[3220/286] 1989

SCOTTISH CERTIFICATE OF EDUCATION

PHYSICS

Higher Grade—PAPER I

Tuesday, 9th May—9.30 a.m. to 11.00 a.m.

READ CAREFULLY

1. **Check that the answer sheet provided is for Physics Higher I.**
2. **Fill in the details required on the answer sheet.**
3. **Use the approximation $g = 10\ \text{m s}^{-2}$ or $g = 10\ \text{N kg}^{-1}$.**
4. **Any other data required will be found in the Science Data Booklet (1982 edition) provided.**
5. **Rough working, if required, should be done only on this question paper, or on the rough working sheet provided—NOT on the answer sheet.**
6. **For each question there is only ONE correct answer.**

QUESTIONS 1–33

In this paper Questions 1–33 are answered by indicating the choice A, B, C, D or E by a stroke made in INK in the appropriate place in the answer sheet—

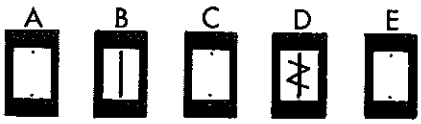
SAMPLE QUESTION FOR QUESTIONS 1–33

The momentum of a body is the product of

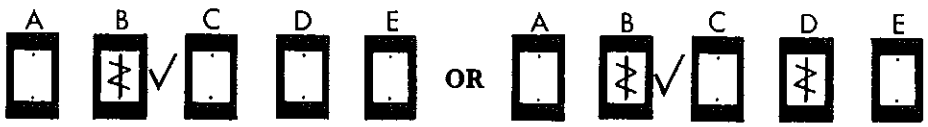
A mass and velocity squared
B mass and velocity
C mass and acceleration
D force and velocity
E force and displacement.

The correct answer is B—mass and velocity. A **heavy** vertical line should be drawn joining the two dots in the appropriate box in the column headed B as shown in the example below.

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:



QUESTIONS 34–40

Each of Questions 34–40 consists of a problem with a numerical answer. Insert the answer in INK in the space provided on the answer sheet.

Show your answer as a whole number.

Round off to the nearest whole number if necessary.

Your answer must be consistent with the unit printed on the answer sheet.

SAMPLE QUESTION FOR QUESTIONS 34–40

What force is required to give an acceleration of 4 m s^{-2} to a mass of 4 kg?

The correct answer is 16 N. The response should be as shown:

16	N

UCP 3220/286 6/6/6/19560

1. The statements below were found in a pupil's notebook.

   I Acceleration, velocity and displacement are all vector quantities.

   II Force and weight are vector quantities but mass is a scalar quantity.

   III Time, distance and speed are all scalar quantities.

   Which of these statements is/are correct?

   A I only

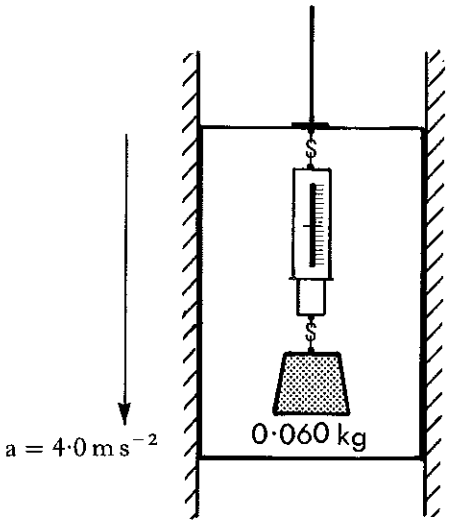
   B II only

   C III only

   D II and III only

   E I, II and III

2. A mass of 0·060 kg is suspended from a spring balance inside a lift. The lift accelerates downwards at $4{\cdot}0\,m\,s^{-2}$.



   What is the reading on the spring balance during this acceleration?

   A 0·60 N

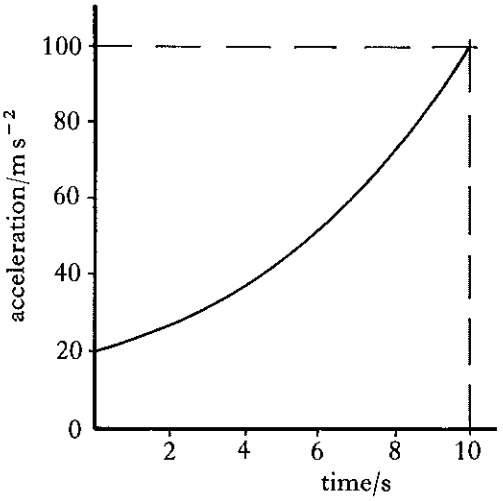
   B 0·24 N

   C 0·36 N

   D 0·84 N

   E 2·4 N

3. The graph below shows how the acceleration of a rocket, in outer space, changed during a 10 s period.



   The rocket motors produced a constant thrust of $4{\cdot}0 \times 10^4$ N.

   How much fuel was used in the 10 s period?

