

X069/201

NATIONAL
QUALIFICATIONS
2007

WEDNESDAY, 16 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 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

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

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	0.99×10^5
Aluminium	3.95×10^5
Carbon dioxide	1.80×10^5
Copper	2.05×10^5
Iron	2.67×10^5
Lead	0.25×10^5
Water	3.34×10^5

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	2747

Specific latent heat of vaporisation of materials

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

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

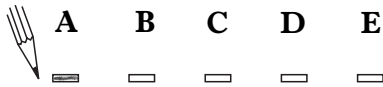
For questions 1 to 20 in this section of the paper the answer to each question is either A, B, C, D or E. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided—see the example below.

EXAMPLE

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

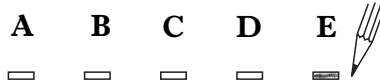
- A kilowatt-hour
- B ampere
- C watt
- D coulomb
- E volt.

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. In the following statements X, Y and Z represent physical quantities.

X is the displacement of an object in a given time.

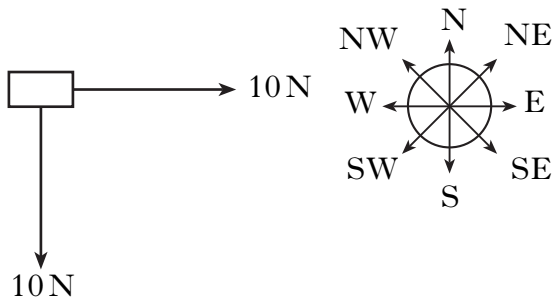
Y is the change in velocity of an object in a given time.

Z is the distance travelled by an object in a given time.

Which row in the table shows the quantities represented by X, Y and Z?

	X	Y	Z
A	speed	acceleration	velocity
B	velocity	speed	acceleration
C	acceleration	velocity	speed
D	acceleration	speed	velocity
E	velocity	acceleration	speed

2. Two forces act on an object as shown.

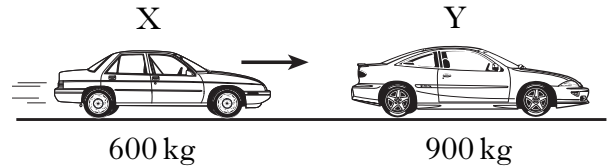


The angle between the forces is 90° .

The resultant force is

- A zero
- B 14 N SE
- C 14 N NE
- D 20 N SE
- E 20 N NE.

3. A moving vehicle X has a mass of 600 kg. It collides with a stationary vehicle Y of mass 900 kg.



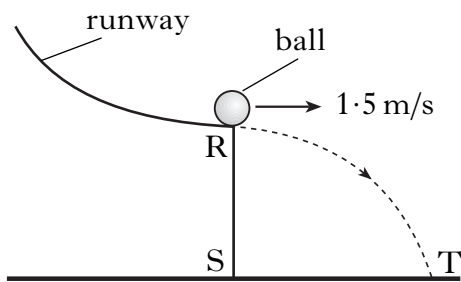
The two vehicles lock together.

The speed of the vehicles immediately after the collision is 8.0 m/s.

The speed of vehicle X just before the collision is

- A 8.0 m/s
- B 12 m/s
- C 13 m/s
- D 16 m/s
- E 20 m/s.

4. A ball rolls down a runway and leaves it at point R.



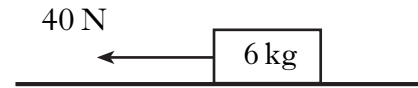
The horizontal speed of the ball at R is 1.5 m/s.

The ball takes 0.6 s to travel from R to T.

The distance ST is

- A 0.40 m
 - B 0.90 m
 - C 2.5 m
 - D 9.0 m
 - E 15 m.
5. An aircraft engine exerts a force on the air.
- Which of the following completes the 'Newton pair' of forces?
- A The force of the air on the aircraft engine
 - B The force of friction between the aircraft engine and the air
 - C The force of friction between the aircraft and the aircraft engine
 - D The force of the Earth on the aircraft engine
 - E The force of the aircraft engine on the Earth

6. A block of mass 6 kg is pulled across a horizontal bench by a force of 40 N as shown below.



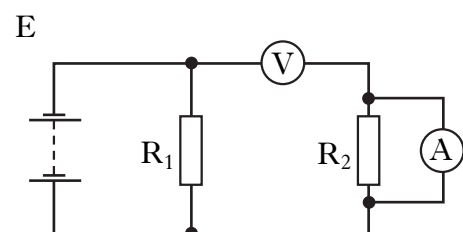
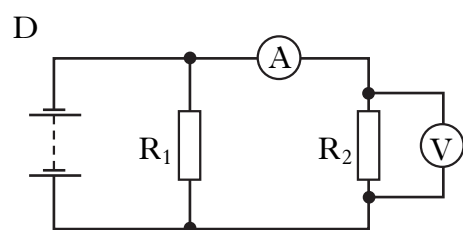
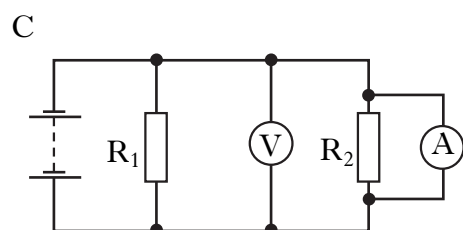
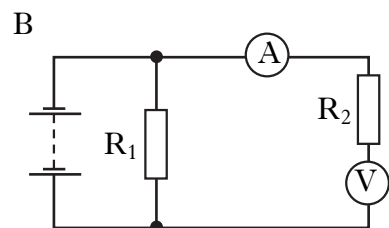
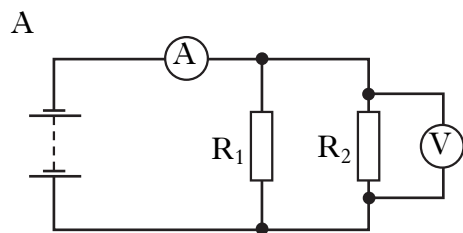
The block accelerates at 4 m/s^2 .

