

**x069/11/02**

# 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	$3.0 \times 10^8$
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	$2.3 \times 10^8$

### 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 latent heat of fusion of materials

Material	Specific latent heat of fusion in J/kg
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	$3.34 \times 10^5$

### Specific latent heat of vaporisation of materials

Material	Specific latent heat of vaporisation in J/kg
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	$22.6 \times 10^5$

### 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

### 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
Silica	1033
Water	4180

### 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	2737

### Radiation weighting factors

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

## SECTION A

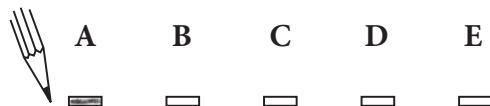
For questions 1 to 20 in this section of the paper the answer to each question is either A, B, C, D or E. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided—see the example below.

### EXAMPLE

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

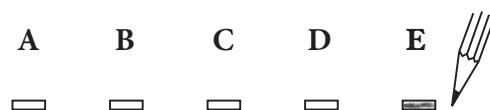
- A kilowatt-hour
- B ampere
- C watt
- D coulomb
- E volt.

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**.



## SECTION A

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

1. Which row in the table contains only vector quantities?

A	momentum	displacement	force
B	distance	velocity	energy
C	momentum	speed	force
D	force	energy	distance
E	speed	distance	time

2. A seagull is flying horizontally at a speed of 8 m/s. The seagull drops a piece of food which hits the ground 2.5 s later.

Which row in the table shows the horizontal and vertical speeds of the piece of food just as it hits the ground? The effects of air resistance can be ignored.

	Horizontal speed (m/s)	Vertical speed (m/s)
A	0	8
B	8	20
C	8	25
D	25	25
E	33	50

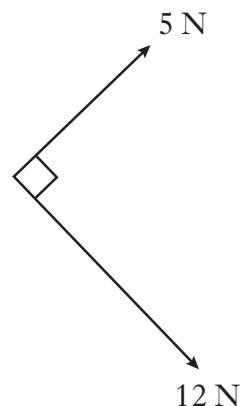
3. A robot has a weight of 900 N on Earth.

The gravitational field strength on Mars is 4 N/kg.

Which row in the table shows the mass and weight of the robot on Mars?

	Mass (kg)	Weight (N)
A	90	360
B	90	225
C	900	3600
D	9000	360
E	9000	3600

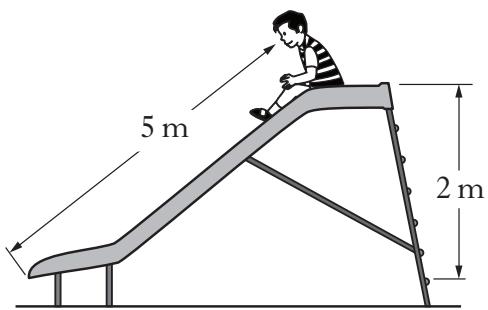
4. Two forces act on an object at right angles as shown.



The size of the resultant force is

A 7 N  
 B 13 N  
 C 17 N  
 D 60 N  
 E 169 N.

5. A diagram of a slide is shown.



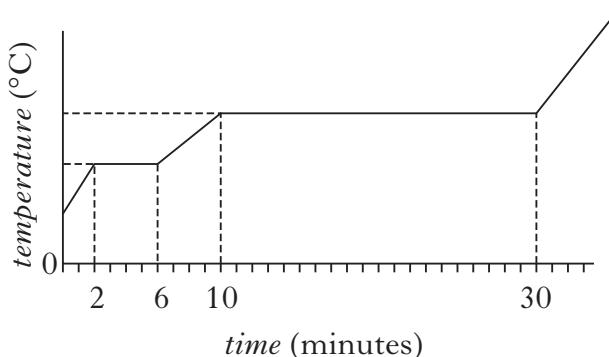
A child of weight 250 N slides from the top to the bottom.

The change in gravitational potential energy of the child is

- A 50 J
- B 500 J
- C 1250 J
- D 5000 J
- E 12 500 J.

6. A solid substance is placed in an insulated flask and heated continuously with an immersion heater.

The graph shows how the temperature of the substance in the flask changes with time.



After 5 minutes the substance is a

- A solid
- B liquid
- C gas
- D mixture of solid and liquid
- E mixture of liquid and gas.

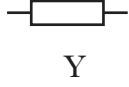
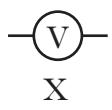
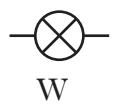
7. A hair dryer is connected to a 230 V supply. The current in the hair dryer is 2.0 A.