   A $0{\cdot}4 \times 10^3$ kg

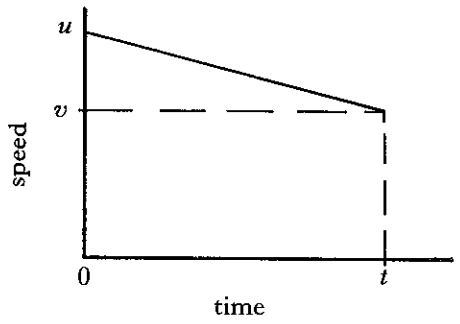
   B $1{\cdot}6 \times 10^3$ kg

   C $2{\cdot}0 \times 10^3$ kg

   D $2{\cdot}4 \times 10^3$ kg

   E $4{\cdot}0 \times 10^3$ kg

4. The speed-time graph below represents the motion of an object moving along a straight line with an initial speed u and a speed v after time t.



The average speed during this time interval t is given by

A $\frac{u+v}{2}$

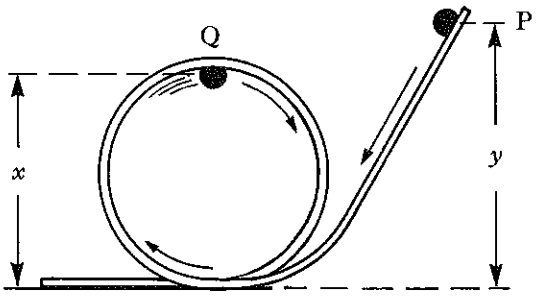
B $\frac{u-v}{2}$

C $\frac{u+v}{t}$

D $\frac{u-v}{t}$

E $\frac{u+v}{2t}$.

5. A steel ball of mass m is released from point P and it moves along a track which is bent into a loop, as shown.



Neglecting friction, the kinetic energy of the ball at point Q is given by

A mgx

B mgy

C $mg(x+y)$

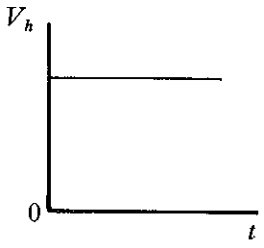
D $mg(y-x)$

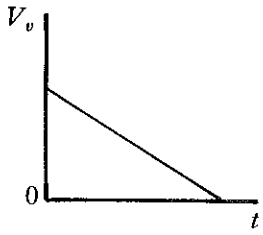
E $mg\sqrt{x^2+y^2}$.

6. A shell is fired from a gun at an angle to the horizontal. Graphs are drawn of its horizontal component of velocity V_h and its vertical component of velocity V_v against time t, up to the time when the shell reaches its maximum height.

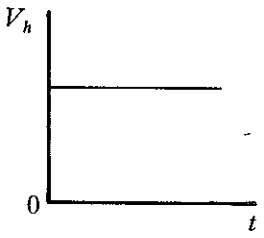
Assuming air resistance to be negligible, which pair of the following graphs is correct?

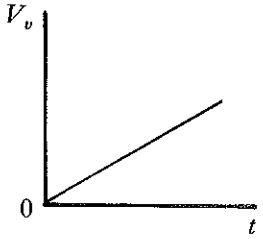
A



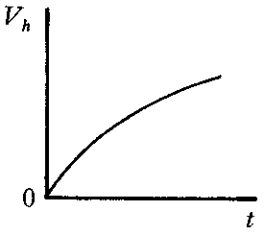


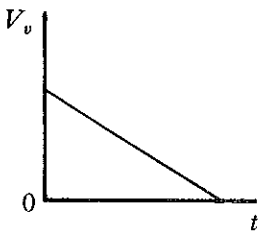
B



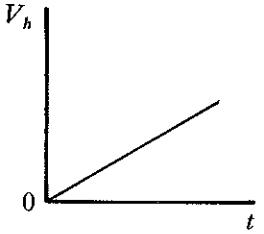


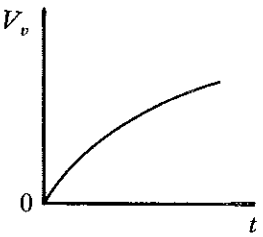
C



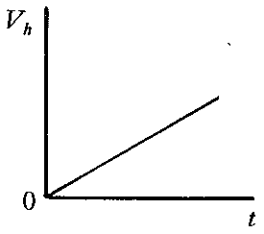


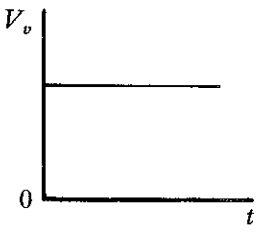
D





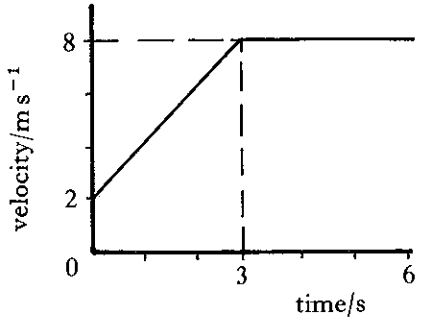
E





7. The motion of an object of mass 2 kg over a 6 s period is described on the following velocity-time graph.

There are no opposing forces acting on the object which is moving in a straight line along a horizontal surface.



Which of the following can be calculated from the information given?

