[3220/239] 1986

SCOTTISH CERTIFICATE OF EDUCATION

PHYSICS

Higher Grade—PAPER I

Monday, 12th 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. **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—see the sample question below.**
4. **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—see the sample question below. Note that the units are already filled in.**
5. **For each question there is only ONE correct answer.**
6. **Use the approximation $g = 10\,\mathrm{m\,s^{-2}}$ or $g = 10\,\mathrm{N\,kg^{-1}}$.**
7. **Reference may be made to the booklets of Mathematical Tables and Science Data provided (1982 editions).**
8. **Rough working, if required, should be done only on this question paper, or on the rough working sheet provided—NOT on 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

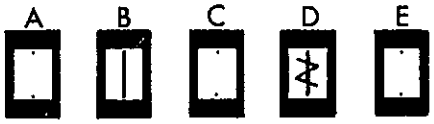
C mass and acceleration

D force and velocity

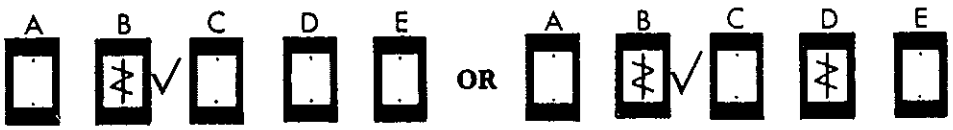
E force and displacement.

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:



SAMPLE QUESTION FOR QUESTIONS 34–40

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

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

16	N

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1. Which one of the following pairs contains one vector and one scalar quantity?

A displacement; acceleration

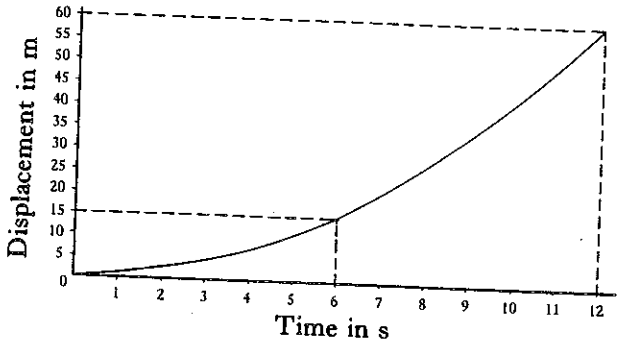
B power; speed

C work; potential energy

D force; kinetic energy

E momentum; velocity

2. The displacement-time graph shows the motion of a car which is accelerating from rest along a straight road.



Which of the following statements is/are true?

I The car's average speed for the 60 m journey is $5\,m\,s^{-1}$.

II The car's average speed during the first 6 s is $2{\cdot}5\,m\,s^{-1}$.

III At some time during the 12 s journey the car's speed is $5\,m\,s^{-1}$.

A I only

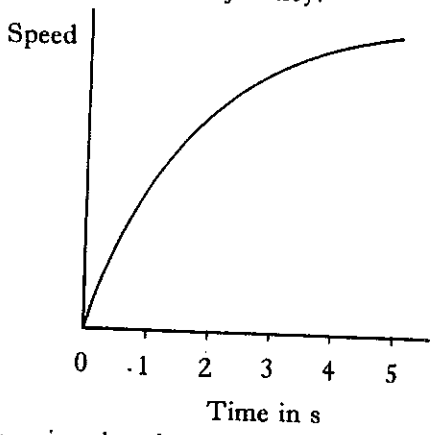
B II only

C I and II only

D II and III only

E I, II and III

3. The following is a speed-time graph of the beginning of a car's journey.



Assuming that the car is travelling in a straight line, which statement best describes the motion during the first 5 s of the car's journey?

A Uniform deceleration

B Uniform acceleration

C Increasing acceleration

D Decreasing acceleration

E Decreasing deceleration

4. A wheel nut falls straight down from a helicopter which is descending vertically at a constant speed of $5\,m\,s^{-1}$. The wheel nut strikes the ground 5 s later.

Assuming that the effect of air resistance on the nut is negligible, how far does the nut drop?