The electrical charge that passes through the hair dryer in 5 minutes is

- A 10 C
- B 460 C
- C 600 C
- D 1150 C
- E 2300 C.

**[Turn over**

8. Four circuit symbols, W, X, Y and Z, are shown.



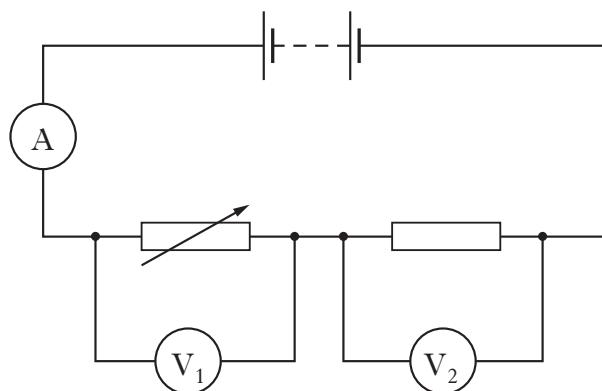
Which row in the table identifies the components represented by these symbols?

	W	X	Y	Z
A	battery	ammeter	resistor	variable resistor
B	battery	ammeter	fuse	resistor
C	lamp	ammeter	variable resistor	resistor
D	lamp	voltmeter	resistor	fuse
E	lamp	voltmeter	variable resistor	fuse

9. 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 power developed in the circuit
- D energy given to the charges in the circuit
- E current in the circuit.

10. A circuit is set up as shown.



The resistance of the variable resistor is increased.

Which row in the table shows the change in the readings on the ammeter and voltmeters?

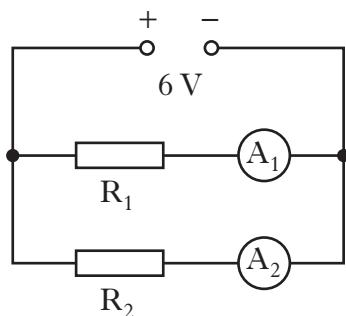
	<i>Reading on ammeter</i>	<i>Reading on voltmeter <math>V_1</math></i>	<i>Reading on voltmeter <math>V_2</math></i>
A	increases	increases	increases
B	decreases	unchanged	decreases
C	increases	unchanged	decreases
D	decreases	increases	decreases
E	increases	decreases	increases

**[Turn over**

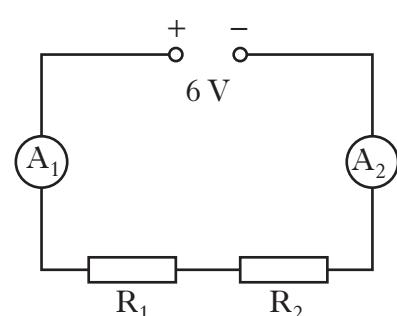
11. A student suspects that ammeter  $A_1$  may be inaccurate. Ammeter  $A_2$  is known to be accurate.

Which of the following circuits should be used to compare the reading on  $A_1$  with  $A_2$ ?

