R2019_511 *[40 marks]*

1. Two copper wires X and Y are connected in series. The diameter of Y is double that of X. The drift speed in X is *v*. What is the drift speed in Y? *[1 mark]*

   A. $\frac{v}{4}$

   B. $\frac{v}{2}$

   C. $2v$

   D. $4v$

2. A wire of length *L* is used in an electric heater. When the potential difference across the wire is 200 V, the power dissipated in the wire is 1000 W. The same potential difference is applied across a second similar wire of length $2L$. What is the power dissipated in the second wire? *[1 mark]*

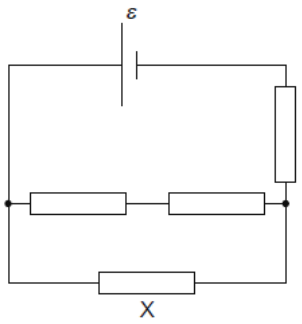
   A. 250 W

   B. 500 W

   C. 2000 W

   D. 4000 W

3. A combination of four identical resistors each of resistance *R* are connected to a source of emf ε of negligible internal resistance. What is the current in the resistor X? *[1 mark]*



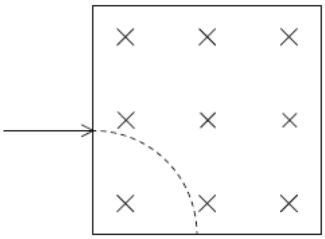
   A. $\frac{\varepsilon}{5R}$

   B. $\frac{3\varepsilon}{10R}$

   C. $\frac{2\varepsilon}{5R}$

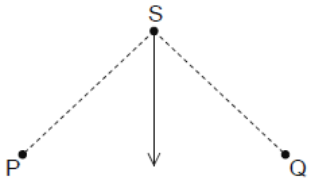
   D. $\frac{3\varepsilon}{5R}$

4. A particle of mass m and charge of magnitude q enters a region of uniform magnetic field B that is directed into the page. The particle follows a circular path of radius R. What are the sign of the charge of the particle and the speed of the particle? *[1 mark]*



	Charge of the particle	Speed of the particle
A.	positive	$\frac{qBR}{m}$
B.	negative	$\frac{qBR}{m}$
C.	negative	$\sqrt{\frac{qBR}{m}}$
D.	positive	$\sqrt{\frac{qBR}{m}}$

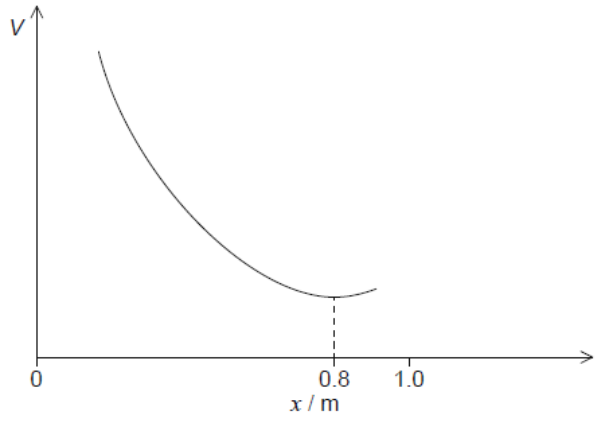
5. Two parallel wires P and Q are perpendicular to the page and carry equal currents. Point S is the same distance from both wires. The arrow shows the magnetic field at S due to P and Q. *[1 mark]*



What are the correct directions for the current at P and the current at Q?

	Current direction at P	Current direction at Q
A.	into page	out of page
B.	out of page	out of page
C.	into page	into page
D.	out of page	into page

6. Two point charges Q_1 and Q_2 are one metre apart. The graph shows the variation of electric potential V with distance x from Q_1. *[1 mark]*



What is $\frac{Q_1}{Q_2}$?

A. $\frac{1}{16}$

B. $\frac{1}{4}$

C. 4

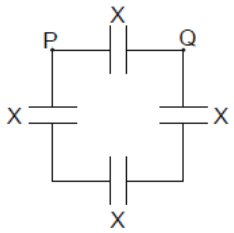
D. 16

7. A current of 1.0×10^{-3} A flows in the primary coil of a step-up transformer. The number of turns in the primary coil is N_p and the number of turns in the secondary coil is N_s. *[1 mark]*
One coil has 1000 times more turns than the other coil.