The force of friction between the block and the bench is

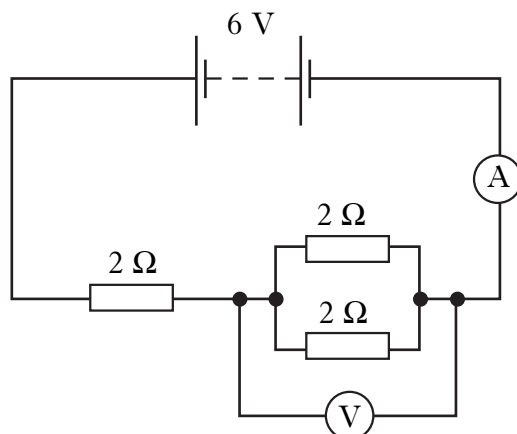
- A zero
 - B 16 N
 - C 24 N
 - D 40 N
 - E 64 N.
7. The voltage of an electrical supply is a measure of the
- A resistance of the circuit
 - B speed of the charges in the circuit
 - C energy given to the charges in the circuit
 - D power developed in the circuit
 - E current in the circuit.

[Turn over

8. Which circuit is used to find the resistance of resistor R_2 ?



9. A circuit is set up as shown.



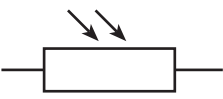
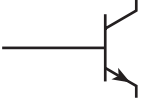
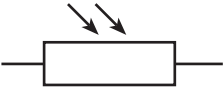

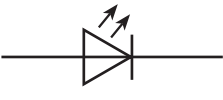
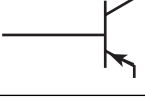
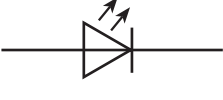


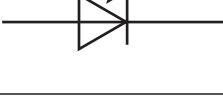
Which row in the table shows the readings on the meters?

	<i>Reading on voltmeter (V)</i>	<i>Reading on ammeter (A)</i>
A	2	1
B	2	2
C	3	2
D	4	1
E	4	2

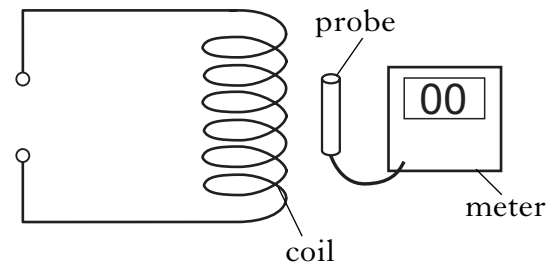
10. An amplifier has a voltage gain of 200. A 20 mV, 100 Hz signal is applied to the input of the amplifier. Which row in the table shows the voltage and frequency of the output signal?

	Output voltage (V)	Output frequency (Hz)
A	0.1×10^{-3}	0.5
B	0.1×10^{-3}	100
C	20×10^{-3}	20 000
D	4	100
E	4	20 000

11. Which row in the table shows the symbols for an LED and an NPN transistor?

	LED	NPN transistor
A		
B		
C		
D		
E		

12. A student uses a probe connected to a meter to detect the magnetic field close to a coil of wire.



The reading on the meter is zero.

Which of the following will cause the reading on the meter to change?

- A Decreasing the number of turns in the coil
- B Increasing the number of turns in the coil
- C Passing a current through the coil
- D Replacing the coil with another coil made of thicker wire
- E Replacing the coil with another coil made of thinner wire

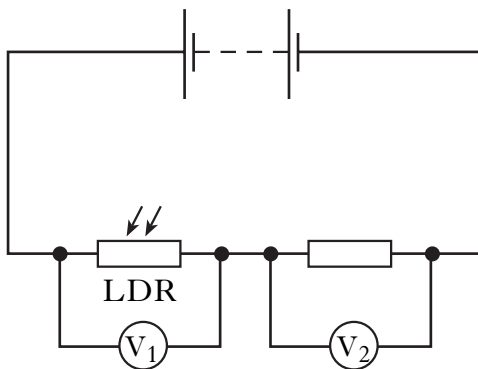
[Turn over

13. A car headlamp is rated at 60 W.
The light produced is 20% of the total energy transferred by the lamp.

The energy transferred as light in 10 s is

- A 12 J
- B 120 J
- C 600 J
- D 3000 J
- E 12 000 J.

14. A circuit is set up as shown.



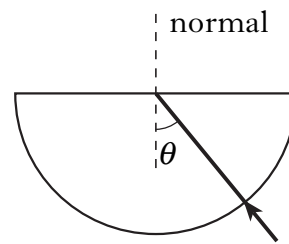
The initial reading on both voltmeters V_1 and V_2 is 2.5 V.

The light shining on the LDR is made brighter.

Which row in the table shows possible new readings on voltmeters V_1 and V_2 ?

