the directions shown.



The size of the resultant force is

- A 14 N
- B 24 N
- C 38 N
- D 45 N
- E 62 N.

4. The diagram shows the horizontal forces acting on a box.



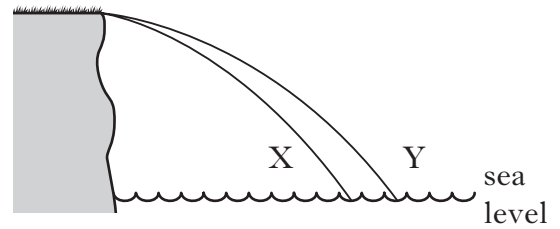
The box accelerates at  $1.6 \text{ m/s}^2$ .

The mass of the box is

- A 0.10 kg
- B 10.0 kg
- C 15.0 kg
- D 25.6 kg
- E 38.4 kg.

5. Two identical balls X and Y are projected horizontally from the edge of a cliff.

The path taken by each ball is shown.



A student makes the following statements about the motion of the two balls.

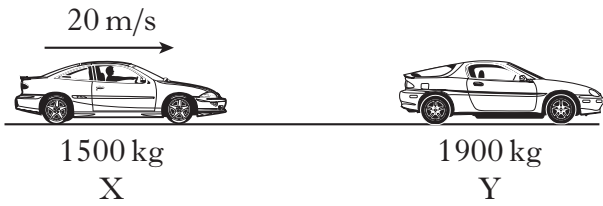
- I They take the same time to reach sea level.
- II They have the same vertical acceleration.
- III They have the same horizontal velocity.

Which of these statements is/are correct?

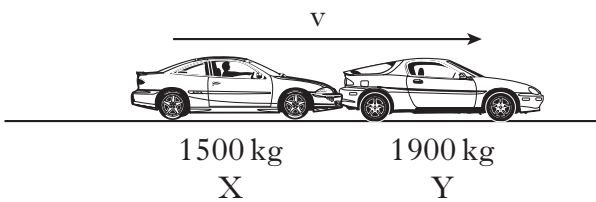
- A I only
- B II only
- C I and II only
- D I and III only
- E II and III only

**[Turn over**

6. Car X of mass 1500 kg travels at 20 m/s along a straight, horizontal road. It collides with a stationary car Y of mass 1900 kg.



The two cars lock together after the collision.



The speed of the cars after the collision is

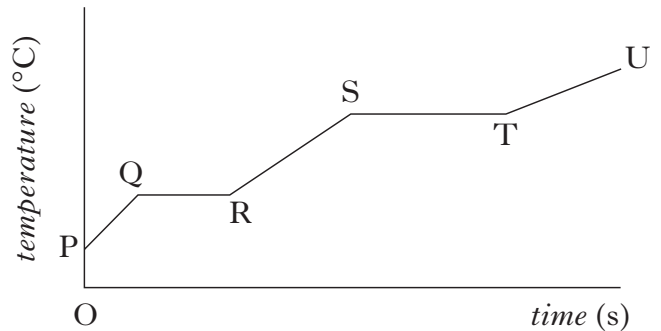
- A 8.8 m/s
  - B 9.4 m/s
  - C 11 m/s
  - D 16 m/s
  - E 20 m/s.
7. An electrical motor raises a crate of mass 500 kg through a height of 12 m in 4 s.

The minimum power rating of the motor is

- A 1.25 kW
- B 1.5 kW
- C 15 kW
- D 60 kW
- E 240 kW.

8. A heater is immersed in a substance. The heater is then switched on.

The graph shows the temperature of the substance over a period of time.



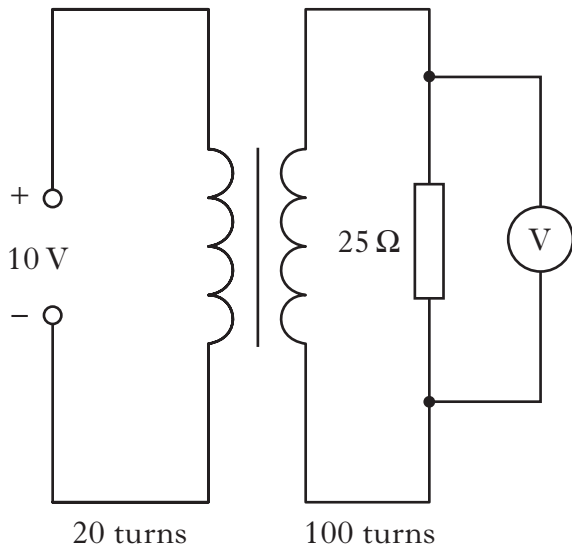
Which row in the table identifies the sections of the graph when the substance is changing state?

