SCOTTISH CERTIFICATE OF EDUCATION

PHYSICS

Higher Grade—PAPER I

Wednesday, 4th 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 to be used are already filled in.**
5. **For each question there is only ONE correct answer.**
6. **Use the approximation $g = 10\ \text{m s}^{-2}$ or $g = 10\ \text{N kg}^{-1}$.**
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

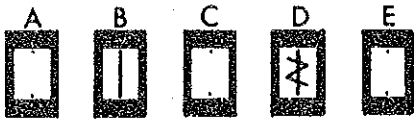
C mass and acceleration

D force and velocity

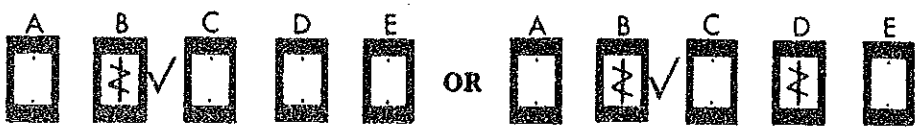
E force and displacement.

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

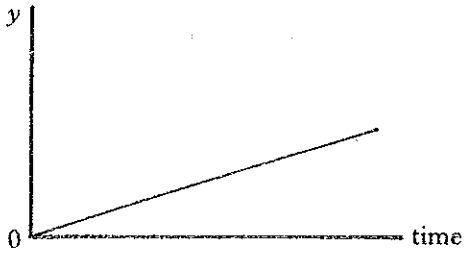
What force is required to give an acceleration of $4\ \text{m s}^{-2}$ to a mass of 4 kg?

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

16	N

UCP 3220/263 6/6/20560

1. The graph below represents the motion of a body falling freely in a vacuum.



The quantity y plotted along the vertical axis is

A speed

B distance

C acceleration

D force

E kinetic energy.

2. 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 if the deceleration is uniform?

A 25 m

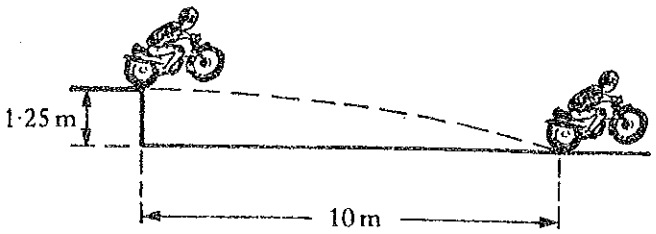
B 50 m

C 75 m

D 100 m

E 175 m

3. A motocross rider takes a jump which is 1·25 m high. He lands 10 m from the base of the jump.



Assuming that he was travelling horizontally when he left the edge and that air resistance can be ignored, at what speed did he approach the jump?

A $5\,m\,s^{-1}$

B $10\,m\,s^{-1}$

C $15\,m\,s^{-1}$

D $20\,m\,s^{-1}$

E $25\,m\,s^{-1}$

4. Figure 1 shows a trolley of mass 2 kg moving to the right with a **constant** velocity of $10\,m\,s^{-1}$.

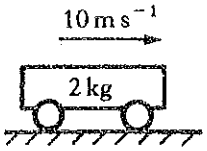


Figure 1

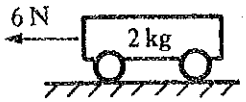


Figure 2

At a certain instant, a constant force of 6 N is suddenly applied to the trolley in a direction to the left as shown in Figure 2. The acceleration of the trolley while this force acts is

A $3\,m\,s^{-2}$ to the right

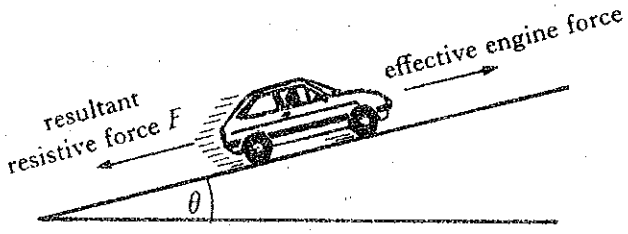
B $3\,m\,s^{-2}$ to the left

C $7\,m\,s^{-2}$ to the right

D $12\,m\,s^{-2}$ to the right

E $12\,m\,s^{-2}$ to the left.