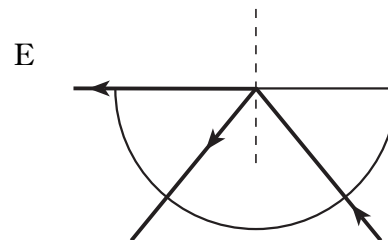
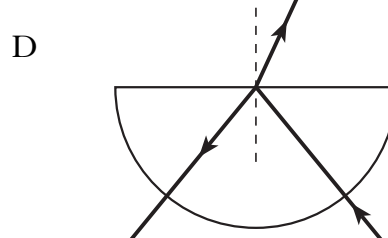
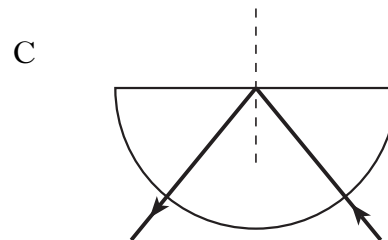
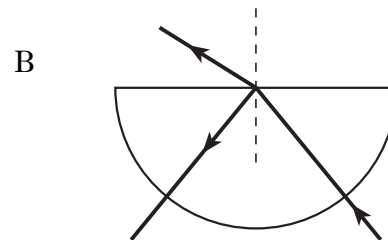
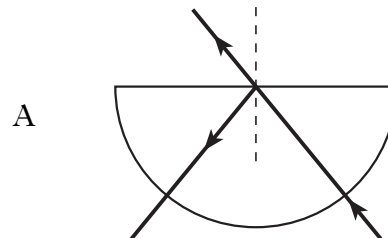
	Reading on V_1 (V)	Reading on V_2 (V)
A	2.0	3.0
B	2.5	2.0
C	2.5	2.5
D	2.5	3.0
E	3.0	2.0

15. The diagram below shows a ray of red light entering a block of perspex.

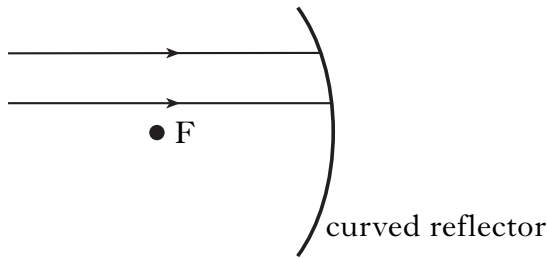


The angle θ is greater than the critical angle in the perspex for this light.

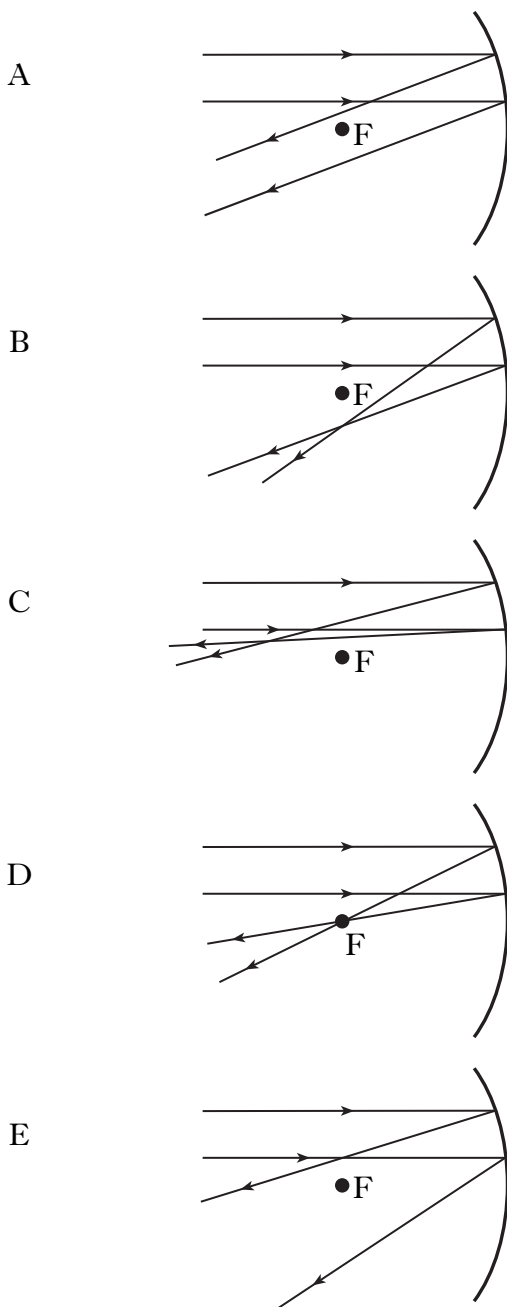
Which of the following diagrams shows the path of the ray of red light after striking the straight surface of the perspex block?



16. The diagram shows two rays of light incident on a curved reflector. The focal point, F, of the reflector is shown.



Which of the following diagrams shows the paths of the rays of light after reflection?



17. A student makes the following statements about members of the electromagnetic spectrum.

- I Gamma rays have a longer wavelength than X-rays.
- II Ultraviolet rays have a longer wavelength than infrared rays.
- III TV and radio waves have a longer wavelength than microwaves.

Which of the statements is/are correct?

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

18. Which of the following statements is/are true about fission?

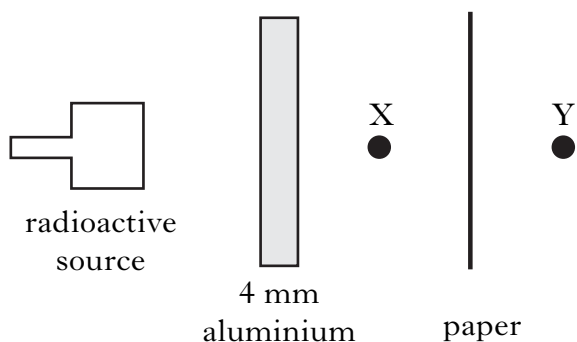
- I A large nucleus is split into two smaller nuclei.
- II Two smaller nuclei join together to form a larger nucleus.
- III Fission can result in a chain reaction.