	<i>Solid to liquid</i>	<i>Liquid to gas</i>
A	QR	TU
B	QR	ST
C	PQ	RS
D	PQ	TU
E	ST	QR

9. Which row in the table gives the accepted values for the UK mains supply?

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

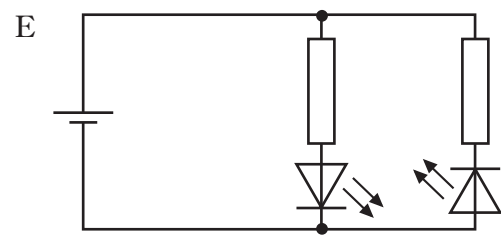
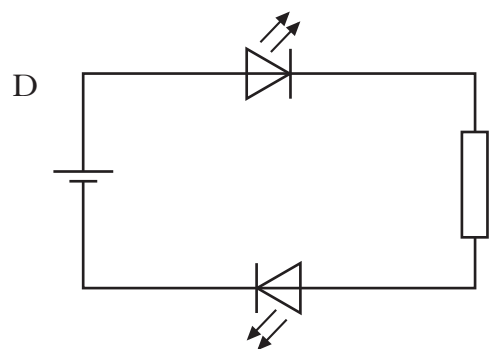
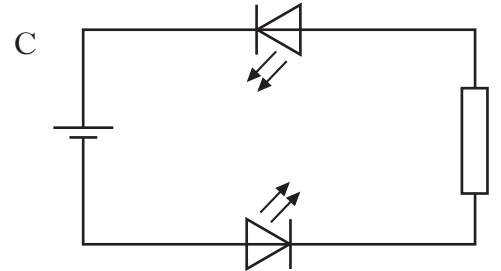
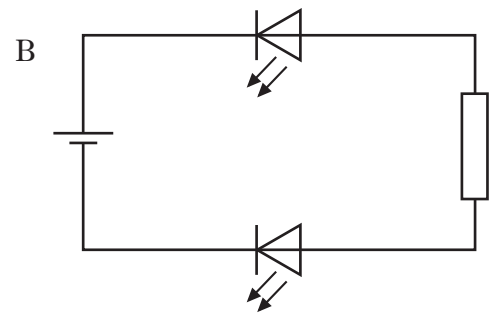
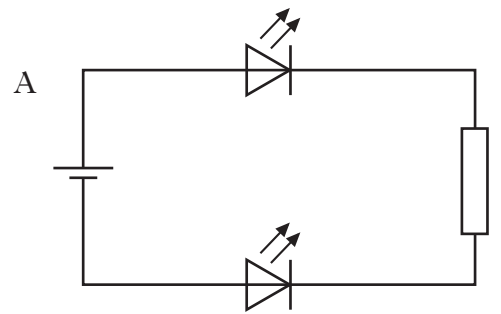
10. A circuit contains an ideal transformer connected to a 10 V d.c. supply.



The potential difference across the  $25\ \Omega$  resistor is

- A 0 V
- B 2 V
- C 10 V
- D 50 V
- E 80 V.

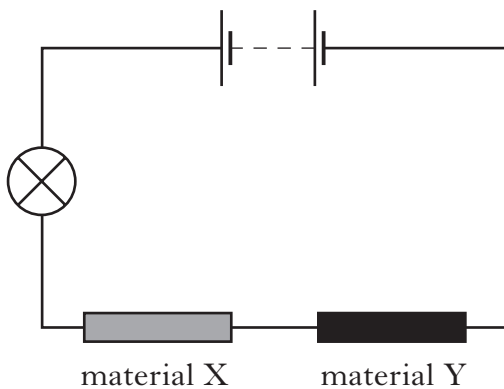
11. A student sets up the circuits shown.  
In which circuit will both LEDs be lit?



12. Which row in the table correctly identifies input and output devices?

	<i>Input device</i>	<i>Output devices</i>
A	microphone	loudspeaker, LED
B	solar cell	thermocouple, LED
C	loudspeaker	microphone, relay
D	LED	loudspeaker, relay
E	thermocouple	microphone, LED

13. A circuit is set up to test electrical conduction in materials.



The lamp lights.

Which row in the table identifies materials X and Y?

	<i>Material X</i>	<i>Material Y</i>
A	copper	wood
B	copper	aluminium
C	glass	copper
D	aluminium	glass
E	wood	glass

14. The current in an  $8\ \Omega$  resistor is 2 A.  
The charge passing through the resistor in 10 s is

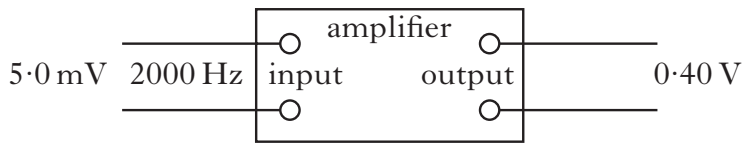
- A 4 C
- B 5 C
- C 16 C
- D 20 C
- E 80 C.

