Solution to 1920 S6 Physics Mock Exam

<u>Paper 1</u>

Section A

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B	B	A	C	D	B	D	A	C	D	D	A	A	B	A

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
C	C	D	C	B	B	A	D	B	C	A	A	B	B	D

31	32	33
A	D	D

Section B

1. (a) $mgh = \frac{1}{2}mv^2$

$9.81 \times 1.5 = \frac{1}{2}v^2$ 1M

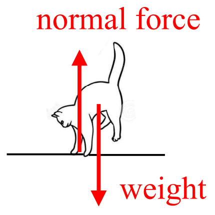
$v = 5.42 \text{ m s}^{-1}$ 1A

(b) $s = \frac{1}{2}gt^2$

$1.5 = \frac{1}{2}9.81 \times t^2$ 1M

$t = 0.553 \text{ s}$ 1A

(c) (i) The normal force has to be on the point of contact. 1M+1M



(ii) $R - W = \frac{mv - mu}{t} = \frac{0.8 \times 5.42}{0.2} = 21.7 \text{ N}$ 1M

$R = 21.7 + 0.8 \times 9.81 = 29.5 \text{ N}$ 1A

(upward) 1A

(iii) Bend the legs when landing. 1A

2.(a) $\omega = \frac{2\pi}{T} = 4 \rightarrow T = 1.57$ s 1A

(b) Taking $\omega = 4$ rad s^{-1},

$F = mr\omega^2 = 0.24\times(0.04+0.2 \sin 30°)\times4^2$ (correct r) 1M+1M

$= 0.5376$ N 1A

(c) (i) As the radius r becomes smaller, 1M

$F = mr\omega^2$ would decrease. 1M

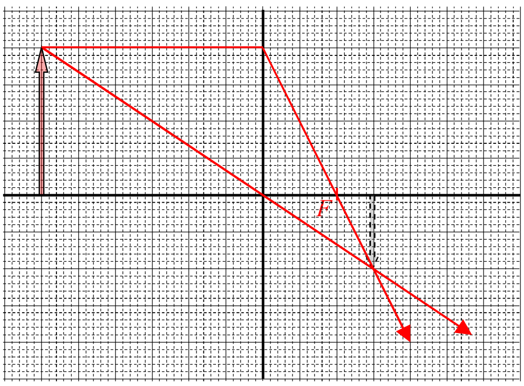
(ii) When the string breaks, the ball first moves horizontally and 1M

then undergoes projectile motion under gravity. 1M

3. (a) Convex lens 1M

(b) (distance) 1M

(height) 1M



(c) (ray towards focus) 1M

(mark F) 1M

$f = 10$ cm 1A

(d) $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

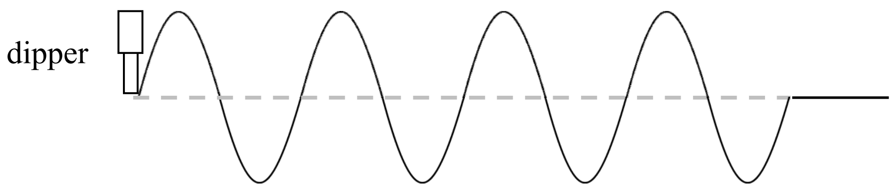
$\frac{1}{10} = \frac{1}{60} + \frac{1}{v} \rightarrow v = 12$ cm 1M+1A

$m = \frac{v}{u} = \frac{12}{60} = 0.2$ 1A

4. (a) $v = \frac{\lambda}{T} = \frac{0.04}{0.5} = 0.08 \text{ m s}^{-1}$ 1M+1A

(b) (drawing 4 λ) 1A

(correct phase) 1A



(c) (i) path difference = 2 cm = 0.5 λ 1A

Destructive interference takes place so that the water remains calm. 1A

(ii) If the frequency is doubled, the λ is halved. 1A

Path difference at Q = 1 λ → constructive interference takes place. 1A

5.

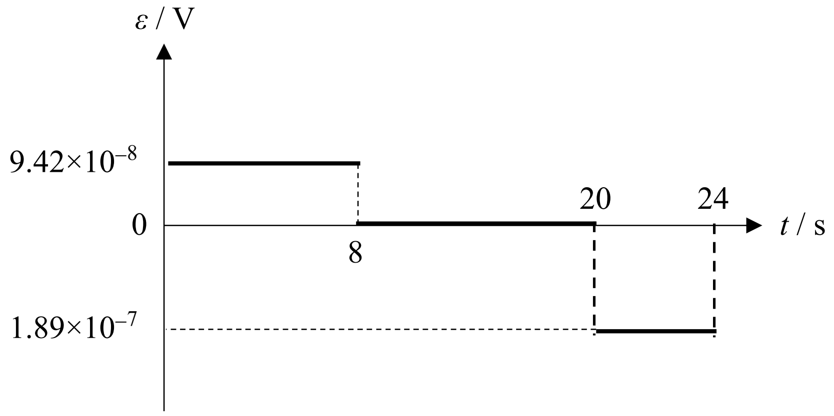
(a) (i) $B = \mu_0 nI = 4\pi \times 10^{-7} \times \frac{100}{0.5} \times 1.5 = 3.77 \times 10^{-4}$ T 1M+1A

