# BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI (RAJ)

Physics Laboratory (PHY F110): Comprehensive Examination (2017 - 2018)

**Date : 30 Nov 2017** **A**

**Max. Marks : 90** **Duration : 1 hour**

**Name :** **ID. :**

- ✓ Question No. (9) and (10) carry 5 marks each, rest are of 4 marks each.
- ✓ **For every wrong answer 2 marks will be deducted.**
- ✓ Any overwriting would be considered as Not Attempted.
- ✓ **Please answer in the boxes provided below**.
- ✓ **Constants:** $h = 6.62607 \times 10^{-34}$ J s ; $c = 2.997 \times 10^{8}$ m/s; $e = 1.602 \times 10^{-19}$ C.

| | | |
|---|---|---|
| Corrrect Answers | | |
| Wrong Answers | | |
| Marks Obtained | | |

| **Question** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Answer** | | | | | | | | | | | | | | | | | | | | | | |

1. (EMI) Let, $m$ be the total mass of the magnet and the metallic frame, and $x$ be the distance of the center of the mass magnet+frame system from the point suspension. If you release the system at an initial angle $\theta_0$, and $\omega_{max}$ be the maximum angular speed of the system, which of the following relations is correct ?

   (A) $\frac{1}{2}I\omega_{max}^2 = mgx(1-\cos\theta_0)$ ✓ (B) $I\omega_{max}^2 = mgx\sin^2\left(\frac{\theta_0}{2}\right)$ (C) $\frac{1}{2}I\omega_{max}^2 = 2mgx(1+\sin\theta_0)$ (D) $\frac{1}{2}I\omega_{max}^2 = 2mgx(1+\cos\theta_0)$

2. (EMI) A sinusoidal wave voltage is applied across a capacitor. When the frequency of the voltage is decreased, how will the current across the capacitor change ?

   (A) it will increase (B) it will decrease ✓ (C) there will be no change (D) insufficient data

3. (Young's Modulus) A copper wire and a steel wire of the same diameter and length are connected end to end. The entire system hangs vertically from the ceiling and supports a load at the free end. The weight of the wire is negligible as compare to the hanging load. The two wires will have :

   (A) Different stresses and strains
   (B) The same stress and strain
   (C) The same strain but different stresses
   (D) The same stress but different strains ✓

4. (Young's Modulus) An aluminium rod of length 1.0 m and cross-sectional area 500 mm$^2$ is used to support a load of 5 kN which causes the rod to contract by 100 $\mu m$. The Young's modulus of the rod is ?

   (A) 100 MPa (B) 100 GPa ✓ (C) 10 MPa (D) 10 GPa

5. (Velocity of sound) Velocity of sound experiment is conducted at 20$^\circ C$ and a value of 343 m/s is obtained when the input frequency was 2 KHz. The average distance between successive nodes must have been,

   (A) 8.6 cm ✓ (B) 4.5 cm (C) 10.2 cm (D) 6.5 cm

6. (Velocity of sound) An audio frequency generator generating sound waves of 4 KHz is connected to X-channel of the CRO and waves are visualized on the CRO. The time base knob of the CRO is kept at 0.2 ms/div. Note that each division of the CRO screen has 5 sub-divisions. Two crest of the X-channel CRO signal would be:

   (A) 0.8 divisions apart (B) 1.2 division apart ✓ (C) 1.4 divisions apart (D) 2.5 divisions apart

7. (Slit) In a single slit experiment, if $I_0$ and $I_1$ are the intensities of central and 1st maximum respectively, which among the following fractions represents (approximately) the ratio, $I_1/I_0$ ? [You may use, if required : The first non-zero root of $\tan\theta = \theta$ is $\theta = 1.43\pi$]

   (A) 0.40 (B) 0.05 ✓ (C) 0.20 (D) 0.50

8. (Slit) In single/double slit experiment, assume $I_1$ and $I_2$ are the intensities of the central maxium for the case of single slit and double slit, respectively. Choose the correct relationship between them from the following.