5. A car of mass m is travelling with a constant velocity up a hill at an angle θ to the horizontal, as indicated.



If F is the resultant resistive force acting on the car, the effective engine force needed to maintain this **constant** velocity must be

A $mg\cos\theta + F$

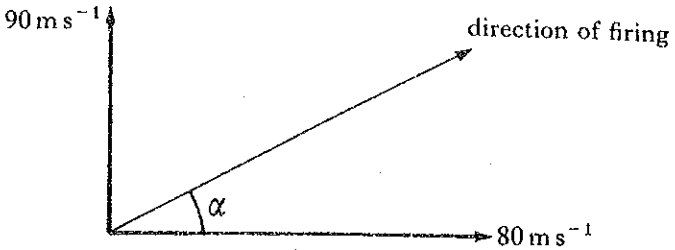
B $mg\cos\theta - F$

C $mg\sin\theta + F$

D $mg\sin\theta - F$

E $mg + F\sin\theta$.

6. A projectile is fired at an angle α to the horizontal. The vertical and horizontal components of velocity at the instant of firing are as shown.



What will be the vertical and horizontal components of velocity after 5 s, if air resistance is negligible?

	Vertical component of velocity	*Horizontal component of velocity*
A	$30\,m\,s^{-1}$	$30\,m\,s^{-1}$
B	$40\,m\,s^{-1}$	$30\,m\,s^{-1}$
C	$30\,m\,s^{-1}$	$80\,m\,s^{-1}$
D	$40\,m\,s^{-1}$	$80\,m\,s^{-1}$
E	$90\,m\,s^{-1}$	$80\,m\,s^{-1}$

7. A motorcycle safety helmet has a soft inner lining which is compressed on impact with the skull. This design protects the skull because it

A decreases the impulse applied to the skull

B increases the time of impact of the skull

C decreases the time of impact of the skull

D decreases the change in momentum of the skull

E increases the change in momentum of the skull.

8. The unit of electric field strength is the

A volt

B joule

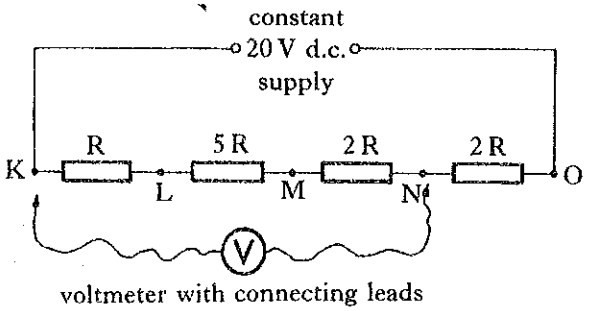
C volt per coulomb

D joule per coulomb

E newton per coulomb.

[Turn over

9. A 20 V supply, connected to a set of resistors in series as shown, can be used to provide a selection of output voltages by suitable choice of connecting points. The resistance of each resistor is as shown in the diagram.



voltmeter with connecting leads

Between which two points does the voltmeter read 8 V?

A LN

B MO

C KL

D KN

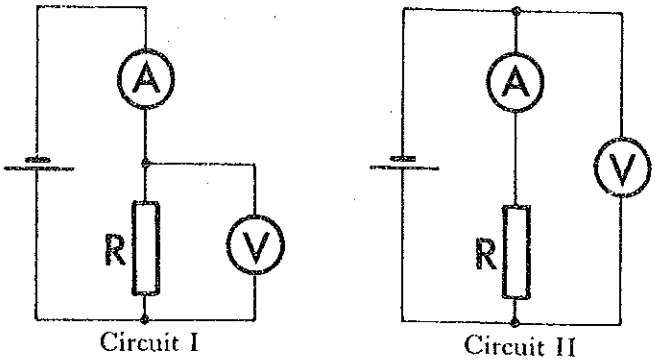
E LO

10. An amplifier has two output sockets marked 4 Ω and 8 Ω. The amplifier is designed so that a 4 Ω loudspeaker connected to the 4 Ω output, or an 8 Ω loudspeaker connected to the 8 Ω output, produces the same maximum power. Two loudspeakers each of resistance 8 Ω are available. Which combination of amplifier output and loudspeaker/s gives the biggest power output?