(ii) $\Phi = NBA = 10 \times 3.77 \times 10^{-4} \times 2 \times 10^{-4} = 7.54 \times 10^{-7}$ Wb 1M

(b) (i) $\varepsilon = \frac{\Phi}{8} = 9.42 \times 10^{-8}$ V 1M+1A

(ii) $\varepsilon = \frac{\Phi}{4} = 1.89 \times 10^{-7}$ V

1A for shape, 1A for correct labels of V, 1A for correct labels of t



6. (a) a.c. 1A

(b) 240 / 12 = 20

Turn ratio is 20 : 1 1A

(c) $240 \times I \times 0.8 = 96$ 1M

$I = 0.5$ A 1A

(d) resistance of the motor: $R = \dfrac{12^2}{96} = 1.5\,\Omega$ 1A

$$240 \times \frac{1.5}{R + 1.5} = 12$$ (any correct method) 1M

$R = 28.5\,\Omega$ 1A

(e) Advantage : d.c. power supply can be used. 1A

OR: Adjust the voltage more easily.

Disadvantage : low efficiency due to the heat loss in the resistor. 1A

7. (a) β-decay 1A

(b) (i) $k = \dfrac{\ln 2}{5700 \times 3.156 \times 10^7} = 3.85\times10^{-12}\ \text{s}^{-1}$ 1A

(ii) $A = kN$

$5.8 = 3.85\times10^{-12}\,N$ 1M

$N = 1.505\times10^{12}$

No. of carbon atoms $=1.505\times10^{12} \times 10^{12} = 1.505\times10^{24}$ 1A

(c) $1.02 = 5.80e^{-(3.85\times10^{-12})t}$ 1M

$t = 4.51\times10^{11}$ s = 14300 y 1A

(d) The no. of C-14/activity will be too low to be detected accurately. 1A

8. (a) energy

$= (235.043923 + 1.008665 - 95.908273 - 134.916449 - 5\times1.008665)\times931$ 1M

$= 0.184541 \times 931$

$= 172$ MeV 1A

(b) $N \times 172 \times 10^{6} \times 1.6 \times 10^{-19} \times 0.35 = 600 \times 10^{6}$ 1M

$N = 6.24 \times 10^{19}$ 1A

(c) α and β radiation. 1A

They can be blocked completely by the steel container. 1A

(d) Slow-moving will be easily repelled by the electrons orbiting around the U-235 nucleus. / The mass of electron is too small comparing to proton/neutron. 1A

No. 1A

9. (a)(i) When the inner side of the flask is heated,

atoms at that side <u>vibrate</u> faster. 1M

They <u>hit</u> the slower <u>neighbouring</u> atoms and 1M

make them vibrate more rapidly.

This process continues and

atoms at the <u>outer</u> side of the flask are eventually set to <u>vibrate</u> quickly. 1M

Therefore, the temperature at the side increases.

(ii) Box C 1M

Silvery wall is a poor emitter of radiation. 1M

Vacuum inside the box effectively reduces heat lost by conduction. 1M

(b) Put the thermometer in the water. Measure the initial temperature.

Put the beaker on the hotplate. (proper setup) 1M

Use the stopwatch to record the heating time t. (recording time) 1M

Record the final (highest) temperature of the water. (measure two temperatures) 1M

Power = $\dfrac{0.5c\Delta T}{t}$ where c is the specific heat capacity of water 1M

Assumption: There is no heat lost to the surroundings. OR 1M

The beaker has negligible heat capacity.

10. (a) $V = 0.6 \times 0.1 \times 0.2 = 0.012 \text{ m}^3$

$PV = nRT$

$0.5 \times 100 \times 10^3 \times 0.012 = n \times 8.31 \times (18+273)$ 1M

$n = 0.248$ (mole) 1A

(b) $\text{K.E.} = \frac{3}{2}nRT = \frac{3}{2}PV$

$= \frac{3}{2} \times 0.5 \times 100 \times 10^3 \times 0.012$ 1M

$= 900 \text{ J}$ 1A

(c) When the temperature decreases,

the air particles move more slowly. (not accept 'KE decreases') 1M

They hit the wall inside the can less frequently 1M

(OR the change in momentum in each collision would also decrease).

Hence the air pressure decreases.

