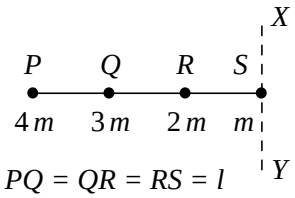
1981 Hong Kong Advanced Level Examination
AL Physics
Multiple Choice Question

1. If u and v represent speeds, x and y distances, t a time and a an acceleration, which of the following equations is dimensionally incorrect?

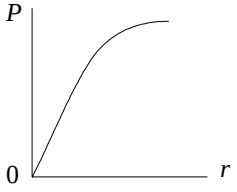
   A. $x^2 + y^2 = uvt^2$
   B. $v^2 - u^2 = ax$
   C. $v = at + y/t$
   D. $ux = (x + y)/t$
   E. $av = (x - y)^2/t^3$

2. 

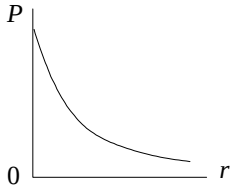
   $PQRS$ is a light, rigid rod with masses attached to it as shown in the diagram. The moment of inertia of the system about XY is

   A. $6\ ml^2$
   B. $10\ ml^2$
   C. $14\ ml^2$
   D. $50\ ml^2$
   E. $60\ ml^2$

3. Which of the graphs below best represents the variation of the excess pressure P inside a soap bubble with its radius r?

   A.
   

   B.
   

   C.
   

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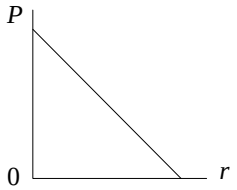
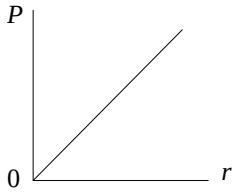
   

   E.
   

4. The moon orbits the earth once every 27.3 days, with a mean orbital radius of R. What is the period of an earth satellite with an orbital radius of $R/30$?

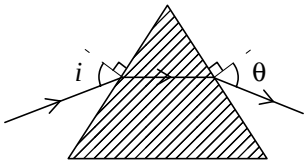
   A. 4 hr
   B. 22 hr
   C. 68 hr
   D. 260 days
   E. 4500 days

5. A sphere of radius r and density ρ acquires a terminal speed v when it is dropped through air from a great height. Neglecting the buoyancy of the air, what is the terminal speed acquired by a sphere of radius $2r$ and density 3ρ under the same conditions?

   A. $v/2$
   B. $3v$
   C. $6v$
   D. $12v$
   E. $24v$

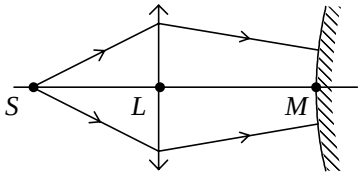
6. One mole of an ideal gas expands isothermally at absolute temperature T from volume V_1 to volume V_2. The work done by the gas is

A. $\dfrac{RT(V_2 - V_1)}{V_1}$
B. $RT(\dfrac{1}{V_1} - \dfrac{1}{V_2})$
C. $\dfrac{RTV_2}{V_1}$
D. $\dfrac{2RT(V_2 - V_1)}{(V_1 + V_2)}$
E. $RT(\ln V_2 - \ln V_1)$

7. 

A ray of light passes through a prism as shown. As the angle i is increased from zero to 90°, the angle θ

A. remains constant
B. passes through a minimum value
C. passes through a maximum value
D. decreases continuously
E. increases continuously

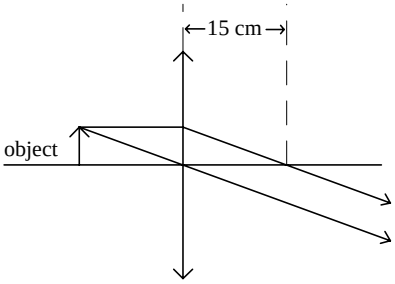
8. 

The diagram shows a converging lens L, of focal length of magnitude F, a convex mirror M of focal length of magnitude f, and the position S at which an object is coincident with its own image. If $SL = x$ and $LM = y$, then

A. $\dfrac{1}{x} + \dfrac{1}{y} = \dfrac{1}{F}$
B. $\dfrac{1}{x} + \dfrac{1}{y + f} = \dfrac{1}{F}$
C. $\dfrac{1}{x} + \dfrac{1}{y + 2f} = \dfrac{1}{F}$
D. $y + F = 2f$
E. $x + (\dfrac{1}{y} + \dfrac{1}{F})^{-1} = f$

9. The image of an object formed on a screen by a thin converging lens has height a. By moving the lens towards the screen, a second lens position is found at which the height of the image formed on the screen is b. What is the height of the object?