15. Which of the following statements is/are correct?

- I In an a.c. circuit the direction of the current changes regularly.
  - II In a d.c. circuit positive charges flow in one direction only.
  - III In an a.c. circuit the size of the current varies with time.
- A I only
  - B II only
  - C I and II only
  - D I and III only
  - E I, II and III



16. A signal of voltage 5.0 mV and frequency 2000 Hz is applied to the input of an amplifier.

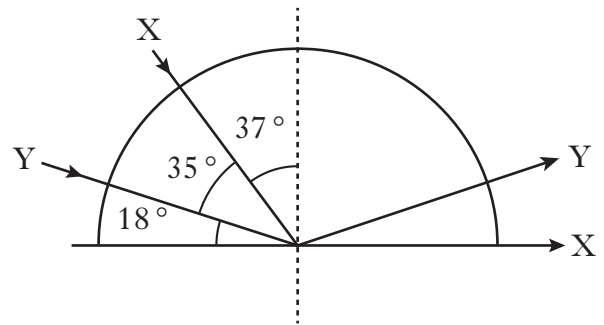


The output voltage is 0.40 V.

Which row shows the voltage gain of the amplifier and the frequency of the output signal?

	<i>Voltage gain</i>	<i>Frequency of output signal (Hz)</i>
A	0.0125	2000
B	0.08	50
C	0.08	2000
D	80	50
E	80	2000

17. The diagram shows two rays of red light X and Y passing through a block of glass.



The critical angle of the glass for this light is

- A 18°
- B 35°
- C 37°
- D 53°
- E 72°.

18. A student makes the following statements.

- I In an atom there are neutrons and electrons in the nucleus and protons which orbit the nucleus.
- II An alpha particle consists of two neutrons and two electrons.
- III A beta particle is a fast moving electron.

Which of the statements is/are correct?

- A I only
- B II only
- C III only
- D I and III only
- E I, II and III

[Turn over

19. A radioactive source emits alpha, beta and gamma radiation. A detector, connected to a counter, is placed 10 mm in front of the source. The counter records 400 counts per minute.

A sheet of paper is placed between the source and the detector. The counter records 300 counts per minute.

The radiation now detected is

- A alpha only
- B beta only
- C gamma only
- D alpha and beta only
- E beta and gamma only.

20. A radioactive tracer is injected into a patient to study the flow of blood.

The tracer should have a

- A short half-life and emit  $\alpha$  particles
- B long half-life and emit  $\beta$  particles
- C long half-life and emit  $\gamma$  rays
- D long half-life and emit  $\alpha$  particles
- E short half-life and emit  $\gamma$  rays.

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

**[Turn over for Section B on *Page twelve***

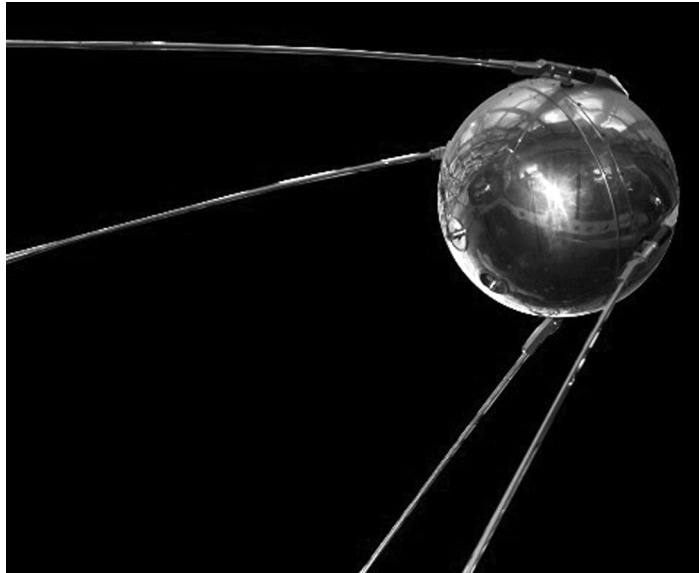
**SECTION B**

*Marks*

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

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

21. Sputnik 1, the first man-made satellite, was launched in 1957. It orbited the Earth at a speed of 8300 m/s and had a mass of 84 kg.

