Form 6

PHYSICS

Solutions for F6 physics (Pre-Mock)

(Source: 2020 - 2021 Final Examination Modified)

Marking Scheme

Pre-Mock MC Questions

1.	C	31.	C
2.	B	32.	D
3.	C	33.	C
4.	B	34.	D
5.	A	35	A
6.	B	36	A
7.	C	37	B
8.	A	38	B
9.	C	39	C
10.	D	40	D
11.	D	41	C
12.	A	42	C
13.	B	43	A
14.	D	44	C
15.	D	45	B
16.	C	46	A
17.	A	47	D
18.	C	48	B
19.	D	49	D
20.	D		
21.	A		
22.	B		
23.	A		
24.	B		
25.	A		
26.	C		
27.	C		
28.	D		
29.	D		
30.	B		

Pre-Mock Paper 1B

Q.1Answer

(a) The energy absorbed by the water

$Q = mc\Delta T = 0.220 \times 4200 \times (55.5 - 25.0) = 28\,182$ J **(1M)**

The average power supplied to the heating element

$$\langle P \rangle = \frac{E}{t} = \frac{28\,182}{5 \times 60} = 93.94 \approx 93.9 \text{ W}$$ **(1M + 1A)**

(b) Applying $\langle P \rangle = \frac{V_{\text{rms}}^2}{R}$, the r.m.s. output voltage of the a.c. power supply is

$$V_{\text{rms}} = \sqrt{\langle P \rangle R} = \sqrt{93.94 \times 12} = 33.57 \approx 33.6 \text{ V}$$ **(1M + 1A)**

Applying $V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$, the peak output voltage is $V_0 = V_{\text{rms}}\sqrt{2} = 33.57\sqrt{2} \approx 47.5$ V. **(1M + 1A)**

(c) (Any reasonable answers)

1. Use a polystyrene foam cup to reduce the heat lost to the surroundings **(1A)**
2. Use a stirrer to stir the water gently during heating **(1A)**

(d) Use a CRO (cathode ray oscilloscope) **(1A)**

Q.2 Answer

(a) Let m_X and m_Y be the mass of the gas inside X and Y respectively.

From $pV = nRT$, we have

$$\frac{p_X V_X}{p_Y V_Y} = \frac{n_X R T_X}{n_Y R T_Y}$$
$$\frac{200}{300} = \frac{m_X \times (20 + 273)}{m_Y \times (120 + 273)}$$
$$\frac{m_X}{m_Y} = 0.8942$$ **(1M)**

Let T be the final temperature of the mixture. By the law of conservation of energy, energy gained by the colder gas is equal to the energy lost by the hotter gas, i.e.

$$m_X c \times (T - 20) = m_Y c \times (120 - T)$$
$$\frac{120 - T}{T - 20} = 0.8942$$
$$T = 72.79$$ **(1M)**

The final temperature is 72.8℃. **(1A)**

(b) From $pV = nRT$, we have

$$\frac{200 \times V}{R \times (20 + 273)} + \frac{300 \times V}{R \times (120 + 273)} = \frac{p \times 2V}{R \times (72.79 + 273)}$$
$$p = 250$$ **(1M)**

The final gas pressure is 250 kPa. **(1A)**

(a) $P_x V_x = n_x R T_x$

$P_y V_y = n_y R T_y$ ➔ $n_x / n_y = (P_x / P_y)(T_y / T_x) = 0.894197952$ ➔ $n_x = 0.894197952\, n_y$

By conservation of energy,

$3/2\, n_x RT_x + 3/2\, n_y RT_y = 3/2\, (n_x + n_y)RT$

$n_x T_x + n_y T_y = (n_x + n_y) T$

$0.894197952\,(293) + 1\,(393) = (0.894197952 + 1)\, T$ ➔ $T = 345.79$ K $= 72.79$ °C $= 72.8$ °C

(b) $3/2\, n_x RT_x + 3/2\, n_y RT_y = 3/2\, (n_x + n_y)RT$

$P_x V_x + P_y V_y = P\,(2V)$ *[$V_x = V_y = V$]*

$P_x + P_y = P\,(2)$ ➔ $P = 250$ kPa

(c) Gas particles in a container are moving randomly.

They hit the container's walls and rebound continuously. (1A)

The change of momentum per unit time ($F = (mv - mu) / t$) of all particles hitting the walls give rise to the force acting on the wall. (1A)

By $P = F / A$, gas pressure arises. (1A)

(d) By $P V = 1/3\, N m c_r^2$, $c_r^2 = 3 P V / (N_A m) = 3 P V / M = 3 P / \rho$ **(1+1M)**

➔ $c_r = \sqrt{(3 \times 1.02 \times 10^5 / 0.9)} = 583$ m s^{-1} **(1A)**

Q.3 Answer

(a) $mgh_1 = 1/2\, mv_1^2 - 0$ **(1M)**

$v_1^2 = 2gh_1$ ➔ $v_1 = 2.80$ ms^{-1} **(1A)**

(b) $mgh_2 = 1/2\, mv_2^2 - 0$

$v_2^2 = 2gh_2$ ➔ $v_2 = 1.98$ ms^{-1} **(1A)**

(c) $\cos\theta = v_2 / v_1$ **(1M)**

$\cos\theta = 1.98 / 2.80$ ➔ $\theta = 45°$ **(1A)**

(d) By $s = u t + 1/2\, a t^2$,

$-0.2 = (2.80 \cos 45°)\, t + 1/2\, (-9.81)\, t^2$ **(1M)**

➔ $t = 0.487$ s **(1M)**

$R = u_x t = 1.98\,(0.487) = 0.966$ m **(1A)**

(e) $mgh_3 = 1/2\, mv_3^2 - 0$ **(1M)**

$v_3^2 = 2gh_3$ ➔ $v_3 = 3.43$ ms^{-1} **(1A)**

Q.4 Answer

(a) By F = ma and net force = 0,

$25 - 7\,(9.81)\sin\theta - 2 \times 2 = 0$ (1M + 1M)

⇨ $\sin\theta = 17.8°$ (1A)

(b)

(i) For X (3-kg block),

$25 - 2 - (3)(9.81)\sin 17.8 = 3\,a$ **(1M)**

$a = 4.67\ m\ s^{-2}$ **(1A)**

(ii) For the 3-kg block,

$(4)(9.81)\sin 17.8 + 2 = 4\,a$ **(1M)**

$a = -3.5\ m\ s^{-2}$ **(1A)**

By v = u + at

→ $0 = 3.5 + -3.5\,(t)$ → $t = 1$ s **(1A)**

(iii) For the 3-kg block,

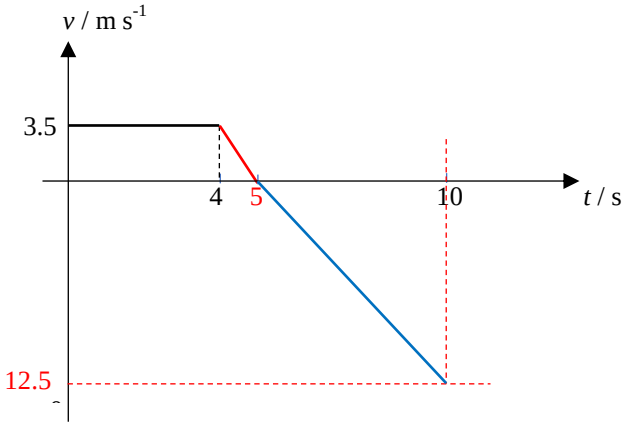
$12 - 2 = 4\,a$

$a = +2.5\ m\ s^{-2}$ **(1A)**

By v = u + at,

→ $v = 0 + 2.5\,(10 - 1 - 4)$ → $v = 12.5\ m\ s^{-1}$ **(1A)**

(c)