	Amplifier Output	*Loudspeaker System*
A	4 Ω	8 Ω on its own
B	4 Ω	8 Ω and 8 Ω in series
C	4 Ω	8 Ω and 8 Ω in parallel
D	8 Ω	8 Ω and 8 Ω in series
E	8 Ω	8 Ω and 8 Ω in parallel

11. A low resistance ammeter and a high resistance voltmeter are used to measure resistance R. The resistance of the voltmeter is known to be about the value of R.

Initially circuit I is used, then circuit II.



What changes are there in the meter readings when circuit II is used?

	Ammeter reading	*Voltmeter reading*
A	little change	little change
B	increased	decreased
C	increased	little change
D	decreased	decreased
E	decreased	little change

12. A particular wire wound resistor has a resistance of 100 Ω when used at a room temperature of 20°C.

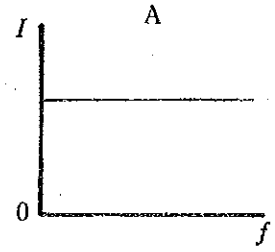
Using wire of the same metal, another resistor is constructed. Which of the following combinations of factors would be **certain** to give a resistance greater than 100 Ω?

	Length of wire	*Thickness of wire*	*Temperature*
A	longer	thicker	20°C
B	shorter	thinner	20°C
C	longer	thicker	0°C
D	shorter	thicker	0°C
E	longer	thinner	20°C

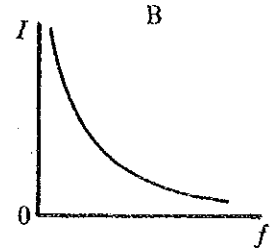
13. A resistor is connected across the terminals of a constant peak voltage a.c. supply whose frequency f can be varied.

Which graph below shows how the peak current I in the resistor varies with f?

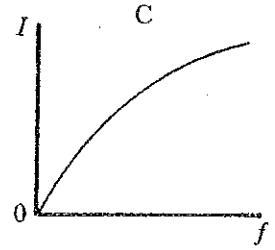
A



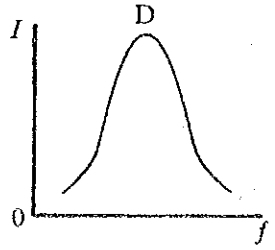
B



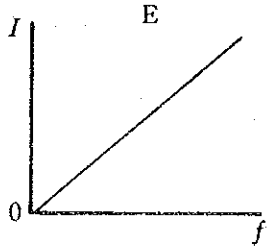
C



D



E



14. When a capacitor of capacitance C is connected to a supply of potential difference V, it stores a charge Q.

Which of the following expressions correctly gives the energy stored in the capacitor?

A $\frac{1}{2}\frac{C^2}{Q}$

B $\frac{1}{2}\frac{C}{Q^2}$

C $\frac{1}{2}QV^2$

D $\frac{1}{2}CV$

E $\frac{1}{2}QV$

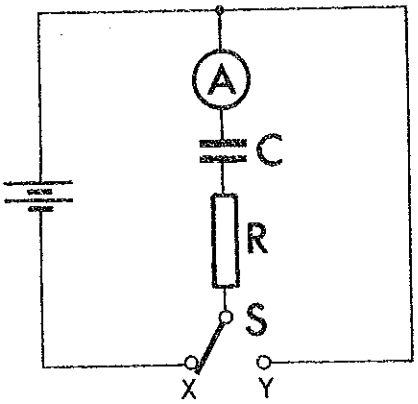
15. A parallel plate capacitor is connected to a battery. While the battery is still connected, the capacitor plates are moved closer together.