I The average acceleration over the 6 s period

II The kinetic energy of the object after 3 s

III The work done on the object during the 6 s period

A I only

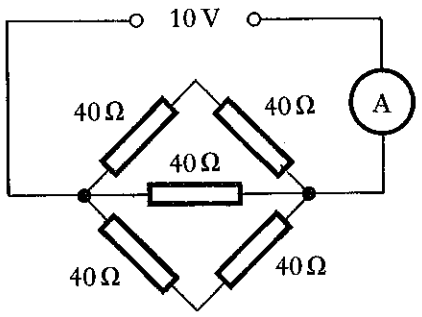
B I and II only

C I and III only

D II and III only

E I, II and III

8. The circuit below is set up in the laboratory during some practical work in electricity, using a power supply which has no internal resistance.



What reading is recorded on the ammeter, assuming it has no resistance?

A 0·05 A

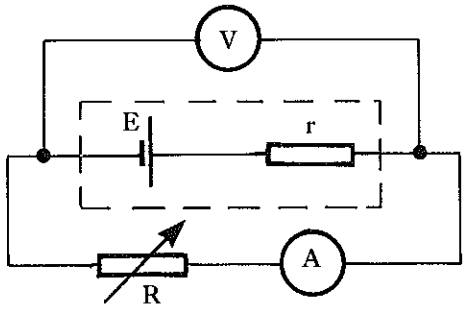
B 0·125 A

C 0·25 A

D 0·50 A

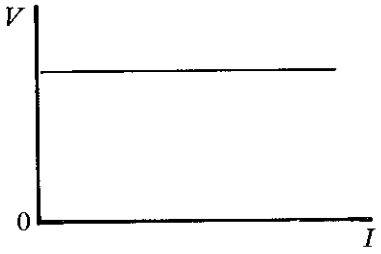
E 1·25 A

9. The diagram shows a circuit used to determine the e.m.f. E and the internal resistance r of a cell.

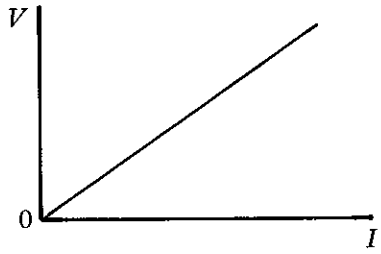


Which graph correctly shows how the potential difference V across the terminals of the cell varies with the current I drawn from it?

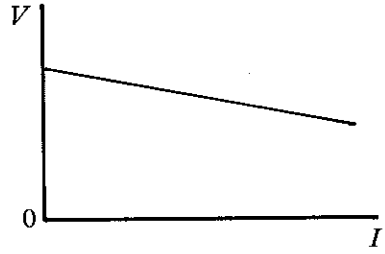
A



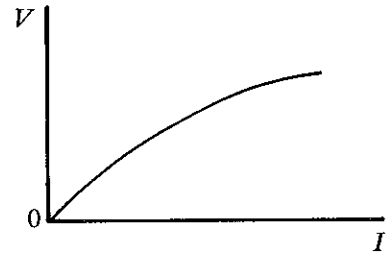
B



C



D

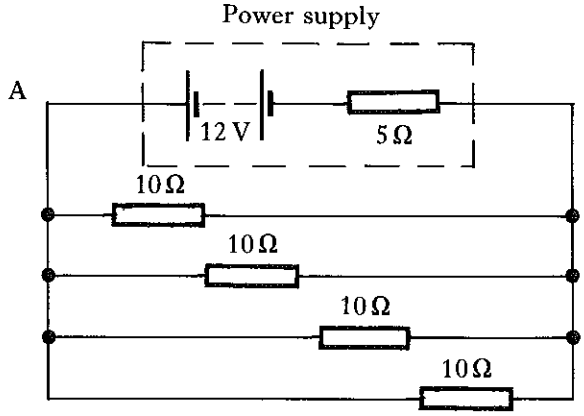


E

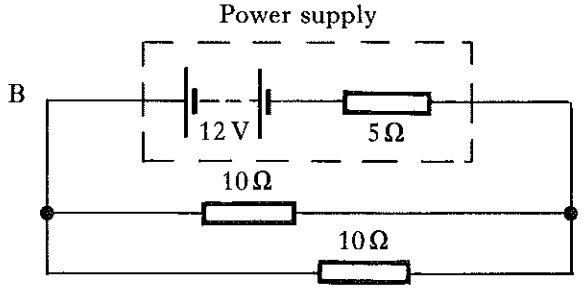
10. A power supply has an e.m.f. of 12 V and an internal resistance of 5 Ω. It can be connected in various ways to several small heaters, each of resistance 10 Ω.

Which of the following arrangements would produce maximum heating power in the system of heaters?

