[94/233] 1984

SCOTTISH CERTIFICATE OF EDUCATION

PHYSICS

Higher Grade—PAPER I

Wednesday, 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. **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 $g = 10$ m s^{-2} or $g = 10$ 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.**

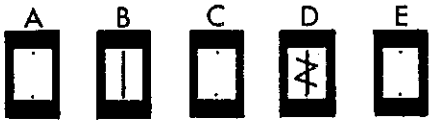
SAMPLE QUESTION FOR QUESTIONS 1–33

The momentum of a body is the product of

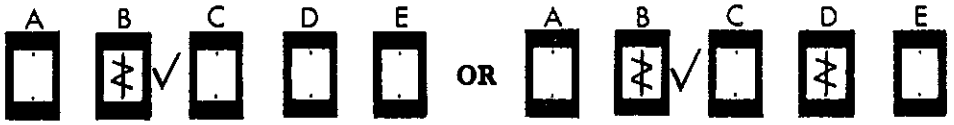
A mass and velocity squared
B mass and velocity
C mass and acceleration
D force and velocity
E force and displacement.

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 ms^{-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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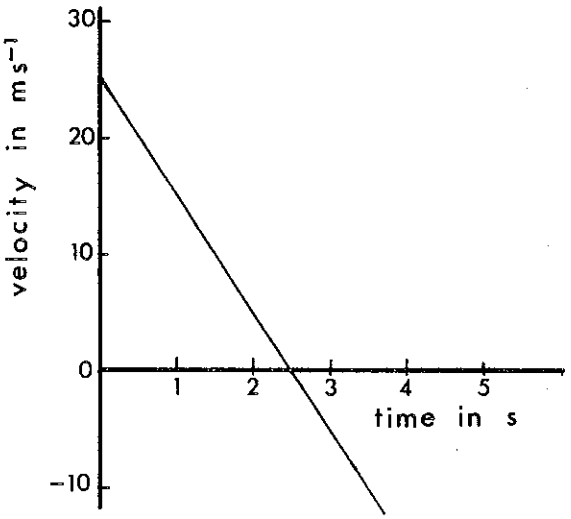
1. Which one of the following pairs is entered correctly?

	Scalar	*Vector*
A	weight	force
B	force	mass
C	mass	distance
D	distance	momentum
E	momentum	time

2. The velocity-time graph for the motion of a body is as shown.



Which of the following motions could produce such a velocity-time graph?

A A body projected vertically upwards at $25\,m\,s^{-1}$.

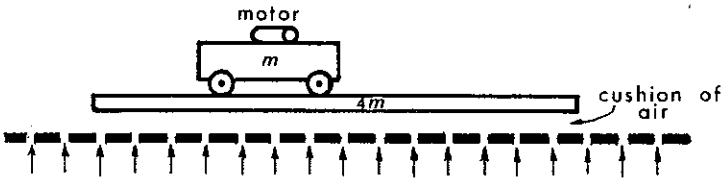
B A body projected upwards at $25\,m\,s^{-1}$ at an angle of 60° to the horizontal.

C A body projected horizontally at $25\,m\,s^{-1}$.

D A body projected downwards at $25\,m\,s^{-1}$ at an angle of 60° to the horizontal.

E A body projected vertically downwards at $25\,m\,s^{-1}$.

3 A motor-driven trolley of mass m rests on a plank of mass $4m$ which is supported on a cushion of air.



The trolley starts moving to the right. When the trolley reaches a velocity v the plank is

A still at rest

B moving to the right with speed $\frac{v}{5}$

C moving to the left with speed $\frac{v}{5}$

D moving to the right with speed $\frac{v}{4}$

E moving to the left with speed $\frac{v}{4}$.

4. A railway wagon travelling at uniform speed along a track collides with an identical stationary wagon. They are automatically coupled and move together. In the collision

A kinetic energy and momentum are both conserved

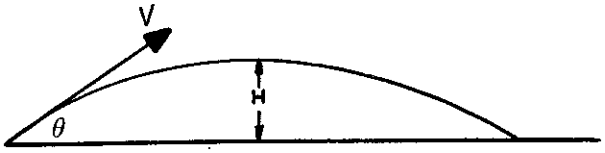
B neither kinetic energy nor momentum is conserved

C the total energy is conserved, but momentum is not

D kinetic energy is not conserved, but momentum is

E the total energy is not conserved, but momentum is.