A 50 m

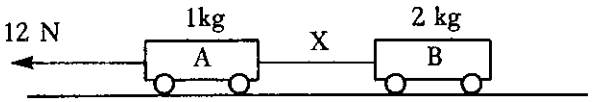
B 55 m

C 100 m

D 125 m

E 150 m

5. Two trolleys are joined together by a thread and are pulled along a level bench by a force of 12 N, as shown.

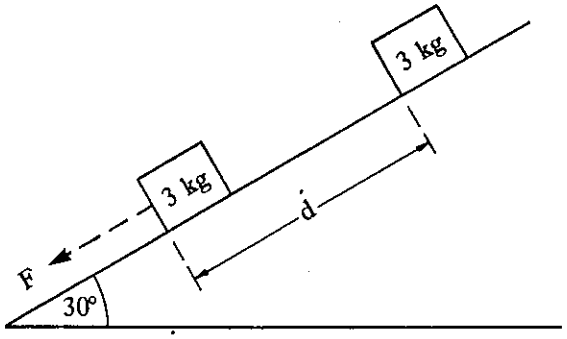


One second after starting from rest, the thread breaks at X.

Neglecting possible effects of friction, which pair of statements correctly describes the motion of each trolley after the thread breaks?

	Trolley A	*Trolley B*
A	constant velocity of $8\,m\,s^{-1}$	constant velocity of $4\,m\,s^{-1}$
B	uniform acceleration of $4\,m\,s^{-2}$	uniform acceleration of $4\,m\,s^{-2}$
C	uniform acceleration of $12\,m\,s^{-2}$	constant velocity of $4\,m\,s^{-1}$
D	uniform acceleration of $12\,m\,s^{-2}$	comes to rest
E	comes to rest	comes to rest

6. A block of mass 3 kg is held at rest on a friction-free surface inclined at 30° to the horizontal.



Two seconds after the block is released, the component of the weight (F) acting down the slope, and the distance (d) travelled are

	F	d
A	15 N	10 m
B	15 N	5·0 m
C	26 N	2·5 m
D	26 N	5·0 m
E	30 N	5·0 m

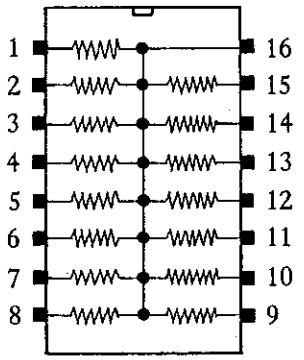
7. An inelastic collision takes place between a moving object and a stationary object of equal mass.

Which of the following quantities is/are conserved for this system in this situation?

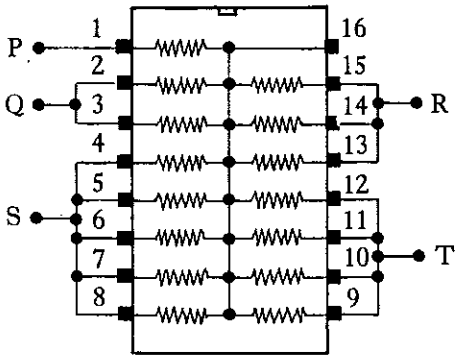
I Momentum
II Total energy
III Kinetic energy

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

8. A 16-pin package contains 15 identical resistors connected together as shown.



To test these resistors, an engineer connected pins together externally and labelled them terminals P, Q, R, S and T, as shown below.



When he measured the resistance between pin 16 and each of these terminals in turn, the engineer found the greatest resistance between pin 16 and

A terminal P
B terminal Q
C terminal R
D terminal S
E terminal T.

[**Turn over**

9. A moving-coil galvanometer is usually adapted for use as an ammeter by connecting a resistor of

A low resistance in parallel with it

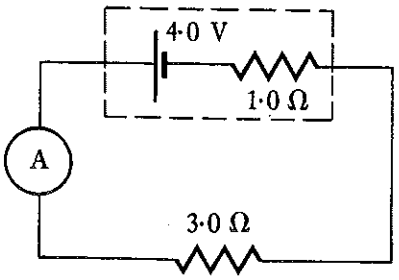
B high resistance in parallel with it

C low resistance in series with it

D high resistance in series with it

E variable resistance in series with it.

10. A cell of e.m.f. 4·0 V and internal resistance 1·0 Ω is used in the following circuit. The ammeter has negligible resistance.

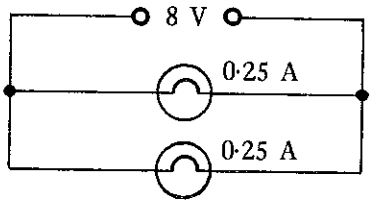


When another 3·0 Ω resistor is connected in parallel with the original one, the ammeter reading changes.

What would be the two readings on the ammeter?

