[94/233] 1985

SCOTTISH CERTIFICATE OF EDUCATION

PHYSICS

Higher Grade—PAPER I

Wednesday, 8th 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.**

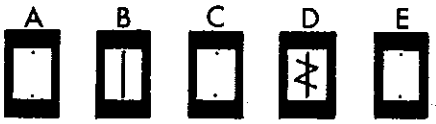
SAMPLE QUESTION FOR QUESTIONS 1–33

The momentum of a body is the product of

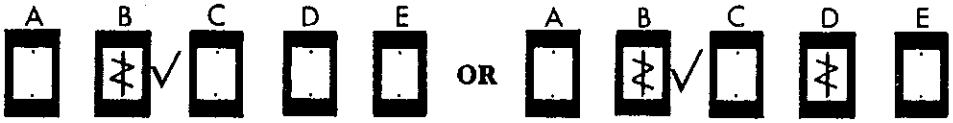
A mass and velocity squared
B mass and velocity
C mass and acceleration
D force and velocity
E force and displacement.

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

TE&S 94/233 6/3/20960

1. A man weighs 800 N and stands on an accurate weighing-machine in a lift. The reading on this weighing-machine is 820 N. This indicates that the lift is

   A stationary

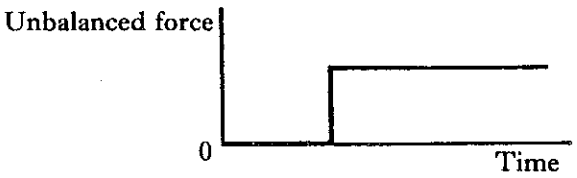
   B moving upwards at a steady speed

   C moving downwards at a steady speed

   D accelerating upwards

   E accelerating downwards.

2. A car driver presses the accelerator sharply when the traffic lights go green. The unbalanced force on the car varies with time as shown.

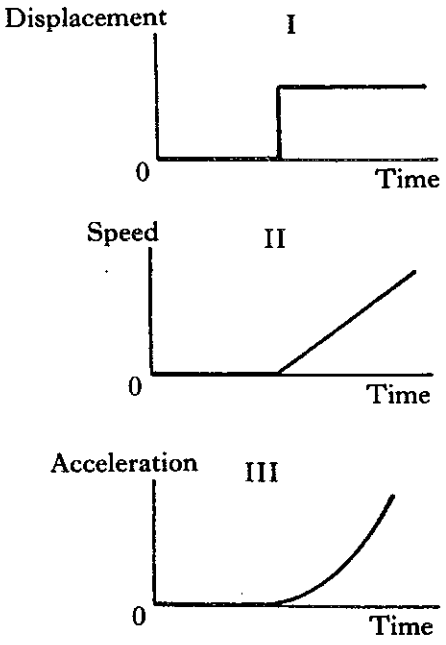


The graphs I to III below attempt to show the variation with time of

I the car's displacement;

II the car's speed;

III the car's acceleration.



Which of these graphs is/are correct?

A I only

B II only

C I and III only

D II and III only

E I, II and III

3. A block X of mass 3 kg is accelerated from rest by a force of 5 N for 2 s. An identical block Y is accelerated from rest by a force of 5 N for 4 s. The ratio of the kinetic energy of X to the kinetic energy of Y after acceleration is

A 5 : 3

B 3 : 4

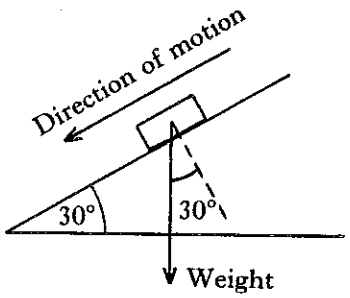
C 2 : 1

D 1 : 2

E 1 : 4.

4. The diagram below shows a block moving down a 30° slope, at a constant speed. The weight of the block is 20 N.

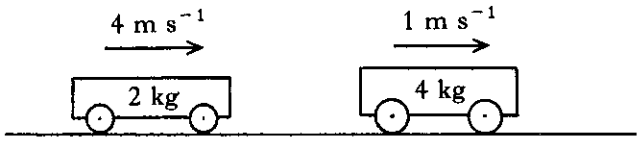
$\left(\sin 30° = \frac{1}{2}, \cos 30° = \frac{\sqrt{3}}{2}\right)$



From the above information, which entry in the table is correct?