5. An object is projected with a velocity V at angle θ with the horizontal.



At the point of maximum height H reached by the object, the values of the vertical acceleration and vertical and horizontal velocities are

	Vertical acceleration	*Vertical velocity*	*Horizontal velocity*
A	g	0	$V \sin \theta$
B	0	$V \cos \theta$	$V \sin \theta$
C	0	0	$V \cos \theta$
D	0	$V \sin \theta$	0
E	g	0	$V \cos \theta$

6. One volt is defined to be the potential difference between two points when

A one watt of power is developed when one coulomb of charge moves between the points

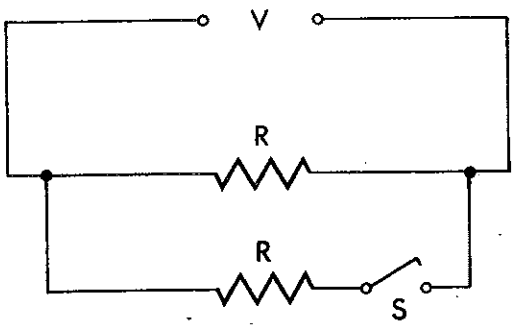
B one ampere of current moves one coulomb of charge between the points

C one ampere of current flows between the points in one second

D one joule of energy is used to move one ampere of current between the points

E one joule of energy is used to move one coulomb of charge between the points.

7. In the circuit below the supply has negligible internal resistance. When switch S is open, power P is drawn from the supply.



Assuming no change in the resistance of the identical resistors, what is the power drawn from the supply when the switch S is closed?

A $P/4$

B $P/2$

C P

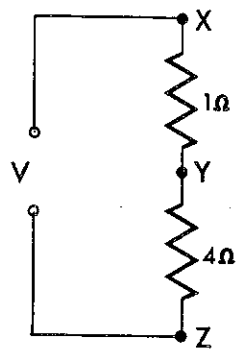
D $2P$

E $4P$

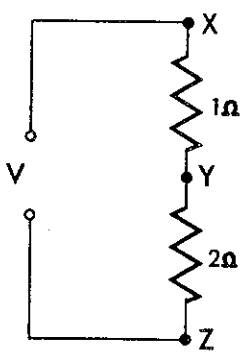
[Turn over

8. Assuming supply V has negligible internal resistance, in which circuit will the potential difference across YZ be twice the potential difference across XY?

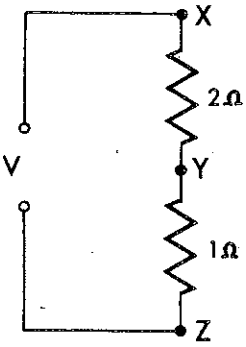
A



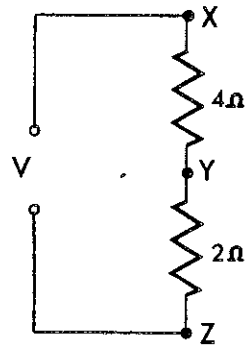
B



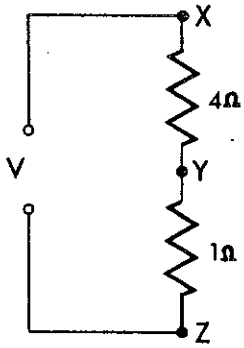
C



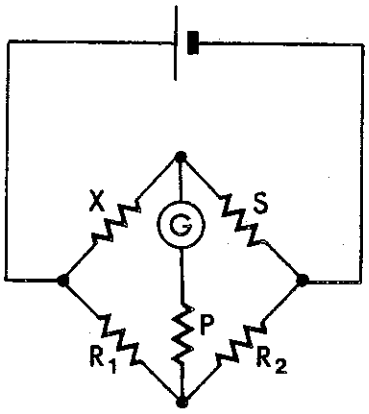
D



E



9. The diagram shows a Wheatstone bridge circuit used to compare two resistances X and S, R_1 and R_2 being known resistances.