Which line in the table below correctly states how this change affects the capacitor?

	charge on capacitor	*p.d. between plates*
A	increases	stays the same
B	decreases	stays the same
C	stays the same	increases
D	stays the same	decreases
E	increases	increases

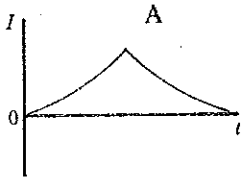
[Turn over

16. In the circuit below, S is a two-way switch and A is a centre-zero ammeter.

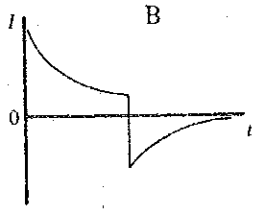


The switch contact is moved to X then very quickly to Y. Which of the graphs shows how the current I in the ammeter varies with time?

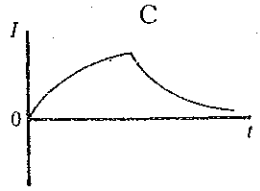
A



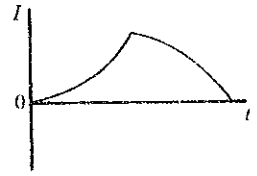
B



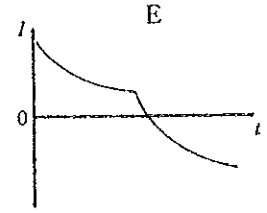
C



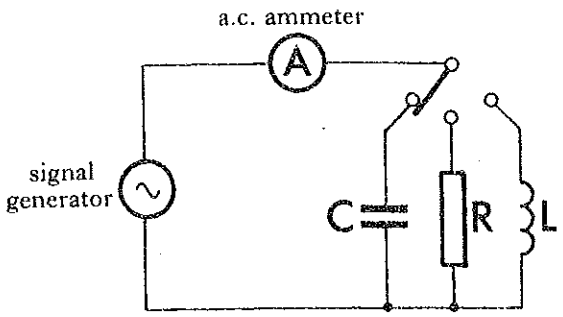
D



E



17. A capacitor C, a resistor R and an inductor L are connected in a circuit with a signal generator, an a.c. ammeter and a 3-way switch, as shown.



At a particular frequency, the reading on the ammeter is the same for all the three positions of the switch. The frequency of the generator is now **increased**, while the peak output voltage remains constant. The current is noted for each switch position. Which of the following statements is/are correct?

I Current in C increases

II Current in L increases

III Current in R remains the same

A I only

B II only

C III only

D I and III only

E II and III only

18. Which of the following statements about the reflection of light is/are true?

I The reflected ray lies in the same plane as the incident ray and the normal to the reflecting surface, at the point of incidence.

II The angle between the reflected ray and the normal is equal to the angle between the incident ray and the normal.

III The reflected ray lies in the same plane as the reflecting surface.

A I only

B II only

C I and II only

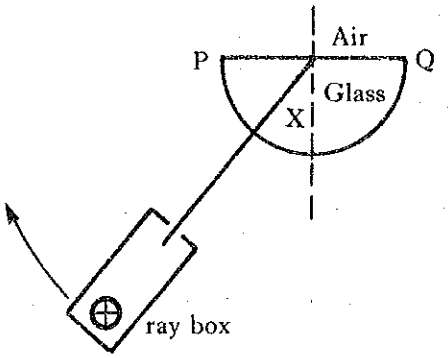
D II and III only

E I, II and III

19. Measurements of the intensity of light are taken at a position 1 metre away from a monochromatic point source of light. The measurements are then repeated at a new position which is 2 metres away from the same source. What differences, if any, are observed?

	Wavelength of light	*Intensity of light*
A	unchanged	unchanged
B	unchanged	halved
C	unchanged	quartered
D	doubled	unchanged
E	doubled	quartered

20. A ray of light is shown in a semi-circular glass block.



Which effect/s occur/s as the angle X is gradually increased to just less than 90°, by moving the ray box in the direction shown?