   (A) $I_2 = I_1$ (B) $I_2 = 2\,I_1$ (C) $I_2 = 4\,I_1$ ✓ (D) $I_2 = I_1/2$

9. (Error Analysis) The answer book provided to students in an exam consists of 20 sheets of blank paper. The paper manufacturing company specifies the mass of each paper to be $3g \pm 0.05g$ (std dev error). The mass of the answerbook is

   (A) $60g \pm 1g$ (B) $60g \pm 0.22g$ ✓ (C) $60g \pm 0.47g$ (D) $60g \pm 0.66g$

10. (Error Analysis) Two measurable quantities $x$ and $y$ are known to follow a relation of the type $y = \alpha\exp(\beta x)$ where $\alpha$ and $\beta$ are constants. The quantities are measured and the data points $(x_i, y_i)$ obtained are : $(2, 3.5), (3, 6.7), (4, 10.8), (5, 14.0), (6, 19.0)$. The best value of $\beta$ obtained from this data is :

    (A) 1.43 (B) 1.53 ✓ (C) 1.63 (D) 1.73

11. (Planck's constant) In the Planck's constant experiment, the photoelectron current for a given frequency $\nu$ is given as $\ln I_{ph} \propto h\nu/KT$, this is only valid when ?

(A) $h\nu \approx KT$ (B) $h\nu \ll KT$ (C) $h\nu \gg KT$ ✓ (D) $R \approx R_0(1+\alpha T)$ ($R$ is filament resistance)

12. (Planck's constant) The wavelength corresponding to threshold frequency for photoelectric emission in Tungsten is 240 nm. What wavelength of light must be used in order that the emitted photoelectrons have a maximum kinetic energy of 1.2 eV.

(A) 200 nm (B) 230 nm (C) 350 nm (D) 195 nm ✓

13. (Diffraction Grating) Light of wavelength $\lambda$ and intensity $I_0$ is incident normally on the grating having $N$ lines per unit length. Let $\Delta\lambda$ be the smallest resolvable wavelength difference. The resolving power of the grating is :

(A) $\propto (\lambda/\Delta\lambda)^2$ (B) $\propto \sqrt{N}$ (C) $\propto N$ ✓ (D) $\propto \sqrt{\lambda/\Delta\lambda}$

14. (Diffraction Grating) The wave front we have used in our laboratory to perform diffraction grating experiment is :

(A) Cylindrical in nature
(B) Spherical in nature
(C) Plane wave front ✓
(D) Mixture of spherical and cylindrical wave front

15. (Coupled Pendulum) Consider the coupled pendulum experiment. Displace one of the pendulums by a small amount, keeping the other one fixed at its equilibrium position and then release both. The time period of individual oscillations in this mode is $T$, and the time between the successive stops of the pendulum is $\Delta T$. If $\Delta T = 3T$, then the lower ($\omega_1$) and higher ($\omega_2$) normal mode frequencies are related by,

(A) $\omega_2 = \omega_1$ (B) $\omega_2 = 2\omega_1$ ✓ (C) $\omega_2 = 3\omega_1$ (D) $\omega_2 = 4\omega_1$

16. (Coupled Pendulum) Two identical pendulums of mass $m$ and length $L$ are coupled together by a spring of spring constant $k$ at a distance $\ell$ from the pivot. The ratio ($\omega_2/\omega_1$) of angular frequencies of higher mode to lower mode is ?

(A) $\sqrt{1+2k\ell^2/(mgL)}$ ✓ (B) $\sqrt{1+mgL/(2k\ell^2)}$ (C) $\sqrt{2k\ell^2/(mgL)}+1$ (D) $\sqrt{mgL/(2k\ell^2)}+1$

17. (LCR) For a given values of resistance ($R$), capacitance ($C$) and inductance ($L$), Quality factor is found to be $Q$ for a LCR series circuit. Now keeping $R$ and $L$ fixed, what should be the value of the capacitance to get a 10 times original $Q$ ?

(A) 10 $C$ (B) 100 $C$ (C) 0.01 $C$ ✓ (D) 0.1 $C$.

