

# X069/201

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NATIONAL  
QUALIFICATIONS  
2001

MONDAY, 4 JUNE  
9.00 AM – 11.00 AM

PHYSICS  
INTERMEDIATE 2

## Read Carefully

- 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 Answer the questions numbered 1 to 20 on the answer sheet provided.
- 4 Fill in the details required on the answer sheet.
- 5 Rough working, if required, should be done only on this question paper, or on the first two pages of the answer book provided—**not** on the answer sheet.
- 6 For each of the questions 1 to 20 there is only **one** correct answer and each is worth 1 mark.
- 7 Instructions as to how to record your answers to questions 1–20 are given on page two.

## Section B (questions 21 to 31)

- 8 Answer the questions numbered 21 to 31 in the answer book provided.
- 9 Fill in the details on the front of the answer book.
- 10 Enter the question number clearly in the margin of the answer book beside each of your answers to questions 21 to 31.
- 11 Care should be taken to give an appropriate number of significant figures in the final answers to calculations.

## SECTION A

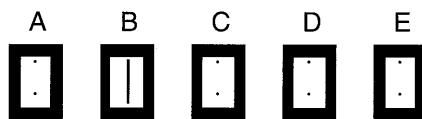
For questions 1 to 20 in this section of the paper, an answer is recorded on the answer sheet by indicating the choice A, B, C, D or E by a stroke made in ink in the appropriate box of the answer sheet—see the example below.

### EXAMPLE

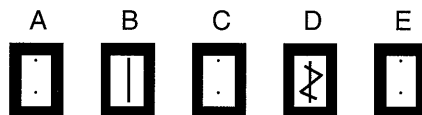
The energy unit measured by the electricity meter in your home is the

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

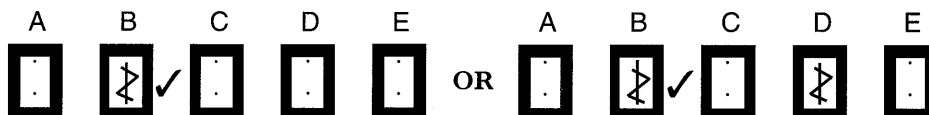
The correct answer to the question is B—kilowatt-hour. Record your answer by drawing a heavy vertical line joining the two dots in the appropriate box on your answer sheet in the column of boxes headed B. The entry on your answer sheet would now look like this:



If after you have recorded your answer you decide that you have made an error and wish to make a change, you should cancel the original answer and put a vertical stroke in the box you now consider to be correct. Thus, if you want to change an answer D to an answer B, your answer sheet would look like this:



If you want to change back to an answer which has already been scored out, you should enter a tick (✓) to the RIGHT of the box of your choice, thus:

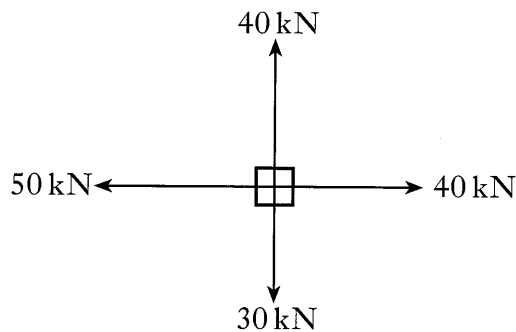


## SECTION A

**Answer questions 1–20 on the answer sheet.**

1. Which of the following pairs contain two scalar quantities?
- A Force and mass
  - B Weight and mass
  - C Displacement and speed
  - D Distance and speed
  - E Displacement and velocity

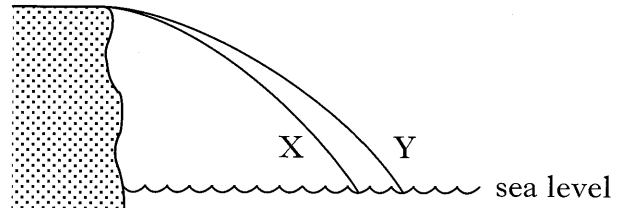
2. Four tugs apply forces to an oil-rig as shown.



Which of the following could represent the resultant force?

- A
- B
- C
- D
- E

3. Two identical balls X and Y are projected horizontally from the edge of a cliff. The paths they take are as shown below.



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

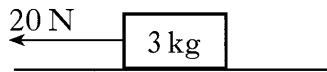
- I The balls take the same time to reach sea level.
- II The balls have the same vertical acceleration.
- III The balls have the same horizontal velocity.

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**

4. A block of mass 3 kg is pulled across a horizontal bench by a force of 20 N as shown below.



The block accelerates at  $4 \text{ m/s}^2$ .