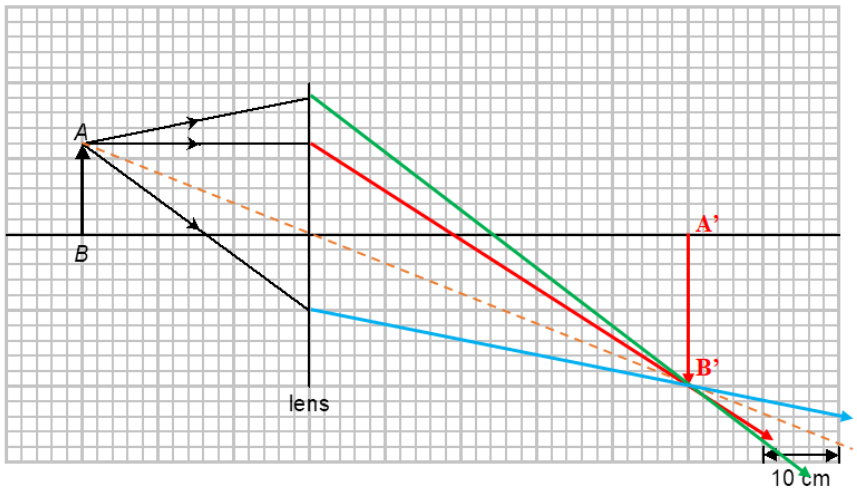
Q.5 Answer:

(a) (i) Convex lens **(1A)**. Only convex lenses can form real images **(1A)**.

(ii) R **(1A)**

(iii) The image is real, inverted and magnified. **(1A)**

(b) (i)



(2A)

(ii) Linear magnification = $\frac{\text{image distance}}{\text{object distance}} = \frac{50\,\text{cm}}{30\,\text{cm}} \approx 1.67$. **(1A)**

(iii) The focal length of the lens is (1.9 × 10) cm = 19cm. **(1A)**

(c) The image would become dimmer.**(1A)**

Q.6 Answer

(a) Stationary transverse wave **(1A)**

(b) 54 cm × 4 = 216 cm = 2.16 m **(1M+1A)**

(c) f = 50 / 18 = 2.777778 Hz **(1M)**

v = f λ = (2.77778)(2.16) =6 m s^{-1} **(1A)**

Q.7 Answer

(a)(i) E = V / d = 350 / 0.025 = 14000 V m^{-1} = 14000 N C^{-1} **(1M+1A)**

(ii) F = q E = (1.6×10^{-19}) (14000 N C^{-1}) = 2.24×10^{-15} N **(1M+1A)**

(b)(i) a = F / m = 2.24×10^{-15} N / 9.11×10^{-31} kg = 2.46×10^{15} m s^{-2} **(1A)**

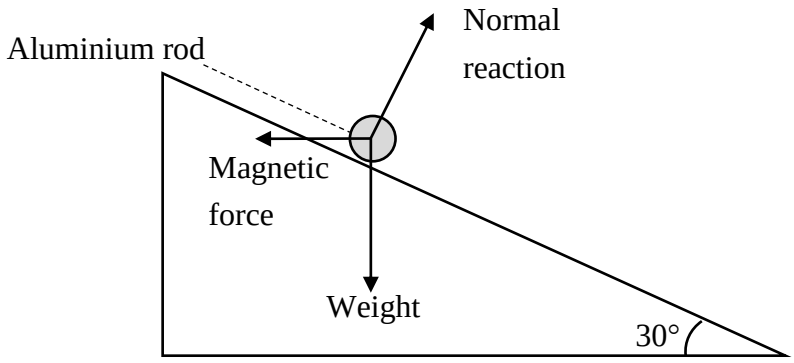
(ii) $s = u\,t + 1/2\,a\,t^2$,

$0.025 = 0 + 1/2\,(2.46 \times 10^{15})\,t^2$ **(1M)**

➔ $t = 4.51 \times 10^{-9}$ s **(1A)**

Q.8 Answer

(a)



(1A+1A+1A)

(b) $\varepsilon = B\,l\,v\cos\theta$ & $V = I\,R$

➔ Induced current $I = \varepsilon / R = B\,l\,v\cos\theta / R$ (1M + 1M)

$= (2)\,(0.12)\,(0.01)\,(\cos 30°) / 0.03 = 0.0693$ A (1A)

(c) $\varepsilon = N\,\Delta(B\Phi) / \Delta t = NB\,\Delta\Phi / \Delta t$

$= (50)\,(6)\,(\pi)\,(0.04)^2 / 2 = 0.754$ V (1M + 1A)

(d) $R = \rho\,l / A = \rho\,(2\pi r \times N) / A$ (1M)

$= (2 \times 10^{-6})\,(2\pi)\,(0.04)\,(50) / (0.5 \times 10^{-6}) = 50.3\ \Omega$ (1M)

$I = \frac{V}{R} = \frac{0.754}{50.3} = 0.0153\ A$ (1A)

Q.9 Answer

(a) ${}^{137}_{55}Cs \rightarrow {}^{137}_{56}X + {}^{0}_{-1}e$ X **(1M + 1A)**

(b)(i) $k = \ln 2 / t_{1/2}$ **(1M)**

$= \ln 2 / (30.2 \times 365 \times 24 \times 3600) = 7.28 \times 10^{-10}\ s^{-1}$ **(1A)**

(ii) $A = A_o\,e^{-kt}$

$A / A_o = e^{-kt}$ ➔ $\ln (A / A_o) = \ln (e^{-kt})$ ➔ $t = 3.16 \times 10^9 = 100$ years **(1M + 1A)**

Or

$A / A_o = (1/2)^n$ ➔ $\log (1/10) = \log (1/2)^n$ ➔ $\log 0.1 = n \log 0.5$ ➔ $n = 3.322$