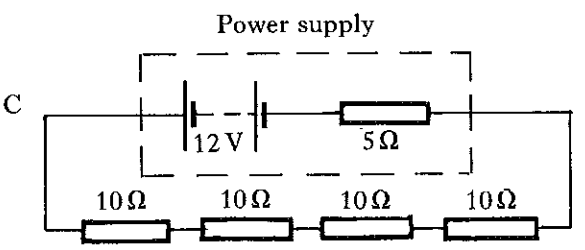
A



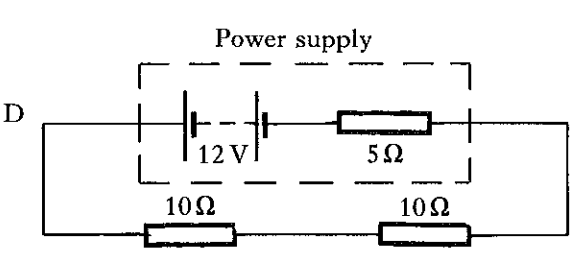
B



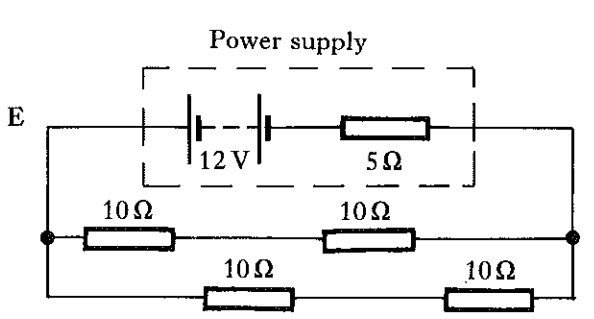
C



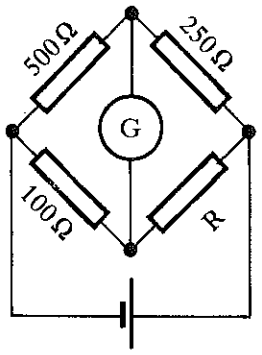
D



E

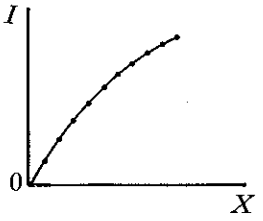


11. In the Wheatstone Bridge circuit below, the variable resistor R is initially set at 50·0 Ω.

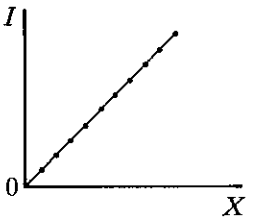


The value of R is then increased in 0·1 Ω steps up to 51·0 Ω and the corresponding values of galvanometer current I are noted. A graph of galvanometer current I against **change in resistance** X from the initial value is of the form

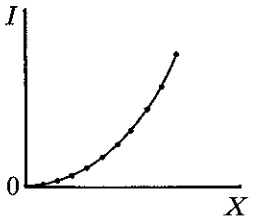
A



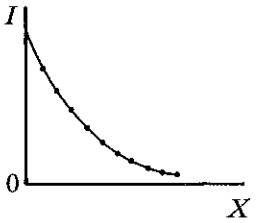
B



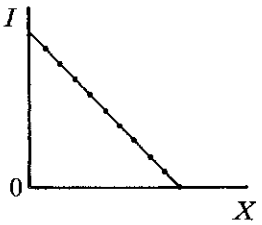
C



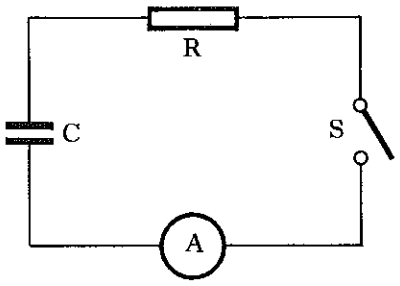
D



E

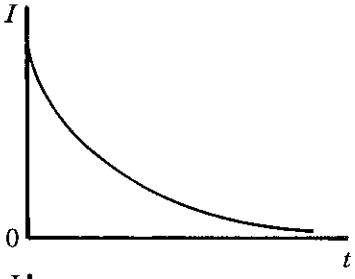


12. The diagram below shows a charged capacitor C in a circuit with a resistor R and a switch S.

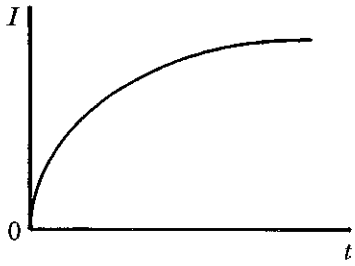


Which one of the following graphs correctly represents the variation of current I with time t in the above circuit after S is closed?

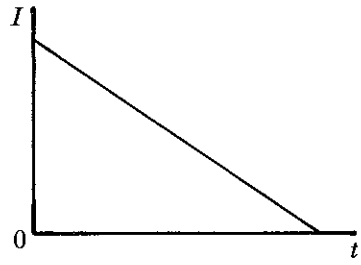
A



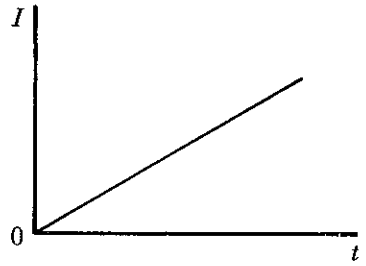
B



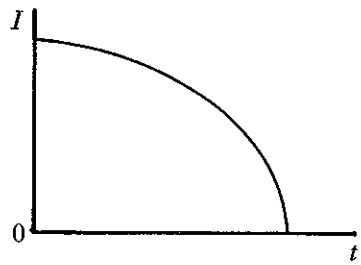
C



D



E



13. The resistance of a heating coil increases as its temperature rises. When operating from a constant voltage supply, the power produced in the heating coil is

A largest just after it is switched on

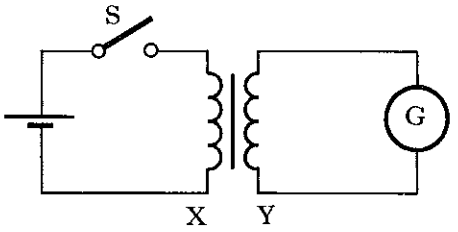
B smallest just after it is switched on

C the same all the time after it is switched on

D increasing all the time after it is switched on

E independent of its temperature.