I Beyond a certain value of X, no refraction takes place at PQ.

II At the critical angle, the refracted ray passes along face PQ.

III There is always a ray reflected from PQ.

A I and II only

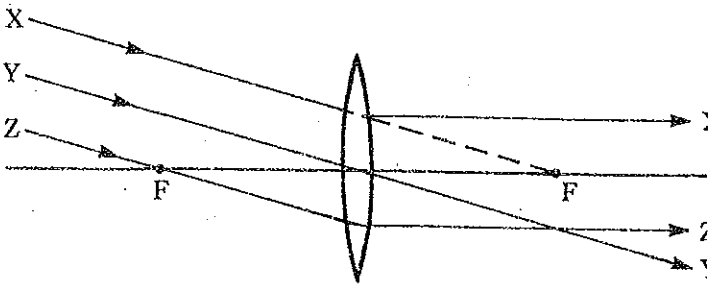
B II and III only

C I and III only

D I only

E I, II and III

21. Three parallel rays of light X, Y and Z pass through a thin converging lens. The letter F denotes the principal focal points.



Which of the rays is/are drawn correctly after passing through the lens?

A Y only

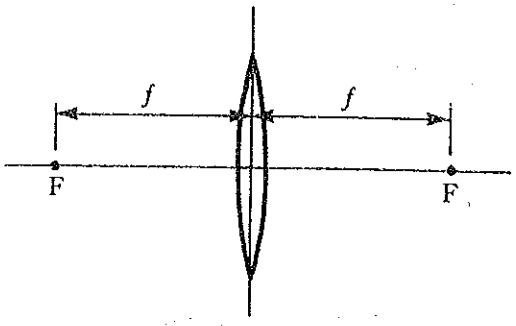
B X and Z only

C X and Y only

D Y and Z only

E X, Y and Z

22. The diagram shows a thin, converging lens. The principal focal points are marked.



Where should an object be positioned to produce a magnified, real, inverted image on the right hand side of the lens?

	Position of object	
	Side of lens	*Distance u from lens*
A	left	$f < u < 2f$
B	right	$f < u < 2f$
C	left	$u < f$
D	right	$u < f$
E	left	$u = f$

[Turn over

23. When light passes from air into glass,

A the speed of the light increases

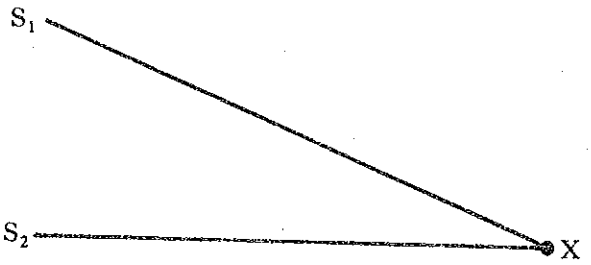
B the speed of the light decreases

C the frequency of the light increases

D the frequency of the light decreases

E the wavelength of the light increases.

24. S_1 and S_2 are coherent point sources of microwaves of wavelength λ.



At point X a maximum signal is detected. This could occur when the path difference is

A $\frac{\lambda}{4}$

B $\frac{\lambda}{2}$

C $\frac{3\lambda}{4}$

D λ

E $\frac{3\lambda}{2}$.

25. A Young's double slit apparatus is set up to produce interference fringes on a screen using a monochromatic source of green light.

It would be possible to produce fringes with greater separation by

A decreasing the distance between the slits and the screen

B increasing the distance between the source and the slits

C increasing the distance between the two slits

D increasing the width of each slit

E replacing the light source with a monochromatic source of red light.