Paper 2

Section B: Atomic World

M.C. 1A 2D 3B 4B 5B 6A 7C 8C

Structured question (10 marks)

(a) No. of photoelectron $= \dfrac{2.8\times10^{-7}}{1.6\times10^{-19}}$ 1M

$= 1.75 \times 10^{12}$ 1A

(b)(i) Energy of each photon $= \dfrac{hc}{\lambda} = \dfrac{6.63\times10^{-34}\times3\times10^{8}}{480\times10^{-9}}$ 1M

$= 4.144 \times 10^{-19}$ J or 2.59 eV 1A

(ii) No. of photon $= \dfrac{0.04\times1\times10^{-4}}{4.144\times10^{-19}}$ 1M

$= 9.65 \times 10^{12}$ 1A

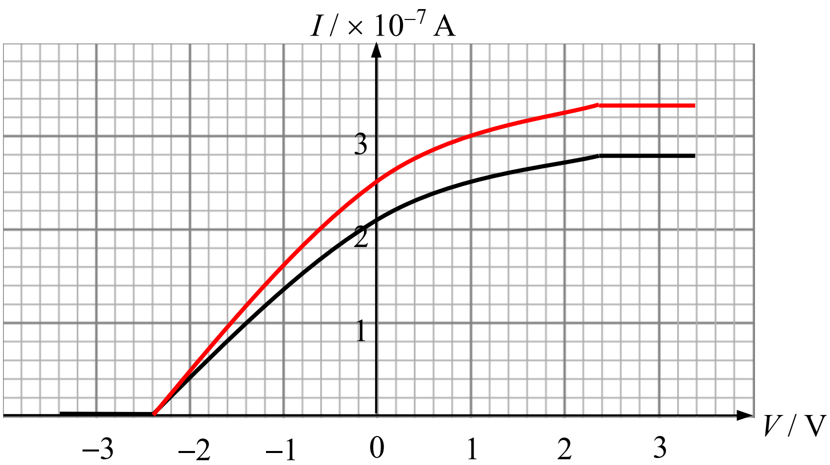
(c) $KE = hf - \phi$

$2.4 \times 1.6\times10^{-19} = 4.144\times10^{-19} - \phi$ 1M

$\phi = 3.04\times10^{-20}$ J or 0.190 eV 1A

(d) Same stopping potential 1A

Higher saturated current 1A



Section C: Uses of Energy

Section B: Atomic World

M.C. 1C 2A 3C 4D 5A 6B 7B 8D

Structured question (10 marks)

(a)(i) luminous flux of LED = 50 x 40 = 2000 lm

luminous flux of incandescent lamp = 100 x 20 = 2000 lm 1A

→the two light blubs should be equally bright because their luminous flux are the same. 1A

(ii) number of hour used in 10 years = $365\times10\times12 = 43800$

number of LED required for 10 y = $\dfrac{43800}{12500} = 3.5$ → 4 bulbs

number of incandescent lamp = $\dfrac{43800}{2200} = 19.9$ → 20 bulbs

Cost saved $=\left(\dfrac{100}{1000}\times43800\times1.2+50\times20\right)-\left(\dfrac{50}{1000}\times43800\times1.2+110\times4\right)$ 1M

$= 5256 + 1000 - 2628 - 440$

$= \$3188$ 1A

(iii) pro: LED releases less heat to the surroundings. 1A

/ It can emit light of specific colour. / It has longer lifetime.

/ It may withstand impact better.

con: LED can only work with a d.c. source. 1A

(b)(i) $E = \dfrac{2000\cos 20^\circ}{4\pi(1.5)^2} = 66.5\,\text{lx}$ (66.4716) 1M+1A

Reflected light from other objects in the room is neglected. 1A

(ii) put the book directly under the lamp

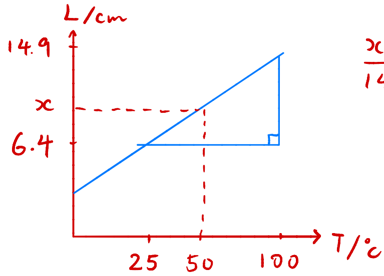
/ replace the table with a taller one

/ lower the lamp from the ceiling 1A

Section A

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

1. A student calibrates a liquid-in-glass thermometer in a physics lesson. At room temperature 25 °C, the liquid column in the thermometer is 6.4 cm. When he puts the thermometer in boiling water, the liquid column becomes 14.9 cm. Assume the liquid expands or contracts linearly with the temperature change. How long is the liquid column when the temperature is 50 °C?