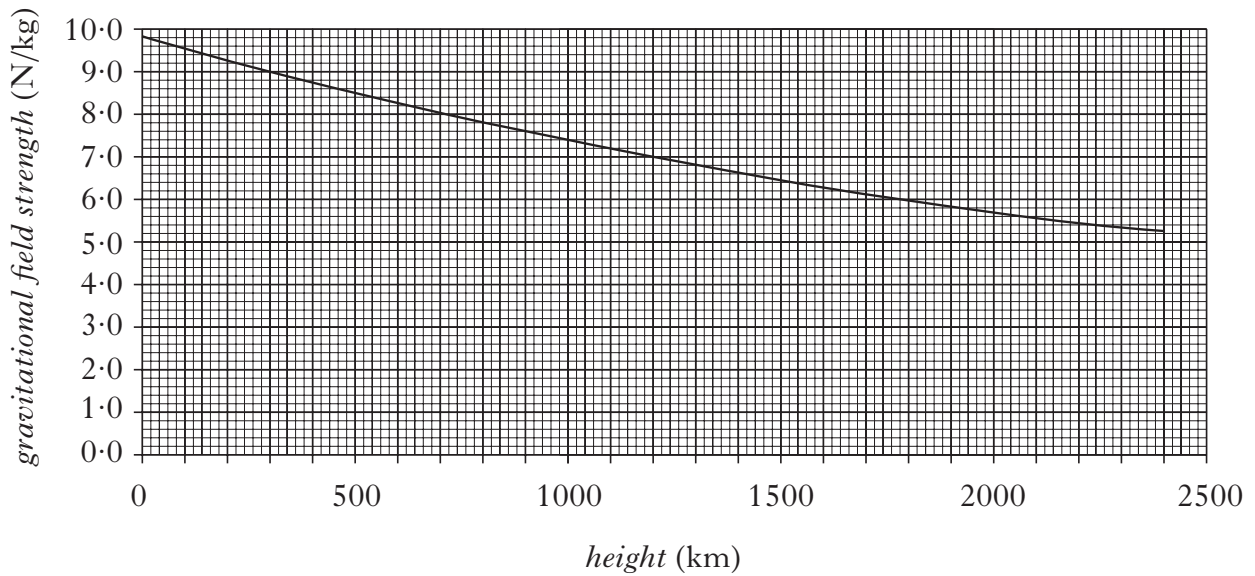


- (a) (i) Sputnik 1 orbited Earth in 100 minutes.  
Calculate the distance it travelled in this time. 2
- (ii) Although Sputnik 1 travelled at a constant speed in a circular orbit, it accelerated continuously.  
Explain this statement. 2
- (b) Sputnik 1 transmitted radio signals a distance of 800 km to the surface of the Earth.  
Calculate the time taken for the signals to reach the Earth's surface. 2

21. (continued)

Marks

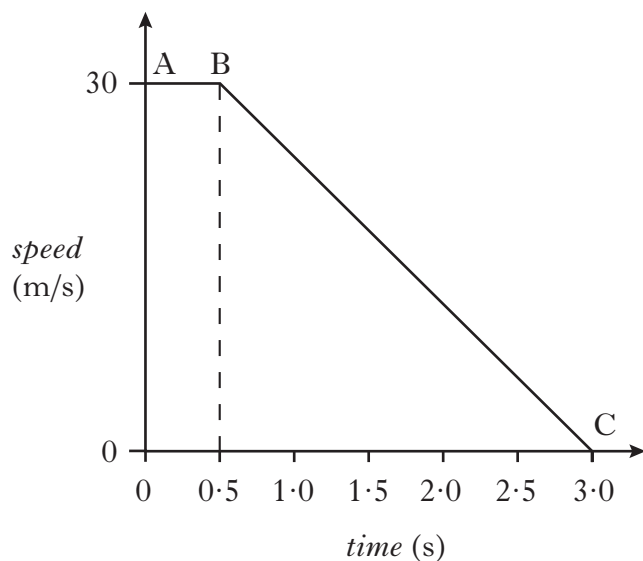
(c) The graph shows how gravitational field strength varies with height above the surface of the Earth.



- (i) Define the term **gravitational field strength**. 1
  - (ii) What is the value of the gravitational field strength at a height of 800 km? 1
  - (iii) Calculate the weight of Sputnik 1 at this height. 2
- (10)**