A. $\dfrac{1}{2}(a + b)$
B. $\dfrac{1}{2}\sqrt{ab}$
C. $\sqrt{ab}$
D. $\sqrt{\dfrac{a^3}{b}}$
E. $\sqrt{\dfrac{b^3}{a}}$

10. 

A converging lens of focal length 15 cm is used as a magnifying glass with the final image at infinity. If the least distance of distinct vision is 25 cm, the angular magnification achieved is

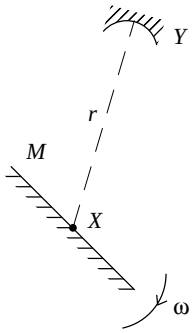
A. 0
B. 1
C. 5/3
D. 15
E. infinite

11. When two notes of nearly equal frequencies f_1 and f_2, with $f_2 > f_1$, are sounded together, beats are heard. Beats are periodic variations in

A. pitch, with beat frequency $(f_2 - f_1)$.
B. pitch, with beat frequency $\frac{1}{2}(f_1 + f_2)$.
C. loudness, with beat frequency $(f_2 - f_1)$.
D. intensity, with beat frequency $\frac{1}{2}(f_2 - f_1)$.

E. intensity, with beat frequency $\frac{1}{2}(f_1 + f_2)$.

12. The diagram shows a mirror *M* which rotates about an axis through *X* with constant angular velocity ω, and a spherical mirror *Y* whose centre of curvature is at *X*, where *XY* = *r*.



A narrow parallel beam of light strikes *M* at *X*, with angle of incidence θ, such that it is reflected along *XY*, then along *YX* and is again reflected by *M*, to form the emergent beam. What is the angle between the initial incident and final emergent beams? (*c* is the speed of light.)

A. $\frac{\omega r}{4c}$
B. $\frac{\omega r}{2c}$
C. $\frac{\omega r}{c}$
D. $\frac{2\omega r}{c}$
E. $\frac{4\omega r}{c}$

13. A vertical wire 0.4 m long carries a current of 5 A in a magnetic field of flux density 10^{-3} T, which dips at an angle of 30º to the horizontal. The force on the wire is

A. 5.0×10^{-4} N
B. 8.7×10^{-4} N
C. 1.0×10^{-3} N
D. 1.5×10^{-3} N
E. 1.7×10^{-3} N

14. A thermionic diode is operated at 100 V and the current through it is 30 mA. How many electrons reach the anode in one second?

Electronic charge = -1.6×10^{-19} C.

A. 1.875×10^{17}
B. 3.000×10^{17}
C. 9.375×10^{18}
D. 1.875×10^{20}
E. 3.000×10^{24}

15. Two long vertical wires *X* and *Y* are at a short distance apart, and the vertical plane containing them is at right angles to the earth's magnetic field. When each wire carries the same current *I*, the force on *X* due to the earth's field is $\vec{F}_e$ and the force on *X* due to the current in *Y* is $\vec{F}_c$. If the current is now doubled in both wires, the resultant force on *X* is

A. $\vec{F}_e + \vec{F}_c$
B. $\vec{F}_e + 2\vec{F}_c$
C. $2\vec{F}_e + 2\vec{F}_c$
D. $2\vec{F}_e + 4\vec{F}_c$
E. $4\vec{F}_e + 4\vec{F}_c$

16. A galvanometer has a scale divided into 120 equal divisions. It has a current sensitivity of 10 divisions per milliampere, and a resistance of 4.0 ohms. What is its voltage sensitivity, in divisions per millivolt?

A. 0.25
B. 2.5
C. 4.0
D. 12
E. 30

17. The specific charge (charge per unit mass) of a Zn^{2+} ion is 2.9×10^6 C/kg. A dry cell with a zinc anode has an e.m.f. of 1.53 V. When the cell drives a current round a circuit, zinc is removed from the anode. Assuming that the system is a perfectly efficient converter of energy, what is the electrical energy produced per kg of zinc?