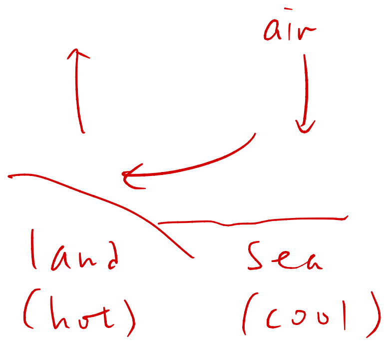


$$\frac{x-6.4}{14.9-6.4} = \frac{50-25}{100-25}$$

$$x = 9.23$$

A. 2.83 cm
B. 9.23 cm
C. 10.5 cm
D. 12.8 cm

2. On a hot sunny day, the wind blows from the sea to the land. Which of the following is a possible reason?



A. The sea is hotter than the land.
B. The land is hotter than the sea.
C. The sea is a better conductor of heat than the land.
D. The land is a better conductor of heat than the sea.

3. Peter puts 500 g of ice cubes at –5 °C in a cup of 500 g water at 80 °C as shown. Assume there is no heat loss to the surroundings, what is the final temperature of this mixture?

Given: specific heat capacity of water = 4200 J kg^{-1} °C^{-1}
specific heat capacity of ice = 2100 J kg^{-1} °C^{-1}
specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}

A. 0 °C
B. 4.51 °C
C. 10.2 °C
D. 17.7 °C

Heat loss for hot water cooling to 0°c :
$E = mc\Delta T$
$= 0.5 \times 4200 (80 - 0)$
$= 168\,000$ J —①

Heat gain for -5°c ice becoming 0°c ice:
$E = mc\Delta T$
$= 0.5 \times 2100 (0 - (-5))$
$= 5250$ J —②

Heat gain for 0°c ice completely melted :
$E = ml = 0.5 \times 3.34 \times 10^5$
$= 167\,000$ J —③

As ② + ③ > ①,
not all ice can be melted
by the hot water
→ 0°c

Given: $PV = nRT = \frac{1}{3}Nmc^2$

*4. In which of the following situations would the r.m.s. speed of the molecules of a fixed mass of an ideal gas increase?

✓(1) The gas is heated at constant pressure. $T\uparrow$, $c^2\uparrow$

(2) The gas expands under constant temperature. constant T, constant c^2

✓(3) The gas pressure increases under constant volume.

$P\uparrow$, $c^2\uparrow$

A. (1) only

B. (2) only

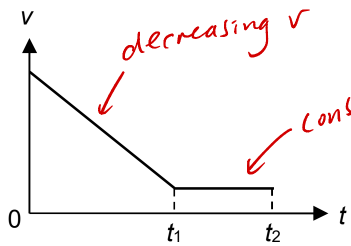
C. (1) and (3) only

D. (1), (2) and (3)

5. An object moves along a straight pathway according to the velocity-time graph below.

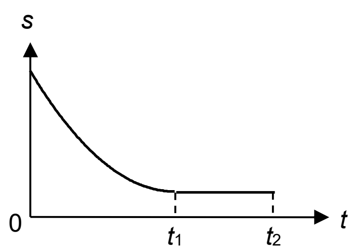
decreasing v

constant v

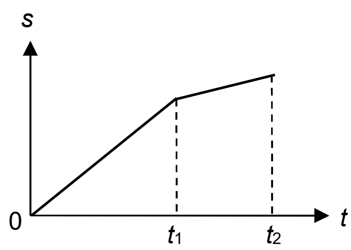


Which of the following graphs best shows the variation of the displacement s of the object with time t?

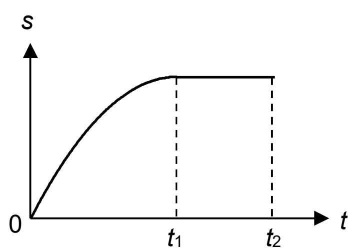
A.



B.



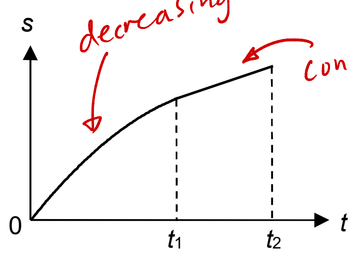
C.



D.

decreasing slope

constant slope



slope in s-t graph = v

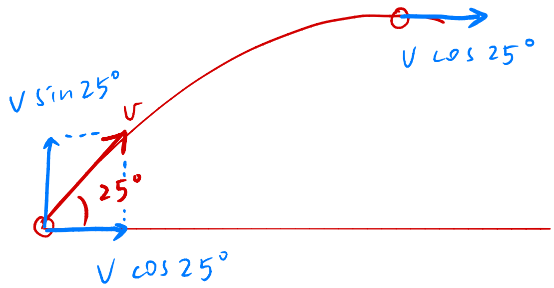
*6. A cannon ball is fired at an angle 25° above the horizontal with initial kinetic energy K. What is the kinetic energy of the cannon ball at the highest position?