The force of friction between the block and the bench is

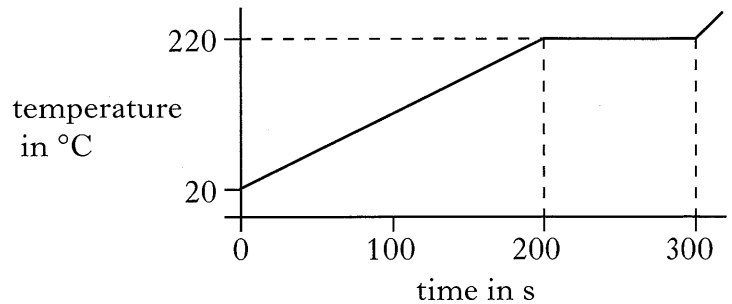
- A zero  
 B 8 N  
 C 12 N  
 D 20 N  
 E 32 N.
5. A ball of mass 2 kg rolls with a velocity of 4 m/s along a horizontal surface.

Which line of the table below correctly shows the momentum and kinetic energy of the ball?

	<i>Momentum</i> (kg m/s)	<i>Kinetic energy</i> (J)
A	2	4
B	4	8
C	4	16
D	8	8
E	8	16

6. A heater rated at 500 W is used to heat 1 kg of a substance. Initially the substance is in the solid state.

The following graph of temperature of substance against time is obtained.

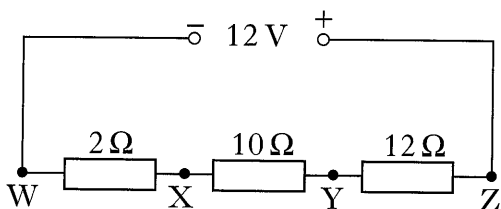


Which of the following values can be obtained from the information given?

- I The melting point of the substance.  
 II The specific heat capacity of the solid substance.  
 III The specific latent heat of fusion of the substance.
- A I only  
 B I and II only  
 C I and III only  
 D II and III only  
 E I, II and III
7. Which of the following is the unit of gravitational field strength?
- A kg m/s  
 B N m  
 C N m/s  
 D  $\text{kg m/s}^2$   
 E N/kg

8. An electric motor with an input power of 1 kW is 80% efficient. The "wasted" energy is all transferred as heat energy. How much heat energy is produced in 1 s?
- A 200 J  
 B 800 J  
 C 1000 J  
 D 2000 J  
 E 8000 J

9. A circuit is set up as shown below.



The potential difference between X and Y is

- A 1.2 V  
 B 4.0 V  
 C 5.0 V  
 D 10.0 V  
 E 12.0 V.
10. A car headlamp is operating at its rated values of 12 V and 48 W.

Which of the following statements is/are correct?

- I The lamp uses energy at the rate of 48 joules per second.  
 II The current through the lamp is 4 amperes.  
 III 12 coulombs of charge flow through the lamp every second.

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

11. The filament of a lamp has a resistance of  $3\ \Omega$  and the current through the filament is 2 A.

The electrical power produced by the lamp is

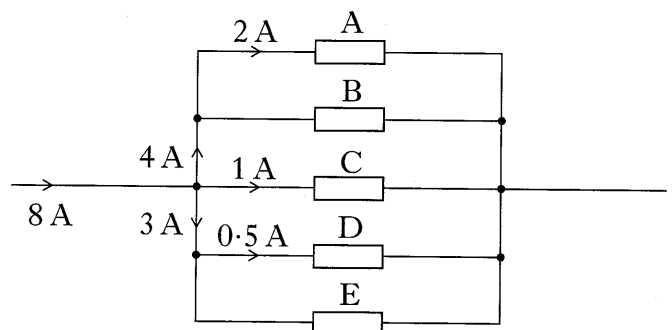
- A 1.5 W  
 B 6 W  
 C 12 W  
 D 18 W  
 E 36 W.

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

Which line in the table below correctly shows the output voltage and the output frequency?

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

13. Which resistor in the diagram below has the smallest resistance?



14. Which of the following devices converts heat energy into electrical energy?

- A Solar cell
- B Resistor
- C Thermocouple
- D Transformer
- E Transistor

15. The diagram shows part of the electromagnetic spectrum.

Radio waves	Micro-waves	Z	Visible light
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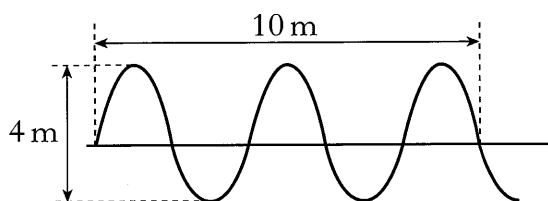
The radiation in the region marked Z is called

- A ultraviolet
- B infrared
- C X-rays
- D sound
- E gamma rays.