When the bridge is balanced, which of the following statements is/are true?

I The bridge becomes unbalanced if the e.m.f. of the cell varies.

II The product of X and R_2 equals the product of S and R_1.

III The resistor P is included to increase the sensitivity of the bridge.

A II only

B I and II only

C I only

D I and III only

E II and III only

10. Two resistors, R_1 and R_2, are connected in parallel. R_1 has a fixed value, while the value of R_2 is variable but always greater than R_1. The resistance of the combination is

A greater than R_1 and increases as R_2 increases

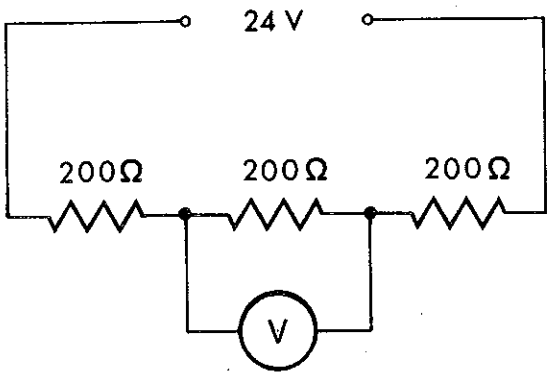
B greater than R_1 and decreases as R_2 increases

C always the average of R_1 and R_2

D less than R_1 and decreases as R_2 increases

E less than R_1 and decreases as R_2 decreases.

11. The voltmeter in the circuit below has a resistance of 1000 ohms, and the supply has negligible internal resistance.



The reading on the voltmeter will be

A between 0 V and 4 V
B between 4 V and 8 V
C exactly 8 V
D between 8 V and 12 V
E exactly 24 V.

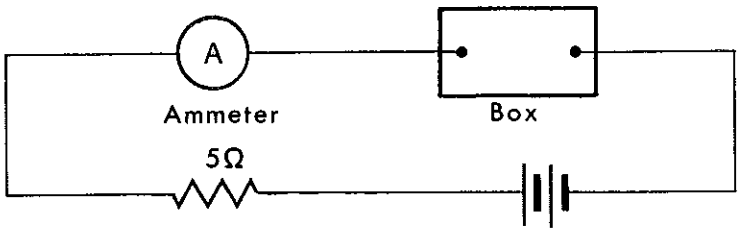
12. A common design of galvanometer has a rectangular coil which can turn in a magnetic field against a spring. The coil can be made to turn through a bigger angle for a given current by **increasing**

I the magnetic field strength
II the strength of the spring
III the number of turns of the coil.

Which of these 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

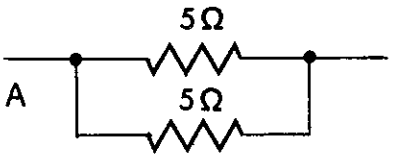
13. The following circuit is set up.

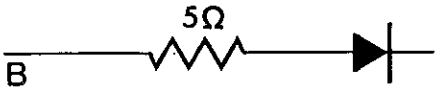


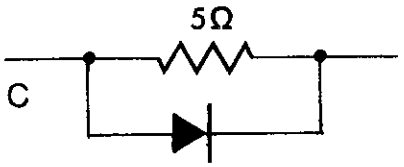
The ammeter (of negligible resistance) reads 2.0 A.

On reversing the connections to the box, the ammeter reads 1.0 A.

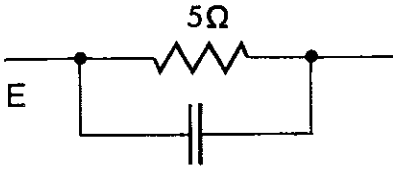
The components in the box were arranged as

A


B


C


D


E


[Turn over

14. An insulated metal plate which is parallel and close to a similar earthed plate is given an electric charge by being connected briefly to a d.c. supply. The separation of the plates is now increased using a non-conducting handle. Which, if any, of the following will remain constant?