14. The diagram represents two coils X and Y wound on a soft-iron core.



A deflection of the centre-zero galavanometer G is observed

A momentarily on closing S, but not on opening it again

B momentarily on opening S, but not on closing it again

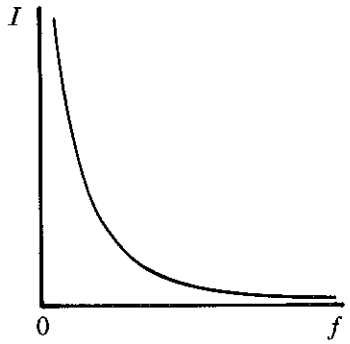
C on closing S and for as long as it remains closed

D neither on closing S nor on opening it

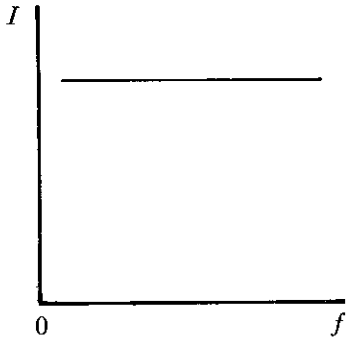
E momentarily on closing S and momentarily on opening it.

15. The variation of current I with frequency f for three different components connected in turn to a variable frequency, constant r.m.s. voltage supply is indicated by the graphs below.

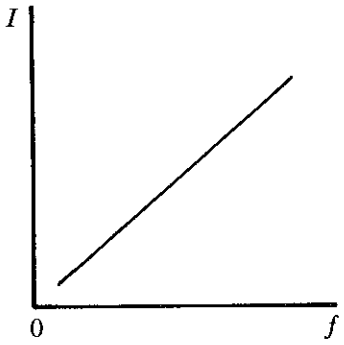
Component (i)



Component (ii)



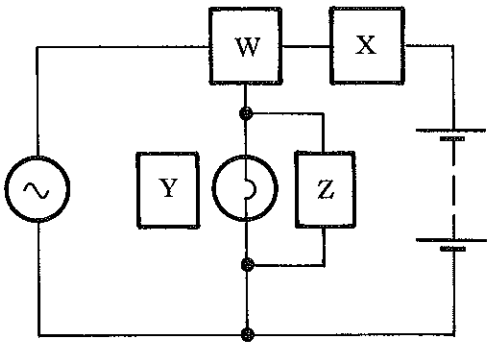
Component (iii)



The components are, respectively,

	Component (i)	*Component (ii)*	*Component (iii)*
A	capacitor	inductor	resistor
B	capacitor	resistor	inductor
C	inductor	capacitor	resistor
D	inductor	resistor	capacitor
E	resistor	capacitor	inductor

16. The diagram illustrates an experiment to compare the a.c. and d.c. voltages which will produce the same brightness in the lamp.

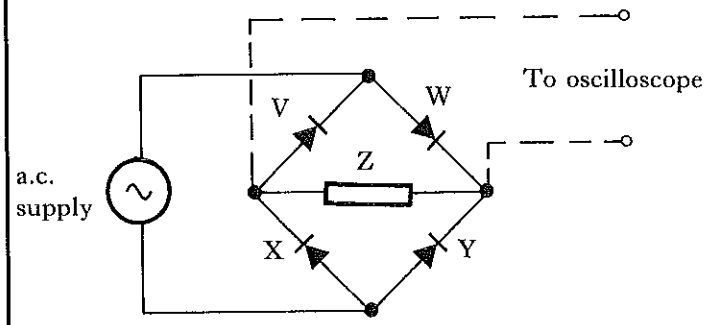


The circuit is adjusted until the lamp brightness is the same with either a.c. or d.c. voltages across it.

The pieces of apparatus marked W, X, Y and Z are

	W	X	Y	Z
A	Rheostat	Switch	Oscilloscope	Galvanometer
B	Rheostat	Oscilloscope	Light meter	Galvanometer
C	Rheostat	Galvanometer	Oscilloscope	Switch
D	Switch	Rheostat	Light meter	Oscilloscope
E	Switch	Rheostat	Oscilloscope	Light meter

17. A pupil makes a mistake when setting up a circuit for full wave rectification.



Which of the following components should be reversed so that full-wave rectification is displayed on the oscilloscope?

A V

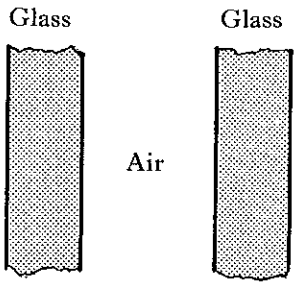
B W

C X

D Y

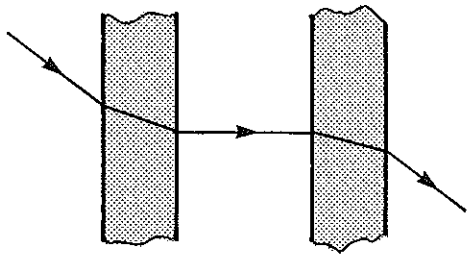
E Z

18. A double-glazed window panel consists of two sheets of glass with an air gap as shown below.

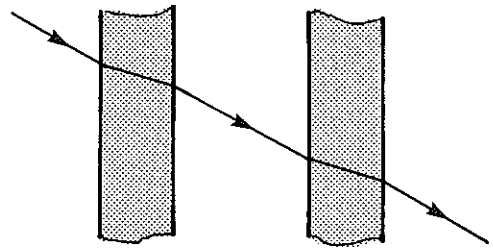


Which diagram shows the path of a ray of light through such a double-glazed panel?