26. In the equation

$$p\,V = \frac{1}{3}\,N\,m\,\overline{u^2}$$

the symbol N represents

A the number of molecules in the volume V

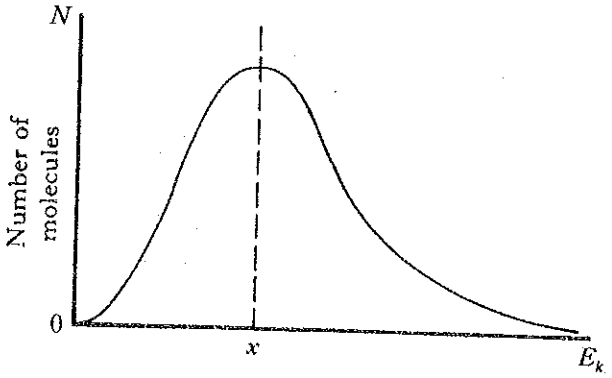
B the number of molecules in $1\ m^3$

C Avogadro's constant

D the number of atoms in a molecule of the gas

E the number of molecular collisions every second.

27. The graph below shows the distribution of kinetic energies E_k of the molecules of a gas at a uniform temperature.



Which of the following statements is true?

A If the temperature does not change, the kinetic energy of each molecule cannot change.

B The commonest value of kinetic energy is also the greatest kinetic energy of any of the molecules.

C The total kinetic energy of the molecules is independent of the temperature of the gas.

D The value x, of E_k at which the peak of the curve occurs increases when the temperature rises.

E The value x, of E_k at which the peak of the curve occurs is termed the binding energy.

28. In the equation $E = hf$, what do the three symbols represent?

	E	h	f
A	Energy	Distance between electron orbitals	Frequency of radiation
B	Energy	Planck's constant	Number of electrons per second
C	Energy	Planck's constant	Frequency of radiation
D	Electric field strength	Planck's constant	Frequency of radiation
E	Electric field strength	Distance between plates	Force between plates

29. The pressure gauge on an oxygen cylinder of capacity $0{\cdot}1\,m^3$ reads $1{\cdot}0 \times 10^7$ Pa. The density of oxygen at atmospheric pressure ($1{\cdot}0 \times 10^5$ Pa) is $1{\cdot}4\,kg\,m^{-3}$. Assuming that the temperature remains constant, what is the density of the oxygen in the cylinder?

A $0{\cdot}14\,kg\,m^{-3}$

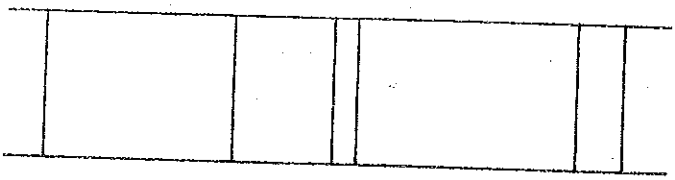
B $1{\cdot}4\,kg\,m^{-3}$

C $14\,kg\,m^{-3}$

D $140\,kg\,m^{-3}$

E $1400\,kg\,m^{-3}$

30. A line spectrum obtained in an experiment is shown below.



This result leads to a model of the atom. Which of the following assumptions is/are consistent with this model?

I The electrons in the atom are changing from one energy level to another.

II The energy levels of the electrons have definite values.

III The atom is gradually losing electrons.

A I only

B II only

C III only

D I and II only

E I, II and III

31. A cleaned zinc plate is placed on the cap of a gold leaf electroscope which is then charged negatively.

When ultra-violet radiation is directed towards the zinc plate, the electroscope is discharged.

This is because

A the ultra-violet radiation ionises the air and the negative ions are repelled by the zinc plate

B the ultra-violet radiation ionises the air and the positive ions are attracted to the zinc plate

C the wavelength of the ultra-violet radiation is large enough to eject electrons from the zinc plate

D the intensity of the ultra-violet radiation is large enough to eject electrons from the zinc plate

E the energy of each photon of the ultra-violet radiation is large enough to eject an electron from the zinc plate.

[Turn over

32. Isotope X usually decays by α-emission into isotope P which then decays by β-emission to isotope Q.

$$X \xrightarrow{\alpha} P \xrightarrow{\beta} Q$$

A small percentage of X decays first by β-emission into isotope R which in turn decays by α-emission into isotope S.

$$X \xrightarrow{\beta} R \xrightarrow{\alpha} S$$

Which of the following is/are correct?