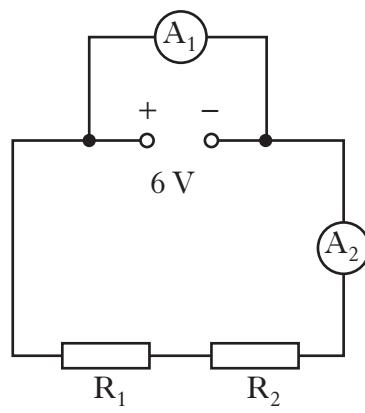
A



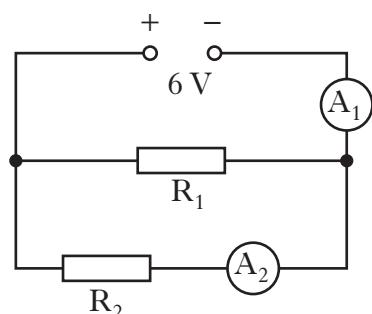
B



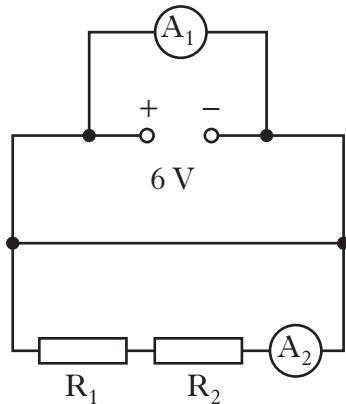
C



D



E



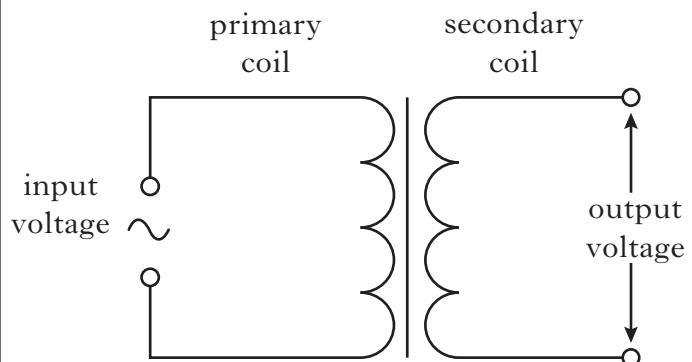
12. The mains supply voltage in the UK is quoted as 230 V.

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

	Peak voltage (V)	Mains frequency (Hz)
A	163	50
B	230	50
C	230	60
D	325	50
E	325	60

13. A student investigates the operation of a transformer.

The circuit used is shown.



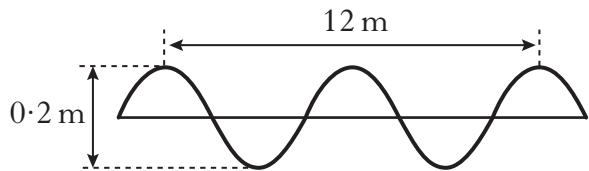
The input voltage and the number of turns on both the primary and secondary coils of the transformer are varied.

Which row in the table shows the combination that would produce the greatest output voltage?

	Input voltage (V)	Number of turns on the primary coil	Number of turns on the secondary coil
A	2	200	8000
B	2	200	40
C	4	200	8000
D	4	400	20
E	8	400	2000

**[Turn over**

14. The diagram represents a wave.



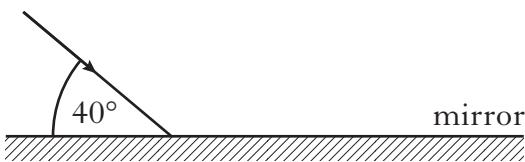
Which row in the table shows the wavelength and amplitude of the wave?

	Wavelength (m)	Amplitude (m)
A	4	0.2
B	6	0.1
C	6	0.2
D	12	0.1
E	12	0.2

15. A water wave is an example of a transverse wave. When water waves travel, the particles of water

- A move continuously towards the source
- B move continuously away from the source
- C vibrate at random
- D vibrate along the wave direction
- E vibrate at  $90^\circ$  to the wave direction.

16. A ray of light strikes a plane mirror at an angle of  $40^\circ$  to the mirror surface.



Which row shows the correct values of angle of incidence and angle of reflection for this ray?

	Angle of incidence	Angle of reflection
A	$40^\circ$	$40^\circ$
B	$40^\circ$	$50^\circ$
C	$40^\circ$	$140^\circ$
D	$50^\circ$	$40^\circ$
E	$50^\circ$	$50^\circ$

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

- I The student is short sighted.
- II Concave lenses are converging lenses.
- III The glasses help the student to see near objects clearly.

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

18. Which row in the table describes alpha ( $\alpha$ ), beta ( $\beta$ ) and gamma ( $\gamma$ ) radiations?

	$\alpha$	$\beta$	$\gamma$
A	helium nucleus	electro-magnetic radiation	electron from the nucleus
B	helium nucleus	electron from the nucleus	electro-magnetic radiation
C	electron from the nucleus	helium nucleus	electro-magnetic radiation
D	electro-magnetic radiation	helium nucleus	electron from the nucleus
E	electro-magnetic radiation	electron from the nucleus	helium nucleus

19. A student states that the risk of biological harm from exposure to radiation depends on the:

- I tissue exposed;
- II type of radiation;
- III activity of the radioactive source.

Which of the statements is/are correct?

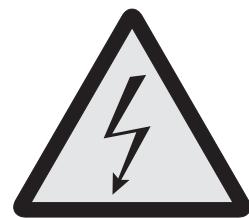
- A I only
- B II only
- C I and II only
- D II and III only
- E I, II and III