$t = t_{1/2} \times n = 30.2 \times 3.322 = 100$ years

Paper 2 Structured Question

Pre-Mock Paper 2

Q1	Solutions	Marks
(a)(i)	Average U-value of the side wall $= \frac{2.3 \times (3 \times 15 - 1.2) + 1.8 \times 1.2}{3 \times 15}$ $= 2.29 \text{ W m}^{-2} \text{ K}^{-1}$	 1M 1A
(a)(ii)	Average U-value of the front wall $= \frac{2.3 \times (3 \times 15 - 1.2 - 2 \times 1) + 1.8 \times 1.2 + 3.7 \times 2 \times 1}{3 \times 15}$ $= 2.35 \text{ W m}^{-2} \text{ K}^{-1}$	 1M 1A
(b)(i)	Rate of heat transfer by conduction through the hut envelope $= (2.3 \times 15 \times 15 + 3 \times \underline{2.29} \times 3 \times 15 + \underline{2.35} \times 3 \times 15) \times (33 - 24)$ $= 8390 \text{ W}$	 1M 1A
(b)(ii)	Rate of heat transfer by radiation through the windows $= 4 \times 80 \times 1.2$ $= 384 \text{ W}$	 1A
(b)(iii)	Minimum cooling capacity required = rate of heat gain through the hut envelope = 8390 + 384 = 8770 W	 1A
(b)(iv)	OTTV = sum of average rate of heat gain / total area of the building envelope $= 8770 / (15 \times 15 + 4 \times 3 \times 15)$ $= 21.7 \text{ W m}^{-2}$ Remove the windows / use solar control window film / grow plants or install water pool on the roof top / …	 1A 1A

Q2	Solutions	Marks
(a)(i)	A	1A
(a)(ii)	Intensity of X-rays is attenuated when they pass through a medium. The attenuation in bone in bone is greater than that in soft tissue. Therefore, the film appears lighter under bone and darker under soft tissue.	1A 1A
(a)(iii)	$I = I_0 e^{-\mu x}$ $I / I_0 = e^{-\mu x}$ $0.14 = e^{-\mu 11.6}$ $\mu = 16.9\ m^{-1}$	 1M 1A
(b)(i)	CT scan is better at mapping soft tissues / differentiating between overlaying structures in the body / making 3D images	1A
(b)(ii)	The radiation dosage for CT scan is much higher than that of X-ray imaging. CT scan is not as mobile as X-ray imaging (OR not easily accessible).	1A 1A
(c)(i)	The effective dose of CT scan is much higher because multiple X-ray images are taken for a CT scan.	1A
(c)(ii)	Equivalent background radiation dose $= 1.85 \times 1.5 / 0.02$ $= 138.75$ days	 1A

Form 6

Name:_____

Class:_____ No.: _____

Final Examination 2020/21
PHYSICS

Time Allowed: 2 hours 30 minutes

GENERAL INSTRUCTIONS

(1) There are TWO sections, A and B, in this Paper. You are advised to finish Section A in about 50 minutes.

(2) Section A consists of multiple-choice questions in this question book, while Section B contains conventional questions printed separately in Question-Answer Book B.

(3) Answers to Section A should be marked on the Multiple-choice Answer Sheet while answers to Section B should be written in the spaces provided in Question-Answer Book. The Answer Sheet for Section A and the Question-Answer Book for Section B will be collected separately at the end of the examination.

(4) The diagrams in this paper are NOT necessarily drawn to scale.

(5) The last two pages of this question paper contain a list of data, formulae and relationships which you may find useful.

INSTRUCTIONS FOR SECTION A

1. Read carefully the instructions on the Answer Sheet. After the announcement of the start of the examination, you should first insert the information required in the spaces provided.
2. When told to open this book, you should check that all the questions are there. Look for the words 'END OF SECTION A' after the last question.
3. All questions carry equal marks.
4. ANSWER ALL QUESTIONS. You are advised to use an HB pencil to mark all the answers on the Answer Sheet, so that wrong marks can be completely erased with a clean rubber. You must mark the answers clearly; otherwise you will lose marks if the answers cannot be captured.
5. You should mark only ONE answer for each question. If you mark more than one answer, you will receive NO MARKS for that question.
6. No marks will be deducted for wrong answers.

Section A

There are 33 questions. Questions marked with * involve knowledge of the extension component.

1. A microwave oven is used to heat up 0.2 kg of water at 20 °C. Energy is transferred to the water at a constant rate of 800 W. How long does it take to boil away all the water in the glass?

(The specific latent heat of vaporization of water is 2 260 000 J kg^{-1}. The specific heat capacity of water is 4 200 J kg^{-1} $°C^{-1}$.)

$Pt = mc(\Delta T) + ml_v$

$800(t) = 0.2(4200)(100-20) + 0.2(2.26\times10^6)$

$t = 649\,s$.

A. 84 s
B. 565 s
C. 649 s
D. 724 s

2. When water vapour condenses, which of the following statements is/are correct?

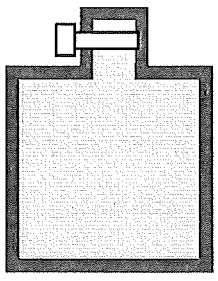
(1) The average intermolecular distance between water molecules decreases. ✓ (∵ PE ↓)
(2) The internal energy of water decreases. ✓ (∵ IE = PE + KE, when PE ↓ → IE ↓)
(3) The average kinetic energy of water molecules decreases. ✗ (∵ only Affect by Temperature)

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

water vapour (g) → water droplet (l), PE ↓

Ans: B.

*3. An ideal gas is held in a constant volume container fitted with a valve through which gas can escape.



By $PV = nRT$

$V = \frac{nRT}{P}$

$\therefore \frac{n_1T_1}{P_1} = \frac{n_2T_2}{P_2}$

Starting at 250 K, the temperature of the gas is raised by 1000 K while its pressure in he container is allowed to double. → $T_f = 1000 + 250$

What fraction of the original number of gas molecules escape through the valve?

$\frac{n(250)}{P} = \frac{n'(1000+250)}{2P}$

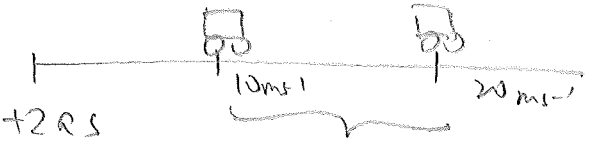
$n' = 0.4n$

$\therefore$ escape $= n - n' = 0.6n$

A. 0.4
B. 0.5
C. 0.6
D. 0.9

4. A car is travelling with uniform acceleration along a straight road. The road has marker posts every 100 m. When the car passes one post, it has a speed of 10 ms^{-1} and, when it passes the next one, its speed is 20 ms^{-1}. What is the car's acceleration?

A. 0.67 ms^{-2}
B. 1.5 ms^{-2}
C. 2.5 ms^{-2}
D. 6.0 ms^{-2}



By $v^2 = u^2 + 2as$

$20^2 = 10^2 + 2(a)(100)$

$a = 1.5\ ms^{-2}$

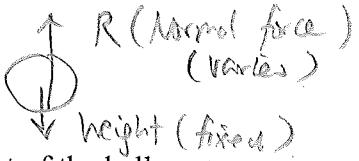
5. An experiment is done to measure the acceleration of free fall of a body from rest.
What measurements are needed?