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

[Turn over

19. A radioactive source emits α , β and γ radiation.

Sheets of aluminium and paper are placed close to the source as shown.



Which row in the table shows the radiation(s) from the source detected at points X and Y?

	<i>Radiation(s) detected at X</i>	<i>Radiation detected at Y</i>
A	α, γ	γ
B	β, γ	α
C	α	β
D	β	γ
E	γ	γ

20. Which of the following statements about the function of parts of a nuclear reactor is/are correct?

- I The coolant removes heat from the core of the reactor.
 - II Control rods contain the fuel used for the nuclear reaction.
 - III The moderator slows down neutrons.
- A I only
 B I and II only
 C I and III only
 D II and III only
 E I, II and III

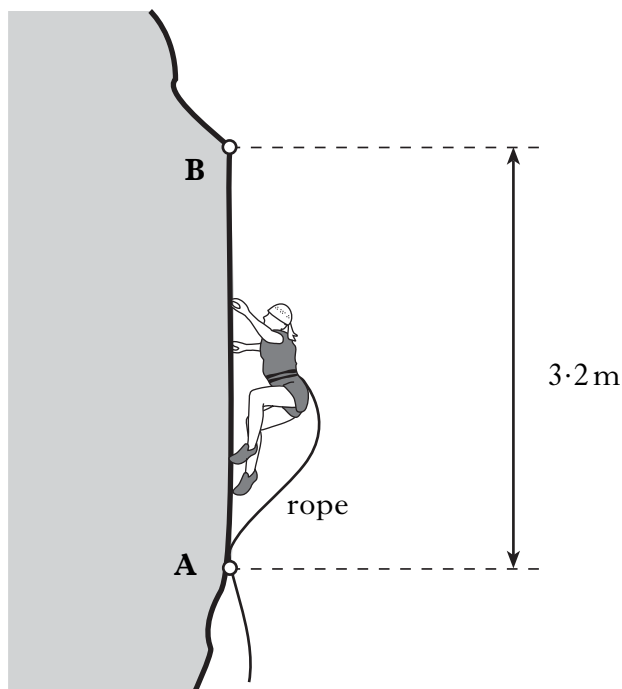
SECTION B

Marks

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

All answers must be written clearly and legibly in ink.

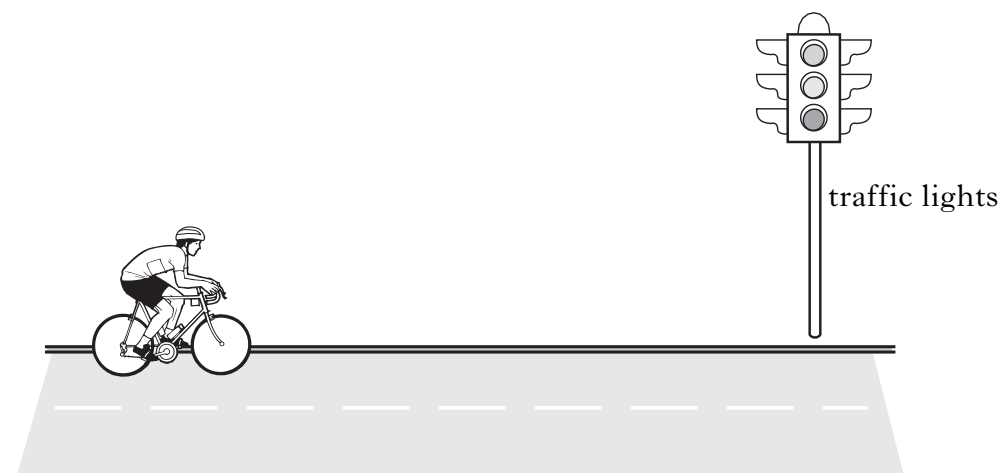
21. A climber of mass 60 kg is attached by a rope to point A on a rock face. She climbs up to point B in 20 seconds. Point B is 3.2 m vertically above point A.



- (a) (i) Calculate the average speed of the climber between A and B. 2
- (ii) Calculate the weight of the climber. 2
- (iii) Calculate her gain in potential energy. 2
- (b) She then loses her footing and free falls from point B. After passing point A she is held safely by the rope.
- (i) Calculate her speed as she passes point A. 2
- (ii) How would her actual speed when passing point A compare with the speed calculated in (b) (i)?
You **must** explain your answer. 2
- (10)**

[Turn over

22. A cyclist rides along a road.



- (a) Describe a method by which the average speed of the cyclist could be measured.

Your description must include the following

- Measurements made
- Equipment used
- Any necessary calculations.

3

- (b) The cyclist approaches traffic lights at a speed of 8 m/s. He sees the traffic lights turn red and 3 s later he applies the brakes. He comes to rest in a further 2.5 s.

- (i) Calculate the acceleration of the cyclist whilst braking.

2

- (ii) Sketch a speed time graph showing the motion of the cyclist from the moment the lights turn red until he stops at the traffic lights. Numerical values **must** be included.