	Original reading	*Reading with second 3·0 Ω resistor connected*
A	1·0 A	0·5 A
B	1·0 A	1·6 A
C	1·0 A	2·0 A
D	1·3 A	0·7 A
E	1·3 A	2·7 A

11. The diagram below shows an 8 V supply connected to two bulbs.



In 16 s, the electrical energy converted in the two bulbs is

A 2 J

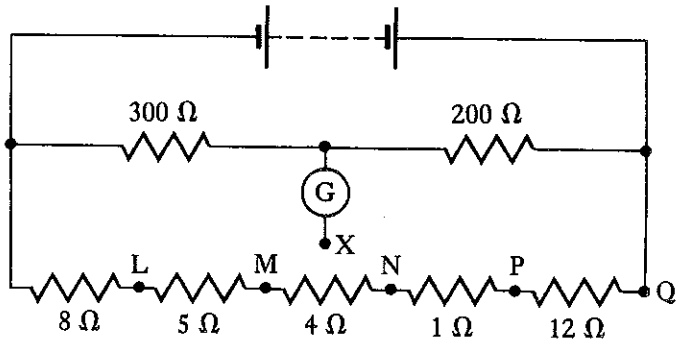
B 4 J

C 8 J

D 32 J

E 64 J.

12. In the circuit shown below, point X can be attached to any of the points L, M, N, P or Q.



To which point must X be connected to obtain a zero reading on the galvanometer G?

A L

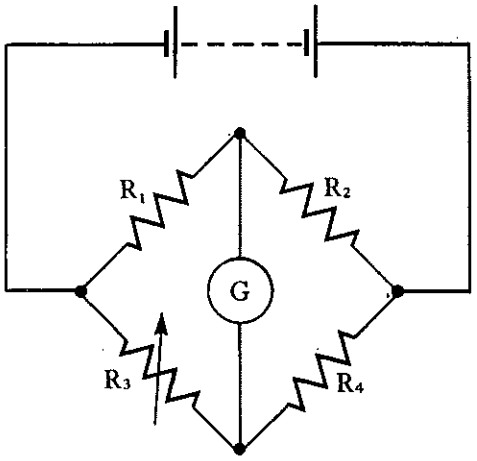
B M

C N

D P

E Q

13. In the following circuit, the Wheatstone Bridge is balanced.

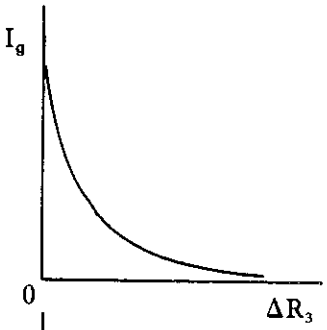


Small adjustments are made to the variable resistor R_3 and the corresponding current reading in the galvanometer (I_g) is noted.

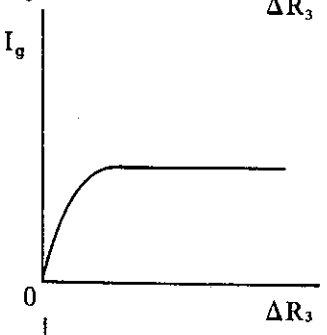
A graph of the current through the galvanometer is plotted against ΔR_3, the small change in the resistance of R_3.

Which of the following shows that graph?