$s = ut + \frac{1}{2}at^2$

$s = \frac{1}{2}at^2$

A. the height of fall and the time of fall
B. the height of fall and the weight of the body
C. the mass of the body and the height of fall
D. the mass of the body and the time of fall

6. A ball falls vertically and bounces on the ground. The following statements are about the forces acting while the ball is in contact with the ground.
Which statement is correct?



A. The force that the ball exerts on the ground is always equal to the weight of the ball. ✗
B. The force that the ball exerts on the ground is always equal in magnitude and opposite in direction to the force the ground exerts on the ball. ✓
C. The net force acting on the ball is always greater than the weight of the ball. ✗
D. The weight of the ball is always equal and opposite of the force that the ground exerts on the ball. ✗

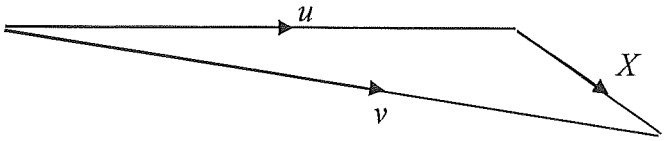
Net force can be smaller

$W - R = F_{net}$

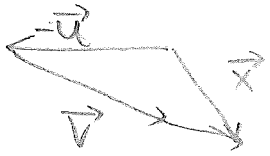
$\therefore F_{net} < W$

7. An object has an initial velocity u. It is subjected to a constant force F for t seconds, causing a constant acceleration a. The force is not in the same direction as the initial velocity.
A vector diagram is drawn to find the final velocity v.

In vector,



$\vec{v} - \vec{u} = \vec{X} = \Delta\vec{v}$



What is the meaning of the length of side X in the vector diagram?

A. F
B. Ft
C. at
D. u + at

Also $F = \frac{\Delta p}{\Delta t} = \frac{m\Delta\vec{v}}{\Delta t} = m\vec{a}$

$\therefore \Delta\vec{v} = \vec{a}(\Delta t)$

8. Two railway trucks of masses m and 3m move towards each other in opposite directions with speeds 2v and v respectively. These trucks collide and stick together.
What is the speed of the trucks after the collision?

→ the

[m] → ← [3m] → [m][3m] → ? v'

2v -v

A. v/4

B. v/2

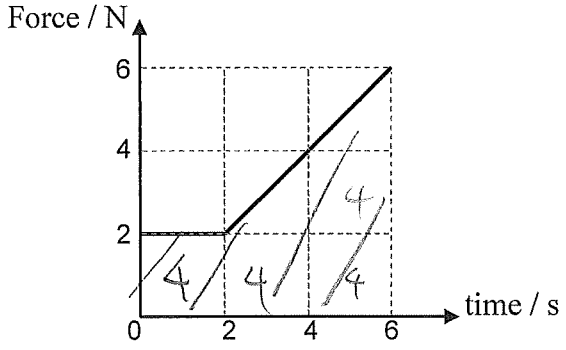
C. v

D. 5v/4

$2mv + 3m(-v) = (4m)v'$

$v' = -\frac{1}{4}v$

9. The graph shows how the force acting on a body varies with time.



$\frac{\Delta p}{\Delta t} = F$

!. Δp = Area under F-t graph = 20 kg ms^{-1}

Assuming that the body is moving in a straight line, by how much does its momentum change?

A. 40 kg ms^{-1}

B. 36 kg ms^{-1}

C. 20 kg ms^{-1}

D. 16 kg ms^{-1}

10. An object in a space capsule orbiting the Earth seems to be floating.
Which statement describes the forces acting on the object?

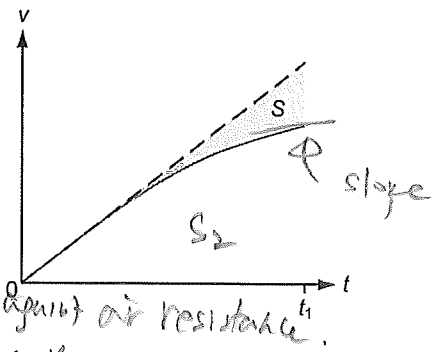
A. There are no forces on the object. ✗ (∵ orbiting the Earth ⇒ attracted by Earth (in circular motion))

B. The centripetal force acting on the object is zero. ✗

C. The centripetal force acting on the object is equal and opposite to its weight. ✗

D. The weight of the object is the only force acting on it. ✓

11. A ball is released from rest at a certain height above the ground. The graph (solid line) below shows how the velocity v of the ball changes with time t. Which of the following statements about the ball **must be incorrect**?



ONLY KE TYPE → exclude W.D against air resistance

(1) The total mechanical energy of it from $t = 0$ to t_1 is conserved. ✗

(2) At $t = t_1$, the distance travelled by it is represented by the area of the shaded region S. ✗ (should $\frac{1}{2}bc\sin A$)

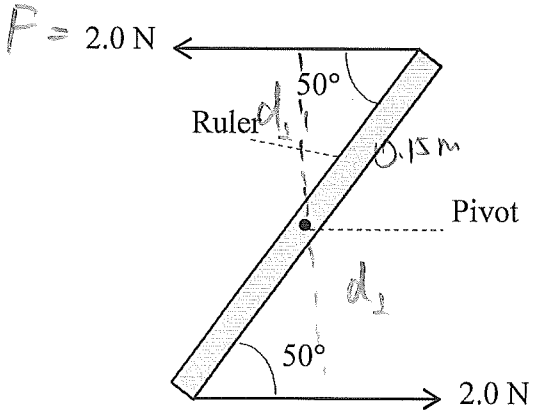
(3) At $t = t_1$, the air resistance against it is greater than the gravitational force acting on it. ✗

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

∵ slope of v-t graph > 0,
∴ a > 0
∴ W > f

Air resistance f
↕
weight W

12. A ruler of length 0.30 m is pivoted at its centre. Equal and opposite forces of magnitude 2.0 N are applied to the ends of the ruler, creating a couple as shown.



$d_1 = 0.15(\sin 50°)$

What is the magnitude of the torque of the couple on the ruler when it is in the position shown?

$\tau = F \cdot d_1 \times 2$
$= 2(0.15)(\sin 50°) \times 2$

A. 0.46 Nm
B. 0.64 Nm
C. 0.72 Nm
D. 0.79 Nm

13. A ball is thrown vertically upwards. Neglecting air resistance, which statement is correct?

A. The kinetic energy of the ball is greatest at the greatest height attained. ✗ At highest → V=0
B. By the principle of conservation of energy, the total energy of the ball is constant throughout its motion. ✓
C. By the principle of conservation of momentum, the momentum of the ball is constant throughout its motion.
D. The potential energy of the ball increases uniformly with time during the ascent.