2

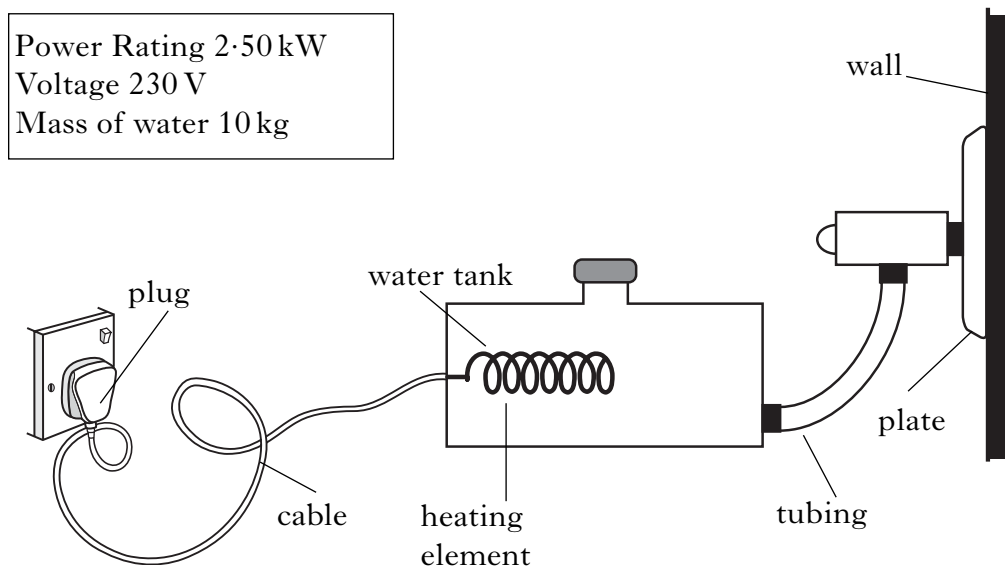
- (iii) Calculate the total distance the cyclist travels from the moment the lights turn red until he stops at the traffic lights.

2

(9)

23. A steam wallpaper stripper is used on the walls of a room.

Water is heated until it boils and produces steam. The plate is held against the wall and steam is released from the plate.

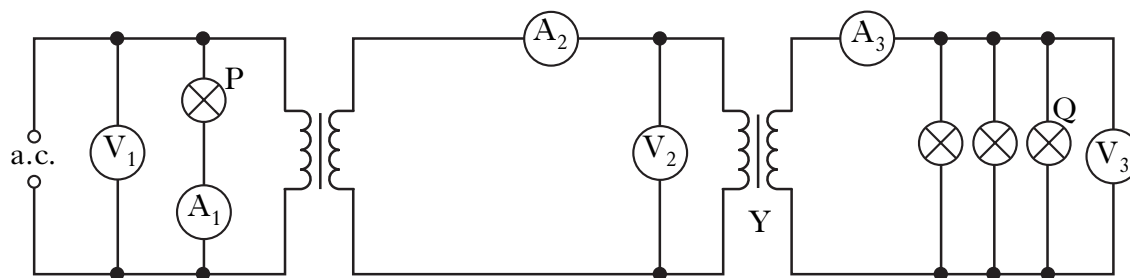


The tank is filled with water. The water has an initial temperature of 20°C .

- (a) (i) Calculate the energy required to bring the water to its boiling point. 2
- (ii) Calculate the time taken for this to happen. 2
- (iii) The actual time taken for this to happen was found to be longer than that calculated in (a) (ii). Explain why. 1
- (b) Calculate the current required by the wallpaper stripper. 2
- (c) After using the wallpaper stripper for some time, 1.2 kg of water is converted into steam. Calculate the energy used to do this. 2
- (9)**

[Turn over

24. The following circuit shows a method of transmitting power over long distances.

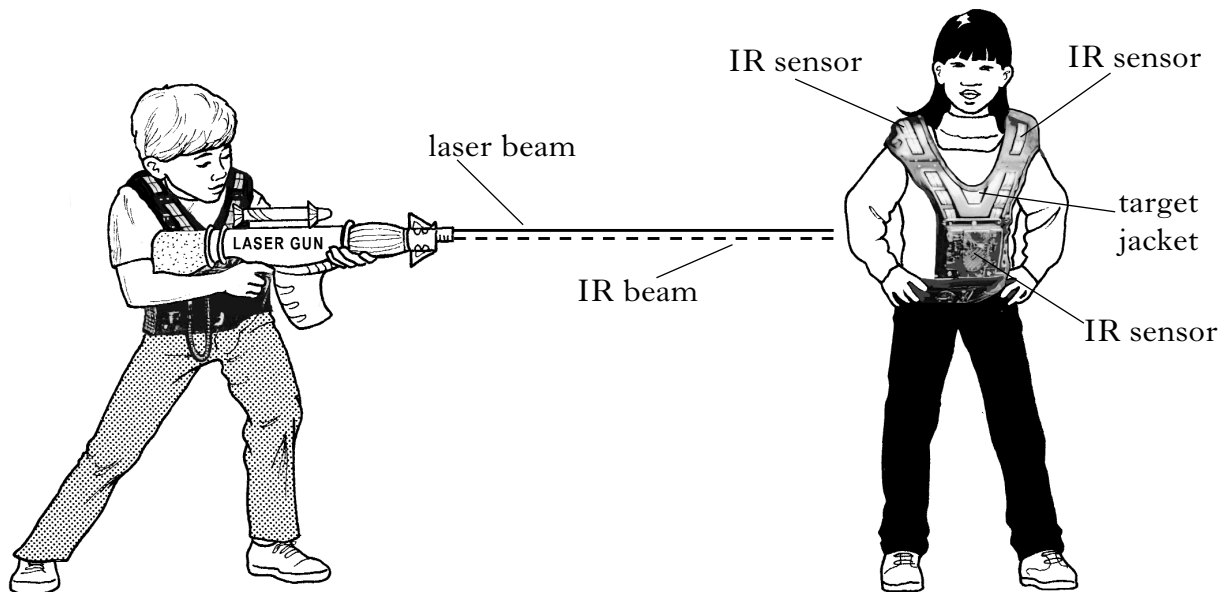


The table shows the readings on some of the meters.