	Perpendicular reaction between block and slope	*Component of weight down the slope*	*Frictional force between block and slope*
A	20 N	20 N	20 N
B	20 N	10 N	10 N
C	$10\sqrt{3}$ N	10 N	0 N
D	10 N	$10\sqrt{3}$ N	10 N
E	$10\sqrt{3}$ N	10 N	10 N

5. Two trolleys are travelling in the same direction, as shown below. The trolleys collide.



After impact they move off together. The amount of kinetic energy lost is

A 4 J

B 6 J

C 12 J

D 14 J

E 18 J.

6. The equation $s = ut + \frac{1}{2}at^2$ can be derived from

A the area under a velocity–time graph

B the area under an acceleration–time graph

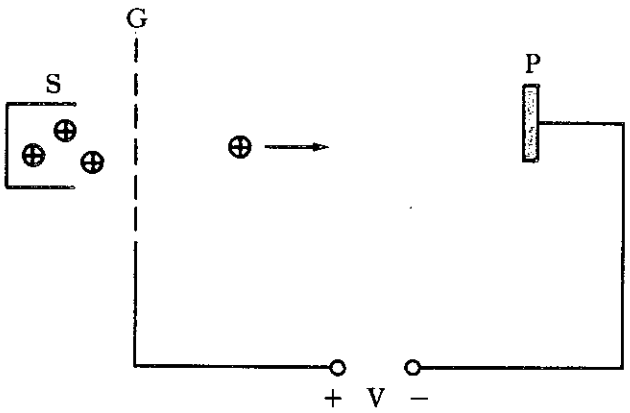
C the slope of a velocity–time graph

D the slope of a displacement–time graph

E the slope of an acceleration–time graph.

[Turn over

7. The diagram shows a source of ions S, and a grid G beyond which is a collecting plate P. There is a potential difference V between P and G so that ions drifting into the space between P and G are accelerated to P. The whole apparatus is in an evacuated chamber.



Which of the following will affect the time an ion takes to go from G to P?

I the potential difference V

II the mass of the ion

III the charge on the ion

A I only

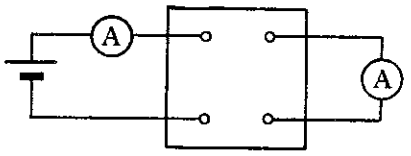
B II only

C I and III only

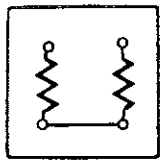
D II and III only

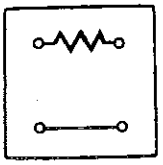
E I, II and III

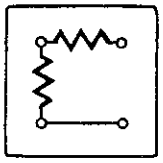
8. A four-terminal box is connected as shown to a battery and two milliammeters. The currents in the two meters are identical.

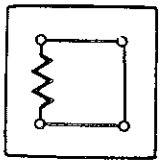


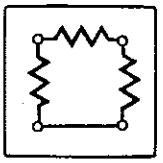
Which of the circuits A to E below, within the box, is the only one which will give this result?

A 

B 

C 

D 

E 

9. An ammeter of 4·5 Ω resistance gives a full scale deflection for 1 mA. What resistance must the meter have added to it to give a full scale deflection for 10 mA?

A 0·45 Ω in parallel

B 0·50 Ω in parallel

C 45·0 Ω in parallel

D 0·45 Ω in series

E 0·50 Ω in series

10. An alternating current of root-mean-square value 2 A flowing through a given resistor generates heat at the same rate as a steady direct current I in another resistor of the same value. What is the value of I?

A 1 A

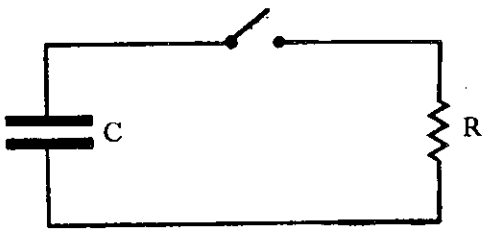
B $\sqrt{2}$ A

C 2 A

D $2\sqrt{2}$ A

E 4 A

11. In the circuit diagram below, C is a 1·0 μF capacitor holding a charge of 10^{-5} C and R is a 10 Ω resistor.



If the switch is suddenly closed, the initial current flowing in the circuit will be

A zero

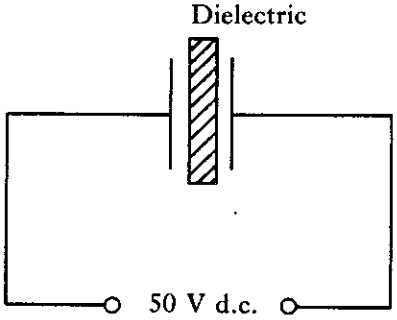
B 10^{-5} A

C 10^{-1} A

D 1 A

E 10 A.