20. Identify the radioactive hazard sign from the following.

A



B



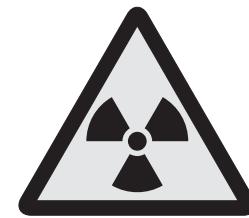
C



D



E



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

## SECTION B

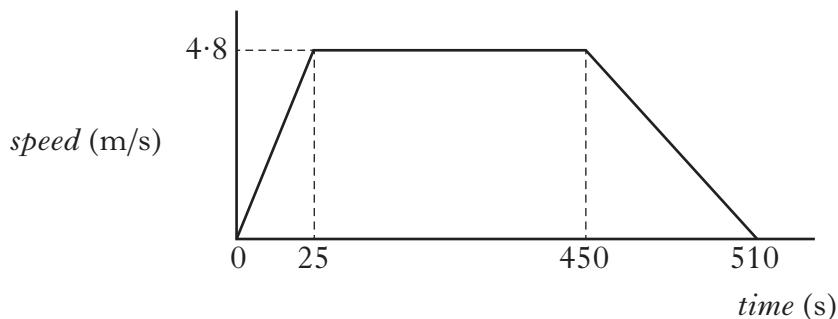
*Marks*

**Write your answers to questions 21–30 in the answer book.  
All answers must be written clearly and legibly in ink.**

21. In a rowing event a boat moves off in a straight line.



A graph for the boat's motion is shown.



(a) (i) Calculate the acceleration of the boat during the first 25 s. 2  
(ii) Describe the motion of the boat between 25 s and 450 s. 1  
(iii) Draw a diagram showing the horizontal forces acting on the boat between 25 s and 450 s.  
You **must** name these forces and show their directions. 2

(b) The boat comes to rest after 510 s.  
(i) Calculate the total distance travelled by the boat. 2  
(ii) Calculate the average speed of the boat. 2

**(9)**

22. An arrow is fired at a target.



not to scale

The average forward force on the arrow is 500 N. The average frictional force acting on the arrow is 15 N. The arrow has a mass of 0.20 kg.

(a) Calculate the average acceleration of the arrow. 3

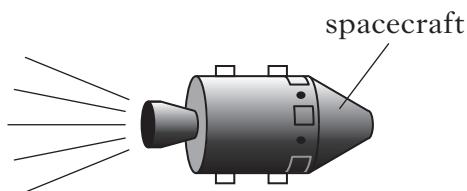
(b) The arrow hits the target and accelerates at  $-3600 \text{ m/s}^2$ . It comes to rest in 12 ms.  
Calculate the velocity of the arrow just before it hits the target. 2

(c) A second arrow of mass of 0.10 kg is now fired at the target with the same average forward force and the same average frictional force.  
Is the time taken for the second arrow longer, shorter or the same as the time taken for the first arrow to reach the target?  
You **must** explain your answer. 2

**(7)**

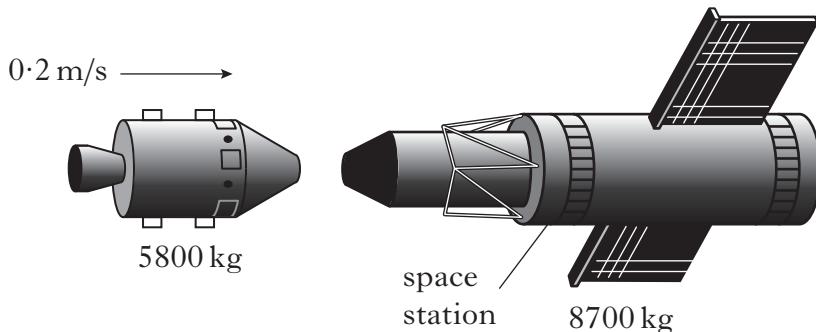
**[Turn over**

23. The rocket engine in a spacecraft burns fuel producing exhaust gases.



(a) Identify the Newton pair of forces involved. 1

(b) In deep space, the spacecraft approaches and docks with a stationary space station.



The spacecraft has a mass of 5800 kg and an initial velocity of 0.2 m/s. The space station has a mass of 8700 kg.

(i) Calculate the velocity of the spacecraft and space station after they have docked. 2

(ii) Calculate the kinetic energy of the spacecraft and space station after they dock. 2

(c) The spacecraft returns to Earth and passes through the atmosphere. The spacecraft has a heat shield of mass 931kg.

During the journey through the Earth's atmosphere the heat shield absorbs  $1.25 \times 10^9$  J of energy and its temperature rises by  $1300^{\circ}\text{C}$ .

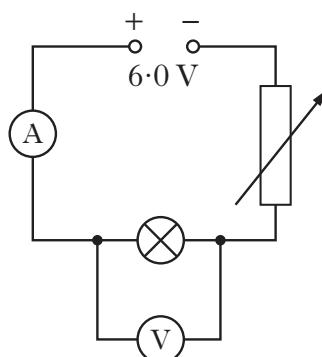
Using this information and the data sheet on *Page two*, identify the material from which the heat shield is made.