A. 0.906 K

B. 0.821 K

C. 0.423 K

D. zero



Initially:

$\frac{1}{2}mv^2 = K$

At the top:

$K' = \frac{1}{2}m(v\cos 25°)^2$

$= K\cos^2 25°$

$= 0.821\ K$

7. Two blocks of respective masses 2 kg and 3 kg are connected by a light inextensible string which passes over a smooth fixed light pulley as shown. The system is released from rest. Estimate the speed of the 3-kg block when both blocks are at the same level of height.

A. 1.12 m s^{-1}

B. 2.53 m s^{-1}

C. 2.97 m s^{-1}

D. 3.13 m s^{-1}

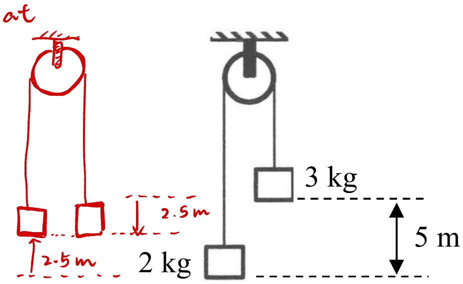
When the boxes are at the same level:

Total PE loss

$= 3 \times 9.81 \times 2.5$

$- 2 \times 9.81 \times 2.5$

$= 24.525$ J



Total KE gain by 2 boxes

$= \frac{1}{2}(2+3)v^2 = 24.525$

$v = 3.13$ m s^{-1}

8. A uniform light rigid rod is hinged smoothly to a wall at P and the other end R is connected by a wire attached to the wall at Q, vertically above P. A weight X is hung somewhere on the rod as shown. If the rod remains horizontal, which force most probably represents the reaction force acting on the rod due to the wall?

A. F_1

B. F_2

C. F_3

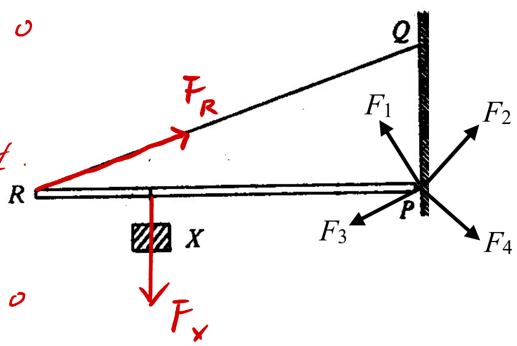
D. F_4

net force on the rod = 0

To balance F_R,

F_P must be toward left.

(i.e. F_1 or F_3 ?)



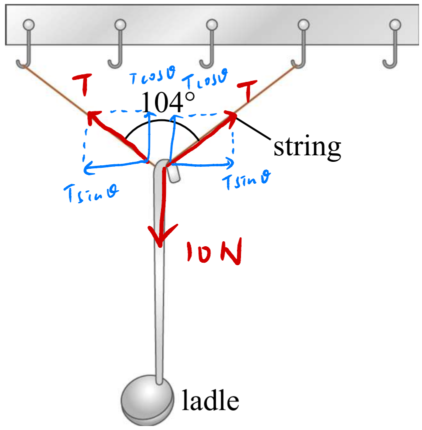
net moment about X = 0

To balance the moment by F_R (clockwise)

The moment by F_P must be anti-clockwise (F_1 or F_2 ?)

$\Rightarrow F_P = F_1$

9. In the figure, the two ends of an inextensible string are fixed on two hooks. A ladle is hung on the string so that the string makes an angle of 104°. If the weight of the ladle is 10 N, find the tension in the string.



Consider the vertical components:

$2T\cos\left(\frac{104°}{2}\right) = 10$

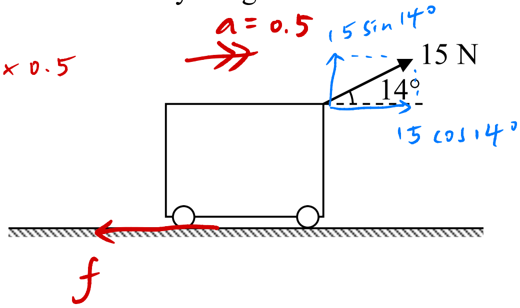
$T = 8.12\ N$

A. 5 N
B. 6.35 N
C. 8.12 N
D. 10 N

10. A suitcase of 6 kg is placed on a rough horizontal ground as shown below. John pulls the suitcase with a force of 15 N at 14° to the horizontal and the suitcase accelerates forwards at 0.5 m s^{-2}. Find the frictional force acting on the suitcase by the ground.