12. A parallel-plate capacitor is connected across a 50 V d.c. supply as shown.



Which of the following alterations would increase its capacitance?

A Connect it to a 25 V supply.

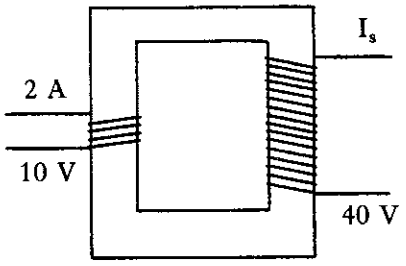
B Connect it to a 100 V supply.

C Remove the slab of dielectric between the plates.

D Decrease the overlap area of the plates.

E Decrease the separation of the plates.

13. The transformer below has a turns ratio of 1 : 4.



If electrical energy is converted to heat in the windings and the core at the rate of 4 watts, what is the current in the secondary?

A 0·1 A

B 0·4 A

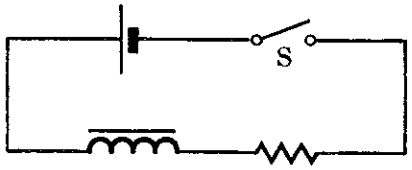
C 0·5 A

D 0·6 A

E 0·8 A

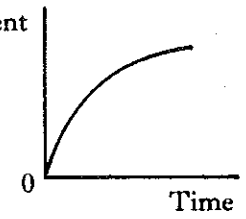
[Turn over

14. The diagram below shows an inductor, a resistor, and a cell in series.

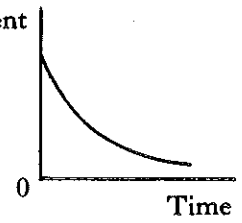


Which of the following graphs shows how the current varies with time from the instant switch S is closed?

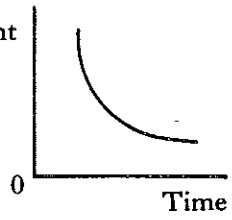
A



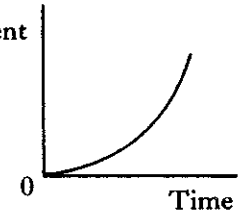
B



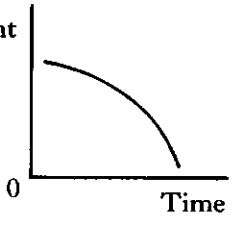
C



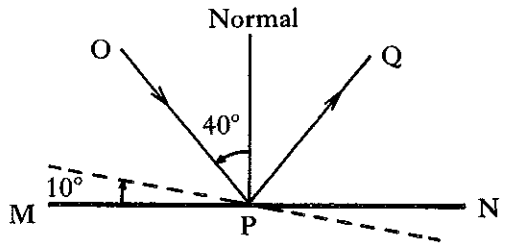
D



E



15. In the diagram below, a ray of light OP strikes a plane mirror MN at an angle of incidence 40°, and is reflected in a direction PQ.



The mirror is now rotated through an angle of 10° into a new position shown by the broken line, but the direction of the incident light remains unchanged. The angle of reflection will now be

A 20°

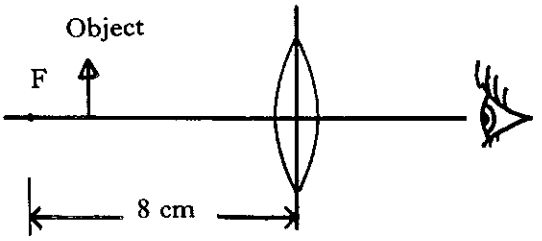
B 30°

C 40°

D 50°

E 60°.

16. The convex lens shown in the diagram has a focal length of 8 cm.



The image of the object seen by the eye will be

A real, upright and magnified

B real, inverted and magnified

C virtual, upright and magnified

D virtual, upright and diminished

E real, inverted and diminished.

17. A beam of parallel light falls on a convex lens of focal length 25 cm. How far away from this lens would a second convex lens, of focal length 10 cm, have to be placed in order that the light would leave it in a parallel beam?