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

3

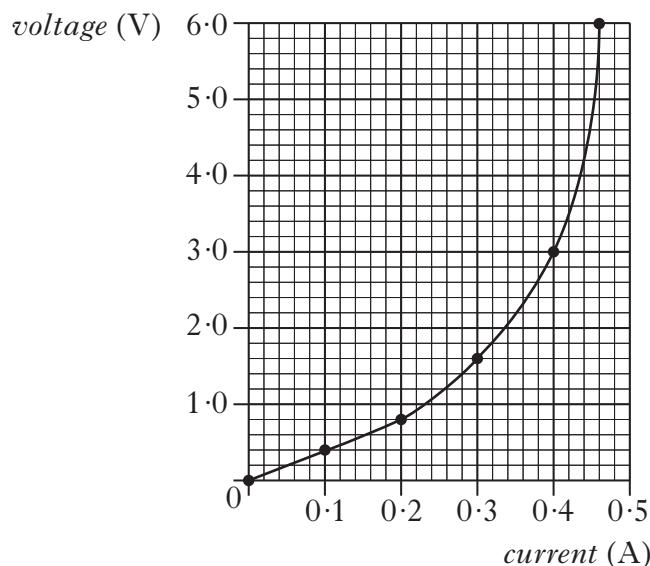
(8)

24. The circuit shown is used to investigate the relationship between voltage and current for a filament lamp.



(a) State the energy transformation in the filament lamp. 1

(b) The variable resistor is altered and readings of current and voltage are taken. These values are plotted on the graph shown.



(i) Calculate the resistance of the filament lamp when the current is 0.4 A. 2

(ii) What happens to the resistance of the filament lamp as the voltage across it increases?

You **must** justify your answer. 2

(c) In many modern electronic systems LEDs are used instead of filament lamps.

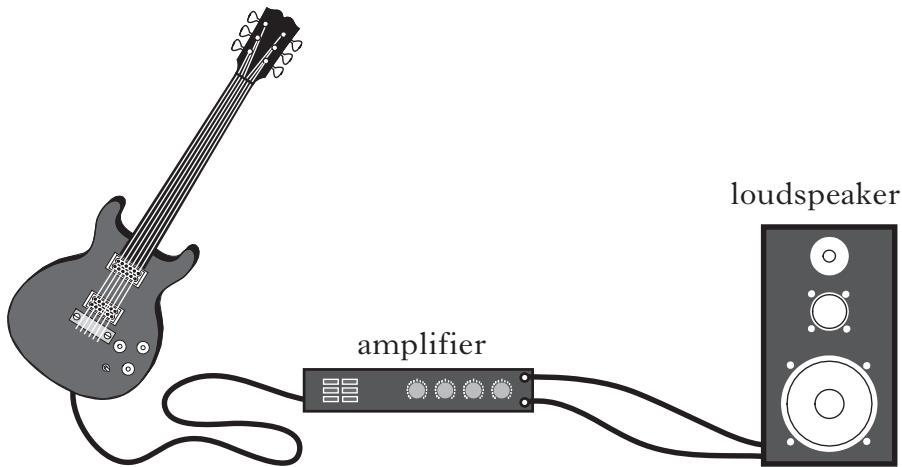
(i) Using a 6.0 V supply, a 2.0 V LED and one other suitable component, draw a circuit that would allow the LED to light. 2

(ii) A red LED emits light of wavelength  $6.0 \times 10^{-7}$  m. Calculate the frequency of this light. 2

(iii) Filament lamps and LEDs are examples of output devices. Name one other output device. 1

(10)

25. A guitar is connected to an amplifier and a loudspeaker. The input power to the amplifier from the guitar is  $20\text{ mW}$ . The output power from the amplifier is  $100\text{ W}$ . The loudspeaker has a resistance of  $9.0\Omega$ .



(a) (i) Calculate the power gain of the amplifier. 2

(ii) Calculate the voltage across the loudspeaker. 2

(b) A second loudspeaker with a resistance of  $6.0\Omega$  is connected in parallel with the first.  
Calculate the combined resistance of the two loudspeakers. 2

(c) The guitarist plays a note of frequency  $440\text{ Hz}$ . State the frequency of the output signal from the amplifier. 1

(d) A guitar string moves through a magnetic field. This induces a voltage in a coil of wire in the guitar.