What is $\frac{N_p}{N_s}$ and what is the current in the secondary coil for this transformer?

	$\frac{N_p}{N_s}$	Current in secondary coil / A
A.	$\frac{1}{1000}$	1.0×10^{-6}
B.	1000	1.0
C.	$\frac{1}{1000}$	1.0
D.	1000	1.0×10^{-6}

8. Four identical capacitors of capacitance X are connected as shown in the diagram. *[1 mark]*



What is the effective capacitance between P and Q?

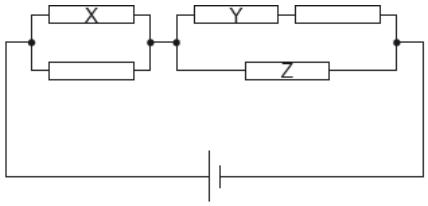
A. $\frac{X}{3}$

B. X

C. $\frac{4X}{3}$

D. 4X

9. Five resistors of equal resistance are connected to a cell as shown. *[1 mark]*



What is correct about the power dissipated in the resistors?

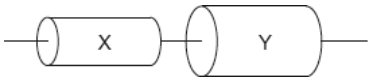
A. The power dissipated is greatest in resistor X.

B. The power dissipated is greatest in resistor Y.

C. The power dissipated is greatest in resistor Z.

D. The power dissipated is the same in all resistors.

10. Two resistors X and Y are made of uniform cylinders of the same material. X and Y are connected in series. X and Y are of equal length and the diameter of Y is twice the diameter of X. *[1 mark]*



The resistance of Y is *R*.

What is the resistance of this series combination?

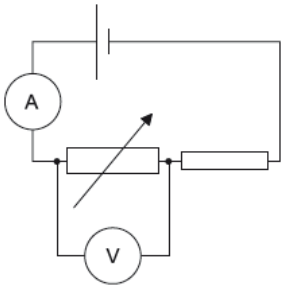
A. $\frac{5R}{4}$

B. $\frac{3R}{2}$

C. 3 *R*

D. 5 *R*

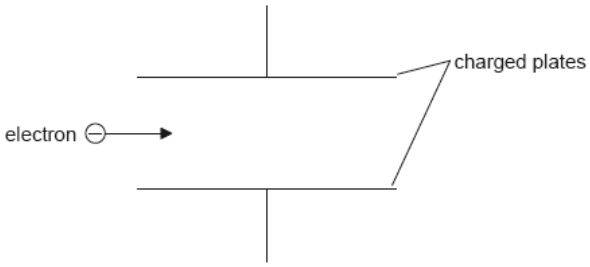
11. A cell with negligible internal resistance is connected as shown. The ammeter and the voltmeter are both ideal. *[1 mark]*



What changes occur in the ammeter reading and in the voltmeter reading when the resistance of the variable resistor is increased?

	Change in ammeter reading	Change in voltmeter reading
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

12. An electron enters the region between two charged parallel plates initially moving parallel to the plates. *[1 mark]*



The electromagnetic force acting on the electron

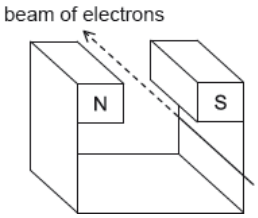
A. causes the electron to decrease its horizontal speed.

B. causes the electron to increase its horizontal speed.

C. is parallel to the field lines and in the opposite direction to them.

D. is perpendicular to the field direction.

13. A beam of electrons moves between the poles of a magnet. *[1 mark]*



What is the direction in which the electrons will be deflected?

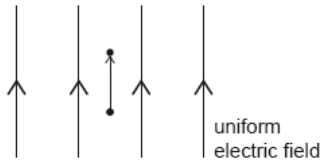
A. Downwards

B. Towards the N pole of the magnet

C. Towards the S pole of the magnet

D. Upwards

14. An ion of charge + *Q* moves vertically upwards through a small distance *s* in a uniform vertical electric field. The electric field has a strength *E* and its direction is shown in the diagram. *[1 mark]*



What is the electric potential difference between the initial and final position of the ion?