16. Which of the following waves is a longitudinal wave?

- A Microwaves
- B Radio waves
- C Sound waves
- D Light waves
- E Water waves

17. The following diagram gives information about a wave.

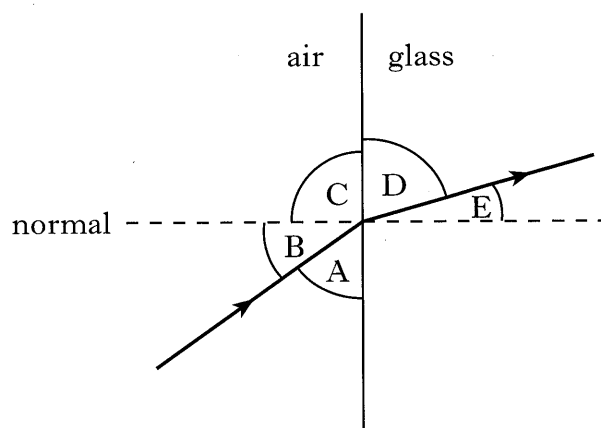


Which line in the table below correctly shows the amplitude and wavelength of the wave?

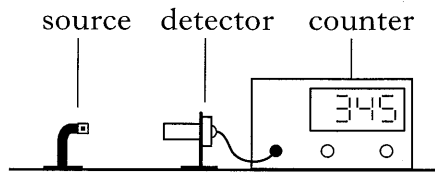
	<i>Amplitude</i> (m)	<i>Wavelength</i> (m)
A	2	2
B	2	4
C	2	5
D	4	2
E	4	4

18. A ray of light passes from air into glass as shown.

Which letter marks the angle of refraction?



19. Measurements of the count rate from a radioactive source were taken using the apparatus shown below.



A sheet of paper, 2 mm of aluminium and 15 mm of lead were placed in turn between the radioactive source and the detector.

Information about the count rate obtained with and without the absorbers is given in the following table.

<i>Absorber</i>	<i>Corrected count-rate</i> (counts per second)
none	80
1 sheet of paper	65
2 mm of aluminium	35
15 mm of lead	5

The radiation emitted by the source is

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

20. Which row in the table below shows the correct units for activity and dose equivalent?

	<i>Activity</i>	<i>Dose equivalent</i>
A	becquerel	gray
B	becquerel	sievert
C	gray	sievert
D	gray	becquerel
E	sievert	gray

**[Turn over**

SECTION B

Marks

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

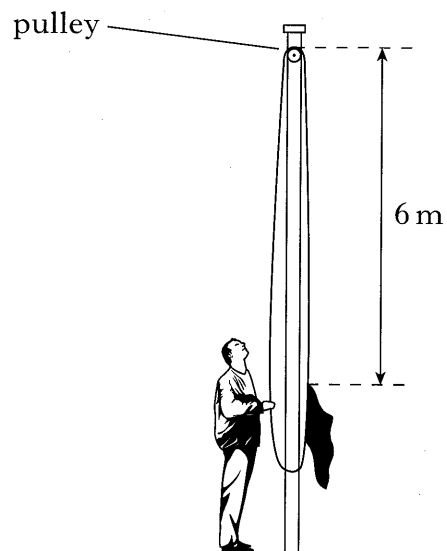
21. A flag is raised at the opening of an athletics competition. The mass of the flag is 0.5 kg and it is raised at constant speed through a height of 6 m.

(a) Calculate the gravitational potential energy gained by the flag. 2

(b) A constant force of 7 N is applied to raise the flag.  
Calculate the work done raising the flag. 2

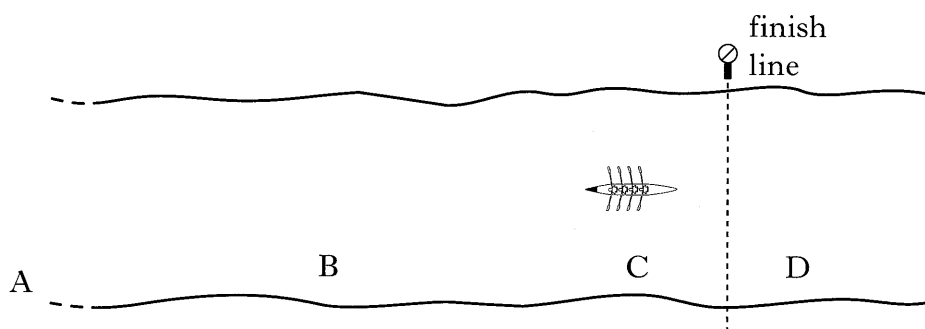
(c) Explain why there is a difference between the answers to parts (a) and (b). 2

(6)