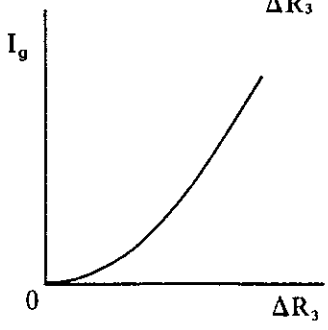
A



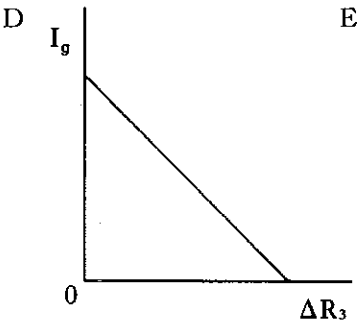
B



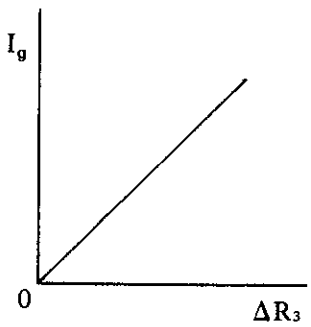
C



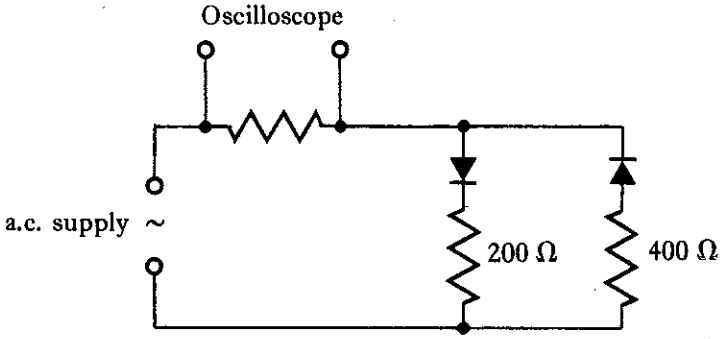
D



E



14. In this circuit, a cathode ray oscilloscope is connected as shown.

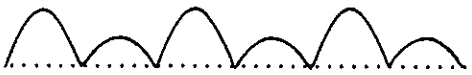


Which diagram shows the trace obtained on the oscilloscope?

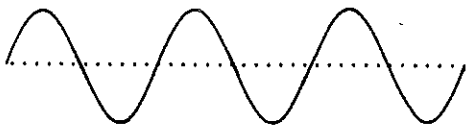
(The dotted lines indicate the undeflected beam position on the screen.)

A

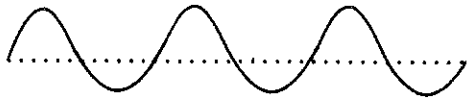
B



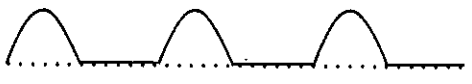
C



D

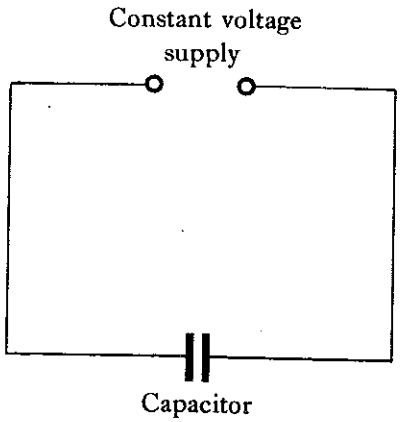


E



[Turn over

15. The diagram below shows a parallel plate capacitor connected to a constant voltage supply.

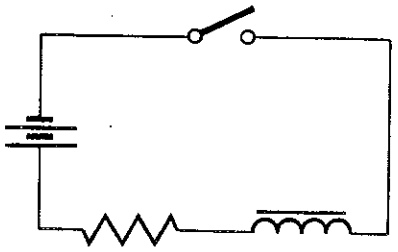


While the supply remains connected, the separation of the plates is increased.

What happens to the capacitance of the capacitor, the voltage across the capacitor and the charge stored in the capacitor?

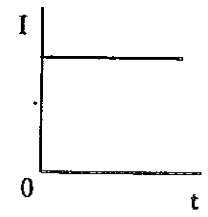
	Capacitance	*Voltage*	*Charge*
A	increases	remains constant	increases
B	remains constant	increases	decreases
C	remains constant	decreases	increases
D	decreases	remains constant	remains constant
E	decreases	remains constant	decreases

16. The following circuit includes a resistor in series with a coil which has a large inductance.

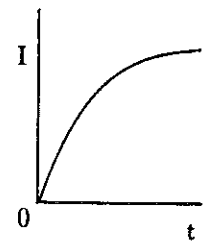


Which of the following graphs shows how the circuit current (I) varies with time (t) from the instant at which the switch is closed?

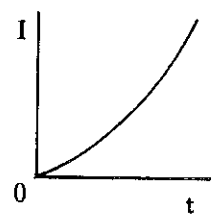
A



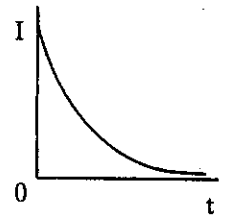
B



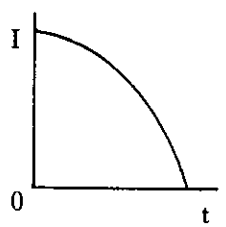
C



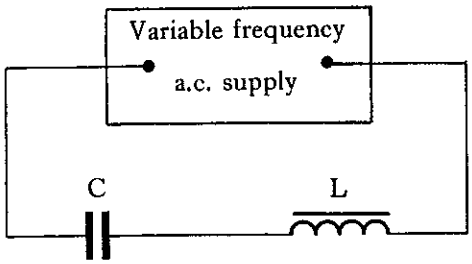
D



E



17. In the following circuit, C is a capacitor and L an inductor.



When the frequency of the a.c. supply is gradually increased, what happens to the reactances of C and L?

