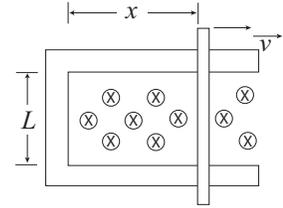


5. A rod with resistance R lies across frictionless conducting rails in a constant uniform magnetic field B , as shown. Assume the rails have negligible resistance. The magnitude of the force that must be applied by a person to pull the rod to the right at constant speed v is:

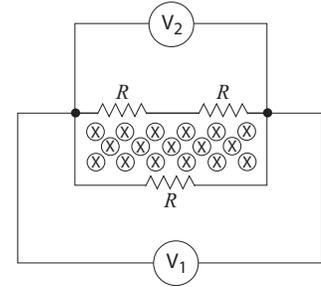


- (1) BLv/R (2) BLv (3) B^2L^2v/R (4) 0 (5) B^2Lxv/R

6. A proton executes helical motion in a uniform B field at a frequency of 820 kHz. It moves at an angle of 30 degrees relative to the direction of the field. What is the magnitude of the B field?

- (1) 0.11 T (2) 0.17 T (3) 0.054 T (4) 0.017 T (5) 0.34 T

7. A changing magnetic field pierces the interior of a circuit containing three identical resistors. Two voltmeters are connected to the same points, as shown. V_1 reads 1 mV. V_2 reads:



- (1) 1/2 mV
(2) 0
(3) 2 mV
(4) 1/3 mV
(5) 1 mV

8. An ac generator producing 10 V (rms) at 200 rad/s is connected in series with a 50- Ω resistor, a 400-mH inductor, and a 200- μ F capacitor. The rms voltage (in volts) across the inductor is:

- (1) 6.7 (2) 10.0 (3) 2.5 (4) 10.8 (5) 3.4

9. An inductance L and a resistance R are connected in series to an ideal battery. A switch in the circuit is closed at time 0, at which time the current is zero. The rate of increase of the energy stored in the inductor is a maximum:

- (1) at the time $t = (L/R)\ln 2$ after the switch is closed
(2) a long time after the switch is closed
(3) at the time $t = 2L/R$ after the switch is closed
(4) at the time $t = L/R$ after the switch is closed
(5) just after the switch is closed

10. An RLC series circuit has $L = 100$ mH and $C = 1\mu$ F. It is connected to a 1000-Hz source emf is found to lead the current by 75° . The value of R is:

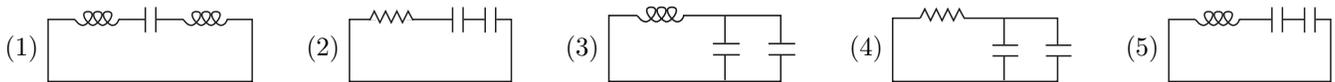
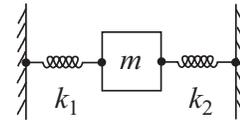
- (1) 126 Ω (2) 15.6 Ω (3) 1750 Ω (4) 1810 Ω (5) 175 Ω

11. The diagrams show three circuits consisting of concentric circular arcs (either half or quarter circles of radii r , $2r$, and $3r$) and radial segments. The circuits carry the same current. Rank them according to the magnitudes of the magnetic fields they produce at C , least to greatest.