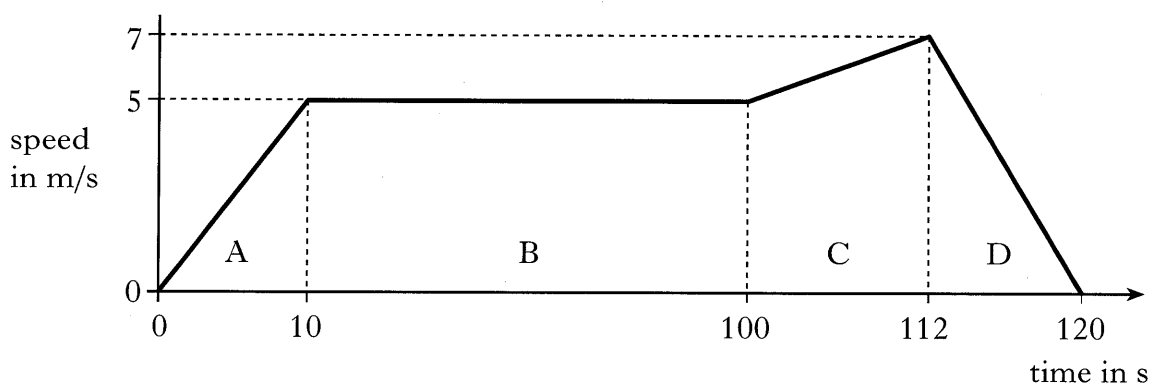




22. A rowing team is taking part in a race on calm water.



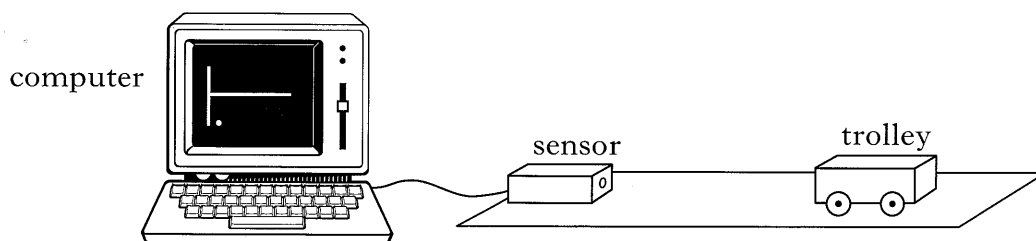
The following graph shows how it is predicted that the speed of the boat will vary with time during the stages A, B, C and D of the race.



The prediction assumes that the frictional force on the team's boat remains constant at 800 N during the race.

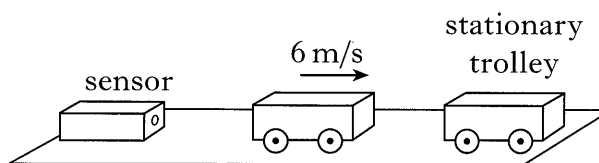
- (a) (i) State the size of the forward force applied by the oars during stage B. 1
- (ii) Calculate the acceleration of the boat during stage C. 2
- (iii) The total mass of the boat and its crew is 400 kg.  
Calculate the size of the forward force applied by the oars during stage C. 3
- (iv) The boat crosses the finishing line after 112 seconds.  
Calculate the distance the boat travels **from the instant it crosses the line** until it comes to rest. 2
- (b) The frictional force acting on the boat during stage D actually becomes smaller as the speed decreases.
- (i) What will be the effect of this smaller frictional force on the time taken for the boat to come to rest? 1
- (ii) Sketch a graph of speed against time for stage D, assuming that the frictional force becomes smaller as the speed decreases. 1
- (10)**

23. A sensor linked to a computer can be used to measure the distance between a trolley and the sensor. Pulses of ultrasound are emitted from the sensor. The pulses are reflected from the trolley and are detected by the sensor.

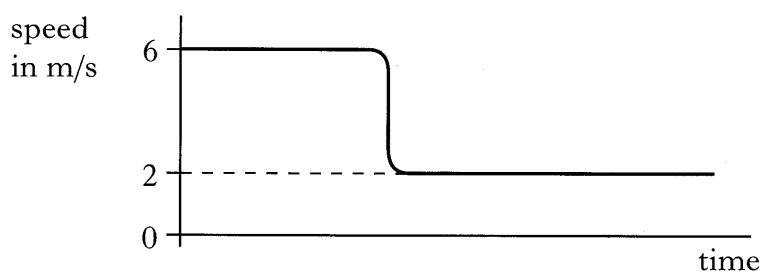


- (a) Ultrasound travels at a speed of 340 m/s in air. The time between the pulses leaving the sensor and the reflected pulses being detected is 5 ms. Calculate the distance between the sensor and the trolley. 3

- (b) The trolley, which has a mass of 1.5 kg, is now given a push so that it moves away from the sensor with a speed of 6 m/s. The trolley collides with a second trolley which is stationary and the two trolleys stick together.