A. 0.23 J
B. 0.53 J
C. 4.4 kJ
D. 1.9 MJ
E. 4.4 MJ

18. A demonstration Van de Graaff generator has a hollow sphere of radius *a* supported by a pillar of resistance *R*. The belt conveys charge to the

sphere at a rate I. The maximum surface density of charge on the sphere is

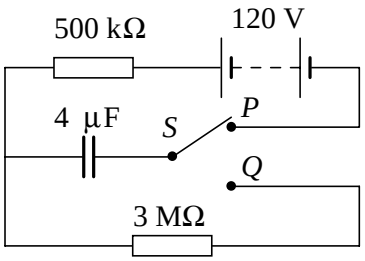
A. $4\pi\varepsilon_0 aIR$
B. $\dfrac{\varepsilon_0 IR}{a}$
C. $\dfrac{\varepsilon_0 IR}{a^2}$
D. $\dfrac{IR}{4\pi\varepsilon_0 a}$
E. $\dfrac{IR}{4\pi\varepsilon_0 a^2}$

19. A secondary coil of N turns and resistance 40 ohms is wound round the middle of a long solenoid of cross-sectional area A m² with n turns per metre carrying a current I amperes. A ballistic galvanometer of resistance 10 ohms and sensitivity k divisions per coulomb is connected in series with the secondary coil. Neglecting damping, how many divisions is the deflection of the galvanometer when the current in the solenoid is switched off?

(μ_0 = the permeability of free space in henry per metre.)

A. $\dfrac{\mu_0 nNAIk}{10}$
B. $\dfrac{\mu_0 nNAIk}{40}$
C. $\dfrac{\mu_0 nNAIk}{50}$
D. $\dfrac{\mu_0 nNAI}{10k}$
E. $\dfrac{\mu_0 nNAI}{50k}$

20.



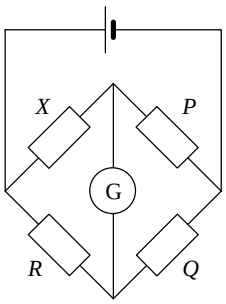
In the circuit shown, S is connected to P until the capacitor is fully charged. Then S is switched to Q. What is the initial value of the current through the 3 MΩ resistor?

A. 2.50×10^{-6} A
B. 3.33×10^{-5} A
C. 3.75×10^{-5} A
D. 4.00×10^{-5} A
E. 4.80×10^{-4} A

21. A long solenoid uniformly wound with N turns is of length l, cross-sectional area A and carries a current I. The total energy stored in the magnetic field inside the solenoid is given approximately by

A. $\dfrac{\mu_0 AI^2 N^2}{l^2}$
B. $\dfrac{\mu_0 AI^2 N^2}{2l^2}$
C. $\dfrac{\mu_0 AIN^2}{l^2}$
D. $\dfrac{\mu_0 AIN^2}{2l^2}$
E. $\dfrac{\mu_0 AI^2 N^2}{2l}$

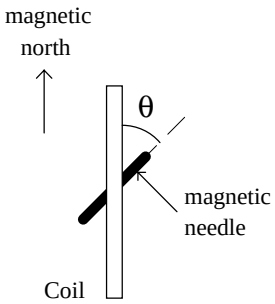
22.



The diagram shows a Wheatstone bridge circuit. P, Q and R are resistance boxes whose resistance may be set at zero or any integral number of ohms, up to 1,000. X is an unknown resistance to be measured by adjusting R. With P and Q each set at 300 ohms, it is not possible to balance the bridge, and the current through the galvanometer is always in the same direction. Which one of the following explanations could account for this failure?

A. X is greater than 300 ohms.
B. X is greater than 600 ohms.
C. X is greater than 1000 ohms.
D. X is not an integral number of ohms.
E. X is less than 1 ohm.

23.