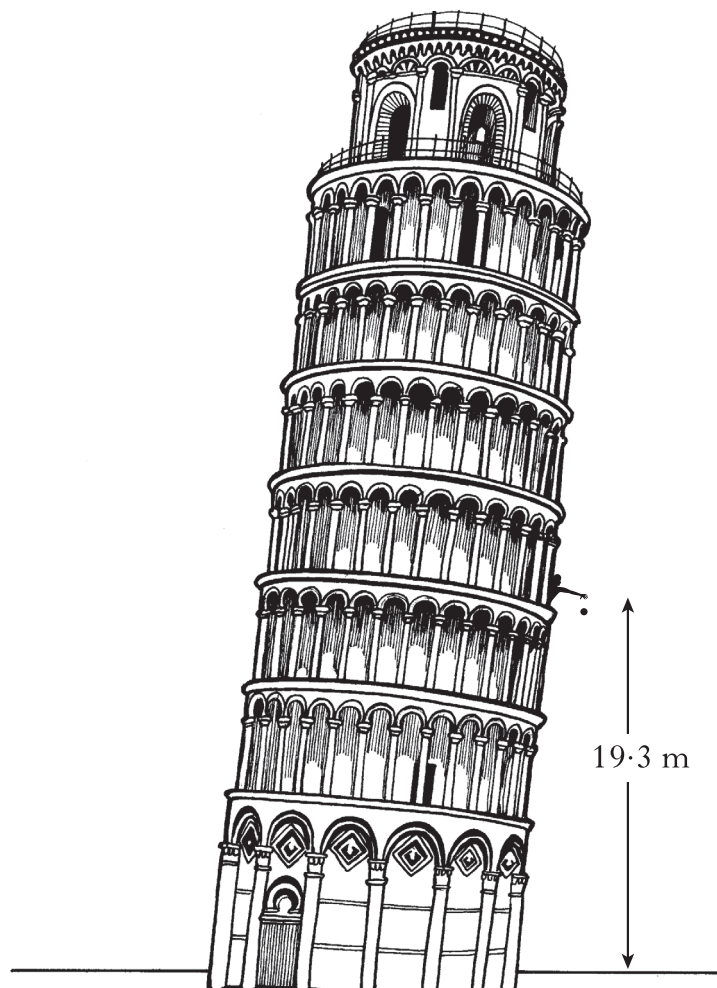
[Turn over

22. A car of mass 700 kg travels along a motorway at a constant speed. The driver sees a traffic hold-up ahead and performs an emergency stop. A graph of the car's motion is shown, from the moment the driver sees the hold-up.



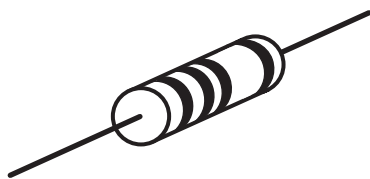
- (a) Describe **and** explain the motion of the car between A and B. 2
- (b) Calculate the kinetic energy of the car at A. 2
- (c) State the work done in bringing the car to a halt between B and C. 1
- (d) Show by calculation that the magnitude of the unbalanced force required to bring the car to a halt between B and C is 8400 N. 2
- (7)**

23. A student reproduces Galileo's famous experiment by dropping a solid copper ball of mass  $0.50 \text{ kg}$  from a balcony on the Leaning Tower of Pisa.



- (a) (i) The ball is released from a height of  $19.3 \text{ m}$ .  
Calculate the gravitational potential energy lost by the ball. 2
- (ii) Assuming that all of this gravitational potential energy is converted into heat energy **in the ball**, calculate the increase in the temperature of the ball on impact with the ground. 2
- (iii) Is the actual temperature change of the ball greater than, the same as or less than the value calculated in part (a)(ii)?  
You **must** explain your answer. 2
- (b) The ball was made by melting  $0.50 \text{ kg}$  of copper at its melting point. Calculate the amount of heat energy required for this. 3
- (9)**

24. A resistor is labelled: “ $10\ \Omega \pm 10\%$ , 3 W”.



This means that the resistance value could actually be between  $9\ \Omega$  and  $11\ \Omega$ .

(a) A student decides to check the value of the resistance.

Draw a circuit diagram, including a 6 V battery, a voltmeter and an ammeter, for a circuit that could be used to determine the resistance. 3

(b) Readings from the circuit give the voltage across the resistor as 5.7 V and the current in the resistor as 0.60 A.

Use these values to calculate the resistance. 2

(c) During this experiment, the resistor becomes very hot and gives off smoke.

Explain why this happens.

You **must** include a calculation as part of your answer. 3

(d) The student states that **two** of these resistors would not have overheated if they were connected together in parallel with the battery.

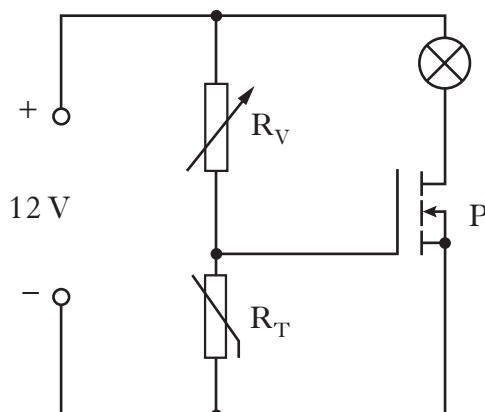
Is the student correct?