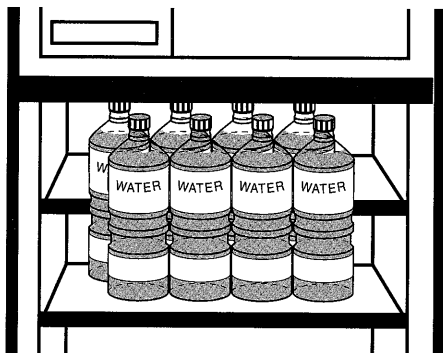
The computer produces the following speed-time graph of the motion before and after the collision.



Calculate the mass of the second trolley. 3

(6)

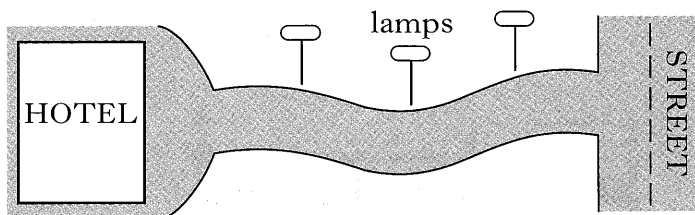
24. Some bottles of water are placed in a compartment of a refrigerator. The refrigerator reduces the temperature of the water from  $22.0^{\circ}\text{C}$  to  $10.0^{\circ}\text{C}$ . The **total** mass of water in the bottles is  $2.40\text{ kg}$ .



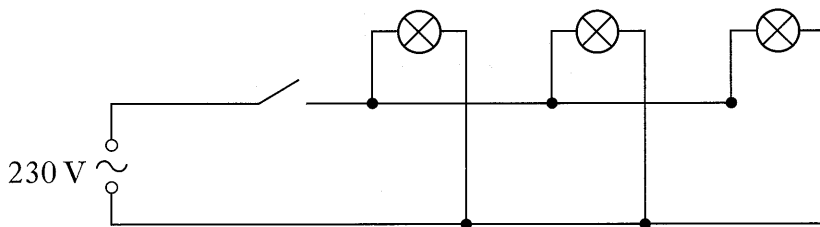
- (a) The specific heat capacity of the water is  $4200\text{ J/kg }^{\circ}\text{C}$ .  
Show that the heat energy lost by the water is  $121\text{ kJ}$ , correct to 3 significant figures. 2
- (b) The refrigeration system removes heat energy from the compartment at a rate of  $100\text{ J/s}$ .
- (i) Assuming that heat is removed **from the water** at this rate, how long will it take to lower the water temperature from  $22.0^{\circ}\text{C}$  to  $10.0^{\circ}\text{C}$ ? 2
- (ii) Explain why the actual time taken to lower the temperature of the water will be longer than the value you calculated in part (i). 1
- (5)

[Turn over

25. A hotel owner decides to instal three lamps on the drive between the hotel and the street.

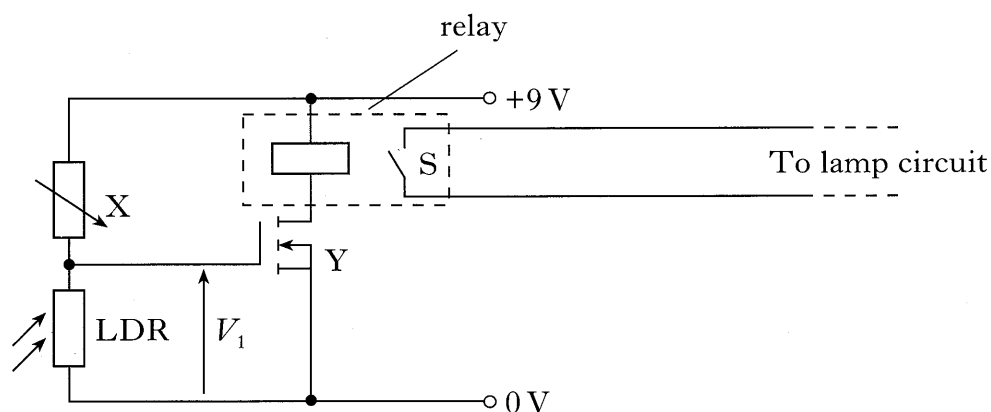


The circuit diagram below shows how the lamps are connected to the mains supply.



Each lamp has a rating of 230 V, 200 W.