$15\cos 14° - f = ma = 6 \times 0.5$

$f = 11.6\ N$



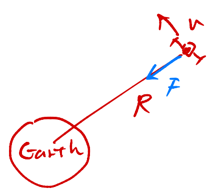
A. 1.42 N
B. 5.06 N
C. 8.41 N
D. 11.6 N

*11. A satellite of mass m revolves around the Earth in a circular orbit of radius R. The orbital speed of the satellite is v. If the satellite revolves around the Earth at speed $2v$, what is the radius of the circular orbit?

gravitational force on the satellite = centripetal force

$\frac{GMm}{R^2} = \frac{mv^2}{R} \Rightarrow R = \frac{GM}{v^2}$

$R' = \frac{GM}{(2v)^2} = \frac{1}{4}\frac{GM}{v^2} = \frac{1}{4}R$



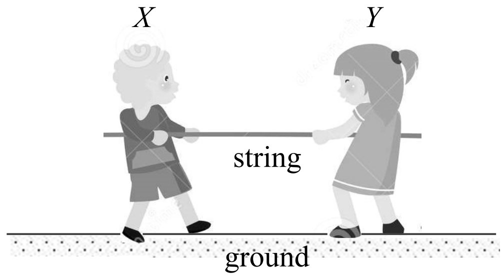
A. $\frac{R}{\sqrt{2}}$

B. $\frac{R}{2}$

C. $\frac{R}{2\sqrt{2}}$

D. $\frac{R}{4}$

12.



X and *Y* are playing tug as war as shown above. Which of the following is/are action-reaction pair(s)?

by the string by the string

(1) the tension acting on *X* and the tension acting on *Y*

(2) the weight of *X* and the normal force on *X* by the ground act on the same body.

(3) the friction on *X* by the ground and the horizontal force acting on the ground by *X*

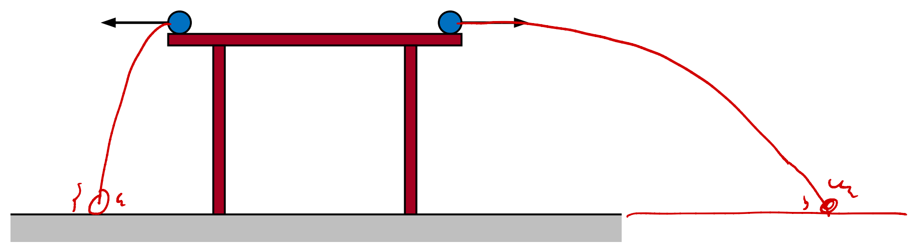
A. (3) only

B. (1) and (2) only

C. (1) and (3) only

D. (2) and (3) only

*13. Two balls of different masses are projected horizontally from a table surface at the same time as shown below. The initial speeds of the two balls are different.



If the air resistance is negligible, which of the following statements is/are correct?

(1) The two balls will reach the ground at the same time. initial vertical speed = 0 , $s = \frac{1}{2}gt^2$

(2) The two balls will reach the ground at the same speed. initial KE are different

(3) The two balls will reach the ground at the same angle to the ground. ⇒ final KE are different.

(as shown above)

A. (1) only

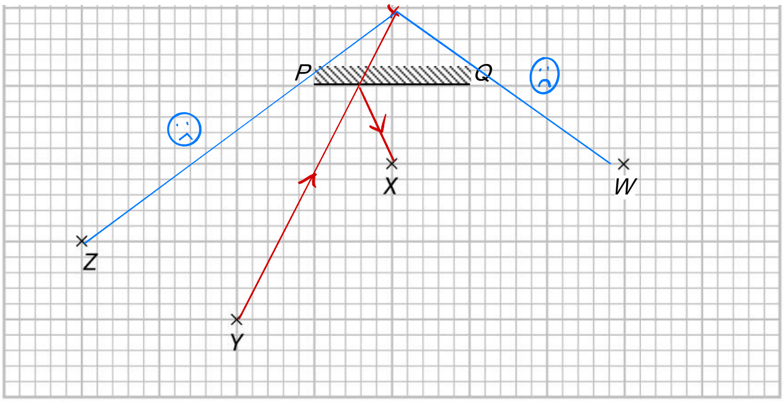
B. (1) and (2) only

C. (1) and (3) only

D. (2) and (3) only

OR: same V_Y, but different V_x.

14. A girl stands at X in front of a mirror PQ as shown. Whom will she see in the mirror?



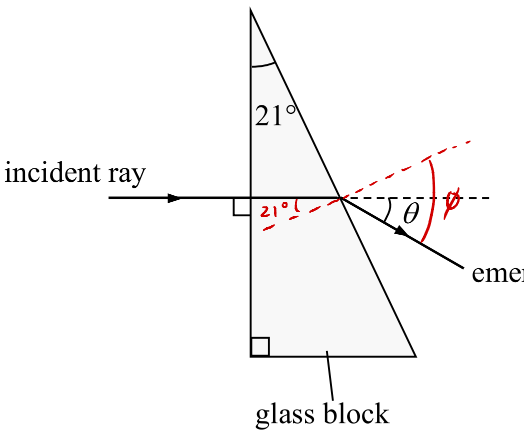
A. W only

B. Y only

C. Y and Z only

D. W, Y and Z

15. A light ray passes through a triangular glass block as shown below.



$\frac{\sin\phi}{\sin 21^\circ} = 1.5$

$\phi = 32.5^\circ$

$\theta = \phi - 21^\circ$

$= 11.5^\circ$

If the refractive index of the glass is 1.5, find the value of θ.