Explain your answer. 2

**(10)**



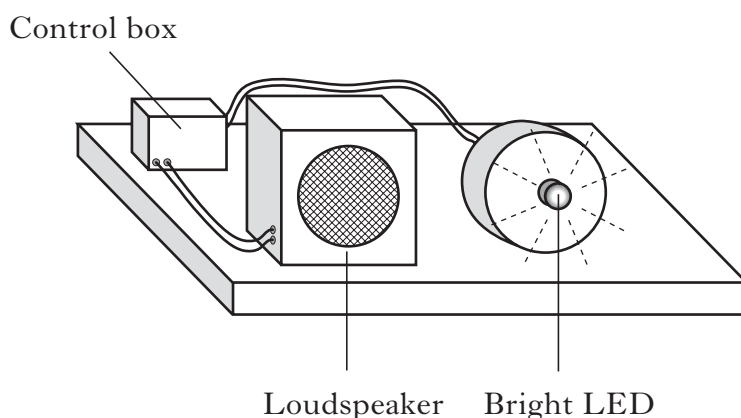
25. The circuit shown switches a warning lamp on or off depending on the temperature.



- (a) Name component P. 1
- (b) As the temperature increases the resistance of thermistor  $R_T$  decreases. What happens to the voltage across  $R_T$  as the temperature increases? 1
- (c) When the voltage applied to component P is equal to or greater than 2.4 V, component P switches on and the warning lamp lights.  
 $R_V$  is adjusted until its resistance is  $5600\ \Omega$  and the warning lamp now lights.  
 At this point calculate:
- (i) the voltage across  $R_V$ ; 1
- (ii) the resistance of  $R_T$ . 2
- (d) The temperature of  $R_T$  now decreases.  
 Will the lamp stay on or go off?  
 You **must** explain your answer. 2
- (7)**

[Turn over

26. An apparatus used to measure the speed of sound consists of a bright LED which flashes every 0.5 s and a loudspeaker which beeps at **exactly the same time** as the LED flashes.



- (a) A student standing beside the apparatus observes the beeps and flashes happening at exactly the same time.

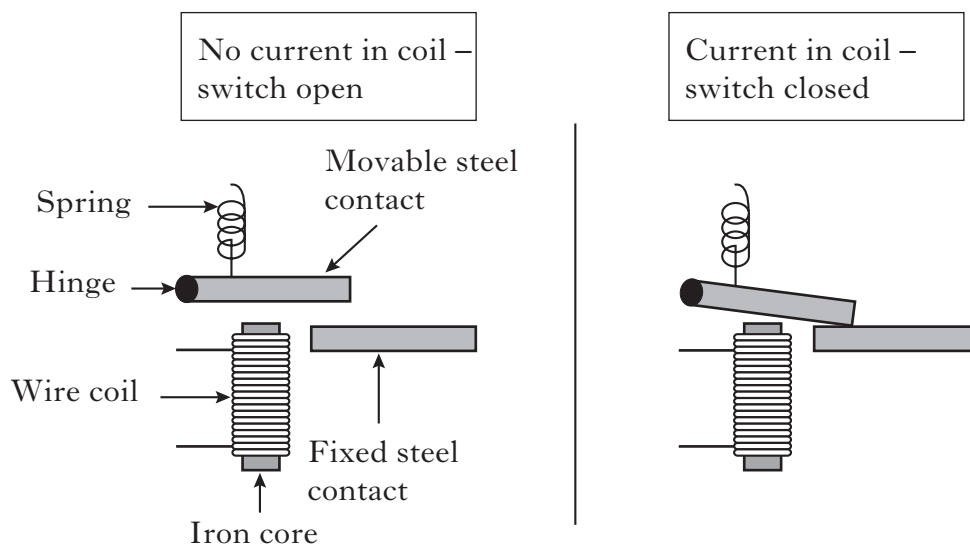
Another student standing 88 m away does **not** observe them happening at the same time.

- (i) Explain this observation. 1
- (ii) A third student 176 m away observes the beeps and flashes happening at exactly the same time.

Use this information to calculate a value for the speed of sound. 2

- (b) The circuit used to operate the LED and loudspeaker uses electric switches called relays.

Simplified diagrams of a relay are shown.