V_1	6 V
A_1	60 mA
V_3	4.8 V
A_3	150 mA

- (a) Why must a.c. be used in this circuit? 1
- (b) All lamps are identical. Calculate the power of lamp Q. 3
- (c) Transformer Y has 1000 turns in the primary coil and 50 turns in the secondary coil. Calculate the reading on voltmeter V_2 assuming the transformer is 100% efficient. 2
- (d) Is the reading on A_2 larger, smaller or the same as the reading on A_3 ?
Explain your answer. 2
- (8)**

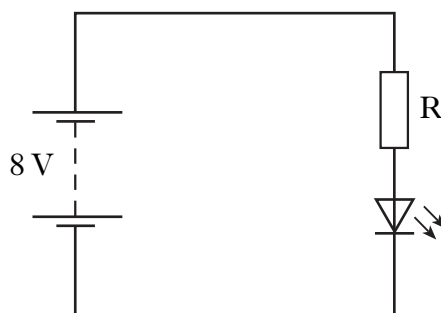
25. A group of students visit a Laser Game Centre. The laser gun emits both a visible beam and an IR beam. Each target jacket contains three IR sensors.



- (a) (i) What does the term IR stand for? 1
 (ii) Which of the two beams arrives at the target first?
 You **must** explain your answer. 2

- (b) The laser gun operates from a 7.2 V rechargeable battery. The battery is charged from the mains and takes two hours to fully recharge. A current of 3 A is used in the charging circuit.
 Calculate how much charge the battery stores when fully charged. 2

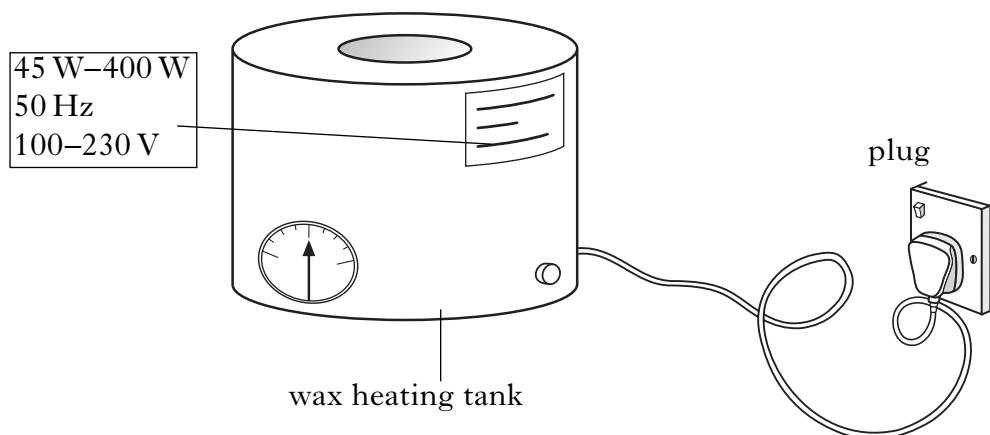
- (c) When the IR beam hits a sensor on the target jacket, the following circuit is completed and the LED lights. The LED has an operating voltage of 2 V and an operating current of 15 mA. The circuit has an 8 V supply.



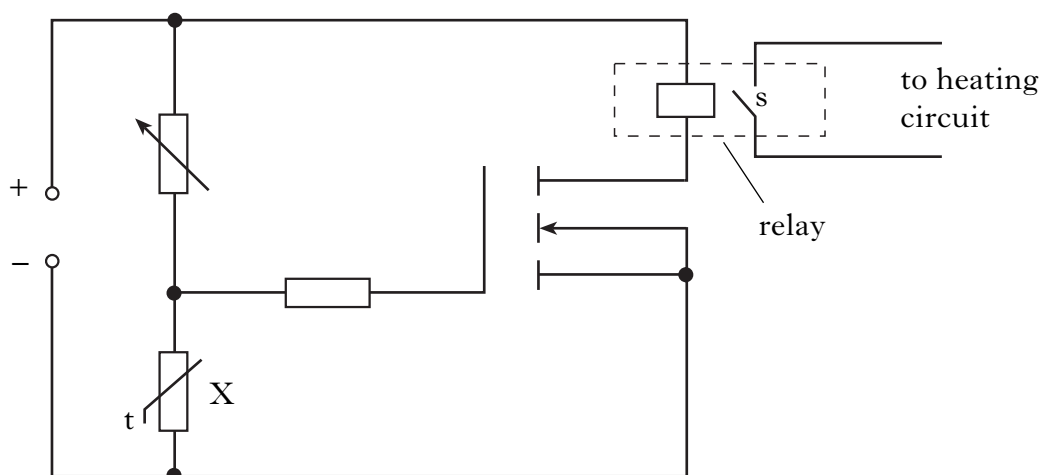
- Calculate the value of resistor R. 3
(8)

[Turn over

26. At a beauty salon, a beautician uses hot wax to help remove hair from a client's leg. It is very important that the wax remains at a constant temperature in the heating tank.



When the wax drops below a certain temperature, a heater is automatically switched on. A simplified circuit is shown.