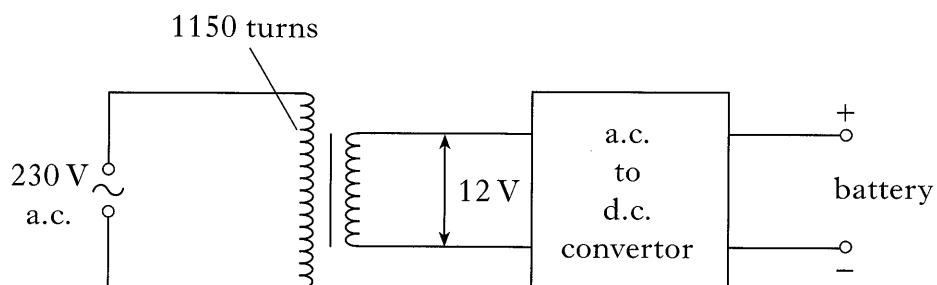
- (a) Explain why the lamps must be connected in parallel. 1
- (b) Calculate the resistance of each lamp. 2
- (c) Calculate the current drawn from the supply when all three lamps are operating. 3
- (d) The lamps are connected to the circuit shown below so that they come on automatically when it gets dark.



- (i) Identify components labelled X and Y. 2
- (ii) Component Y switches on when the voltage  $V_1$  reaches 2.4 V. Switch S is closed when there is a current in the relay. Explain how this circuit will switch the lamps on when it becomes dark. 3

(11)

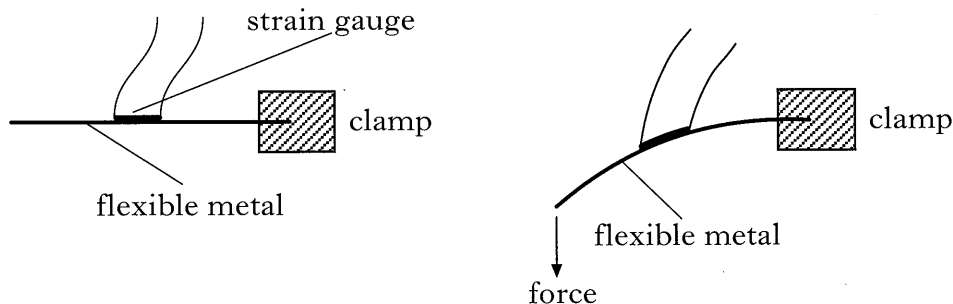
26. In a car battery charger, a transformer is used to step voltage down from 230 V to 12 V. The stepped down voltage is converted to d.c. using a converter. The circuit is shown below.



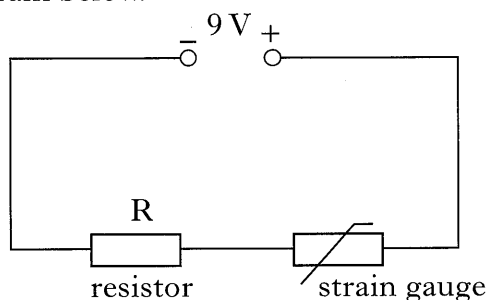
- (a) There are 1150 turns on the primary coil.  
Calculate the number of turns on the secondary coil. 2
- (b) (i) What do the initials d.c. stand for? 1
- (ii) Explain what d.c. means in terms of electron flow in a circuit. 1
- (c) The charger delivers a current of 400 mA to the battery for a period of 5 hours.  
Calculate the charge delivered to the battery during this time. 2
- (6)**

**[Turn over**

27. A strain gauge is an electrical device that is attached to an object. The strain gauge detects a change in the shape of the object. In the following diagrams, the strain gauge is shown attached to a piece of flexible metal.



When a force is applied to the end of the piece of metal, it bends. When the metal is bent, the strain gauge also bends and its resistance changes. The strain gauge is connected in series with a resistor,  $R$ , and a  $9\text{ V}$  supply as shown in the circuit diagram below.



- (a) A student is asked to find the resistance of the strain gauge using a voltmeter and an ammeter. Redraw the diagram to show how the student should connect the meters to measure the resistance of the strain gauge. 2
- (b) The student obtains the following results.

