1. A thin film of oil ($n = 1.20$) floats on water ($n = 1.33$). When sunlight is incident at right angle to the film, the only colors that are enhanced by reflection are blue (458 nm) and red (687 nm). Estimate the thickness of the oil film (in nm).

(1) 572  (2) 624  (3) 528  (4) 198  (5) 286

2. Resistors of values 8, 12 and 24 Ohms are connected in parallel across a fresh battery with voltage 12 volts. Which resistor consumes the least power and how much power in watts is that?

(1) 24 Ohm and 6 W  (2) 8 Ohm and 18 W  (3) 24 Ohm and 1.78 W  (4) 12 Ohm and 12 W  (5) none of these

3. If the number of turns in an inductor of fixed length and fixed cross-sectional area, is increased by a factor of four, what happens to its inductance?

(1) it becomes 16 times the original value  
(2) it triples  
(3) it becomes 9 times the original value  
(4) it decreases by a factor of 4  
(5) it decreases by a factor of 16

4. A proton with a kinetic energy of $4.9 \times 10^{-16} \text{J}$ moves perpendicular to a magnetic field of 0.26T. What is the radius of its circular path?

(1) 3.08 cm  (2) 6.15 cm  (3) 9.23 cm  (4) 12.30 cm  (5) none of these

5. How long is a wire made from 100 cm$^3$ of copper if its resistance is 17 ohms? The resistivity of copper is $1.7 \times 10^{-8} \Omega \cdot m$.

(1) $3.1 \times 10^2 \text{m}$  (2) $2.2 \times 10^2 \text{m}$  (3) 7.1 m  (4) $3.0 \times 10^3 \text{m}$  (5) 0.8 m
6. A horizontal beam of electrons initially moving at $3.9 \times 10^7$ m/s is deflected vertically up by the vertical electric field between oppositely charged parallel plates. The magnitude of the field is $2.30 \times 10^4$ N/C. What is the vertical deflection $d$ of the electrons as they leave the plates?

(1) 0.133 mm  (2) 0.531 mm  (3) 1.5 mm  (4) 3.5 mm  (5) 6.3 mm

7. All resistances are 3 Ohms and the $emf$ is 15 V. Calculate the total current drawn from the $emf$ source.

(1) 2.0 A  (2) 4.0 A  (3) 5.0 A  (4) 3.5 A  (5) 7.0 A

8. A resistor is made of a material that has a resistivity that is proportional to the current going through it. If the voltage across the resistor is doubled, what happens to the current through it?

(1) It increases by factor of $2^{1/2}$.
(2) It doubles.
(3) It quadruples.
(4) It increases by factor of $2^{1/4}$.
(5) It does not change.

9. An electron and a proton are each released from rest in the same uniform electric field. The electron moves a distance $d_{\text{electron}}$ and the proton moves a distance $d_{\text{proton}}$ as each particle’s kinetic energy increases by 1.6 eV. How do $d_{\text{electron}}$ and $d_{\text{proton}}$ compare?

(1) $d_{\text{electron}} = d_{\text{proton}}$
(2) $d_{\text{electron}} < d_{\text{proton}}$
(3) $d_{\text{electron}} > d_{\text{proton}}$
(4) The answer depends on the direction of the electric field.
(5) none of these

10. A flat stack of two materials, the first of index of refraction 1.52 and thickness 2 mm, and the second of index of refraction 1.63 and thickness 3 cm, are setup with the first material on top and a light source at the bottom in the second material. What is the size (radius) of the circle of light that you see at the top of the first material through which you see the light emerge?

(1) 2.5 cm  (2) 2.3 cm  (3) 0.17 cm  (4) 1.4 cm  (5) none of these

11. If a virtual image is formed along the principal axis 10 cm from a concave mirror with the focal length 15 cm, what is the object distance from the mirror?

(1) 6.0 cm  (2) 10 cm  (3) 12 cm  (4) 30 cm  (5) 42 cm

12. A given individual is unable to see objects clearly when they are beyond 100 cm. What focal length lens should be used to correct this problem?

(1) $-100$ cm  (2) $-33.3$ cm  (3) $-20$ cm  (4) 75 cm  (5) 100 cm
13. Two thin lenses with 10.0-cm focal lengths are mounted at opposite ends of a 30.0-cm long tube. An object is located 45.0 cm from one end of the tube. How far from the opposite end is the final image?

(1) 24.0 cm  (2) 12.8 cm  (3) 25.6 cm  (4) 33.6 cm  (5) 48.0 cm

14. In the figure, one wire carries a current 6.4 A in the positive y direction and the other wire carries a current 6.4 A in the positive x direction. The two points have coordinates, A = (16 cm, 16 cm) and B = (−16 cm, 16 cm). What is the magnetic field (in $\mu T$) at points A and B?

(1) 0 and 16  (2) 8 and 0  (3) 16 and 8  (4) 8 and 24  (5) none of these

15. The switch in the figure has been closed for some time. If the energy stored in the conductor is 0.110 Joules, what is the value of the resistance $R$?

(1) 31.3 Ohms  (2) 7.5 Ohms  (3) 21.2 Ohms  (4) 15 Ohms  (5) none of these