I The charge

II The capacitance

III The potential difference between the plates

A I, II and III

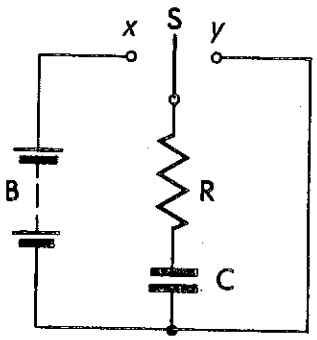
B I and II only

C II and III only

D I only

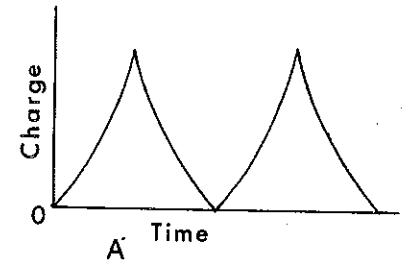
E III only

15. In the following circuit, B is a battery, R is a high resistance and C is a capacitor.

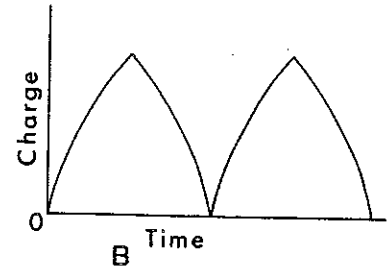


[Question 15 is continued in the next column

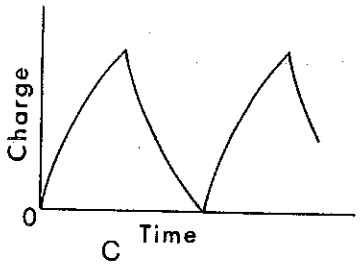
Select the diagram which best represents the variation of charge with time on the capacitor as the switch S is moved to and fro between x and y. (Assume that the time of contact with either x or y is very large compared with the time to move over from one to the other.)



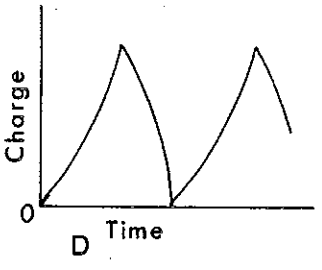
A



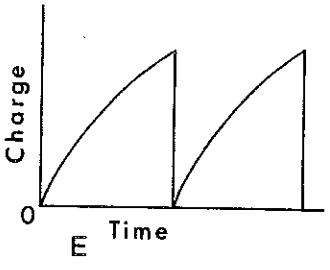
B



C

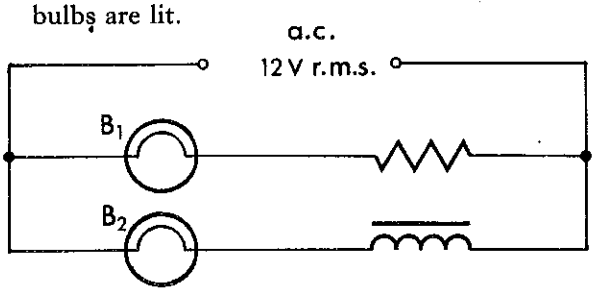


D



E

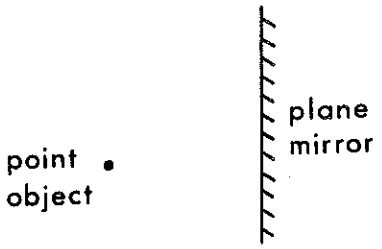
16. Bulbs B_1 and B_2 are connected to an a.c. supply which has negligible internal resistance. Both bulbs are lit.