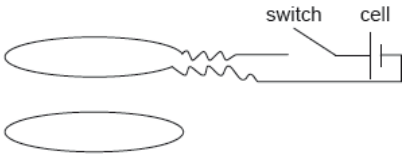
A. $\frac{EQ}{s}$

B. *EQs*

C. *Es*

D. $\frac{E}{s}$

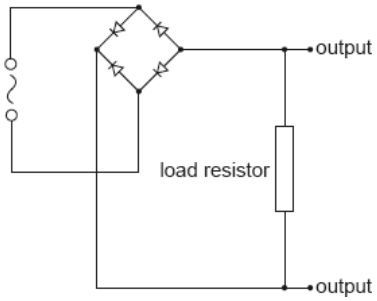
15. Two identical circular coils are placed one below the other so that their planes are both horizontal. The top coil is connected to a cell and a switch. *[1 mark]*



The switch is closed and then opened. What is the force between the coils when the switch is closing and when the switch is opening?

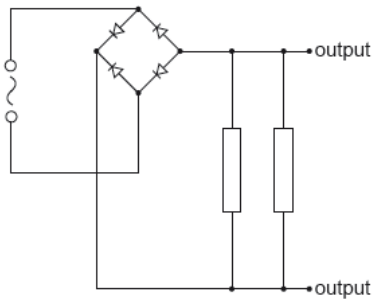
	Switch is closing	Switch is opening
A.	attractive	attractive
B.	attractive	repulsive
C.	repulsive	attractive
D.	repulsive	repulsive

16. The diagram shows a diode bridge rectification circuit and a load resistor. *[1 mark]*

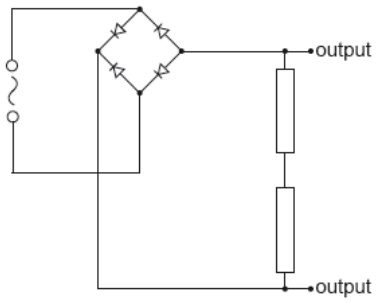


The input is a sinusoidal signal. Which of the following circuits will produce the most smoothed output signal?

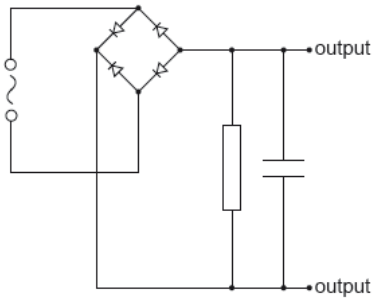
A.



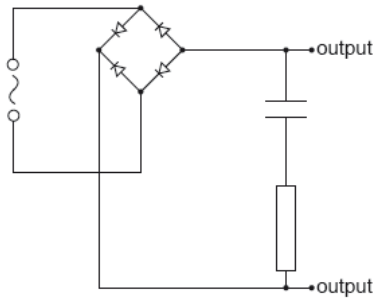
B.



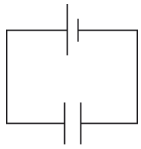
C.



D.



17. A parallel plate capacitor is connected to a cell of negligible internal resistance. *[1 mark]*

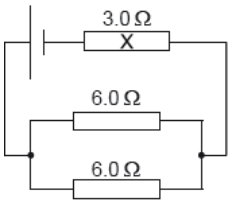


The energy stored in the capacitor is 4 J and the electric field in between the plates is 100 N C $^{-1}$. The distance between the plates of the capacitor is doubled. What are the energy stored and the electric field strength?

	Energy / J	Electric field strength / N C^{-1}
A.	2	50
B.	8	50
C.	2	200
D.	8	200

18. A cell of emf 6.0 V and negligible internal resistance is connected to three resistors as shown. *[1 mark]*

The resistors have resistance of 3.0 Ω and 6.0 Ω as shown.



What is the current in resistor X?

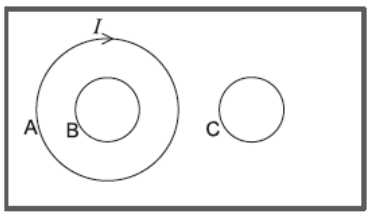
A. 0.40 A

B. 0.50 A

C. 1.0 A

D. 2.0 A

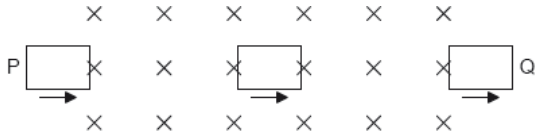
19. The current *I* flowing in loop A in a clockwise direction is increasing so as to induce a current both in loops B and C. All three loops are on the same plane. *[1 mark]*



What is the direction of the induced currents in loop B and loop C?