A tangent galvanometer has a narrow circular coil of radius *r*, with *N* turns. When a current *I* passes through the coil, the magnetic needle, constrained to move in a horizontal plane, sets at an angle θ to magnetic north, as shown. If the flux density of the earth's magnetic field has magnitude *B*, and the horizontal component is B_h, then tan θ is equal to

A. $\dfrac{2rB_h}{\mu_0 NI}$
B. $\dfrac{2rB}{\mu_0 NI}$
C. $\dfrac{2r^2B}{\mu_0 NI}$
D. $\dfrac{\mu_0 NI}{2rB_h}$
E. $\dfrac{\mu_0 NI}{2r^2B_h}$

24. A potential difference *V* is applied between two large parallel plates, distance *s* apart. An electron, mass *m*, charge *-e*, starts from rest at the negative plate and travels across the gap to the positive plate. The time taken is

A. $\dfrac{2s}{V}$
B. $\dfrac{s^2}{V}$
C. $\dfrac{2s^2}{eV}$
D. $\sqrt{\dfrac{2ms^2}{eV}}$
E. $\sqrt{\dfrac{m}{2eV}}$

25. The armature of a d.c. electric motor has resistance 2 Ω. When the applied potential difference is 150 V, a current of 5 A flows. The back e.m.f. is

A. 10 V
B. 93 V
C. 140 V
D. 150 V
E. 160 V

26. C_1 and C_2 are plane parallel plate capacitors of the same area. The plates of C_1 and C_2 are separated by slabs of the same dielectric material of thickness *d* and 2*d* respectively. The capacitance of C_1 is 0.12 μF. The capacitance of C_1 and C_2 connected together in series is

A. 0.04 μF
B. 0.08 μF
C. 0.18 μF
D. 0.24 μF
E. 0.36 μF

27. Given: the mass of a proton is 1.6733×10^{-27} kg
the mass of a neutron is 1.6744×10^{-27} kg
the mass of an alpha particle is 6.6443×10^{-27} kg
the electronic charge *e* is -1.6×10^{-19} C
the speed of light in vacuo is 3.00×10^{8} m/s

The binding energy per nucleon in a helium nucleus is

A. 1.15×10^{-12} J
B. 2.30×10^{-12} J
C. 4.60×10^{-12} J
D. 1.44×10^{7} eV
E. 2.87×10^{7} eV

28. In a Millikan experiment, a droplet of oil of radius *r* with two electronic charges, 2*e*, remains stationary when a potential difference *V* is applied to the plates. When the potential difference is increased to 4*V*, a droplet of oil of radius 2*r* remains stationary. What is the charge on the second droplet?

A. *e*/2
B. *e*
C. 2 *e*

D. 4 *e*
E. 8 *e*

29. For the photoelectic effect, which of the following is the correct relationship between the energy *E* of a photon, the work function *w* of the surface which it strikes, and the maximum kinetic energy *K* of the emitted photoelectron?

A. $E = w + K$
B. $E = w - K$
C. $E = K - w$
D. $K = 2(w + E)$
E. $w = \frac{1}{2}(K + E)$

30. An electron of mass *m* and charge *e*, is accelerated by a potential *V*, then strikes an atom, exciting it from its ground state to a higher energy state. The electron is scattered with speed *u*, and the excited atom subsequently decays back to the ground state with the emission of a photon of frequency *f*. If *h* is the Planck constant, the value of *u* is

A. $eV - hf$

B. $2(eV + hf)$

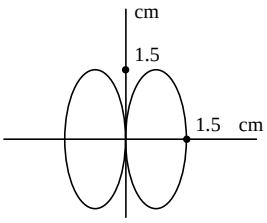
C. $2(eV - hf)/m$

D. $\sqrt{\dfrac{eV + hf}{m}}$

E. $\sqrt{\dfrac{2(eV - hf)}{m}}$

31. A cathode ray tube has *X* and *Y* sensitivities of 5 V/cm and 10 V/cm respectively. A sinusoidal p.d. of frequency 100 Hz and amplitude 7.5 V is applied to the *X* plates, and a sinusoidal p.d. of frequency 50 Hz and amplitude 15 V is applied to the *Y* plates. Which one of the following sketches could represent the pattern seen on the screen?

A.



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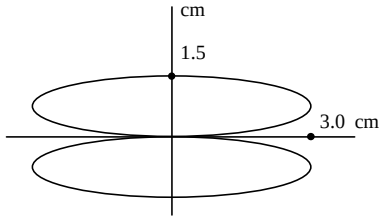
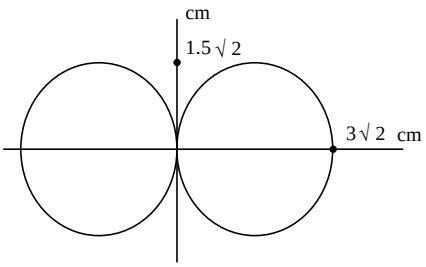


C.