18. (LCR) In the parallel LCR circuit, the phase difference between the currents through the inductor $i_L$ and the capacitor $i_C$ is

(A) 0 degrees
(B) 90 degrees
(C) 180 degrees ✓
(D) dependent on the frequency and hence can not be said from the given information

19. ($e/m$) In the specific charge of electron experiment, an electron beam is moving under uniform magnetic field produced by a pair of Helmholtz coils of radius 0.2 m and a total number of turns 150. A current of 2 A is flowing through the coils. What will be the radius of the electron beam accelerated by a 200 V potential if the velocity of the beam is perpendicular to the direction of the magnetic field?

(A) 2.5 cm (B) 2.1 cm (C) 3.5 cm ✓ (D) 2.8 cm

20. ($e/m$) If you determined the slope for the plot V versus $D^2$ in the e/m experiment to be $2.14\times10^4$ V cm$^{-2}$, what would be the e/m ratio if the Helmholtz coils have 140 turns, the spacing between the two coils is 13.5 cm and the current flowing in the coils is 1.02 A?

(A) $2.12\times10^{11}$ C/kg (B) $1.75\times10^{11}$ C/kg (C) $1.56\times10^{11}$ C/kg (D) $1.89\times10^{11}$ C/kg ✓

21. (Newton's Rings) In the Newton's ring experiment, if the radius of curvature of the Plano-convex lens and the wavelength of the monochromatic source are 1 m and 635 nm respectively, find out the annular area between $11^{th}$ and $12^{th}$ dark ring.

(A) $2\times10^{-5}$ m$^2$ (B) $2\times10^{-7}$ m$^2$ (C) $2\times10^{-6}$ m$^2$ ✓ (D) $2\times10^{-8}$ m$^2$

22. (Newton's Rings) In the Newton's ring experiment, the radius of 5th bright ring becomes the radius of 5th dark ring due to change in the wavelength of the monochromatic source from 590 nm to some value $\lambda_2$. Find the value of $\lambda_2$. (consider the central spot as zeroth order).

(A) 649 nm ✓ (B) 770 nm (C) 532 nm (D) 488 nm

---

**Recheck request if any**

# BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI (RAJ)

Physics Laboratory (PHY F110): Comprehensive Examination (2017 - 2018)

**Date : 30 Nov 2017** **B**

**Max. Marks : 90** **Duration : 1 hour**

**Name :** **ID. :**

- ✓ Question No. (15) and (16) carry 5 marks each, rest are of 4 marks each.
- ✓ **For every wrong answer 2 marks will be deducted.**
- ✓ Any overwriting would be considered as Not Attempted.
- ✓ **Please answer in the boxes provided below**.
- ✓ **Constants:** $h = 6.62607 \times 10^{-34}$ J s ; $c = 2.997 \times 10^{8}$ m/s; $e = 1.602 \times 10^{-19}$ C.

| | | |
|---|---|---|
| Corrrect Answers | | |
| Wrong Answers | | |
| Marks Obtained | | |

| **Question** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Answer** | | | | | | | | | | | | | | | | | | | | | | |

1. (Slit) In a single slit experiment, if $I_0$ and $I_1$ are the intensities of central and 1st maximum respectively, which among the following fractions represents (approximately) the ratio, $I_1/I_0$ ? [You may use, if required : The first non-zero root of $\tan\theta = \theta$ is $\theta = 1.43\pi$]

   (A) 0.40 (B) 0.05 ✓ (C) 0.20 (D) 0.50

2. (Slit) In single/double slit experiment, assume $I_1$ and $I_2$ are the intensities of the central maxium for the case of single slit and double slit, respectively. Choose the correct relationship between them from the following.

   (A) $I_2 = I_1$ (B) $I_2 = 2\ I_1$ (C) $I_2 = 4\ I_1$ ✓ (D) $I_2 = I_1/2$

3. (Young's Modulus) A copper wire and a steel wire of the same diameter and length are connected end to end. The entire system hangs vertically from the ceiling and supports a load at the free end. The weight of the wire is negligible as compare to the hanging load. The two wires will have :

   (A) Different stresses and strains
   (B) The same stress and strain
   (C) The same strain but different stresses
   (D) The same stress but different strains ✓

4. (Young's Modulus) An aluminium rod of length 1.0 m and cross-sectional area 500 mm$^2$ is used to support a load of 5 kN which causes the rod to contract by 100 $\mu m$. The Young's modulus of the rod is ?