	Reactance of C	*Reactance of L*
A	remains constant	remains constant
B	decreases	decreases
C	increases	increases
D	increases	decreases
E	decreases	increases

18. An object is placed in front of a converging lens at a distance which is less than the focal length. Which of the following statements is correct?

A The image is real and diminished.

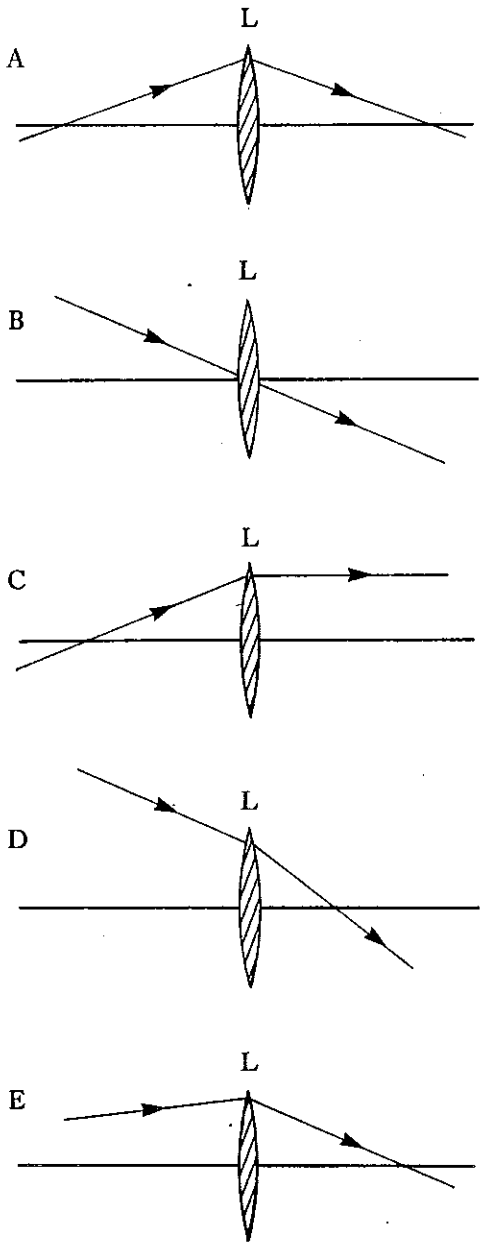
B The image is real and magnified.

C The image is virtual and diminished.

D The image is virtual and erect.

E The image is virtual and inverted.

19. Which ray diagram shows a ray of light passing through a focal point of the converging lens L?



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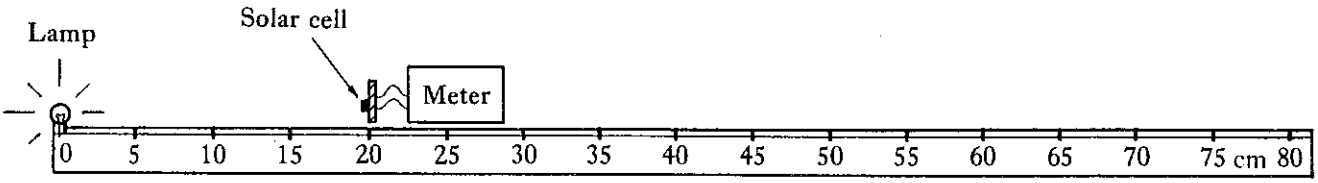
20. The solar cell and meter shown below are used to measure the intensity of light from the small lamp, which may be regarded as a point source.



If the meter reading is 4 units when the solar cell is 20 cm from the lamp, what adjustment could be made to increase the reading to 64 units?

A Move the solar cell to the 80 cm mark.

B Move the solar cell to the 40 cm mark.

C Move the solar cell to the 10 cm mark.

D Move the solar cell to the 5 cm mark.

E Use a bulb which is four times more powerful.