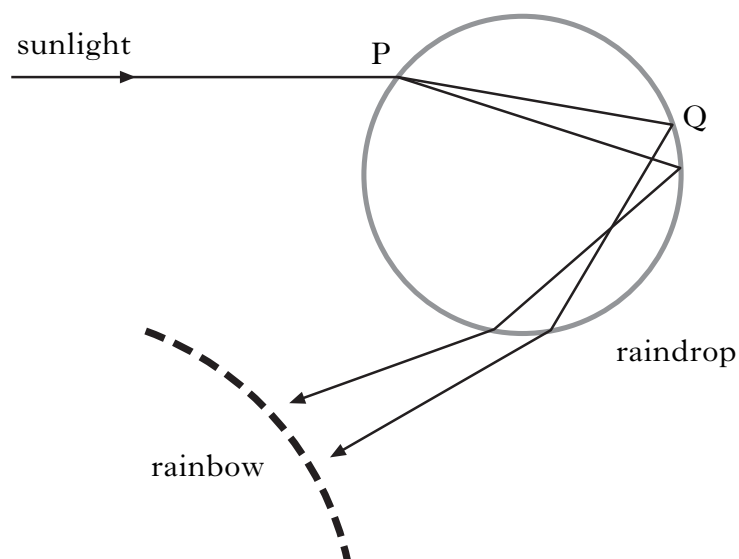


- | | |
|--|-----|
| (a) Name component X. | 1 |
| (b) Explain how the circuit works to switch the heater on. | 3 |
| (c) What is the purpose of the variable resistor? | 1 |
| | (5) |

27. When the sun shines during a shower of rain, a rainbow can sometimes be seen.



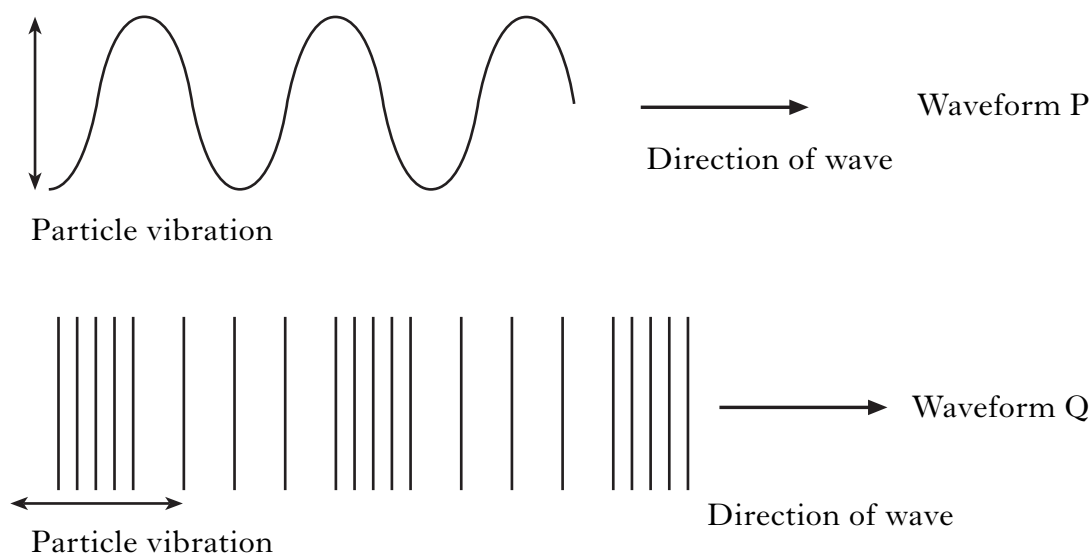
The diagram shows what happens to sunlight when it enters a raindrop.



- (a) (i) Name the wave effect that happens at point P. 1
- (ii) Name the wave effect that happens at point Q. 1
- (iii) Which colour of the rainbow has the longest wavelength? 1
- (b) As a raindrop falls it reaches a steady speed.
- Using Newton's laws of motion, explain why it falls at a steady speed. 2
- (5)**

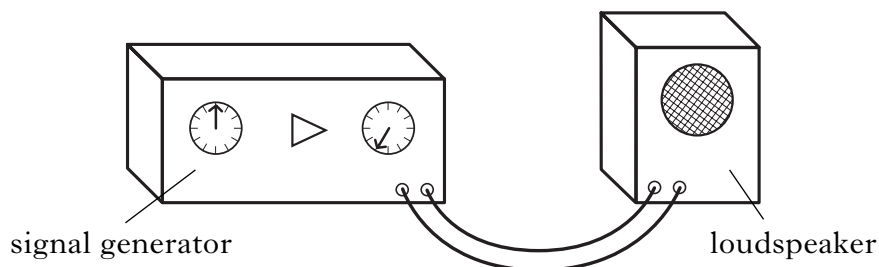
[Turn over

28. (a) Two types of waveform are shown.



- (i) Which waveform represents a longitudinal wave? 1
- (ii) Which waveform represents a sound wave? 1

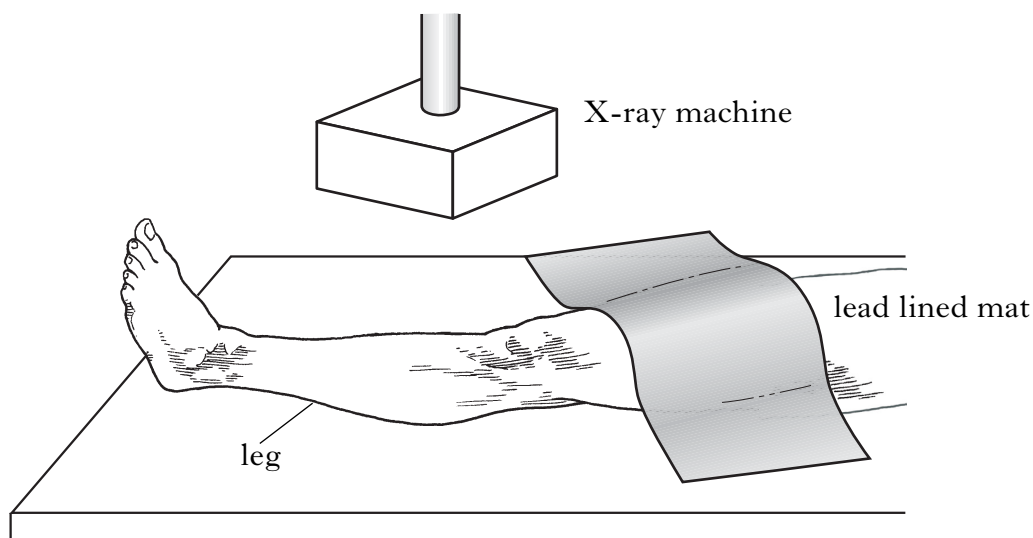
(b) A signal generator is connected to a loudspeaker which produces a sound wave of frequency 2 kHz.