A. 11.5°

B. 17.8°

C. 19.5°

D. There is no emergent ray as total internal reflection occurs.

16. Which of the following phenomena is **NOT** related to refraction of light?

A. A swimming pool looks shallower than it actually is.

B. A pencil appears to be bent when immersed in a beaker of water.

C. The phase of the Moon changes periodically in every month.

D. The objects you see through the hot air appears blurred and flickering.

17. Which of the following about the virtual image formed by a lens are correct?

✗ (1) The virtual image is always diminished. can be magnified by a convex lens

✓ (2) The virtual image is always erect.

✓ (3) The virtual image is always on the same side of the object.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

$d \sin\theta = n\lambda = 4\lambda_b = 3\lambda_o$

same angular position θ

18. A light beam that consists of a blue light and an orange light incident normally on a diffraction grating. It is found that the 4th order blue fringe overlaps with the 3rd order orange fringe on the screen. If a grating with more lines per mm is used, which of the following about the fringes' positions is correct?

A. The 4th order blue fringe displaces more than the 3rd order orange fringe.

B. The 3rd order orange fringe displaces more than the 4th order blue fringe.

C. The two fringes still overlap, and they move towards the 0th order bright fringe.

D. The two fringes still overlap, and they move away from the 0th order bright fringe.

$\because 4\lambda_b = 3\lambda_o$ always

$\because d\downarrow \sin\theta\uparrow$ for the two fringes

19. Which of the following about sound is **NOT** correct?

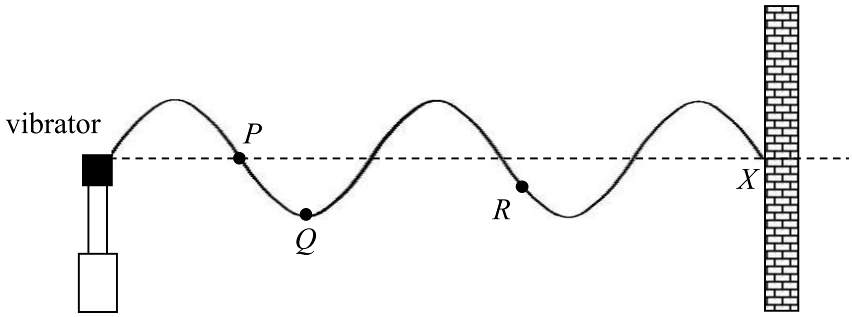
A. Sound is produced by vibration.

B. Sound is a longitudinal wave.

C. The speed of sound is higher in air than in water. faster in liquid

D. Sound cannot travel in vacuum.

20. A string is fixed one end to the wall at X and the other end to a vibrator. A stationary wave is produced on the string. The following figure shows the shape of the string at a certain instant. The dotted line shows the shape of the string when it is at rest. Which of the following statements **MUST** be correct?



(1) Particle P remain at rest for all time. → node

(2) Particle Q is at its maximum displacement. → not stated above

(3) Particle Q and R vibrate in phase.

A. (1) and (2) only

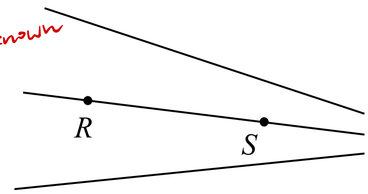
B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

21. The figure below shows some electric field lines without the directions. A charged particle released from rest at S is found to move towards R along the field line. Which of the following statements **MUST** be correct?

field line direction is unknown



(1) The particle is positively charged.

(2) The particle decelerates as it approaches R.

(3) Work is done by the electric force on the charge.

speeded up by the field line $F = EQ$

KE increases

A. (1) only

B. (3) only

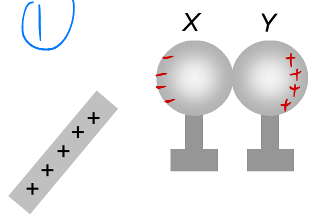
C. (1) and (3) only

D. (2) and (3) only

touch once and then separate

22. Two insulated uncharged metal spheres X and Y are placed in contact with each other. An insulated positively charged rod is put near X. Y is earthed momentarily and then the positively charged rod is removed. X and Y are then separated. What are the net charges on X and Y respectively?

	X	Y
A.	negative	negative
B.	negative	positive
C.	positive	zero
D.	positive	negative



(earthed momentarily)

zero resistance

23. A 6-V cell, an ideal ammeter, three identical resistors and a switch S are connected as shown in the figure below. When the switch is open, the ammeter reads 3 A. Find the ammeter reading when the switch is closed.