21. Which of the following groups of electromagnetic waves is in order of increasing frequency?

A gamma rays; ultra-violet rays; radio-waves

B gamma rays; visible light; ultra-violet rays

C visible light; infra-red radiation; micro-waves

D microwaves; ultra-violet rays; X-rays

E radio-waves; visible light; infra-red radiation

22. Light passes from air into a liquid.

Which one of the following represents the refractive index of the liquid relative to air?

A $\frac{\text{velocity in air}}{\text{velocity in liquid}}$

B $\frac{\text{velocity in liquid}}{\text{velocity in air}}$

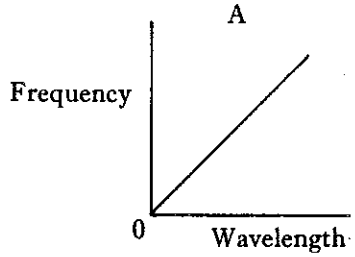
C $\frac{\text{amplitude in liquid}}{\text{amplitude in air}}$

D $\frac{\text{frequency in liquid}}{\text{frequency in air}}$

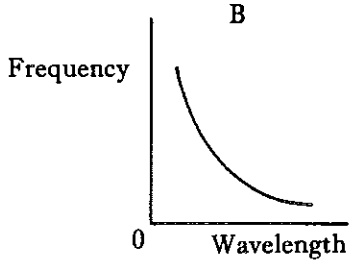
E $\frac{\text{wavelength in liquid}}{\text{wavelength in air}}$

23. Assuming that all frequencies of sound travel through air with the same speed, which one of the following diagrams represents the graph of frequency against wavelength?

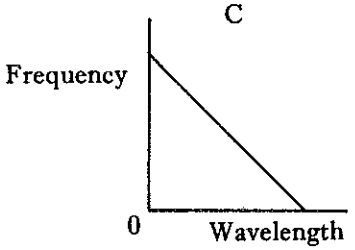
A



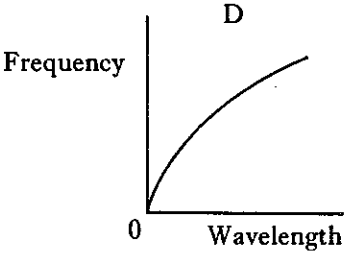
B



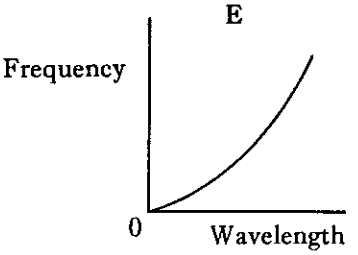
C



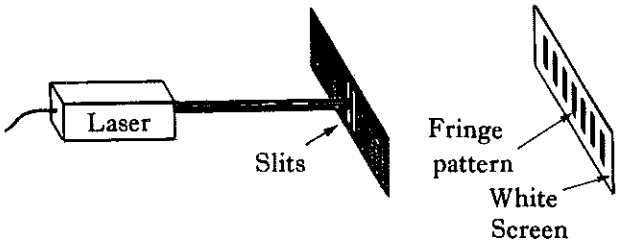
D



E



24. Light from a laser shines on two parallel slits ruled on a blackened glass plate. Interference fringes are formed on a white screen behind the two slits.



The separation of the fringes can be increased by

I increasing the wavelength of the light

II increasing the distance between the slits and the screen

III increasing the distance between the slits.

Which of the above statements is/are correct?

A I only

B I and II only

C I and III only

D II and III only

E I, II and III

25. A white light source is viewed through a diffraction grating. Which of the following would be true?

I Spectra would be produced on both sides of the central position.

II There would be a white central image of the source.

III Blue light would be deviated more than red.

A I only

B II only

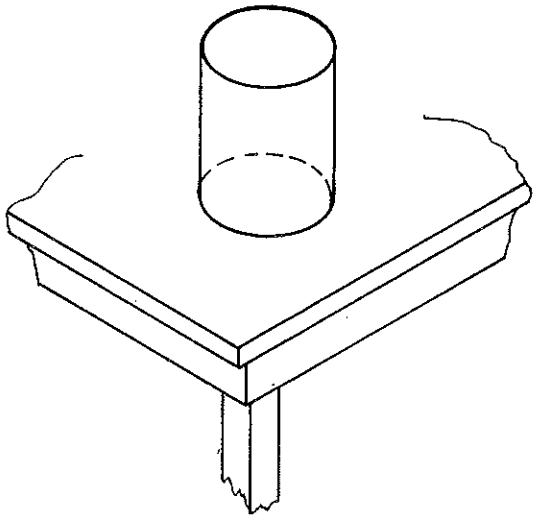
C I and II only

D II and III only

E I, II and III

[Turn over

26. A solid cylinder of mass 20 kg has a flat base of area $0{\cdot}1\ m^2$ in contact with the level table on which it rests.