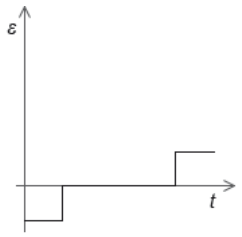
	Loop B	Loop C
A.	clockwise	clockwise
B.	clockwise	anti-clockwise
C.	anti-clockwise	clockwise
D.	anti-clockwise	anti-clockwise

20. A rectangular flat coil moves at constant speed through a uniform magnetic field. The direction of the field is into the plane of the paper. *[1 mark]*

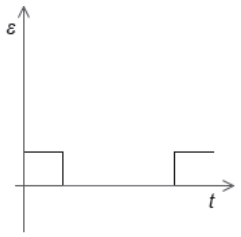


Which graph shows the variation with time t, of the induced emf ε in the coil as it moves from P to Q?

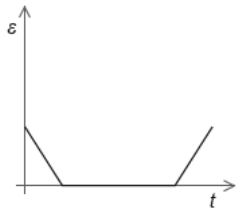
A.



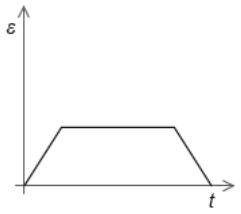
B.



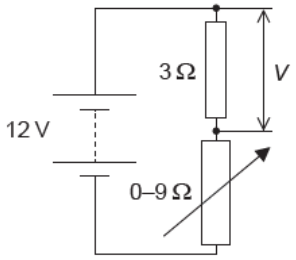
C.



D.



21. In the circuit shown, the fixed resistor has a value of 3 Ω and the variable resistor can be varied between 0 Ω and 9 Ω. *[1 mark]*



The power supply has an emf of 12 V and negligible internal resistance. What is the difference between the maximum and minimum values of voltage V across the 3 Ω resistor?

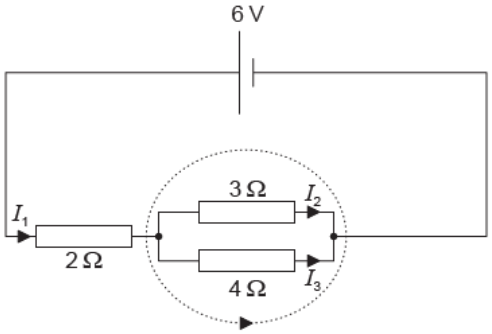
A. 3 V

B. 6 V

C. 9 V

D. 12 V

22. Kirchhoff's laws are applied to the circuit shown. *[1 mark]*



What is the equation for the dotted loop?

A. $0 = 3I_2 + 4I_3$

B. $0 = 4I_3 - 3I_2$

C. $6 = 2I_1 + 3I_2 + 4I_3$

D. $6 = 3I_2 + 4I_3$

23. Two wires, X and Y, are made from the same metal. The wires are connected in series. The radius of X is twice that of Y. The carrier drift speed in X is v_X and in Y it is v_Y. *[1 mark]*

What is the value of the ratio $\frac{v_X}{v_Y}$?

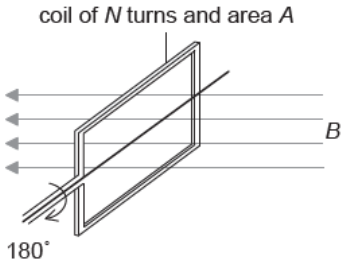
A. 0.25

B. 0.50

C. 2.00

D. 4.00

24. The plane of a coil is positioned at right angles to a magnetic field of flux density B. The coil has N turns, each of area A. The coil is rotated through 180° in time t. *[1 mark]*



What is the magnitude of the induced emf?