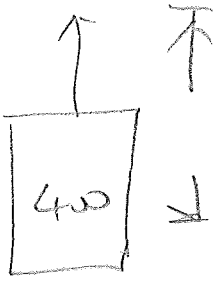
14. An electric motor is required to haul a cage of mass 400 kg up a mine shaft through a vertical height of 1200 m in 2.0 minutes. What will be the electrical power required if the overall efficiency is 80%? (Take g as 10 ms^{-2})

A. 3.2 kW
B. 5.0 kW
C. 32 kW
D. 50 kW

$\eta P = Fv$

$P = \frac{400(10)(\frac{1200}{2\times 60})}{0.8}$

$= 50000 W$



15. A car of mass 1.2×10^3 kg travels along a horizontal road at a speed of 10 ms^{-1}. It then accelerates at 0.20 ms^{-2}. At the time it begins to accelerate, the total resistive force acting on the car is 160 N. What is total output developed by the car as it begins the acceleration?

A. 0.80 kW
B. 1.6 kW
C. 2.4 kW
D. 4.0 kW

$P = \frac{F \cdot s}{t}$

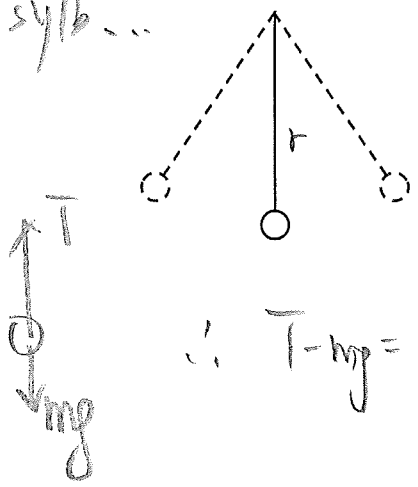
$= (1.2\times 10^3 (0.2) + 160)(10)$

$= 4000 W$

*16. A pendulum bob of mass 1.27 kg is supported by a string so that the radius of its path is 0.600 m. It is moving with velocity 0.575 ms^{-1} horizontally at the centre of its motion when the string is vertical. What is the tension in the string at this instant?

A. 11.8 N
B. 12.5 N
C. 13.2 N
D. 13.7 N

*A bit out syllb...



$\therefore T - mg = F_c$

$T = F_c + mg$

$= \frac{mv^2}{r} + mg$

$= \frac{1.27(0.575)^2}{0.6} + 1.27\times 9.81$

$= 13.1585 N$

$\simeq 13.2 N.$

*17. A satellite of mass m is placed in an equatorial orbit so that it remains vertically above a fixed point on the Earth's surface. If ω is the Earth's angular velocity of rotation and M is the Earth's mass, what is the radius of the satellite's orbit?

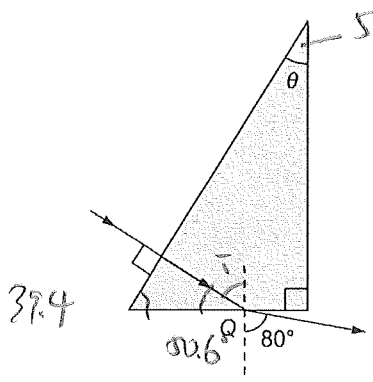
A. $\left(\frac{GM}{\omega^2}\right)^{\frac{1}{3}}$
B. $\left(\frac{Gm}{\omega^2}\right)^{\frac{1}{3}}$
C. $\left(\frac{GMm}{\omega^2}\right)^{\frac{1}{3}}$
D. $\left(\frac{GMm}{\omega^3}\right)^{\frac{1}{2}}$

$\omega = \sqrt{\frac{GM}{r^3}}$ $\left(\frac{GMm}{r^2} = mr\omega^2\right)$

$r = \left(\frac{GM}{\omega^2}\right)^{\frac{1}{3}}$

centre
~~object~~

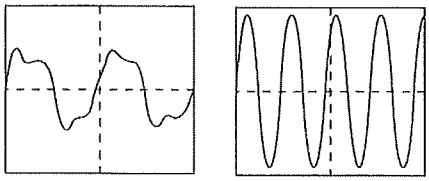
18. A monochromatic light strikes a triangular glass prism as shown below.



If the refractive index of glass is 1.55, find the angle θ of the glass prism.

A. 83.6°
B. 74.3°
C. 50.6°
D. 39.4°

19. The figures below show the waveforms of two notes P and Q, recorded by a CRO under the same settings.



note P note Q

Which of the following comparisons between P and Q are correct?

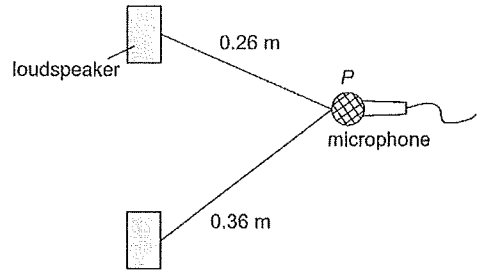
(1) Notes P and Q have different qualities.
(2) The pitch of note P is lower than that of Q.
(3) The loudness of note P is lower than that of Q.

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

20. In a Young's double slit experiment, the distance between the slits and the screen is 0.5 m. The wavelength of the incident light is 7×10^{-7} m and the slit separation is 3×10^{-5} m. If a bright fringe A is approximately 4.67 cm away from the zeroth-order bright fringe, what is the order of A?

A. first
B. second
C. third
D. fourth

21. Two loudspeakers emit the same note in the same phase as shown in the figure below.



Destructive interference

Only soft sound is recorded at point P by microphone. Which of the following could be the possible wavelength of the note?

(1) 0.20 m (2) 0.15 m (3) 0.10 m

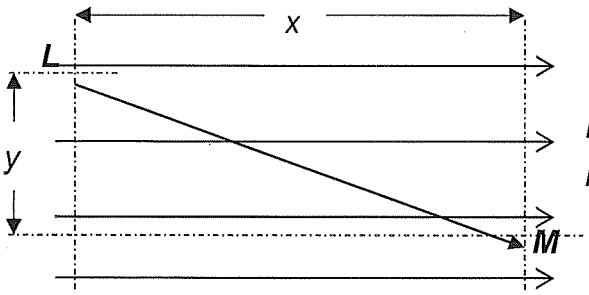
path difference = 0.36 − 0.26
= 0.1m

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

∴ λ = 0.2m or 0.0667m 0.04 m

= 0.5λ, 1.5λ, 2.5λ or ...

22. A small positive charge, placed at a point L inside a uniform electric field, experiences a force of magnitude F. The charge is moved from point L to point M.



loss EPE
gain KE

What is the change in the potential energy of the charge?

↑ independent of the path...
Just horizontal distance is counted.

A. gain of Fx
B. loss of Fx
C. gain of $F\sqrt{x^2 + y^2}$
D. loss of $F\sqrt{x^2 + y^2}$

$\Delta EPE = F \cdot s = Fx$.

23. An oil drop of mass m, carrying a charge q, is in the region between two horizontal plates. When the potential difference between the upper and lower plates is V, the drop is stationary. The potential difference is then doubled. What is the initial upward acceleration of the drop?