The pressure exerted on the table by the cylinder resting in the position shown is

A 2 Pa

B 20 Pa

C 200 Pa

D 2000 Pa

E 20 000 Pa.

27. Specific heat capacity can be found from the experimental results given below.

Which one of the following measurements creates most uncertainty in the calculated value of the specific heat capacity?

A Power = 2000 ± 10 W

B Time = 300 ± 1 s

C Mass = $5{\cdot}0 \pm 0{\cdot}2$ kg

D Final temperature = $50 \pm 0{\cdot}5$ °C

E Change in temperature = 30 ± 1 °C

28. Which of the following changes would lead to the greatest increase in the pressure of a gas in a container?

A Doubling the number of molecules in the gas.

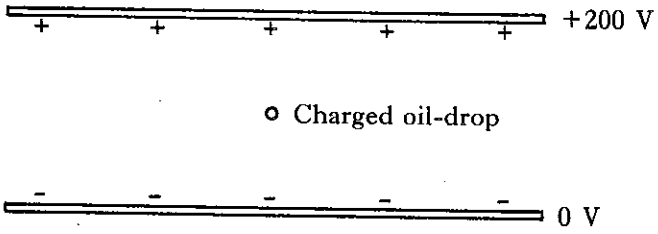
B Doubling the r.m.s. speed of the molecules.

C Doubling the Kelvin temperature of the gas.

D Doubling the volume of the container.

E Doubling the mass of the gas in the container.

29. A potential difference of 200 V between two parallel metal plates holds a charged oil-drop at rest, as shown.



After the charge on the drop is changed by exposure to radiation, a potential difference of only 100 V is needed to keep the drop at rest.

If the original charge on the oil-drop was $-3{\cdot}2 \times 10^{-19}$ C, the new charge is

A $-0{\cdot}8 \times 10^{-19}$ C

B $-1{\cdot}6 \times 10^{-19}$ C

C $-4{\cdot}8 \times 10^{-19}$ C

D $-6{\cdot}4 \times 10^{-19}$ C

E $-12{\cdot}8 \times 10^{-19}$ C.

30. When the spectrum of sunlight is observed, there are two dark lines at wavelengths corresponding to $589{\cdot}0 \times 10^{-9}$ m and $589{\cdot}6 \times 10^{-9}$ m. These are known to be the wavelengths of the two yellow lines seen in the spectrum of hot sodium vapour.

The dark lines are present because

A sodium atoms are absorbing energy in the outer layers of the sun

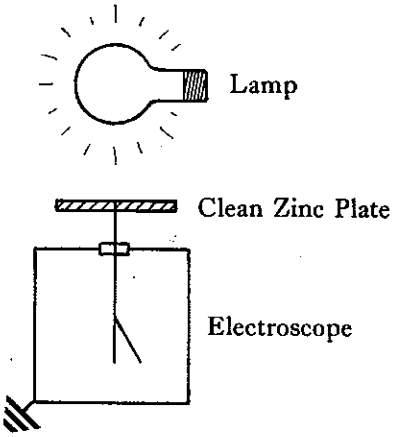
B sodium atoms are emitting energy in the outer layers of the earth's atmosphere

C no sodium atoms exist in the outer layers of the sun

D these wavelengths are not in the visible range

E these wavelengths are absorbed in the optical instrument used to view the spectrum.

31. The diagram represents a simple demonstration of the photoelectric effect. A lamp is switched on and directed at a clean zinc plate, which is mounted on a charged electroscope.



Which of the following factors will decide whether the electroscope discharges, or not?

I The brightness at which the lamp is operating.

II The wavelength of light used.

III The type of charge (+ or −) on the plate.

A III only

B I and II only

C II and III only

D I, II and III

E II only

32. In order to trace the line of a water-pipe buried about half a metre below the surface of a field, an engineer proposes to add a radioactive isotope to the water.

Which of the following isotopes should she choose?