A. $\frac{BA}{t}$

B. $\frac{2BA}{t}$

C. $\frac{BAN}{t}$

D. $\frac{2BAN}{t}$

25. The ratio $\frac{\text{number of primary turns}}{\text{number of secondary turns}}$ for a transformer is 2.5. *[1 mark]*

The primary coil of the transformer draws a current of 0.25 A from a 200 V alternating current (ac) supply. The current in the secondary coil is 0.5 A. What is the efficiency of the transformer?

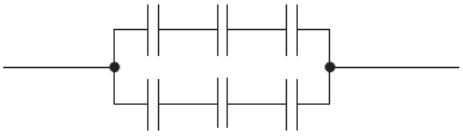
A. 20 %

B. 50 %

C. 80 %

D. 100 %

26. Six identical capacitors, each of value *C*, are connected as shown. *[1 mark]*



What is the total capacitance?

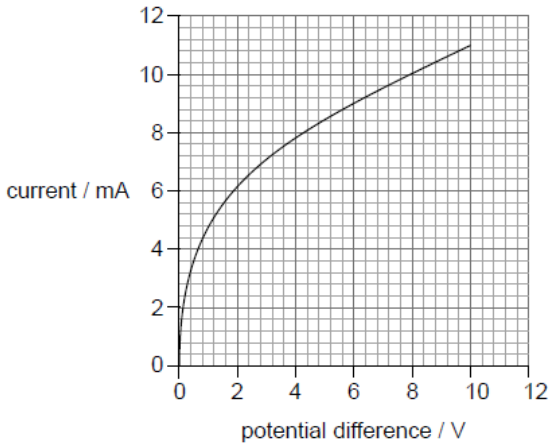
A. $\frac{C}{6}$

B. $\frac{2C}{3}$

C. $\frac{3C}{3}$

D. $6C$

27. The graph shows the variation of current with potential difference for a filament lamp. *[1 mark]*



What is the resistance of the filament when the potential difference across it is 6.0 V?

A. 0.5 mΩ
B. 1.5 mΩ
C. 670 Ω
D. 2000 Ω

28. An electron is accelerated through a potential difference of 2.5 MV. What is the change in kinetic energy of the electron? *[1 mark]*

A. 0.4μJ

B. 0.4 nJ

C. 0.4 pJ

D. 0.4 fJ

29. A cell is connected in series with a resistor and supplies a current of 4.0 A for a time of 500 s. During this time, 1.5 kJ of energy is dissipated in the cell and 2.5 kJ of energy is dissipated in the resistor. *[1 mark]*

What is the emf of the cell?

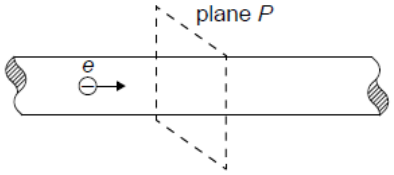
A. 0.50 V

B. 0.75 V

C. 1.5 V

D. 2.0 V

30. Electrons, each with a charge *e*, move with speed *v* along a metal wire. The electric current in the wire is *I*. *[1 mark]*



Plane *P* is perpendicular to the wire. How many electrons pass through plane *P* in each second?

A. $\frac{e}{I}$

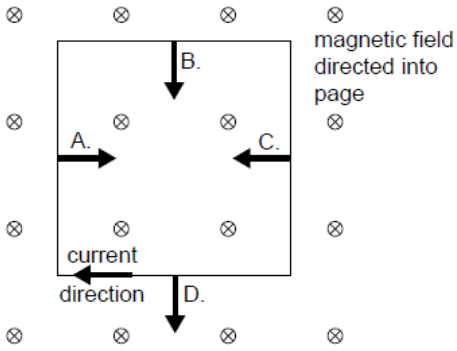
B. $\frac{ve}{I}$

C. $\frac{I}{ve}$

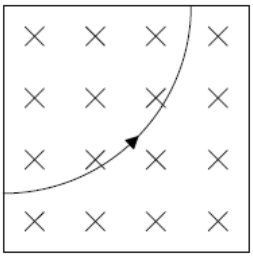
D. $\frac{I}{e}$

31. A conducting square coil is placed in a region where there is a uniform magnetic field. The magnetic field is directed into the page. There is a clockwise current in the coil. *[1 mark]*

What is a correct force that acts on a side of the coil?