A. g
B. 2 g
C. $\frac{2qV}{m}$ - g
D. $\frac{2qV}{m}$

$F_E = q\frac{V}{d} = qE$ $q\frac{V}{d} = mg$

If V ↑ (doubled)

$W = mg$ Net force $= 2F_E - W$

$= 2q\frac{V}{d} - mg = 2mg - mg = mg$

$ma = mg$
$a = g$

24. A thermocouple is connected across a galvanometer of resistance 30 Ω. One junction is immersed in water at 373 K and the other in ice at 273 K. The e.m.f. of the thermocouple is 90 μV for each 1 K difference in temperature between the junctions, and the thermocouple resistance is 6 Ω. What current will flow in the galvanometer?

$\Delta T = 373 - 273 = 100\ K$

$\therefore \Delta V = 90\mu V \times (100) = 9000\mu V$

By $V = IR$

$I = \frac{V}{R} = \frac{9000}{30+6} = 250\mu A$.

A. 1.8 μA
B. 250 μA
C. 300 μA
D. 1.5 μA

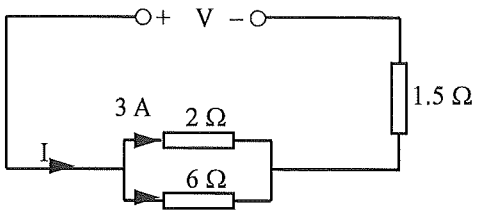
25. The filament of a 240 V, 100 W electric lamp heats up from room temperature to its operating temperature. As it heats up, its resistance increases by a factor of 16.
What is the resistance of this lamp at room temperature?

$R_{HOT} = \frac{V^2}{P} = \frac{240^2}{100} = 576\ \Omega$

$\therefore R_{room} = \frac{576}{16} = 36\ \Omega$

A. 36 Ω
B. 580 Ω
C. 1.5 Ω
D. 9.2 Ω

26. In the circuit shown, there is a current of 3 A in the 2 Ω resistor.



What are the values of the current I delivered by, and the voltage V across the power supply?

	***I* / A**	***V* / V**
A.	3	10.5
B.	4	9.0
C.	4	12.0
D.	12	18.0

$V_{2\Omega} = 3(2) = 6V$

$V_{6\Omega} = V_{2\Omega} = 6V$

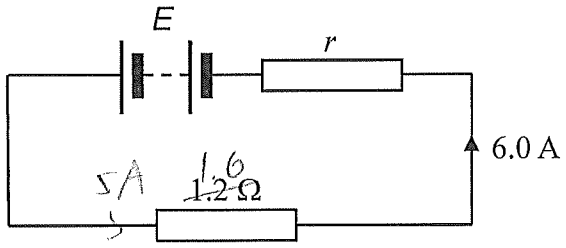
$\therefore I_{6\Omega} = \frac{V}{R} = \frac{6}{6} = 1A$

$I = 3 + 1 = 4A$

$V_{1.5\Omega} = IR = 4(1.5) = 6V$

$\therefore V = 6 + 6 = 12\ V$

27. A battery of internal resistance r and e.m.f. E can supply a current of 6.0 A to a resistor of resistance 1.2 Ω. The circuit is shown in the diagram.



When the resistor is changed to another one having a value of 1.6 Ω, the current becomes 5.0 A. What are the values of the e.m.f. E and internal resistance r?

	E / V	r / Ω
A.	7.6	0.073
B.	12.0	2.0
C.	12.0	0.80
D.	15.0	8.0

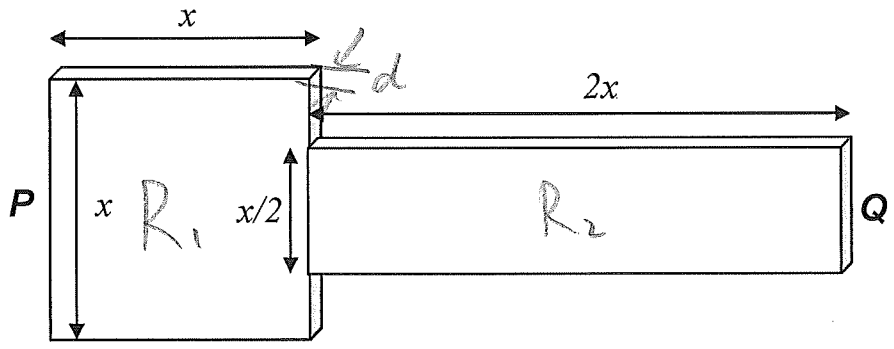
$\mathcal{E} = 6(r+1.2) \quad \therefore \quad \mathcal{E} = 12\ V$

$\mathcal{E} = 5(r+1.6)$

$6r + 7.2 = 5r + 8$

$r = 0.8\ \Omega$

28. A thin square sheet of metal of uniform thickness and of side x has a resistance of 4.0 Ω measured between opposite edges. It is connected to another sheet of the same metal of the same thickness but of length 2x and width x/2.



What is the resistance between edges P and Q?

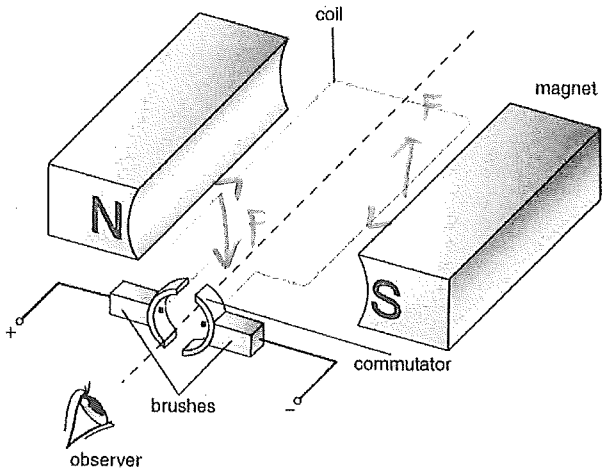
A. 8 Ω
B. 12 Ω
C. 16 Ω
D. 20 Ω

$R_1 = \frac{\rho l}{A} = \frac{\rho(x)}{x(d)} = 4\Omega \Rightarrow \frac{\rho}{d} = 4\ \Omega$

$R_2 = \frac{\rho l}{A} = \frac{\rho(2x)}{(\frac{x}{2})(d)} = \frac{\rho}{d}(4) = 16\Omega$

$\therefore R_1 + R_2 = 20\Omega$

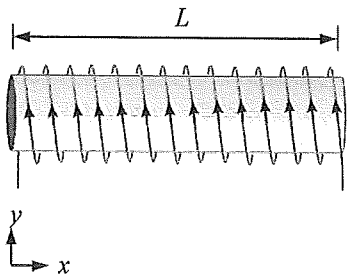
29.



The above figure shows a d.c. motor. Which of the following statements about the motor is **incorrect**?