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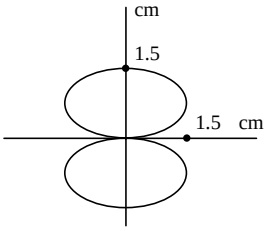
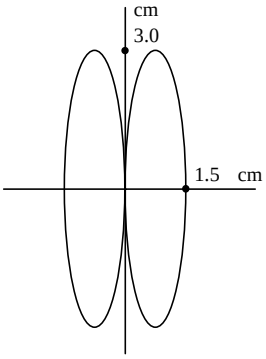


E.



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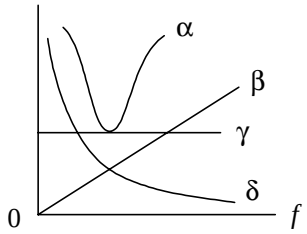


A series circuit consisting of a pure inductor *L*, a pure capacitor *C* and a pure resistor *R* is connected across an a.c. supply. The variations with applied frequency *f* of the resistance *R*, the reactance X_C of the capacitor,

the reactance X_L of the inductor and the impedance Z of the circuit are represented in the diagram. Which of the following sequences places the curves in an order so that they represent the magnitudes of R, X_C, X_L and Z?

A. αδβγ
B. βδαγ
C. γαβδ
D. γβδα
E. γδβα

33. A stationary radioactive nucleus of mass N units emits an alpha particle of mass 4 units, leaving a residual nucleus of mass (N - 4) units. The ratio of the kinetic energy of the alpha particle to the kinetic energy of the residual nucleus is

A. $\frac{N-4}{4}$
B. $\frac{N^2}{(N-4)^2}$
C. $\frac{(N-4)^2}{N^2}$
D. $\frac{(N-4)^2}{4^2}$
E. $\frac{(N-4)^3}{4^3}$

34. Projectiles X and Y are launched simultaneously from the top of a cliff. X is launched horizontally with speed 20 m/s, and Y is launched at an angle of 60º above the horizontal with speed 40 m/s. (The motion of both X and Y is in the same plane.) Which of the following statements is correct?

(1) X and Y travel equal vertical distances in equal times.
(2) X and Y travel equal horizontal distances in equal times.
(3) X and Y never meet.

A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

35. Before the start of a race, the momentum of each competitor is less than his momentum during the race. Which of the following statements is correct?

(1) This situation violates Newton's law of conservation of momentum.
(2) The law of conservation of momentum applies only to collisions between two objects.
(3) A force acts on each competitor to increase his momentum as he starts to race.

A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

36. An astronaut in an orbiting satellite is sometimes said to be 'weightless'. This condition occurs when

(1) the gravitational attraction between the astronaut and the earth is just sufficient to provide the centripetal force which keeps him in orbit.
(2) there is no reaction of the floor of the satellite on the astronaut's feet.
(3) the gravitational pull of the earth is exactly cancelled by the gravitational pull of the moon.

A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

37. An ideal gas is enclosed in a container at absolute temperature T. The absolute temperature is now raised to $2T$, whilst the volume is kept constant. Which of the following statements is correct?

(1) The average separation of the molecules is reduced by a factor of $\sqrt{2}$.
(2) The average speed of the molecules is doubled.
(3) The average kinetic energy of the molecules is doubled.

A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only

E. (3) only

38. The equation of state for mass m of an ideal gas may be written $pV = mrT$. With reference to this equation,

(1) the value of r depends upon the particular gas used.
(2) r is independent of m.
(3) if R is the molar gas constant, then the mass of each mole of this gas is R/r.

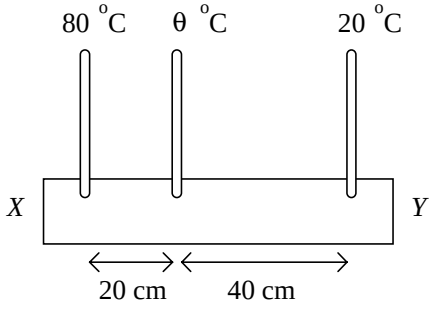
A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

39. The specific heat capacity of a liquid may be determined by heating it in an electrical calorimeter or by using a continuous flow method. The advantage of the continuous flow method is that

(1) the required temperatures are recorded when a steady state has been reached.
(2) it is not necessary to measure the specific heat capacity of the apparatus.
(3) no heat is lost to the surroundings.