A 35 cm

B 25 cm

C 15 cm

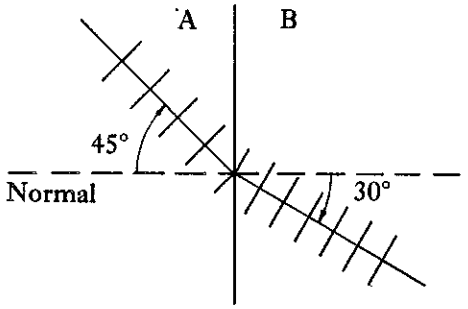
D 10 cm

E There is no suitable position.

18. An illuminated object is placed in front of a convex lens. The distance of the object from the lens is between the focal length and twice the focal length of a convex lens. Which line in this table correctly describes the image produced by the lens?

	Real or Virtual	*Larger or Smaller*	*Inverted or Erect*
A	Real	Larger	Inverted
B	Virtual	Larger	Inverted
C	Real	Smaller	Inverted
D	Virtual	Smaller	Erect
E	Real	Smaller	Erect

19. Waves travel from medium A to medium B. In A, their direction is 45° to the normal and in B it is 30° to the normal.



If the velocity of the waves in medium A is $0{\cdot}283\,m\,s^{-1}$, the velocity in medium B is

A $0{\cdot}200\,m\,s^{-1}$

B $0{\cdot}231\,m\,s^{-1}$

C $0{\cdot}347\,m\,s^{-1}$

D $0{\cdot}400\,m\,s^{-1}$

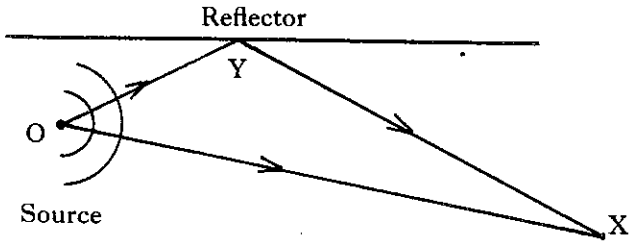
E $0{\cdot}425\,m\,s^{-1}$.

20. Which of the following gives correct values for the wavelength of visible light in nanometers?

	Orange	*Green*	*Yellow*	*Red*	*Blue*
A	470	530	590	630	680
B	680	630	590	530	470
C	530	630	590	470	680
D	630	530	590	680	470
E	530	680	590	630	470

[Turn over

21. A microwave source produces waves, of wavelength 2·8 cm.



When a metal reflector is placed as shown, an interference pattern is observed with X being on a line of **constructive interference.**

If OX equals 40 cm, then the total path length OYX could be

A 41·4 cm

B 42·1 cm

C 44·2 cm

D 45·6 cm

E 46·3 cm.

22. In Young's double slit experiment, both slits are illuminated by the same light source in order to ensure that the light from the slits is

A refracted

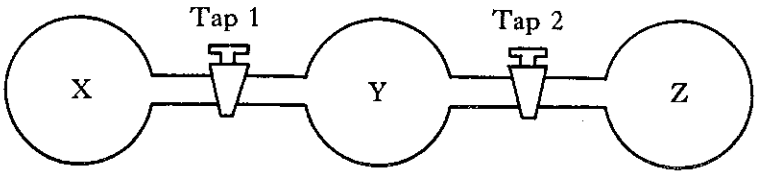
B coherent

C diffracted

D of equal intensity

E of equal frequency.

23. Flasks X, Y and Z have the same volumes. Y contains air at a pressure of 6 atmospheres. X and Z have been evacuated and the taps are closed. Tap 1 is now opened, followed a short time later by Tap 2.



Assuming that the temperature changes are negligible, the pressures in atmospheres in flask Y become respectively

	Tap 1 open	*Taps 1 and 2 open*
A	6	3
B	6	2
C	3	2
D	3	1·5
E	3	1·0

24. The kelvin temperature of a gas varies directly as

A the average momentum of the molecules

B the average inertia of the molecules

C the average velocity of the molecules

D the average kinetic energy of the molecules

E the average potential energy of the molecules.

25. During an experiment involving a fixed mass of gas, the kelvin temperature is trebled and the volume is doubled. Due to these changes, the pressure is

A $\frac{1}{6}$ of its original value

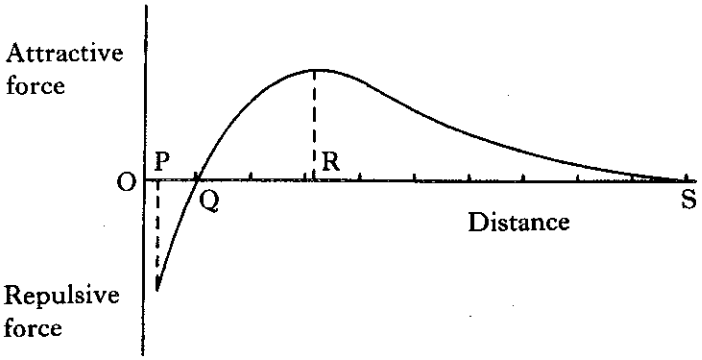
B $\frac{2}{3}$ of its original value

C 1½ times its original value

D 1⅔ times its original value

E 6 times its original value.