A. The coil as seen by the observer rotates in an anticlockwise direction. ✓
B. The rotating speed of the coil can be increased by increasing the number of turns of the coil. ✓
C. The turning effect of the coil can be increased by using a stronger magnet. ✓
D. The coil cannot rotate continuously in one direction. ✗

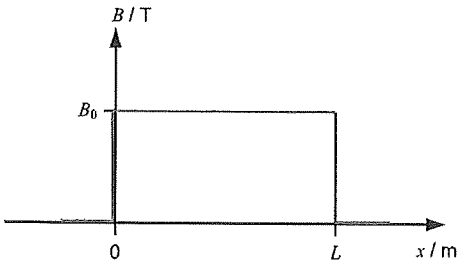
30.



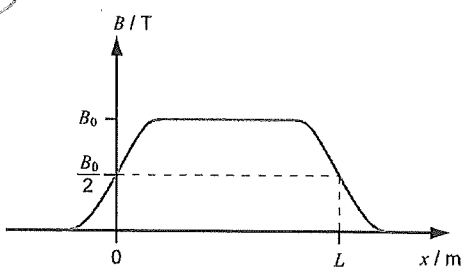
A bit out sylb.

Which of the following figures best shows the variation of the magnitude B of the magnetic field along the central axis of the above solenoid of finite length L?

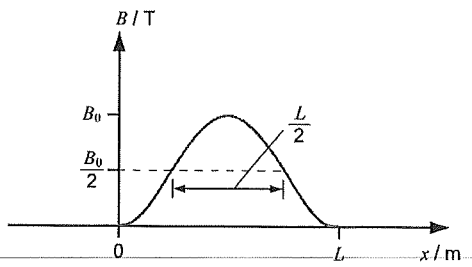
A.



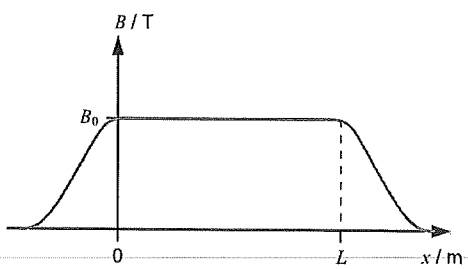
B.



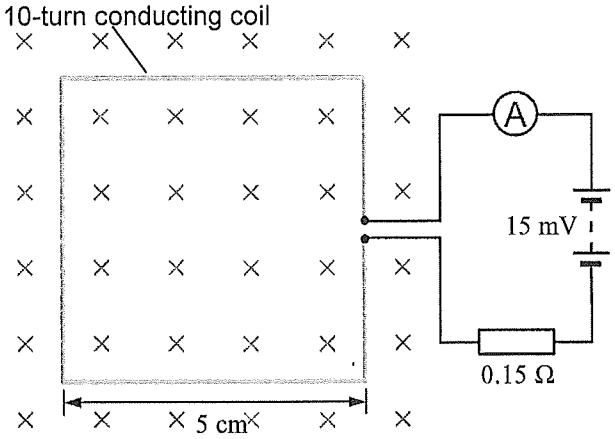
C.



D.



31. A 10-turn square conducting coil, a 0.15 Ω resistor, a battery of e.m.f. 15 mV and an ammeter are connected into a circuit shown below. A uniform magnetic field is applied perpendicularly to the coil and its magnitude is decreasing at a constant rate of 0.25 T s^{-1}. Find the reading of the ammeter.



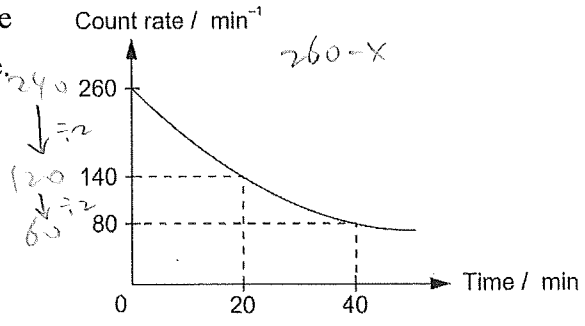
A. 58.3 mA
B. 95.8 mA
C. 100 mA
D. 142 mA

32. In the natural decay series of uranium-235, the nuclide $^{235}_{92}U^*$ decays to $^{207}_{82}Pb$ through a series of radioactive decays. Which of the following statements about the decay series are correct?

(1) $^{235}_{92}U^*$ is an unstable nuclide.
(2) γ radiation is emitted in the decay process.
(3) 7 α particles and 4 β particles are emitted in the decay process.

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

*33. In a laboratory, a data logger is used to measure the count rate of a particular radioactive source. The figure on the right shows the result. Find the background radiation of the laboratory.



A. 260 min^{-1}
B. 80 min^{-1}
C. 20 min^{-1}
D. Since the half life of the radioactive source is unknown, the background radiation of the laboratory cannot be calculated.

~ End of section A ~

Section C : Energy and Use of Energy

Pre-Mock Multiple-choice questions

34 If an incandescent lamp of power rating 40 W has an end-use energy efficiency of only 15%, which of the following statements is correct?

A. 40 J of electromagnetic radiation is emitted from the lamp every second.
B. 34 J of heat is released from the lamp every second.
C. 34 J of infra-red radiation is emitted from the lamp every second.
D. 6 J of visible light is emitted from the lamp every second.

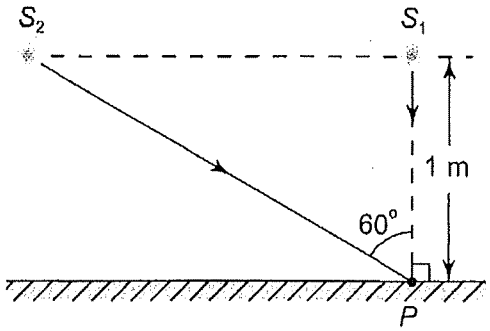
A	B	C	D
○	○	○	●

35 The spectrum of the electromagnetic radiation emitted from a filament lamp is

A. a continuous spectrum, because the energy levels of the atoms of the filament are closely spaced.
B. a continuous spectrum, because the energy levels of the atoms of the filament are widely spaced.
C. a line spectrum, because the energy levels of the atoms of the filament are closely spaced.
D. a line spectrum, because the energy levels of the atoms of the filament are widely spaced.

A	B	C	D
●	○	○	○

36 A point P on a surface is illuminated by two identical lamps S_1 and S_2. The luminance of each of them is 2000 lm as shown in the diagram. The two lamps are at the same height of 1 m above the surface. S_1 is vertically above P, while S_2 makes an angle of 60° with the normal at P. What is the illuminance at P?



A. 179 lx
B. 193.6 lx
C. 198.9 lx
D. 238.7 lx

A	B	C	D
●	○	○	○

37 A cubic refrigerator has side lengths of 0.6 m. All its surfaces are 1 cm thick and are made of an insulating material of conductivity 0.02 W m^{-1} K^{-1}. Suppose heat enters the interior of the refrigerator via **all** its surfaces (6 surfaces) at a rate of 40 W. Estimate the temperature difference between the inside and the outside of the surfaces of the refrigerator.