   (A) 100 MPa (B) 100 GPa ✓ (C) 10 MPa (D) 10 GPa

5. (Planck's constant) In the Planck's constant experiment, the photoelectron current for a given frequency $\nu$ is given as $\ln I_{ph} \propto h\nu/KT$, this is only valid when ?

   (A) $h\nu \approx KT$ (B) $h\nu \ll KT$ (C) $h\nu \gg KT$ ✓ (D) $R \approx R_0(1+\alpha T)$ ($R$ is filament resistance)

6. (Planck's constant) The wavelength corresponding to threshold frequency for photoelectric emission in Tungsten is 240 nm. What wavelength of light must be used in order that the emitted photoelectrons have a maximum kinetic energy of 1.2 eV.

   (A) 200 nm (B) 230 nm (C) 350 nm (D) 195 nm ✓

7. (Newton's Rings) In the Newton's ring experiment, if the radius of curvature of the Plano-convex lens and the wavelength of the monochromatic source are 1 m and 635 nm respectively, find out the annular area between $11^{th}$ and $12^{th}$ dark ring.

   (A) $2 \times 10^{-5}$ m$^2$ (B) $2 \times 10^{-7}$ m$^2$ (C) $2 \times 10^{-6}$ m$^2$ ✓ (D) $2 \times 10^{-8}$ m$^2$

8. (Newton's Rings) In the Newton's ring experiment, the radius of 5th bright ring becomes the radius of 5th dark ring due to change in the wavelength of the monochromatic source from 590 nm to some value $\lambda_2$. Find the value of $\lambda_2$. (consider the central spot as zeroth order).

   (A) 649 nm ✓ (B) 770 nm (C) 532 nm (D) 488 nm

9. ($e/m$) In the specific charge of electron experiment, an electron beam is moving under uniform magnetic field produced by a pair of Helmholtz coils of radius 0.2 m and a total number of turns 150. A current of 2 A is flowing through the coils. What will be the radius of the electron beam accelerated by a 200 V potential if the velocity of the beam is perpendicular to the direction of the magnetic field?

   (A) 2.5 cm (B) 2.1 cm (C) 3.5 cm ✓ (D) 2.8 cm

10. ($e/m$) If you determined the slope for the plot V versus $D^2$ in the e/m experiment to be $2.14 \times 10^4$ V cm$^{-2}$, what would be the e/m ratio if the Helmholtz coils have 140 turns, the spacing between the two coils is 13.5 cm and the current flowing in the coils is 1.02 A?

    (A) $2.12 \times 10^{11}$ C/kg (B) $1.75 \times 10^{11}$ C/kg (C) $1.56 \times 10^{11}$ C/kg (D) $1.89 \times 10^{11}$ C/kg ✓

11. (EMI) Let, $m$ be the total mass of the magnet and the metallic frame, and $x$ be the distance of the center of the mass magnet+frame system from the point suspension. If you release the system at an initial angle $\theta_0$, and $\omega_{max}$ be the maximum angular speed of the system, which of the following relations is correct ?

(A) $\frac{1}{2}I\omega_{max}^2 = mgx(1-\cos\theta_0)$ ✓ (B) $I\omega_{max}^2 = mgx\sin^2\left(\frac{\theta_0}{2}\right)$ (C) $\frac{1}{2}I\omega_{max}^2 = 2mgx(1+\sin\theta_0)$ (D) $\frac{1}{2}I\omega_{max}^2 = 2mgx(1+\cos\theta_0)$

12. (EMI) A sinusoidal wave voltage is applied across a capacitor. When the frequency of the voltage is decreased, how will the current across the capacitor change ?