26. The graph shows how the force exerted by one molecule, positioned at O, on a similar molecule varies with the distance the molecules are apart.



Which of the following gives the approximate separation between the molecules when the material is in the solid state and when it is in the gas state?

	Solid state	*Gas state*
A	OP	OQ
B	OP	OR
C	OP	OS
D	OQ	OR
E	OQ	OS

27. A spectrum of light from a gas discharge tube consists of several distinct coloured lines. This is regarded as evidence that, in the atom,

A the diameter of the nucleus is very small

B the nucleus consists of protons and neutrons

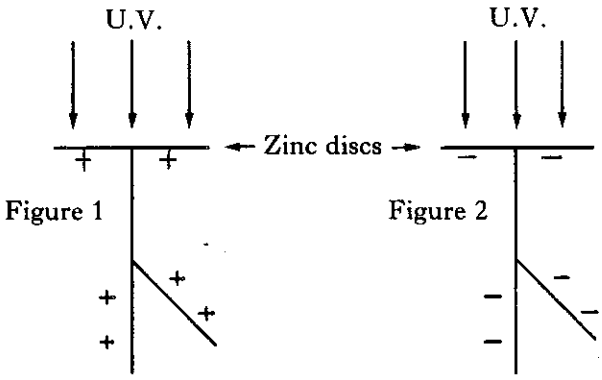
C most of the mass is in the nucleus

D electrons are the negatively charged particles

E electrons orbit the nucleus in discrete energy levels.

28. Figure 1 shows a positively charged gold leaf electroscope with a clean zinc disc on top. Figure 2 shows a similar gold leaf electroscope negatively charged.

Each is irradiated with ultraviolet radiation.



Which of the following describes the possible behaviour of the leaves?

	Figure 1	*Figure 2*
A	Leaf rises	Leaf rises
B	No change	Leaf rises
C	No change	Leaf falls
D	Leaf rises	No change
E	Leaf falls	No change

29. Geiger and Marsden under Rutherford's guidance carried out a series of experiments on the deflection of alpha particles by thin metal foils.

They found that

A the angles of incidence and reflection were equal

B refraction occurred, giving $\frac{\sin i}{\sin r}$ = constant

C only about one particle in eight thousand was deflected through an angle greater than ninety degrees

D the alpha particles were absorbed, changing the atomic number of the metal

E most of the alpha particles were scattered back from the foil.

[Turn over

30. In the table below, which line correctly describes the nucleus of an atom?

	Composition	*Net Charge*
A	protons & neutrons	+
B	protons & neutrons	−
C	protons & electrons	+
D	neutrons & electrons	−
E	protons & neutrons	0

31. A neutron source is made by mixing the beryllium isotope $^{9}_{4}Be$ with an alpha-emitting material. The beryllium isotope absorbs alpha-particles and emits neutrons, one for each alpha-particle absorbed. The nuclide remaining after the emission of a neutron is

A $^{13}_{6}C$

B $^{12}_{6}C$

C $^{12}_{5}B$

D $^{12}_{7}N$

E $^{11}_{7}N$.

32. The table gives the speed of water waves in $m\,s^{-1}$ for various wavelengths and for four different depths of water.

		Wavelength in metres					
		10^{-3}	10^{-2}	10^{-1}	1	10	10^{2}
depth in metres	10^{-1}	0·67	0·25	0·40	0·93	0·99	0·99
	1	0·67	0·25	0·40	1·25	2·95	3·13
	10	0·67	0·25	0·40	1·25	3·95	9·33
	10^{2}	0·67	0·25	0·40	1·25	3·95	12·5

Which of the following statements can be supported by inspection of the data?

I For wavelengths of 10^{-1} m or less, the speed is independent of the depth.

II At a wavelength of 100 m, the wave speed increases with depth.

III For wavelengths of 1 m and more, the wave speeds depend on the wavelength, especially at large depths.