A. 5.56 °C
B. 9.26 °C
C. 18.5 °C
D. 55.6 °C

A	B	C	D
○	●	○	○

$COP = \frac{\text{Cool capacity}}{P}$

38 An insulated room of size 3 m × 4 m × 5 m at an initial temperature of 32 °C is cooled by an air-conditioner of cooling capacity 1.8 kW. If the air-conditioner is turned on for 5 minutes, what is the final temperature of the room? (Given: density of air= 1.2 kg m^{-3}, specific heat capacity of air = 1000 J kg^{-1} K^{-1})

$(60 \times 5 \times 1.8\text{kW}) = mc(\Delta T) \leftarrow P(=\frac{mc(\Delta T)}{t})$

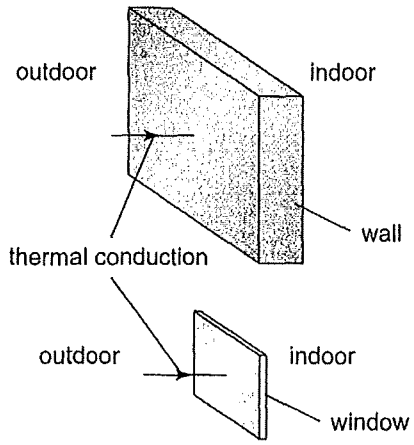
$540\,000 = (1.2(3\times4\times5))(1000)(\Delta T)$

$\Delta T = 7.5°C \quad \therefore T_f = 32 - 7.5 = 24.5°C$

A. 22.3 °C
B. 24.5 °C
C. 26.2 °C
D. 28.8 °C

A	B	C	D
○	◉	○	○

39



$\frac{Q}{t} = UA(\Delta T)$

$\frac{Q}{t_{wall}} = \frac{0.2U(10A)\Delta T}{U(A)\Delta T}$

$= 2$

$= 2:1$

* Thickness Factor is included in U-value already.

A wall and a window belong to the same house. The wall has its area and thickness both 10 times those of the window. The U-value of the wall is 1/5 that of the window. If a temperature difference exists between indoor and outdoor, what is the ratio of the rate of conduction through the wall to that through the window?

A. 1 : 5
B 2 : 5
C. 2 : 1
D. 5 : 2

A	B	C	D
○	○	◉	○

40 Which of the following statements about the moderation of a pressurized water reactor is incorrect?

A. The moderation is required for maintaining the chain reaction. ✓ (slow down fast moving neutrons)
B. The moderation is done by water. ✓
C. In the moderation, the average speed of the neutrons is reduced. ✓
D. If the moderation process accidentally stops, the fuel rods of the reactor would melt down. ✗ → No chain reaction instead.

A	B	C	D
○	○	○	◉

41 The average wind speed in a wind farm is 11 m s^{-1} and the air density is 1.2 kg m^{-3}. 150 identical wind turbines are to be erected in the wind farm so as to output an average electrical power of 100 MW. The wind turbines can capture 40% of the wind power and have an efficiency of 70% in generating electricity. What should be the diameter of the rotors of the wind turbines so that they could meet the electrical power output requirement?

$P = N\frac{1}{2}\rho A v^3 \eta$

A. 48.3 m
B. 54.1 m
C. 61.6 m
D. 66.8 m

A	B	C	D
○	○	◉	○

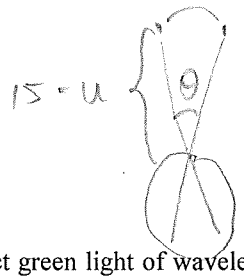
$100 \times 10^6 = 150\left(\frac{1}{2}\right)(1.2)(\pi r^2)(11)^3(0.4)(0.7)$

$r = 30.806\text{ m}$

diameter = 61.6 m

Section D: Medical Physics

Pre-Mock Multiple-choice questions



42 Helen is observing two point objects which reflect green light of wavelength 520 nm. The two objects are 3 mm apart and are 15 m from Helen's eyes. The diameter of the pupil of Helen's eye is 4 mm. Which of the following statements about whether the two point objects can be resolved or not is correct?

A. The two point objects can just be resolved.
B. The two point objects cannot be resolved but begin to be resolvable if they are moved closer to Helen's eyes for a distance of 5 m.
C. The two point objects can be resolved but begin to be unresolvable if they are moved away from Helen's eyes for a distance of 4 m.
D. The two points objects can be resolved but begin to be unresolvable if they are moved away from Helen's eyes for a distance of 19m.

A	B	C	D
○	○	●	○

43 The minimum power of a normal eye (with range of accommodation from 25 cm to infinity) is 38 D. What is the maximum power of the eye?

A. 42 D
B. 43 D
C. 44 D
D. 45 D

A	B	C	D
●	○	○	○

44 A listener is at a certain distance from a source of sound of a certain power. He/she can hear sound from the source at a certain sound intensity level. The listener then moves closer to the source and the power of the source is increased so that finally the distance is halved while the power is doubled. What is the increase in the sound intensity level?

A. 3 dB
B. 8 dB
C. 9 dB
D. 80 dB

A	B	C	D
○	○	●	○

45 Ultrasound can penetrate into our bodies, but some body tissues are more difficult to penetrate than the others. Arrange the following body tissues (bone, fat, lung, muscle) in ascending order of difficulty (from the least difficult to the most difficult) for ultrasound to penetrate.

A. Lung, fat, muscle, bone
B. Fat, muscle, bone, lung
C. Fat, lung, muscle, bone
D. Muscle, bone, fat, lung

A	B	C	D
○	●	○	○

46 Which of the following statements about high frequency ultrasound (10 - 12 MHz) scanning (as compared with low frequency ultrasound scanning (2 - 5 MHz)) is/are correct?

(1) It provides better resolution.
(2) It has higher penetrating power.
(3) It is less safe.

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

A	B	C	D
●	○	○	○

47 Which of the following statements about incoherent optical fibre bundle are correct?

(1) Incoherent optical fibre bundle can transmit light but not image.
(2) The relative positions of the optical fibres in an incoherent optical fibre bundle are not preserved from one end to the other.
(3) Incoherent optical fibre bundle is cheaper than coherent optical fibre bundle.

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

A	B	C	D
○	○	○	●

48 Which of the following is **not** an advantage of X-ray imaging for medical diagnosis?

A. It is a quick method for medical imaging.
B. It can give good quality image of high resolution.
C. It can provide an effective first stage medical diagnosis.
D. It is a cheap method for screening diseases in large population.

A	B	C	D
○	●	○	○

49 A patient received a radionuclide imaging of the liver. A suitable radionuclide emitting gamma rays was taken by the patient and a series of images were taken by a gamma camera at different times. Which of the following statements about the images is/are correct?

(1) The images show the attenuation of the gamma rays by the liver.
(2) The images show the distribution of the radionuclide in the liver.
(3) The images give information about the function of the liver.

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

A	B	C	D
○	○	○	●