(i) State one way in which the value of the induced voltage could be increased. 1

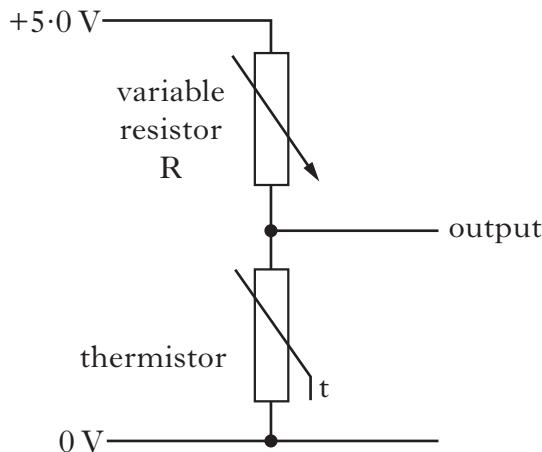
(ii) Explain in terms of electron flow what is meant by alternating current (a.c.). 1

(iii) Explain why the guitar string induces an **a.c.** voltage. 1

**(10)**

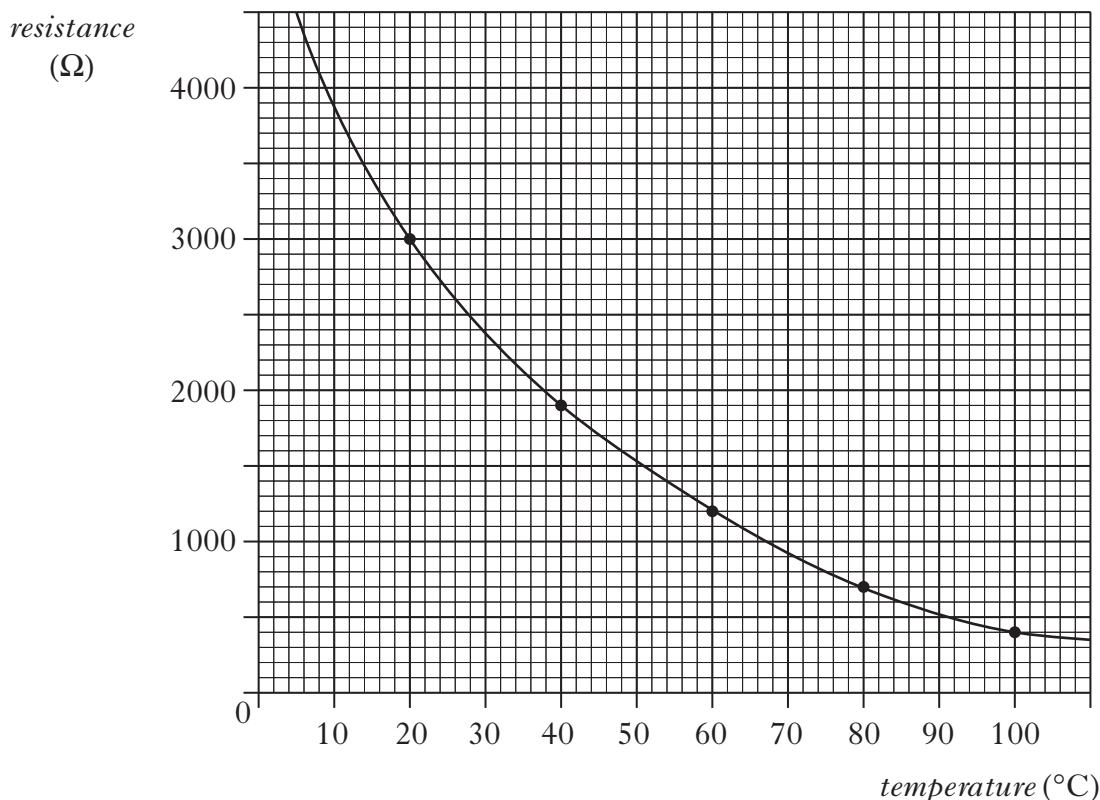
**[Turn over for Question 26 on *Page eighteen***

26. A thermistor is used as a temperature sensor in a circuit to monitor and control the temperature of water in a tank. Part of the circuit is shown.



(a) (i) The variable resistor  $R$  is set to a resistance of  $1050\ \Omega$ . Calculate the resistance of the thermistor when the voltage across the thermistor is  $2.0\text{ V}$ . 2