- (i) Calculate the wavelength of the sound wave in air. 2
 - (ii) The loudspeaker is placed a distance of 10.2 m from a wall. Calculate the time taken for the sound to return to the loudspeaker. 2
- (c) The loudspeaker is now placed in a tank of carbon dioxide gas. The frequency remains at 2 kHz.
 What effect does this have on the wavelength of the sound?
 Explain your answer. 2

(8)

29. A football player injures his leg while playing in a match.

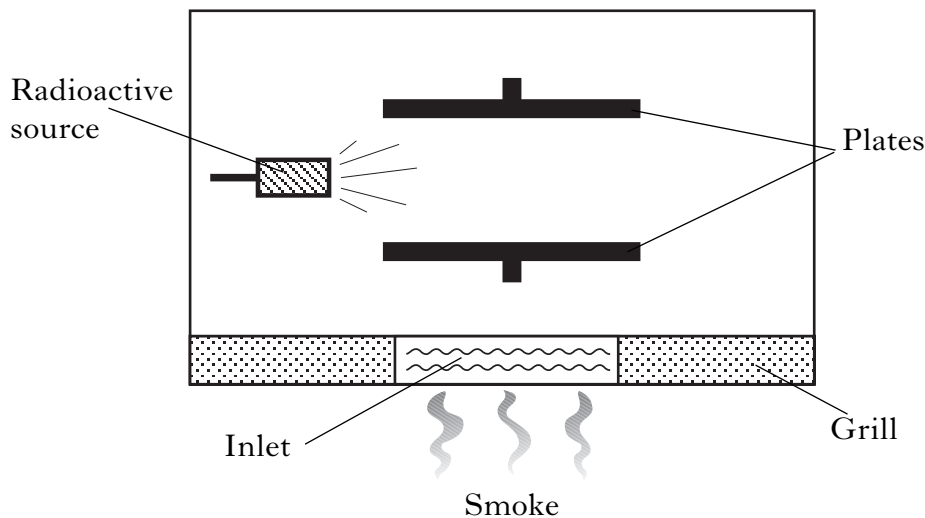


In hospital the player has three X-rays, each producing an absorbed dose of $50\mu\text{Gy}$.

- (a) The mass of the player's leg is 6 kg. Calculate the energy absorbed by the leg from the X-rays. 2
- (b) Why is the rest of the player's leg covered with a lead lined mat? 1
- (c) Apart from absorbed dose, name **one** other factor that contributes to biological harm. 1
- (4)**

[Turn over

30. A simplified diagram of a smoke detector is shown. Radiation from the source causes ionisation of the air molecules between the plates. This produces a small current in a circuit. When smoke particles pass between the plates, the current decreases and a buzzer sounds.



- (a) (i) What is meant by *ionisation*? 1
- (ii) Should the source be an alpha, beta or gamma emitter?
Explain your answer in terms of ionisation. 2
- (iii) A manufacturer is choosing a new source for its smoke detectors.
From the following information, select the most suitable source to use.
Explain your answer. 2

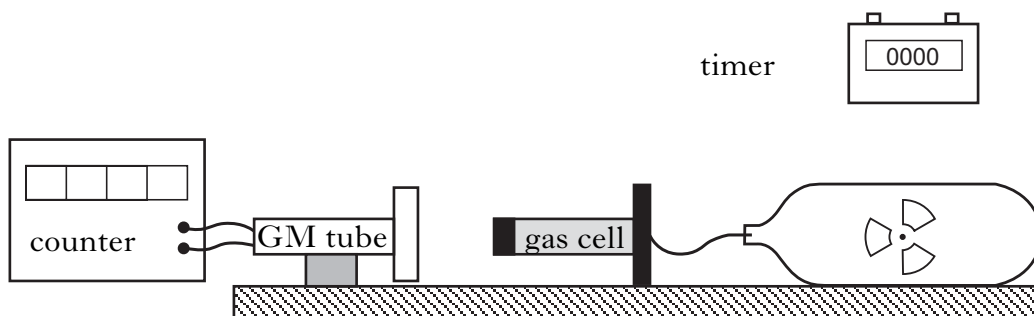
Source	Half-life (years)	Range (metres)
W	1	0.05
X	10	2.0
Y	100	0.05
Z	1000	2.0

- (b) The smoke detector circuit contains a 9 V battery. When there is no smoke present the operating current in the circuit is 30 mA.
- (i) Calculate the resistance of the circuit. 2
- (ii) State the energy change which takes place in the buzzer. 1

(8)

31. An experiment is carried out in a laboratory to determine the half-life of a radioactive source. A Geiger-Müller tube and counter are used to measure the background radiation over a period of 10 seconds. This is repeated several times and an average value of 4 counts in 10 seconds is recorded.

The apparatus shown is used to measure the count rate over a period of time. The readings are corrected for background radiation.



<i>Time (minutes)</i>	<i>Corrected count rate</i>
0	168
2	120
4	84
6	60
8	42
10	30
12	21

- (a) Name **two** factors that affect the background count rate. 2
- (b) Calculate the activity of the background radiation. 2
- (c) Calculate the half-life of the radioactive source. 2
- (6)**

[END OF QUESTION PAPER]

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