32. The diagram shows the path of a particle in a region of uniform magnetic field. The field is directed into the plane of the page. *[1 mark]*



This particle could be

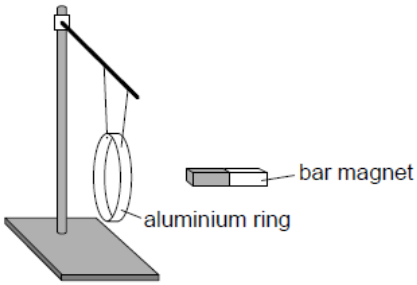
A. an alpha particle.

B. a beta particle.

C. a photon.

D. a neutron.

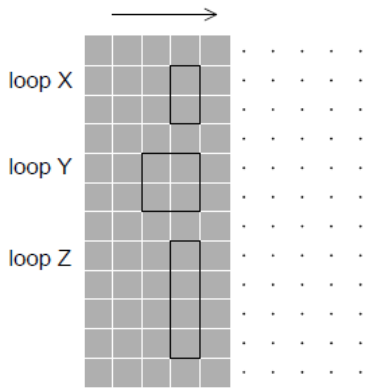
33. The diagram shows a bar magnet near an aluminium ring. *[1 mark]*



The ring is supported so that it is free to move. The ring is initially at rest. In experiment 1 the magnet is moved towards the ring. In experiment 2 the magnet is moved away from the ring. For each experiment what is the initial direction of motion of the ring?

	Experiment 1	Experiment 2
A.	to the left	to the left
B.	to the left	to the right
C.	to the right	to the left
D.	to the right	to the right

34. Three conducting loops, X, Y and Z, are moving with the same speed from a region of zero magnetic field to a region of uniform non-zero magnetic field. *[1 mark]*



Which loop(s) has/have the largest induced electromotive force (emf) at the instant when the loops enter the magnetic field?

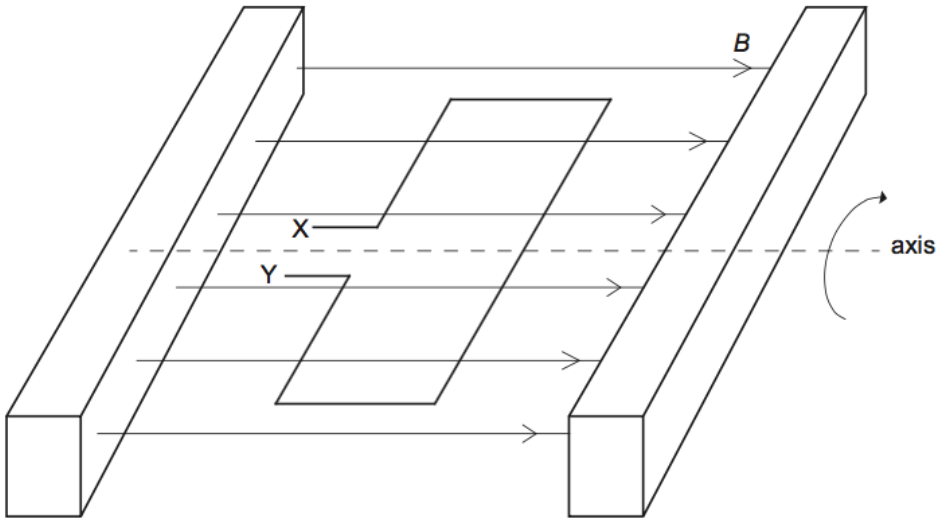
A. Z only

B. Y only

C. Y and Z only

D. X and Y only

35. A coil of area A is placed in a region of uniform horizontal magnetic field B. At t=0, the coil starts to rotate with constant angular speed ω about a horizontal axis. *[1 mark]*



What is the emf between X and Y?