A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

40.



The diagram shows an unlagged bar XY whose ends are maintained at different temperatures, with three thermometers, registering 80 ºC, θ ºC and 20 ºC in the steady state. (The room temperature is below 20 ºC.) Which of the following statements is correct?

(1) The rate at which heat energy crosses any section of the bar decreases from X to Y.
(2) (80 - θ) is greater than ½(θ - 20).
(3) θ must be less than 40.

A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

41. A mixture of saturated water vapour and water is heated in a closed container. As the temperature rises,

(1) the proportion of vapour to liquid decreases.
(2) the density of the saturated vapour increases.
(3) the saturated vapour pressure of the water increases.

A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

42. An enclosure contains a black body X which is in thermal equilibrium with it. A second black body Y, at a higher temperature than X, is introduced into the enclosure. The temperature of the enclosure is maintained at a constant value, and all heat exchange is by radiation. Which of the following statements is correct?

(1) The temperature of Y falls until equilibrium is re-established.
(2) The temperature of X rises initially then falls until equilibrium is re-established.
(3) Equilibrium is re-established with both X and Y at a higher temperature than the enclosure.

A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

43. In a Young's slits experiment to produce interference fringes on a screen, the separation of the interference fringes is increased by increasing

(1) the distance between the slits and the screen.
(2) the wavelength of the light.
(3) the distance between the source and the slits.

A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

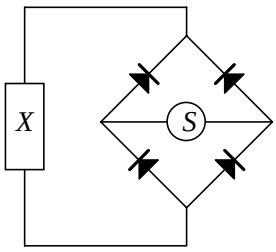
44. A free electron travelling horizontally with speed *v* enters a uniform vertical magnetic field *B*. Which of the following statements is correct?

(1) The path of the electron is a vertical circle.
(2) The speed of the electron remains constant.
(3) The radius of curvature of the path is inversely proportional to *B*.

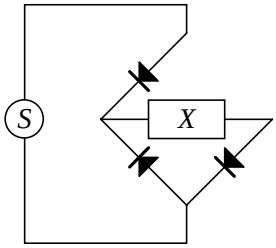
A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

45. *S* is a source of alternating voltage. In which of the following circuits will the current flowing through component *X* be rectified, i.e. flowing in one direction only?

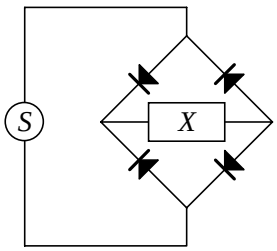
(1)



(2)

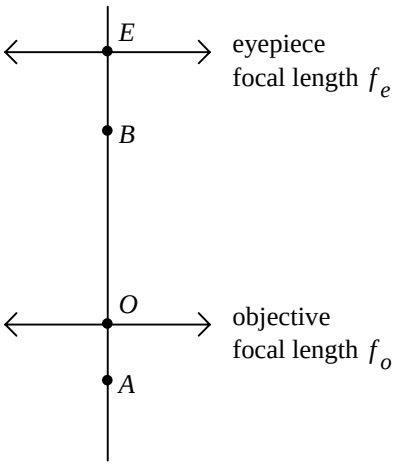


(3)



A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

46.



The diagram represents a microscope with the object at *A*. The image of *A* in the objective is formed at *B*. Which of the following statements is correct?

(1) *AO* is less than f_o.
(2) *BE* is less than f_e.
(3) The image at *B* is real.

A. (1), (2) and (3)
B. (1) and (2) only
C. (2) and (3) only
D. (1) only
E. (3) only

- End of Paper -

Question No.	Key	Question No.	Key
1.	D	26.	A
2.	D	27.	A
3.	B	28.	D
4.	A	29.	A
5.	D	30.	E
6.	E	31.	D
7.	D	32.	E
8.	C	33.	A
9.	C	34.	C
10.	C	35.	E
11.	C	36.	B
12.	E	37.	E
13.	E	38.	A
14.	A	39.	B
15.	D	40.	B
16.	B	41.	C
17.	E	42.	B
18.	B	43.	B
19.	C	44.	C
20.	D	45.	A
21.	E	46.	C
22.	C		
23.	D		
24.	D		
25.	C		