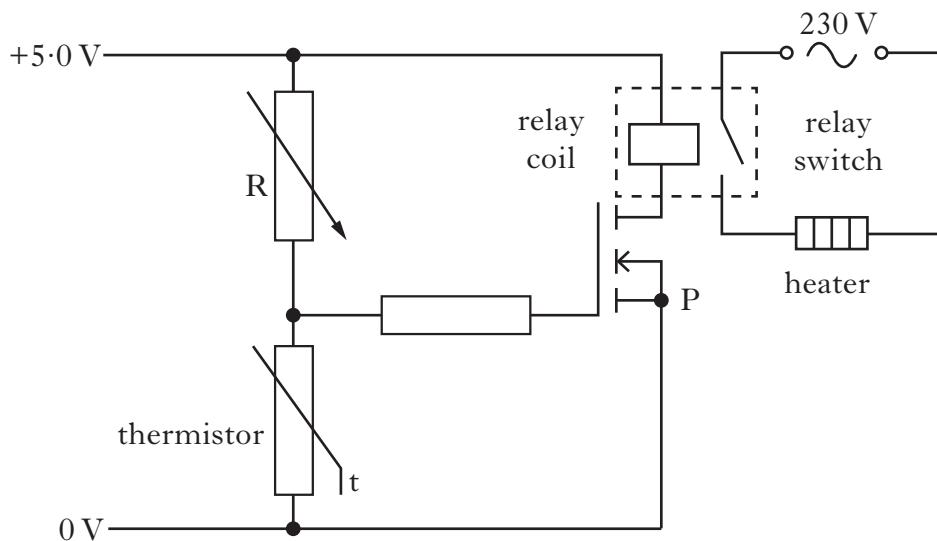
(ii) The graph shows how the resistance of the thermistor changes with temperature.



Use the graph to determine the temperature of the water when the voltage across the thermistor is  $2.0\text{ V}$ . 1

## 26. (continued)

(b) The circuit is now connected to a switching circuit to operate as a heater.



(i) Name component P. 1

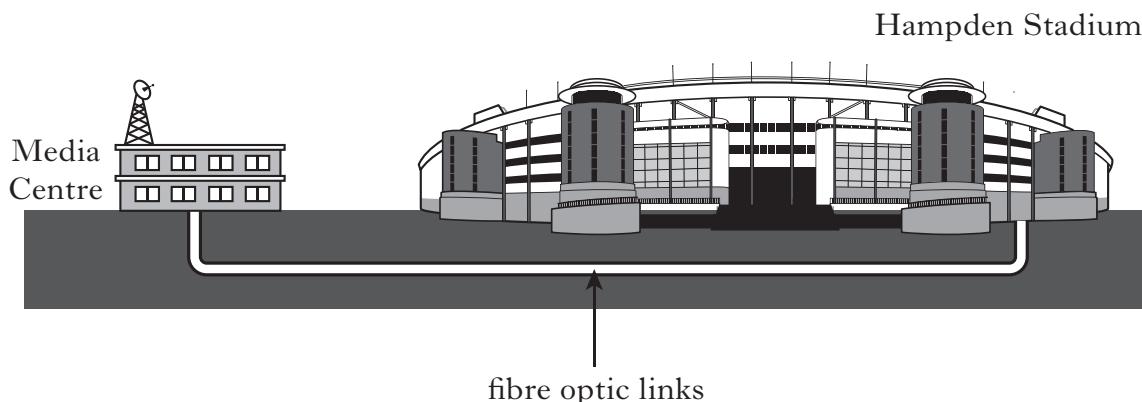
(ii) Explain how the circuit operates to switch on the heater when the temperature falls below a certain value. 3

(iii) The resistance of the variable resistor R is now increased.  
What effect does this have on the temperature at which the heater is switched on?  
You **must** explain your answer. 2

(9)

[Turn over

27. For the Commonwealth Games in Glasgow in 2014, fibre optic links will be used to carry TV signals from Hampden Stadium to the media centre.



(a) The fibre optic link consists of a bundle of glass optical fibres.

(i) Name the effect used to transmit light through a glass optical fibre. 1

(ii) The optical fibre has a length of 1.6 km. Calculate the minimum time taken for a light signal to travel along the fibre. 3

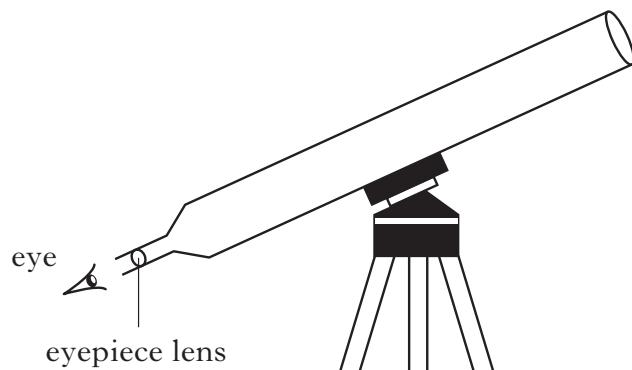
(b) Volunteers directing spectators use mobile phones for communication.