	Half-life of isotope	*Type of radiation emitted*
A	a few hours	α
B	a few hours	β
C	several years	β
D	a few hours	γ
E	several years	γ

33. The following equation shows what happens when a deuteron ($^{2}_{1}H$) interacts with a triton ($^{3}_{1}H$).

$$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n + \text{energy}$$

Energy is released in this fusion reaction because

A the mass of a triton is greater than the mass of a deuteron

B the mass of a helium nucleus is greater than the mass of a neutron

C the mass of the deuteron and triton is greater than the mass of the helium nucleus and neutron

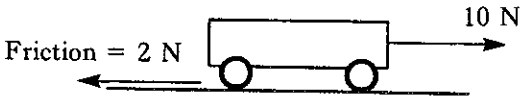
D the mass of the deuteron and triton is less than the mass of the helium nucleus and neutron

E the mass of the helium nucleus is greatest.

[Turn over

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

34. In the diagram, a force of 10 N is pulling a trolley along a level surface.



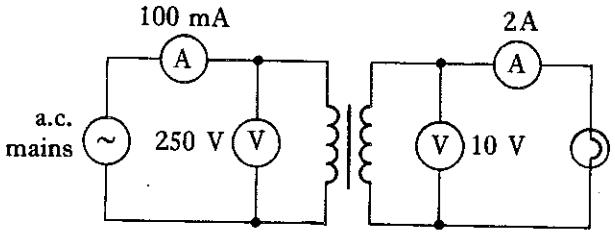
If the trolley moves 3 m against a frictional force of 2 N, what is the work done against friction?

35. A girl on a bicycle is cycling at a constant speed. The combined kinetic energy of the girl and her bicycle is 1600 J. She then slows down.

What is the new combined kinetic energy of the girl and her bicycle when their COMBINED MOMENTUM is half its previous value?

36. A pupil uses a transformer to step down mains voltage to light a bulb.

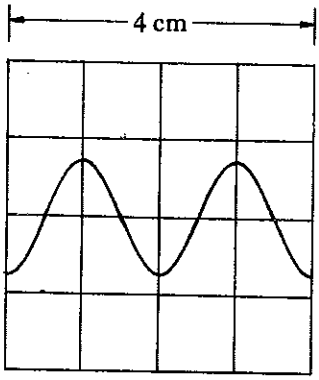
The currents and voltages at various places in the circuit are measured, and are given in the following diagram.



What is the percentage efficiency of the transformer?

37. The volume of a certain mass of air at 27°C is $3\,m^3$. If the temperature is increased to 127°C without changing the pressure, what will the new volume of the air be?

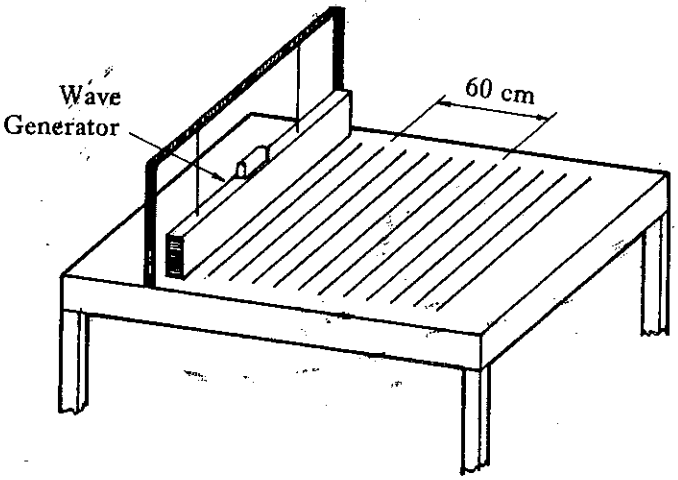
38. An alternating signal is applied to an oscilloscope which has its time-base set at "1 millisecond per centimetre". Two complete waves appear on the screen, which is 4 cm wide.



The time-base is then altered to "10 milliseconds per centimetre", with every other control kept as before.

How many waves will appear on the screen now?

39. In the ripple tank shown below, the lines represent the crests of the water waves.



If the speed of the water waves is $2{\cdot}4\ m\ s^{-1}$ what is the frequency of the wave generator?

40. The half-life of a radioactive sample is 8 days. The sample is held in front of a Geiger–Müller counter and gives a count, corrected for background, of 120 per minute.

A second, corrected count of 120 is taken 24 days later. How many minutes would this second count have lasted?

[END OF QUESTION PAPER]