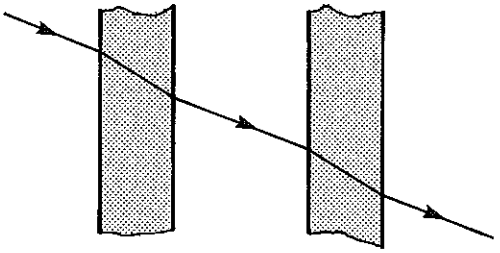
A



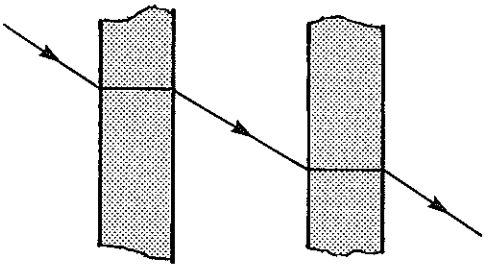
B



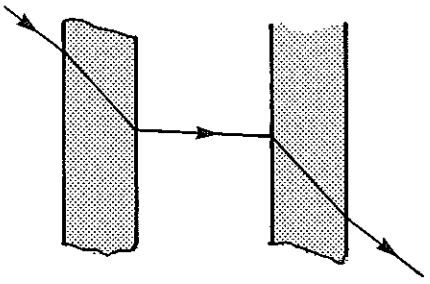
C



D



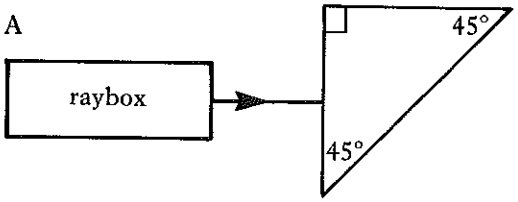
E



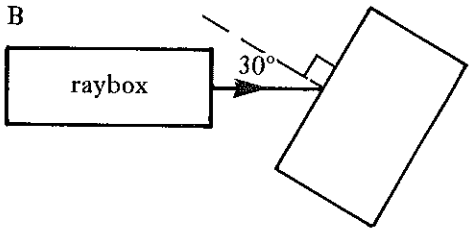
19. In the arrangements of apparatus shown below, a ray of light is incident on a number of transparent perspex blocks. The refractive index of the perspex is 1·5.

Which arrangement can be used to demonstrate total internal reflection in perspex, **without any further adjustment of the apparatus**?

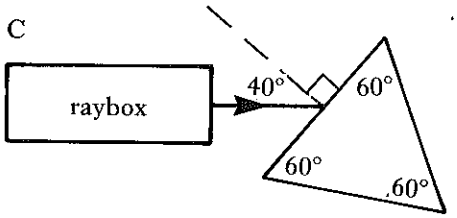
A



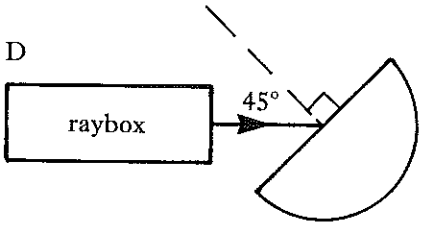
B



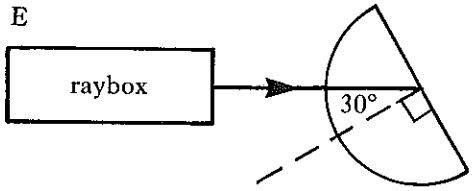
C



D



E



20. When drawing a ray diagram to establish the type, size and position of the image formed by a thin converging lens, certain rules apply.

Consider the following statements:

I Any ray going through the geometrical centre of the lens will pass straight through it.

II The image is always formed at the focal point.

III Rays entering the lens parallel to the principal axis pass through the focal point after passing through the lens.

Which of the above statements is/are correct?

A I only

B II only

C I and II only

D I and III only

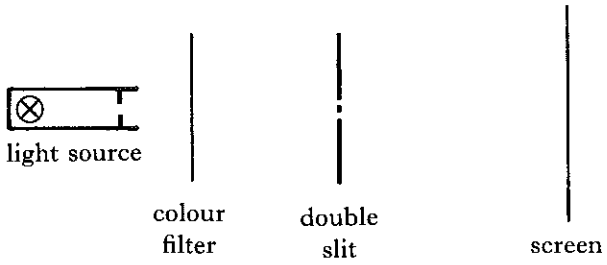
E I, II and III

21. When an object is placed 40 cm from a thin converging lens a real image, equal in size to the object, is formed. The object is then moved 10 cm *towards* the lens.