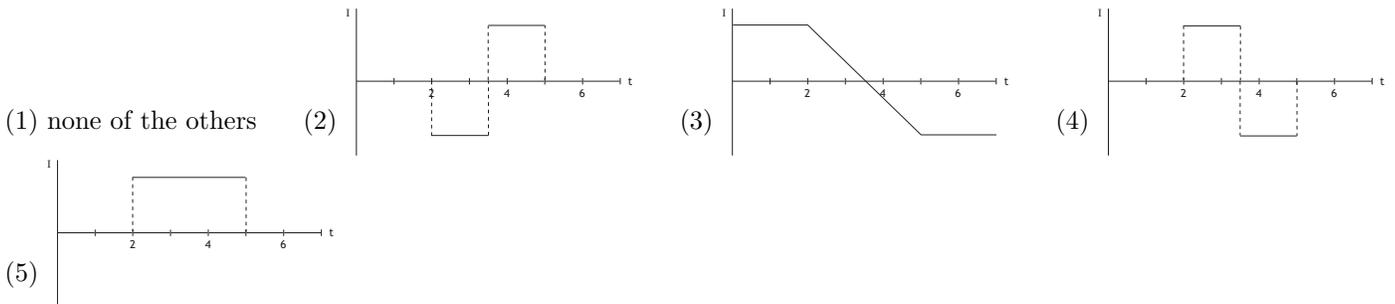
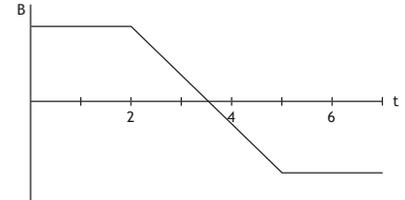


- (1) 1, 3, 2 (2) 3, 2, 1 (3) 2, 3, 1 (4) 1, 2, 3 (5) 2, 1, 3

12. Consider the mechanical system consisting of two springs and a block, as shown. Which one of the five electrical circuits is the analog of the mechanical system?



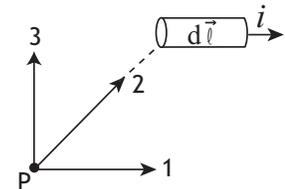
13. A magnetic field is perpendicularly incident through a circle of wire with resistance R . The magnetic field varies in strength as shown. Which is a possible description of the current induced in the wire?



14. A magnetic dipole is in a uniform magnetic field. The dipole experiences a torque of $20 \times 10^{-24} \text{Nm}$. The potential energy of the dipole is $15 \times 10^{-24} \text{J}$. What is the angle between the dipole and the magnetic field (in degrees)?

- (1) 53 (2) not enough information (3) 127 (4) 37 (5) 143

15. In the figure, the current element $id\vec{\ell}$, the point P, and the three vectors (1, 2, 3) are all in the plane of the page. The direction of $d\vec{B}$, due to this current element, at the point P is:

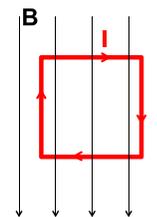


- (1) in the direction marked "3"
 (2) out of the page
 (3) in the direction marked "2"
 (4) in the direction marked "1"
 (5) into the page

16. An electron and a proton both enter a region of uniform magnetic field with the same kinetic energy. They move perpendicular to the magnetic field. What is the ratio of the radius of the proton orbit to the radius of the electron orbit (r_p/r_e)?

- (1) 43 (2) 12.5 (3) 5.4 (4) 72 (5) 9.8

17. A loop with a current is placed in a magnetic field as shown. What is the direction of torque $\vec{\tau}$ on the loop?



- (1)  (2)  (3)  (4)  (5) the torque is zero

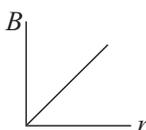
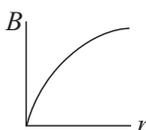
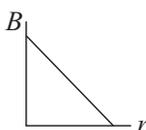
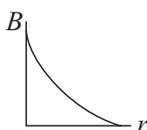
18. A circular loop of wire with radius 6.0cm and resistance 350m Ω is in the plane of the page. It is sitting in a magnetic field directed perpendicular to the page. The magnetic field strength varies in time and generates a counterclockwise current of 3.2A. Which of the following answers is a possibility for the direction and rate of change of the magnetic field?

- (1) out of page, 99.0T/s (2) into page, 2.97T/s (3) none of the others (4) out of page, 2.97T/s (5) into page, 99.0T/s

19. Two parallel long wires carry the same current and repel each other with a force F per unit length. If both these currents are doubled and the wire separation tripled, the force per unit length becomes:

- (1) $2F/9$ (2) $4F/9$ (3) $6F$ (4) $4F/3$ (5) $2F/3$

20. Which graph correctly gives the magnitude of the magnetic field outside an infinitely long straight current-carrying wire as a function of the distance r from the wire?

- (1)  (2)  (3)  (4)  (5) 