(i) A mobile phone uses microwaves of frequency 1200 MHz. Calculate the wavelength of these microwaves. 2

(ii) A second mobile phone operates with a frequency of 1800 MHz. The signals from each phone travel the same distance. How does the time taken for the signals from the second phone compare with the signals from the first phone? 1

(7)

28. An astronomer uses a refracting telescope to view distant objects in space.



(a) One of the lenses in this telescope has a focal length of 800 mm.

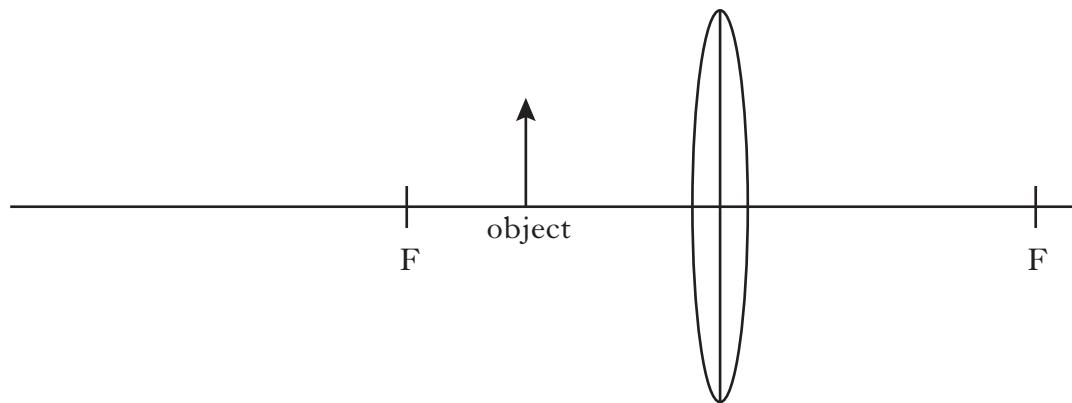
Calculate the power of this lens.

2

(b) The eyepiece lens in the telescope forms an image.

Copy and complete the diagram below by drawing appropriate rays of light to show the formation of the image. The image must be labelled.

2



(4)

[Turn over

29. An airport worker passes suitcases through an X-ray machine.



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(a) The worker has a mass of 80 kg and on a particular day absorbs 7.2 mJ of energy from the X-ray machine.

(i) Calculate the absorbed dose received by the worker. 2

(ii) The radiation weighting factor for X-ray is 1.

Calculate the equivalent dose received by the worker. 2

(b) The worker wears a badge containing photographic film.

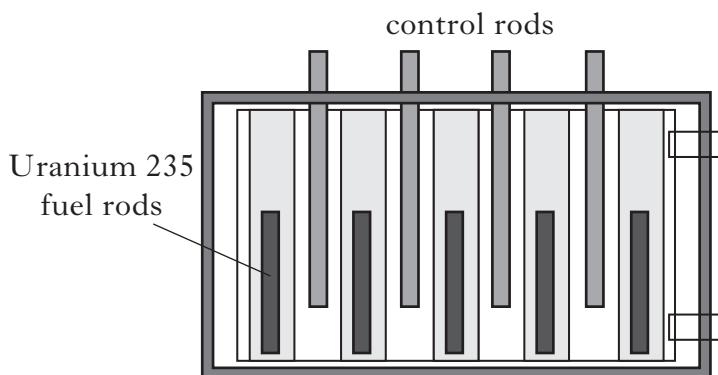
Explain how this can indicate if the worker has been exposed to radiation. 1

(c) X-rays can cause ionisation.

Explain what is meant by *ionisation*. 1

**(6)**

30. A nuclear reactor in a submarine uses uranium fuel rods. During a chain reaction uranium nuclei undergo nuclear fissions in the reactor.



(a) The reactor is fitted with boron control rods.

These can be lowered into the reactor.

What effect does this have on the chain reaction?

You **must** explain your answer.

2

(b) The reactor produces  $2.4 \times 10^9$  J of energy every minute.

Calculate the power produced by the reactor.

2

(c) A generator uses energy from the reactor to produce electrical energy. The generator is 36% efficient.

Calculate the power output of the generator.

2

(d) Radioactive caesium is a waste product of the fission reaction.

Caesium has a half-life of 30 years.

(i) A caesium sample was removed from the reactor on 1 January 1954. On 1 January 2014 the activity of the sample was  $4 \times 10^{12}$  Bq. Calculate the activity of the sample on 1 January 1954.

2

(ii) Calculate how many nuclei would decay during a 5 minute period when the sample has an activity of  $4 \times 10^{12}$  Bq.

2

(10)

[END OF QUESTION PAPER]

## ACKNOWLEDGEMENTS

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