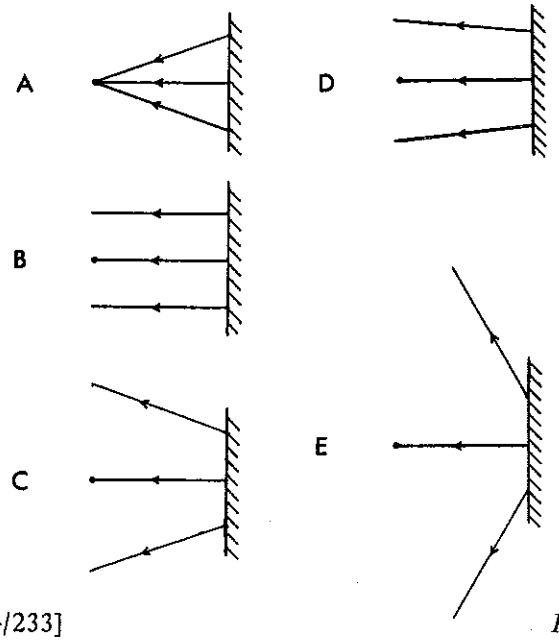
If the a.c. supply is replaced by a d.c. supply of 12 V with no internal resistance, what happens to the brightness of each bulb?

	B_1	B_2
A	decreases	decreases
B	decreases	increases
C	stays the same	stays the same
D	stays the same	increases
E	increases	stays the same

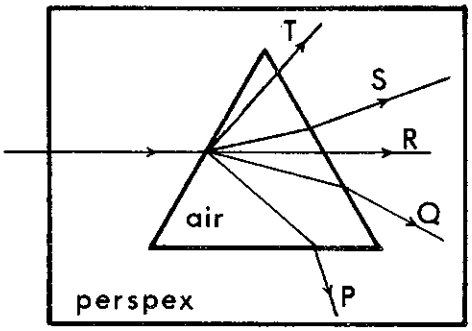
17. The diagram below shows a point object placed a short distance from a plane mirror.



Rays of light from this object are reflected from the mirror. Which one of the following diagrams shows the paths of three of these reflected rays?



18. The diagram below shows a block of perspex out of which a triangular section has been cut.



Which path will the ray of light follow?

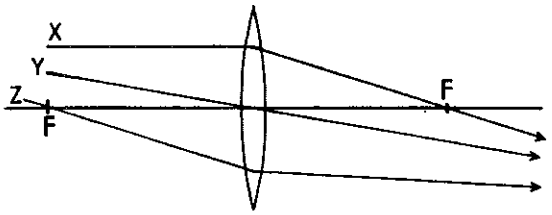
A P
B Q
C R
D S
E T

19. A manufacturer claims that his photocopier uses only one converging lens to project an image of an original drawing on to a light-sensitive sheet of paper. The projected image is the same size as the original drawing.

How far from the converging lens should the original drawing be placed?

A less than one focal length
B exactly one focal length
C between one and two focal lengths
D exactly two focal lengths
E more than two focal lengths

20. Three rays of light X, Y and Z come from different directions and pass through a thin lens.

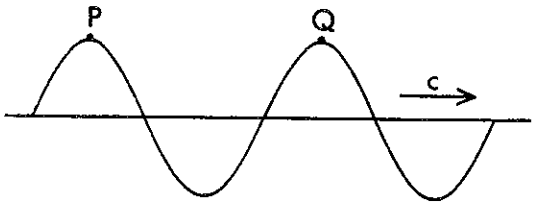


Which rays are correctly drawn?

A X only
B X and Y only
C X and Z only
D Y and Z only
E X, Y and Z

[Turn over

21. The diagram represents a wave of frequency f and wavelength λ moving with a speed c.



The time taken for the crest of the wave shown at position P to reach position Q is given by

A $\frac{\lambda}{c}$

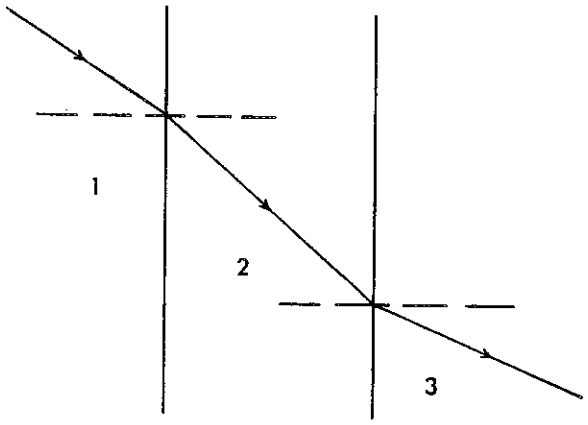
B $\frac{c}{\lambda}$

C $c \times \lambda$

D $\frac{\lambda}{f}$

E $\frac{f}{\lambda}$.