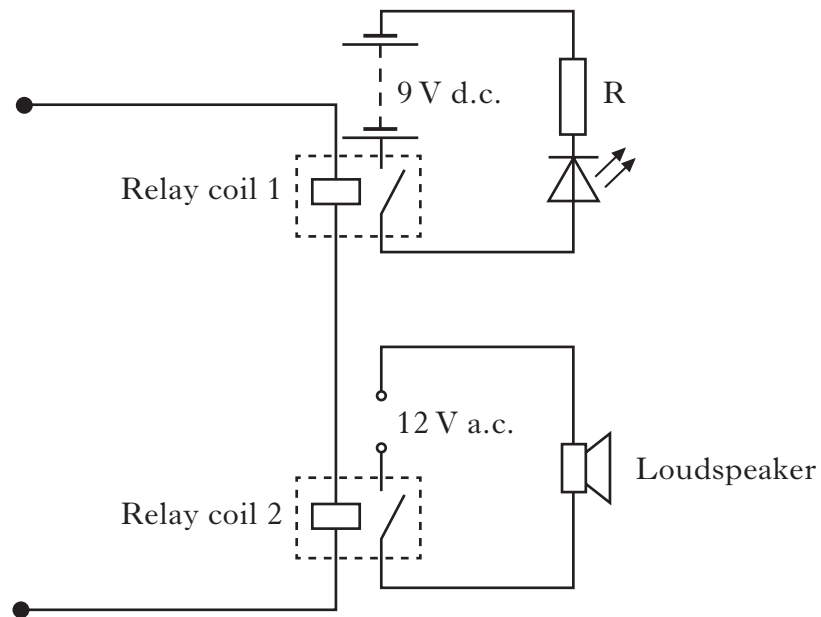


Explain why the steel contact moves when there is a current in the coil. 2

26. (continued)

Marks

(c) Part of the circuit for the apparatus is shown.



The LED is rated 6.0 V, 800 mA.

Calculate the value of resistor R.

3

(d) The 12 V a.c. supply has a frequency of 850 Hz.

Using the value of the speed of sound from the data sheet, calculate the wavelength of the sound in air produced by the loudspeaker.

2

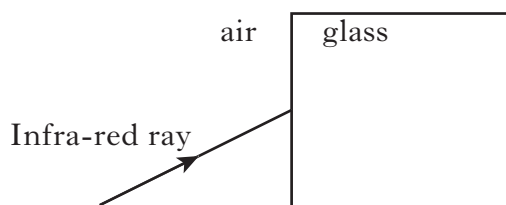
(10)

[Turn over

27. Optical fibres are used to carry internet data using infra-red radiation.

(a) Is the wavelength of infra-red radiation greater than, the same as, or less than the wavelength of visible light? 1

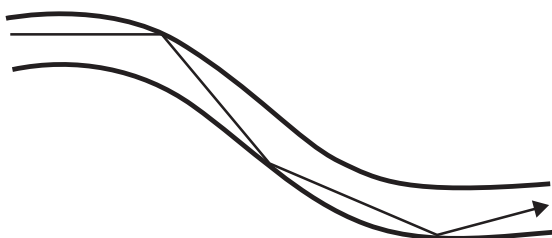
(b) The diagram shows a view of an infra-red ray entering the end of a fibre.



Copy and complete the diagram to show the path of the infra-red ray as it enters the glass from air.

Indicate on your diagram the normal, the angle of incidence and the angle of refraction. 2

(c) The diagram shows the path of the infra-red ray as it passes through a section of the fibre.



Name the effect shown.

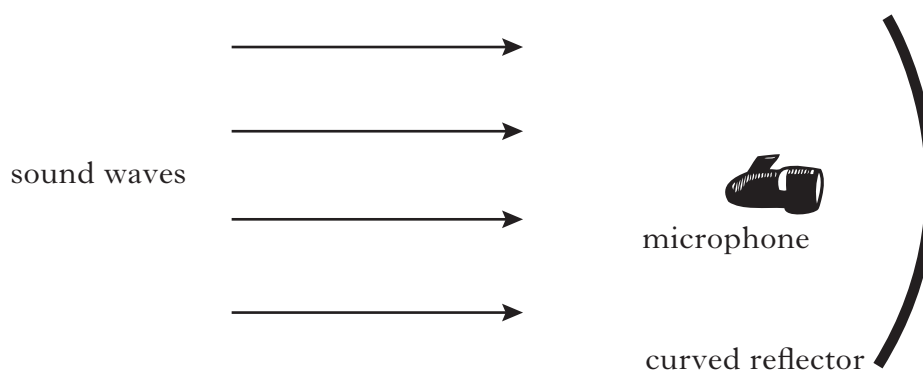
1  
(4)

**[Turn over for Question 28 on *Page twenty-two***

28. The picture shows a spy using a long range microphone and curved reflector to listen to conversations from some distance away.



- (a) Copy and complete the following diagram to show the path of the sound waves.



2

- (b) Explain why using the curved reflector makes the sound detected by the microphone louder.

1

- (c) The microphone produces a signal of 24 mV which is applied to the input of an amplifier.

The output from the amplifier is 3.0 V.

Calculate the voltage gain of the amplifier.

2

28. (continued)

(d) The spy needs spectacles to see distant objects clearly.

(i) What is the name given to this eye defect? **1**

(ii) What type of lens is needed to correct this defect? **1**

(e) The spy uses a magnifying lens of power +10 D to examine some photographs.