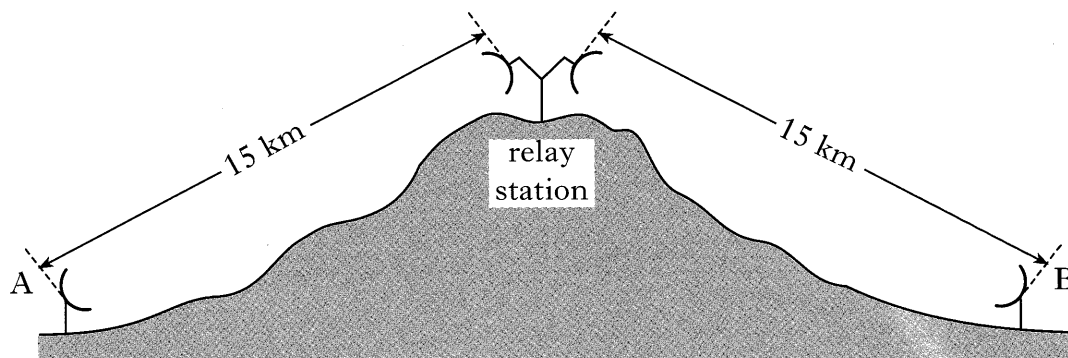
	<i>Voltmeter reading (V)</i>	<i>Ammeter reading (mA)</i>
No force applied	7.20	60.0
Force applied	7.23	59.0

Does the resistance of the strain gauge increase or decrease when the force is applied to the piece of metal? You must justify your answer. 3

- (c) Calculate the resistance of the resistor  $R$ . 3

(8)

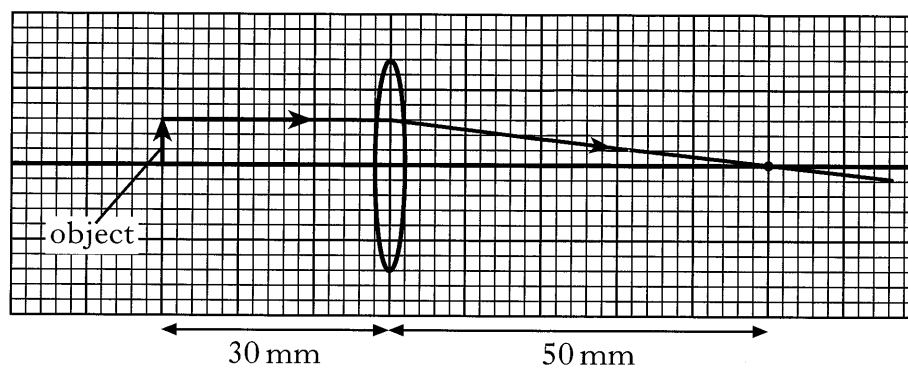
28. A telecommunications company uses microwaves to transmit information between two positions A and B separated by a range of hills. A relay station on top of the hills receives and transmits the signals using curved reflectors.



- (a) Explain why a curved reflector is used to receive a signal. Your answer should include a diagram. 2
- (b) The microwaves have a wavelength of 15 mm and a speed of  $3 \times 10^8$  m/s in air. Calculate the frequency of the microwaves. 2
- (c) Calculate the minimum time taken by the microwaves to travel from A to B. 3
- (d) The relay station requires an energy source but is too remote to have a mains electricity supply. Suggest a possible alternative supply. 1
- (8)**

[Turn over

29. (a) The diagram shows the path of one ray of light from the top of an object placed in front of a converging lens.



- (i) Copy and complete the diagram to find the position of the image. Draw the image on your diagram.  
You may use the graph paper provided.
- (ii) Using information from the diagram, calculate the power of the lens.
- (b) People with long sight need converging lenses to improve their vision. What is meant by long sight?