A I only

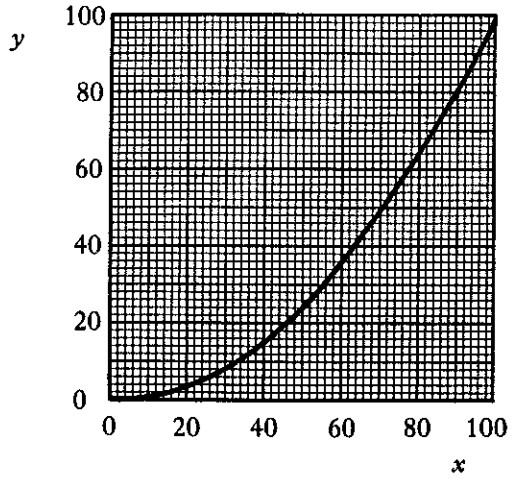
B II only

C I and III only

D II and III only

E I, II and III.

33. If y and x are two physical quantities related as shown by the graph, which of the following is the most likely relation between them?



A y is proportional to x^2.

B y is proportional to x.

C y is inversely proportional to x.

D y is proportional to $\sqrt{x}$.

E y is proportional to $1/x$.

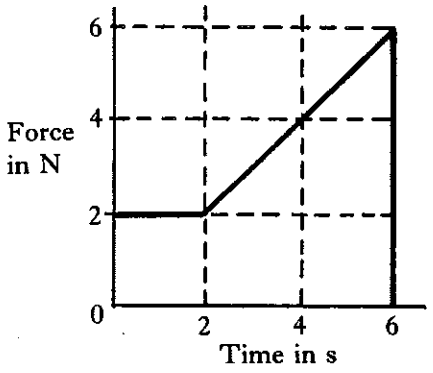
Each of Questions 34–40 consists of a problem with a numerical answer.

34. A car is travelling at $15\,m\,s^{-1}$. It accelerates uniformly for 5 s to a speed of $25\,m\,s^{-1}$. Calculate the distance gone by the car during the acceleration.

35. A tractor of mass 1000 kg pulls a trailer of mass 1000 kg along a horizontal road. The total resistance to motion has a constant value of 4000 N. One quarter of this resistance acts on the trailer.

When the acceleration is $2\,m\,s^{-2}$, what is the force exerted on the tractor by the tow-bar?

36. The graph below shows the force acting on a body over a period of 6 seconds.

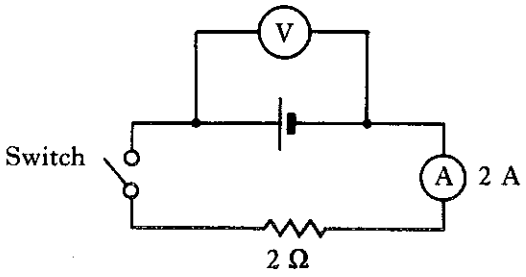


What is the momentum gained by the body in this time?

37. A trolley of mass 1 kg travelling at $3\,m\,s^{-1}$ collides with, and remains attached to, a stationary trolley of mass 2 kg. What is the change in momentum of the 1 kg trolley?

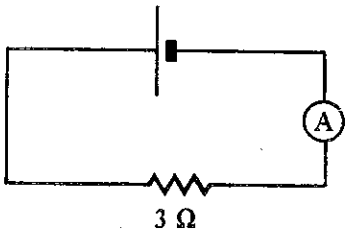
[Turn over

38. In the circuit shown the cell has an e.m.f. of 6·0 V and an internal resistance of 1 Ω.



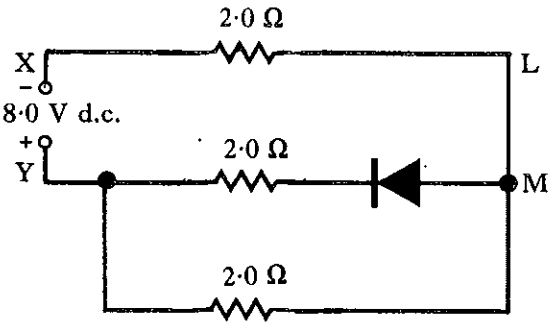
When the switch is closed, the reading on the ammeter is 2 A. What is the corresponding reading on the voltmeter?

39. In the circuit below, the ammeter registers 2 A.



How much energy is dissipated in the resistor in 1 minute?

40. The circuit shown below includes a diode which has negligible forward resistance and infinite reverse resistance.



What is the value of the current in part LM of the circuit when a 8·0 V d.c. supply is connected across XY as indicated?

[END OF QUESTION PAPER]