22. The diagram below shows a ray of light travelling through air, glass and water, **not** necessarily in that order.



If light travels faster in water than in glass then (1), (2) and (3) are respectively

	(1)	(2)	(3)
A	air	water	glass
B	water	glass	air
C	glass	water	air
D	glass	air	water
E	water	air	glass

23. A beam of light passes from a block of glass into air. What will happen to the velocity and frequency of the light as it leaves the glass and enters the air?

	Velocity	*Frequency*
A	decrease	constant
B	decrease	increase
C	constant	decrease
D	increase	decrease
E	increase	constant

24. Which diagram correctly describes the relation between the colour of light and a wave characteristic of visible light travelling in a vacuum?

A red yellow blue
Wavelength decreasing →

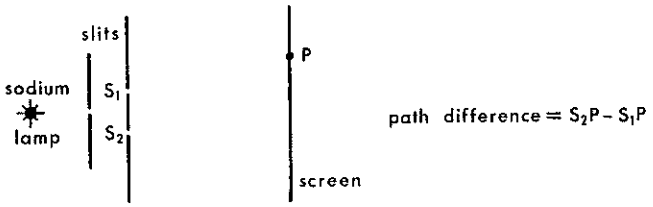
B red yellow blue
Speed decreasing →

C red yellow blue
Frequency decreasing →

D red yellow blue
Speed increasing →

E red yellow blue
Wavelength increasing →

25. The diagram represents the 'Young's Slits' method of obtaining interference fringes.



Destructive interference will occur at points P where the path difference is

A an odd number of quarter wavelengths

B an odd number of half wavelengths

C an even number of half wavelengths

D an odd number of wavelengths

E an even number of wavelengths.

26. Which of the following is **not** consistent with the kinetic theory of an ideal gas?

A The molecules occupy a small fraction of the volume of the container.

B The molecules collide inelastically.

C The temperature gives a measure of the average kinetic energy of the molecules.

D The gas pressure is due to molecular collisions.

E The attractive forces between the molecules are negligible.

27. The quantity $\frac{1}{3}$ N $m\overline{u^2}$ is derived in the study of the kinetic theory of gases. It has the same units as

A volume

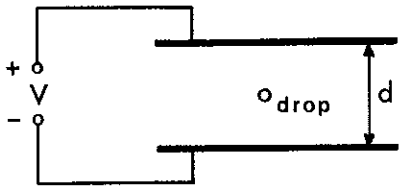
B density

C pressure

D momentum

E energy.

28. In a Millikan's experiment an oil drop is held stationary in the space between the two metal plates.



Which change would cause the drop to start moving downwards?

A loss of oil from the drop by evaporation

B loss of negative charge from the drop

C a rise in the temperature of the drop causing it to expand

D an increase in the magnitude of the voltage, V

E a decrease in the separation, d, of the plates

29. The emission spectrum of helium contains sharp lines in the violet, blue, yellow, orange and red regions of the visible spectrum. The light energy is emitted when

A electrons move from lower to higher energy levels

B electrons move from higher to lower energy levels

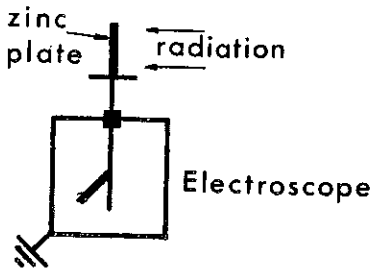
C protons move from lower to higher energy levels

D protons move from higher to lower energy levels

E neutrons moves from lower to higher energy levels.

[Turn over

30. To demonstrate the photo-electric effect, radiation is directed onto the surface of a clean zinc plate mounted on top of a charged electroscope.