2

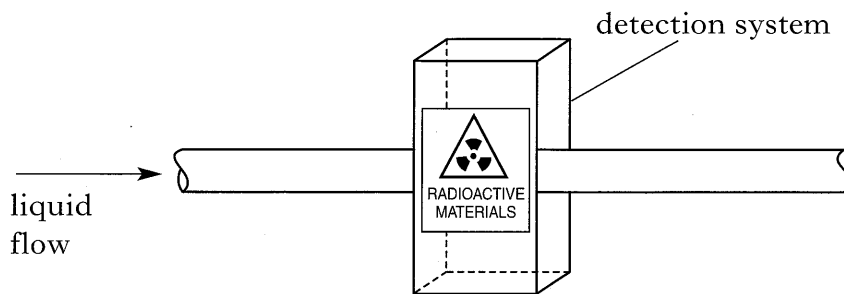
3

1

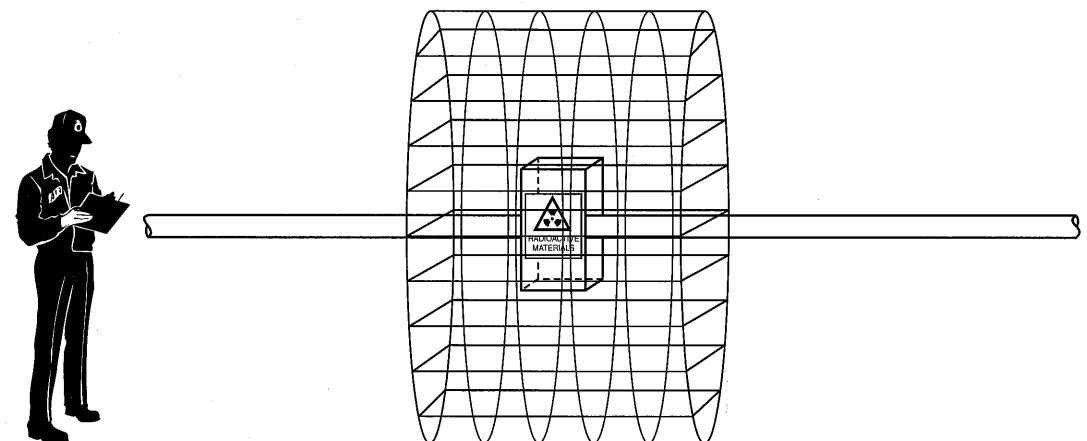
(6)



30. The oil industry uses radioactive sources to monitor the flow of liquids in pipes. The complete detection system is attached to the outside of the pipe as shown.



- (a) The source used has an activity of  $1.11 \text{ GBq}$ .  
Explain what is meant by this statement. 2
- (b) A sample of tissue exposed to this radiation receives an absorbed dose of  $0.13 \text{ mGy}$ .  
The quality factor of the radiation is 9. Calculate the dose equivalent for this sample. 2
- (c) The system is surrounded by a large cage as shown in the diagram.

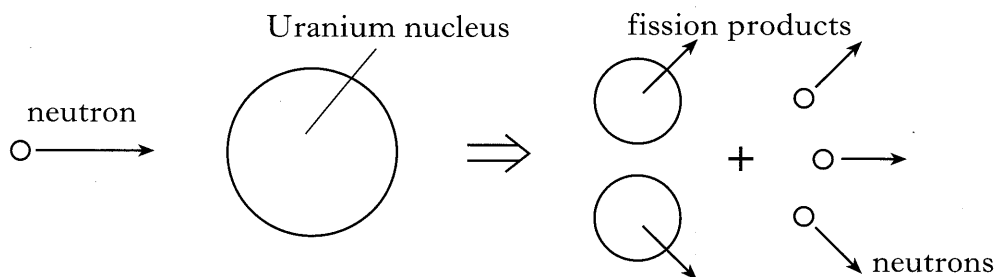


What is the purpose of this cage?

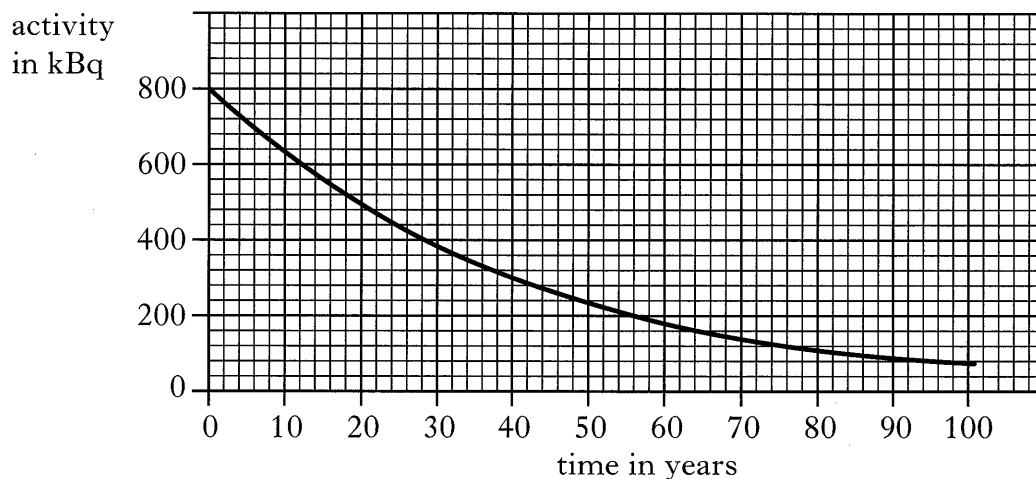
2  
(6)

[Turn over

31. In a nuclear reactor, uranium nuclei are bombarded by neutrons. Fission products and additional neutrons are produced. Energy is also released.



- (a) In a reactor, what is the purpose of
- (i) the coolant? 1
  - (ii) the moderator? 1
- (b) Explain how the additional neutrons can cause a chain reaction. 2
- (c) A graph of activity against time for a sample of one of the fission products is shown below.



- (i) From the graph, determine the half life of the fission product. 2
- (ii) A scientist states that the sample will be safe only when the activity falls to 120 kBq. How long will it take for the activity to fall to this level? 1
- (iii) State a suitable method of storing the sample during the time it takes for the activity to fall to the safe level. 1

(8)

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