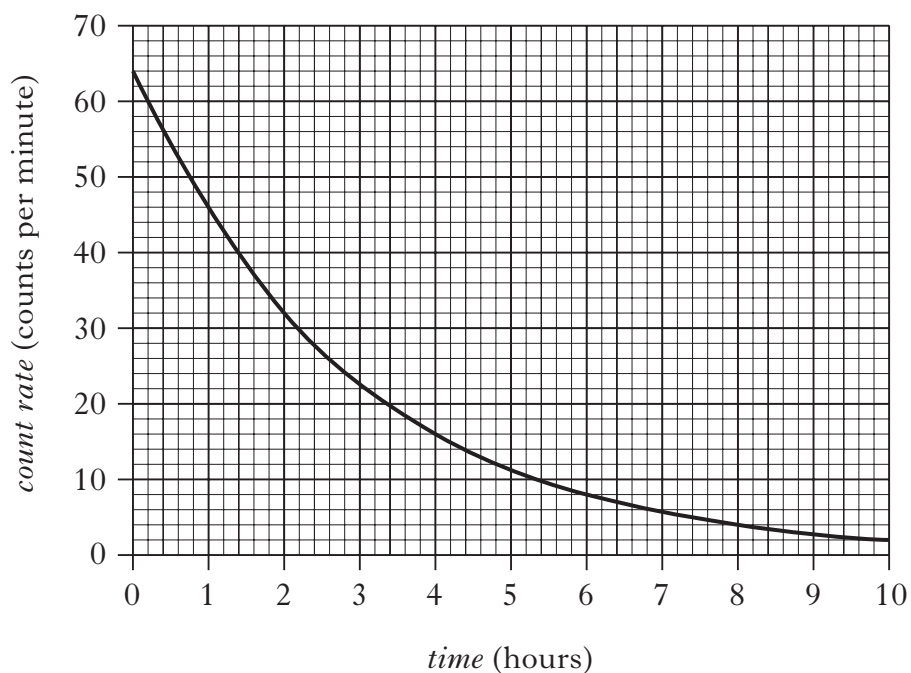


Calculate the focal length of this lens. **2**

**(9)**

**[Turn over**

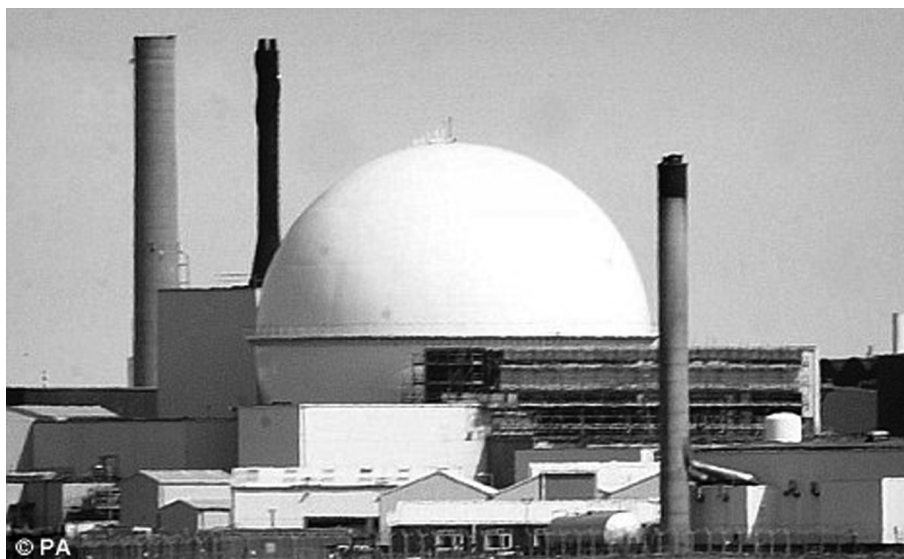
29. A technician checks the count rate of a radioactive source. A graph of count rate against time for the source is shown. The count rate has been corrected for background radiation.



- (a) Use the graph to determine the half-life of the source. 2
- (b) State **two** factors which can affect the background radiation level. 2
- (c) The source emits gamma rays. State what is meant by a gamma ray. 1
- (5)**



30. An ageing nuclear power station is being dismantled.



- (a) During the dismantling process a worker comes into contact with an object that emits 24 000 alpha particles in five minutes. The worker's hand has a mass of 0.50 kg and absorbs  $6.0 \mu\text{J}$  of energy.

Calculate:

- |   |   |
|---|---|
| (i) the absorbed dose received by the worker's hand;    | 2 |
| (ii) the equivalent dose received by the worker's hand; | 2 |
| (iii) the activity of the object.                       | 2 |
- (b) In a nuclear reactor, state the purpose of:
- |                              |   |
|------------------------------|---|
| (i) the moderator;           | 1 |
| (ii) the containment vessel. | 1 |
- (c) What type of nuclear reaction takes place in a nuclear power station's reactor? 1

(9)

[END OF QUESTION PAPER]

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