(A) it will increase (B) it will decrease ✓ (C) there will be no change (D) insufficient data

13. (Diffraction Grating) Light of wavelength $\lambda$ and intensity $I_0$ is incident normally on the grating having $N$ lines per unit length. Let $\Delta\lambda$ be the smallest resolvable wavelength difference. The resolving power of the grating is :

(A) $\propto (\lambda/\Delta\lambda)^2$ (B) $\propto \sqrt{N}$ (C) $\propto N$ ✓ (D) $\propto \sqrt{\lambda/\Delta\lambda}$

14. (Diffraction Grating) The wave front we have used in our laboratory to perform diffraction grating experiment is :

(A) Cylindrical in nature
(B) Spherical in nature
(C) Plane wave front ✓
(D) Mixture of spherical and cylindrical wave front

15. (Error Analysis) The answer book provided to students in an exam consists of 20 sheets of blank paper. The paper manufacturing company specifies the mass of each paper to be $3g \pm 0.05g$ (std dev error). The mass of the answerbook is

(A) $60g \pm 1g$ (B) $60g \pm 0.22g$ ✓ (C) $60g \pm 0.47g$ (D) $60g \pm 0.66g$

16. (Error Analysis) Two measurable quantities $x$ and $y$ are known to follow a relation of the type $y = \alpha\exp(\beta x)$ where $\alpha$ and $\beta$ are constants. The quantities are measured and the data points $(x_i, y_i)$ obtained are : $(2,3.5),(3,6.7),(4,10.8),(5,14.0),(6,19.0)$. The best value of $\beta$ obtained from this data is :

(A) 1.43 (B) 1.53 ✓ (C) 1.63 (D) 1.73

17. (LCR) For a given values of resistance $(R)$, capacitance $(C)$ and inductance $(L)$, Quality factor is found to be $Q$ for a LCR series circuit. Now keeping $R$ and $L$ fixed, what should be the value of the capacitance to get a 10 times original $Q$ ?

(A) 10 $C$ (B) 100 $C$ (C) 0.01 $C$ ✓ (D) 0.1 $C$.

18. (LCR) In the parallel LCR circuit, the phase difference between the currents through the inductor $i_L$ and the capacitor $i_C$ is

(A) 0 degrees
(B) 90 degrees
(C) 180 degrees ✓
(D) dependent on the frequency and hence can not be said from the given information

19. (Velocity of sound) Velocity of sound experiment is conducted at $20^\circ C$ and a value of 343 m/s is obtained when the input frequency was 2 KHz. The average distance between successive nodes must have been,

(A) 8.6 cm ✓ (B) 4.5 cm (C) 10.2 cm (D) 6.5 cm

20. (Velocity of sound) An audio frequency generator generating sound waves of 4 KHz is connected to X-channel of the CRO and waves are visualized on the CRO. The time base knob of the CRO is kept at 0.2 ms/div. Note that each division of the CRO screen has 5 sub-divisions. Two crest of the X-channel CRO signal would be:

(A) 0.8 divisions apart (B) 1.2 division apart ✓ (C) 1.4 divisions apart (D) 2.5 divisions apart

21. (Coupled Pendulum) Consider the coupled pendulum experiment. Displace one of the pendulums by a small amount, keeping the other one fixed at its equilibrium position and then release both. The time period of individual oscillations in this mode is $T$, and the time between the successive stops of the pendulum is $\Delta T$. If $\Delta T = 3T$, then the lower $(\omega_1)$ and higher $(\omega_2)$ normal mode frequencies are related by,

(A) $\omega_2 = \omega_1$ (B) $\omega_2 = 2\omega_1$ ✓ (C) $\omega_2 = 3\omega_1$ (D) $\omega_2 = 4\omega_1$

22. (Coupled Pendulum) Two identical pendulums of mass $m$ and length $L$ are coupled together by a spring of spring constant $k$ at a distance $\ell$ from the pivot. The ratio $(\omega_2/\omega_1)$ of angular frequencies of higher mode to lower mode is ?

(A) $\sqrt{1+2k\ell^2/(mgL)}$ ✓ (B) $\sqrt{1+mgL/(2k\ell^2)}$ (C) $\sqrt{2k\ell^2/(mgL)}+1$ (D) $\sqrt{mgL/(2k\ell^2)}+1$

---

**Recheck request if any**