Which of the following sets of conditions is necessary to show the effect?

	Charge on electroscope	*Frequency of radiation*
A	+ve	above a certain value
B	−ve	above a certain value
C	+ve	any value
D	−ve	any value
E	−ve	below a certain value

31. As a result of Geiger and Marsden's alpha-particle scattering experiments, Rutherford proposed that an atom had

A a plum pudding type structure

B its mass evenly distributed

C a nucleus of small diameter and high density

D a nucleus of large diameter and low density

E a nucleus containing all the charged particles.

32. The symbol $^{194}_{78}Pt$ is used to represent one of the isotopes of platinum.

In the neutral atom of this isotope there will be

A 78 neutrons

B 194 neutrons

C 194 protons

D 78 orbital electrons

E 116 orbital electrons.

33. A radioactive decay series, starting with Thorium $^{232}_{90}Th$, involves the emission, in turn, of the following: alpha, beta, beta, gamma, alpha.

What is the final product of this series?

A $^{224}_{88}Ra$

B $^{230}_{82}Pb$

C $^{226}_{86}Rn$

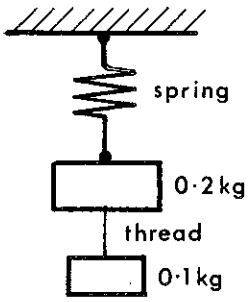
D $^{227}_{85}At$

E $^{225}_{87}Fr$

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

34. A car is travelling at $25\,m\,s^{-1}$. The brakes are applied for 5 s and the speed is reduced to $15\,m\,s^{-1}$. How far does the car travel in this time, assuming that the deceleration was uniform?

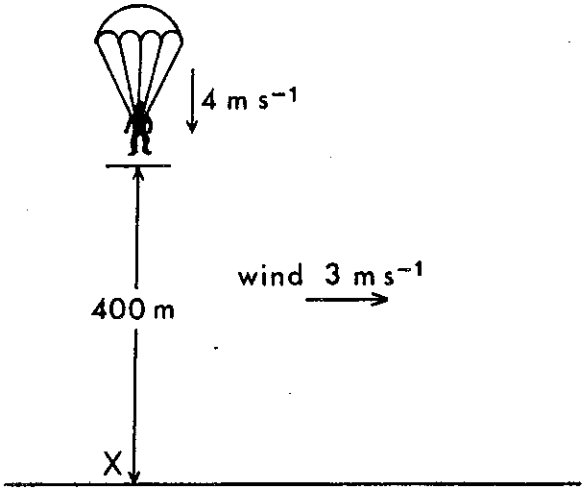
35. A light spring has a mass of 0·2 kg suspended from its lower end. A second mass of 0·1 kg is suspended from the first by a thread.



The arrangement is allowed to become stationary and then the thread is burned through. At this instant what is the upward acceleration of the 0·2 kg mass?

36. A trolley of mass 2 kg moving at $2\,m\,s^{-1}$ collides inelastically with an identical stationary trolley. After the collision, they move off coupled together. How much kinetic energy is lost during the impact?

37. A parachutist drops from a balloon floating above an airfield.



When he is 400 m above a point X on the airfield, he is falling at a constant vertical speed of $4\,m\,s^{-1}$. A steady wind blows him horizontally at $3\,m\,s^{-1}$. How far from X will he land?

38. In a school workshop, a small transformer is used to operate an electric drill from the 240 V, 50 Hz mains. The voltage across the drill is 120 V and the current through it is 2 A (both r.m.s.). Assuming no energy losses in the coil of the transformer, what is the current in the primary?

39. Light of frequency 5×10^{14} Hz passes from air into glass of refractive index 1·5. The speed of light in air is $3 \times 10^8\,m\,s^{-1}$. What is the wavelength of this light in the glass?

40. A gas bubble has a volume of $10\,cm^3$. The pressure of the gas is 1×10^5 Pa and the temperature is 7°C.

The pressure is decreased to 5×10^4 Pa and the temperature is raised to 77°C. What is the volume of the bubble now?

[END OF QUESTION PAPER]