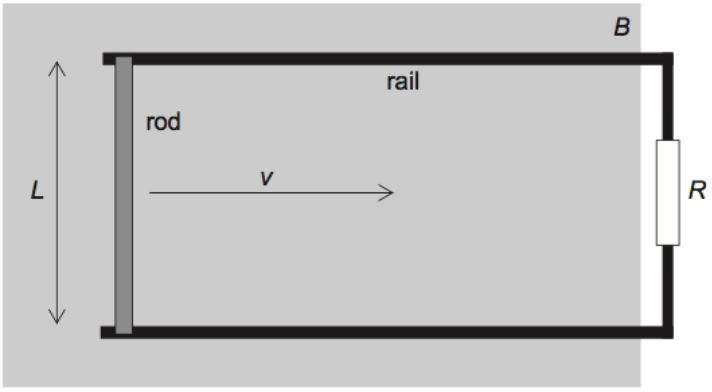
A. zero

B. $\omega AB \sin \omega t$

C. $AB \cos \omega t$

D. $-\omega AB \sin \omega t$

36. The diagram shows a conducting rod of length *L* being moved in a region of uniform magnetic field *B*. The field is directed at right angles to the plane of the paper. The rod slides on conducting rails at a constant speed *v*. A resistor of resistance *R* connects the rails. *[1 mark]*



What is the power required to move the rod?

A. zero

B. $\frac{vBL}{R}$

C. $\frac{v^2B^2L^2}{R}$

D. $\frac{v^2B^2L^2}{R^2}$

37. An alternating current (ac) power supply generates an emf with peak amplitude V_0 and delivers an average power $\bar{P}$. What is the root mean square (rms) current delivered by the supply? *[1 mark]*

A. $\frac{\bar{P}}{2V_0}$

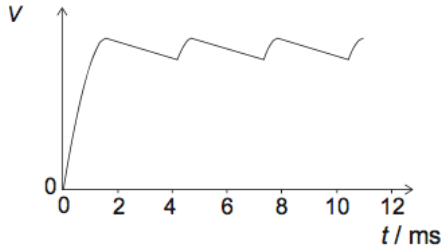
B. $\frac{\bar{P}}{\sqrt{2}V_0}$

C. $\frac{\sqrt{2}\bar{P}}{V_0}$

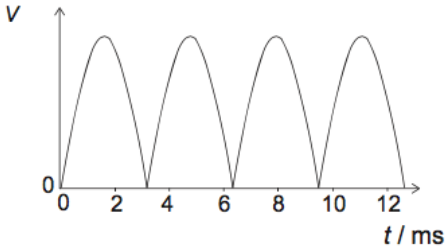
D. $\frac{2\bar{P}}{V_0}$

38. A full-wave diode rectification circuit is modified with the addition of a capacitor in parallel with the load resistor. The circuit is used to rectify a sinusoidal signal of period 6.3ms. Which graph shows how the potential difference *V* across the load varies with time? *[1 mark]*

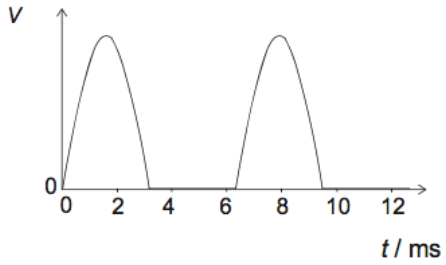
A.



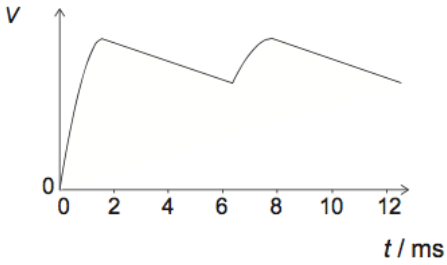
B.



C.



D.



39. Three resistors of resistance R are connected in parallel across a cell of electromotive force (emf) V that has a negligible internal resistance. What is the rate at which the cell supplies energy? *[1 mark]*

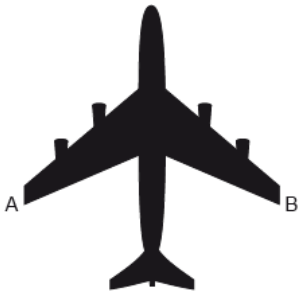
A. $\frac{V^2}{3R}$

B. $\frac{V^2}{9R}$

C. $\frac{9V^2}{R}$

D. $\frac{3V^2}{R}$

40. An aircraft with a wing span of 50 m flies horizontally at a speed of $200\ \mathrm{m\,s^{-1}}$. The vertical component of the Earth's magnetic field at the plane's position is $10\ \mu\mathrm{T}$. *[1 mark]*



What electromotive force (emf) is induced between points A and B on the aircraft?

A. 0.1 V

B. 1 V

C. 10 V

D. 100 V