Which is a correct description of the image now formed?

	image distance from lens	*image size*	*image nature*
A	more than 40 cm	larger than object	real
B	less than 40 cm	larger than object	real
C	more than 40 cm	larger than object	virtual
D	less than 40 cm	smaller than object	real
E	more than 40 cm	smaller than object	virtual

22. The arrangement shown below is used in an experiment to investigate the interference of light. A white light source is used and fringes are seen on the screen.



The colour filter is changed from blue to red and the effect on the fringe pattern is observed.

Which of the following statements correctly describes and explains the change in the appearance of the fringes?

A The fringes would be closer together with RED light because the wavelength of red light is longer.

B The fringes would be closer together with BLUE light because the wavelength of blue light is longer.

C The fringes would be farther apart with RED light because the wavelength of red light is longer.

D The fringes would be farther apart with BLUE light because the wavelength of blue light is shorter.

E The fringes would be closer together with RED light because the wavelength of red light is shorter.

23. Robert sets up an experiment in a darkened laboratory with a small light bulb B_1 which emits light at power P.

The light intensity 50 cm from his bulb is $12\,W\,m^{-2}$.

Alison repeats Robert's experiment with a different small bulb B_2, which emits light at power 0·5 P.

What is the light intensity 25 cm from her bulb?

A $1{\cdot}5\,W\,m^{-2}$

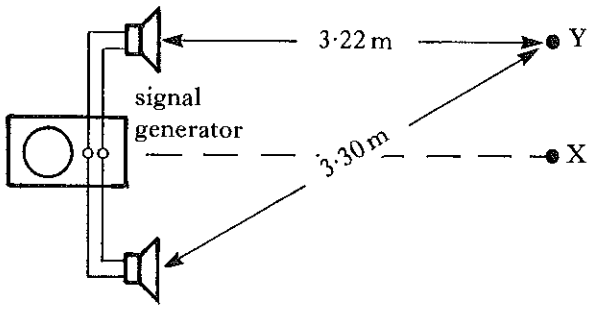
B $3{\cdot}0\,W\,m^{-2}$

C $6{\cdot}0\,W\,m^{-2}$

D $12{\cdot}0\,W\,m^{-2}$

E $24{\cdot}0\,W\,m^{-2}$

24. Two loudspeakers are connected to the same signal generator as shown below.



A microphone at X detects maximum intensity. When the microphone is moved slowly upwards, it detects the first minimum at Y.

The wavelength of the sound emitted from the loudspeakers is

A 0·08 m

B 0·16 m

C 0·32 m

D 0·80 m

E 1·60 m.

25. Consider the following passage in which three words are missing and have been replaced by the letters *X*, *Y* and *Z*.

"When waves from two coherent sources of *X* light (i.e. light of one frequency) combine, it is observed that *Y* occurs. The resulting pattern varies in brightness.

The brightness depends on the combined *Z*"

Which of the following correctly states the missing words?

	Word X	*Word Y*	*Word Z*
A	monochromatic	interference	frequency
B	white	refraction	frequency
C	monochromatic	refraction	amplitude
D	white	interference	amplitude
E	monochromatic	interference	amplitude

26. The velocity of sound in a metal is 11 times the velocity of sound in air. The wavelength of a certain note is 2 m in air.

What would be the wavelength of the **same note** in the metal?

A $\frac{1}{2 \times 11}$ m

B $\frac{2}{11}$ m

C 2 m

D $\frac{11}{2}$ m

E 2×11 m

27. Four molecules of a gas have speeds 4 units, 2 units, 2 units and 4 units. Their r.m.s. speed is

A $\sqrt{\frac{12}{4}}$ units

B $\frac{\sqrt{12}}{4}$ units

C $\frac{12}{4}$ units

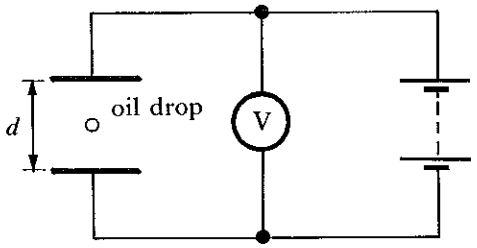
D $\frac{\sqrt{40}}{4}$ units

E $\sqrt{\frac{40}{4}}$ units.

28. A fixed mass of gas condenses at atmospheric pressure to form a liquid. By how much does its density increase and by how much does the spacing between its molecules decrease?

	Approximate increase in density	*Approximate decrease in spacing between molecules*
A	10 times	2 times
B	100 times	10 times
C	1,000 times	10 times
D	1,000,000 times	100 times
E	1,000,000 times	1,000 times

29. A charged oil drop is balanced between two parallel metal plates, separated by a distance d, when a certain p.d. is applied across them.



If the charge on the oil drop is doubled, which of the following changes could keep the drop balanced?

A Reverse the polarity of the p.d.

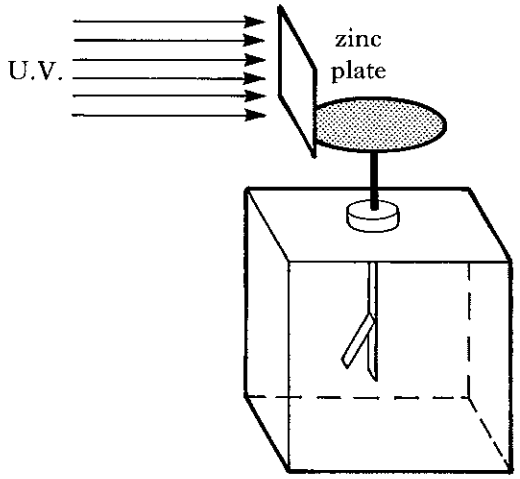
B Double the charge on the plates

C Halve the distance d

D Remove the air between the plates

E Halve the p.d.