I Q and S are identical isotopes.

II The mass number of X is the same as the mass number of R.

III The atomic number of X is the same as the atomic number of R.

IV The atomic number of R is greater than the atomic number of P.

A I only

B I, II and IV only

C I and IV only

D III and IV only

E II and III only

33. Given that the atomic mass of ^{14}N is $23{\cdot}252 \times 10^{-27}$ kg and that the sum of the atomic masses of ^{1}H and ^{13}C is $23{\cdot}265 \times 10^{-27}$ kg, it would be reasonable to suppose that the nuclear reaction

$$^{1}_{1}H + {}^{13}_{6}C \longrightarrow {}^{14}_{7}N$$

A will result in the emission of energy

B can only happen if there is a net supply of energy

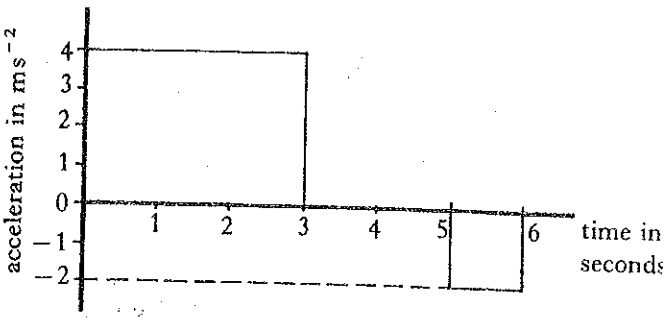
C could not take place at all

D could occur only in conditions of zero gravity, i.e., of "weightlessness"

E must involve the emission of further atomic particles.

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

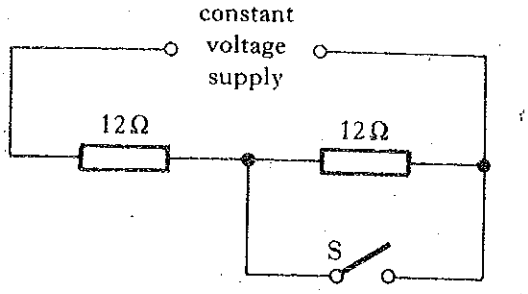
34. The acceleration-time graph of an object starting from rest is shown below.



What is the velocity after 6 s?

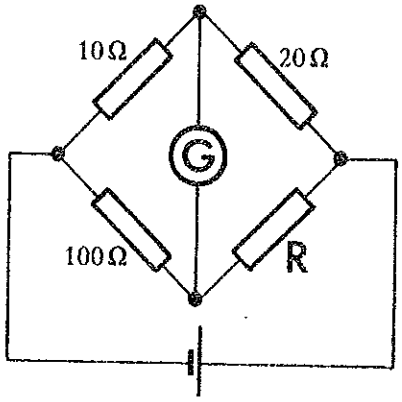
35. A ball X of mass 1 kg travelling at 5 m s^{-1} strikes a stationary ball Y of mass 2 kg. If ball X bounces back along its original path at 1 m s^{-1}, what will be the speed of ball Y?

36. In the following circuit, the supply maintains a constant d.c. voltage. When the switch S is closed, the power delivered to the circuit by the supply is 30 W.



What power is delivered to the circuit by the supply when the switch is open?

37. On setting up the following bridge circuit, a pupil finds that no current flows in the galvanometer.



What is the resistance of the unknown resistor R?

38. An immersion heater is connected to a constant voltage supply. It is found that 2000 J of energy is required to supply a current of 2 A for 4 s through the immersion heater. What is the potential difference between the ends of the heater, in volts?

39. If the refractive index of a certain substance is 1·7, relative to air, what is its critical angle to the nearest degree?

40. In a Millikan experiment, a charged oil drop is balanced between two parallel plates maintained at a potential difference of 200 V. After the charge on the oil drop is changed by exposure to radiation, a p.d. of 100 V keeps the drop balanced. If the original charge on the drop was 32 units, what is the new charge in the same units?

[END OF QUESTION PAPER]