30. A clean zinc plate is attached to the cap of an electroscope and then given a negative charge.



The zinc plate is illuminated with ultra-violet radiation. The leaf of the electroscope then

A falls and rises again

B stays in its original position

C falls and stays down

D rises still further

E moves repeatedly up and down.

31. Which of the following statements about the spectrum of light emitted by the atoms of a gaseous element is/are true?

I The spectrum emitted by one element is not the same as the spectrum emitted by another element.

II The element emits a continuous spectrum.

III The spectrum can be explained if the electrons in the atoms are assumed to occupy discrete energy levels.

A I only

B II only

C I and II only

D I and III only

E I, II and III

32. When an electron falls from a high energy level in an atom to another level, E joules below it, a photon of light of wavelength λ is emitted. If Planck's constant is h and c is the velocity of light in a vacuum, the wavelength of the photon of light is

A $\lambda = \frac{hc}{E}$

B $\lambda = \frac{E}{hc}$

C $\lambda = \frac{Eh}{c}$

D $\lambda = \frac{Ec}{h}$

E $\lambda = \frac{h}{Ec}$.

33. Which one of the following sequences of radioactive decay results in the formation of an isotope of the original nucleus?

A Emission of one α-particle and four β-particles

B Emission of one α-particle and two β-particles

C Emission of one α-particle and one β-particle

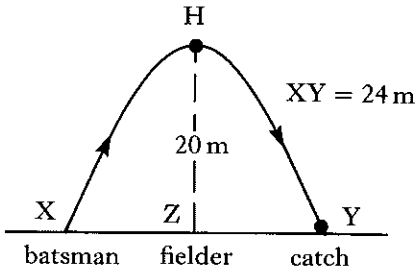
D Emission of two α-particles and one β-particle

E Emission of four α-particles and one β-particle

Each of Questions 34–40 consists of a problem with a numerical answer.

Show your answer as a whole number.

34. In a Test Match, a cricket ball follows the path shown from X to Y. A fielder at Z starts running when the ball is directly overhead at H.

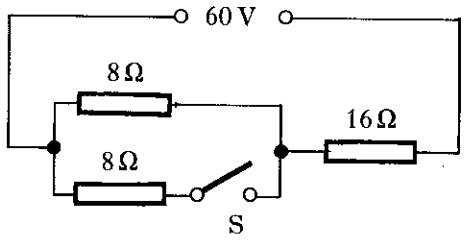


What is the average speed of the fielder during his run from Z to Y, where he catches the ball just before it touches the ground?

35. One million kilograms of water per minute flow through the turbines of a hydroelectric power station, after falling through a height of 50 m. The turbines develop a useful power output of 5 MW.

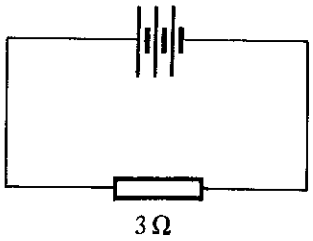
Calculate the percentage efficiency of the energy conversion.

36. In the following circuit, the p.d. across the 16 ohm resistor is 40 volts when switch S is **open**.



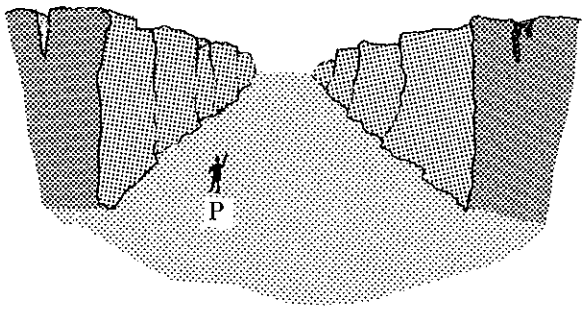
What is the p.d. across the 16 ohm resistor when the switch S is **closed**?

37. Each cell in the circuit below has an e.m.f. of 2 V and an internal resistance of 1 Ω.



Calculate the current in this circuit.

38. A man standing in a steep-sided valley at P fires a gun and listens for the echo.



He hears the first echo 2 s after the shot and a second echo 6 s after the shot. If the speed of sound in air is 330 m s^{-1}, what is the width of the valley in metres?

39. The r.m.s. speed of molecules in a volume V of helium gas at pressure p and temperature T is 1 km s^{-1}. If the pressure of the trapped helium gas is trebled and the volume is reduced to one third of its original value, what is the r.m.s. speed of the molecules?

40. A bicycle pump has its barrel full of air at a pressure of $1{\cdot}0 \times 10^5$ Pa. The pressure in the tyre which is to be inflated is $1{\cdot}5 \times 10^5$ Pa.

If the original volume of air in the barrel is 600 cm^3 and there is no temperature change during the movement of the piston, what will be the new volume of air in the pump when the tyre valve is just beginning to open?

[END OF QUESTION PAPER]