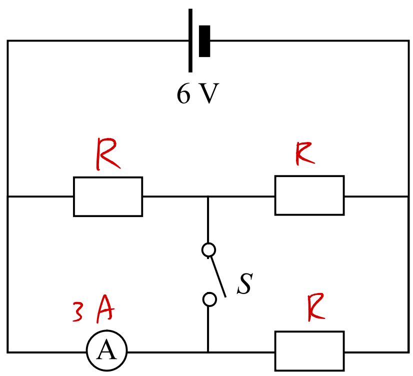
A. 1 A
B. 2 A
C. 3 A
D. 6 A

S is open:

$R = \frac{V}{I} = \frac{6}{3} = 2\,\Omega$

S is closed:

$I = \frac{V}{R} = \frac{6}{1} = 6\text{A}$



$P = P_0 \cos^2\theta$

*24. An incandescent lamp works at power P when it is connected to a sinusoidal a.c. power supply of peak voltage V_0. If the peak voltage is changed to $2V_0$, what are the r.m.s. values of the voltage and the power output? Assume the resistance of the lamp remains unchanged.

	r.m.s. value of the voltage	**power output**
A.	$\sqrt{2}\, V_0$	$2\,P$
B.	$\sqrt{2}\, V_0$	$4\,P$
C.	$2\sqrt{2}\, V_0$	$2\,P$
D.	$2\sqrt{2}\, V_0$	$4\,P$

$P = \frac{1}{2}\frac{V_0^2}{R}$

$V_{rms} = \frac{V_0}{\sqrt{2}}$

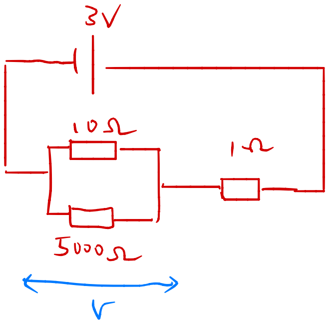
if $V_0 \to 2V_0$,

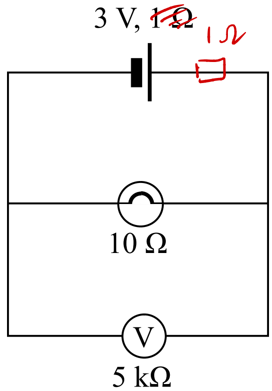
$P' = \frac{1}{2}\frac{(2V_0)^2}{R} = 4P$

$V'_{rms} = \frac{2V_0}{\sqrt{2}} = \sqrt{2}\,V_0$

25. A 3-V dry cell of internal resistance 1 Ω, a voltmeter of internal resistance 5 kΩ and a light bulb of resistance 10 Ω are connected as shown in the circuit diagram below. Find the reading of the voltmeter.

A. 3 V
B. 2.99 V
C. 2.73 V
D. 2.53 V



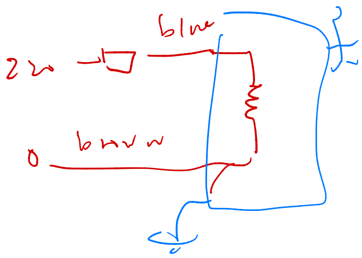


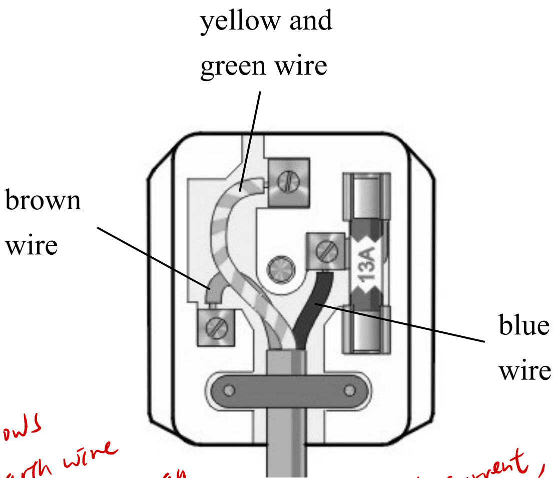
Req of 10Ω & 5000Ω $= \frac{10 \times 5000}{10+5000} = 9.98\ \Omega$

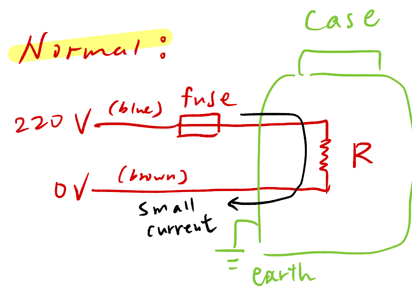
potential divider: $V = \frac{9.88}{9.88+1} \times 3 = 2.73\ V$

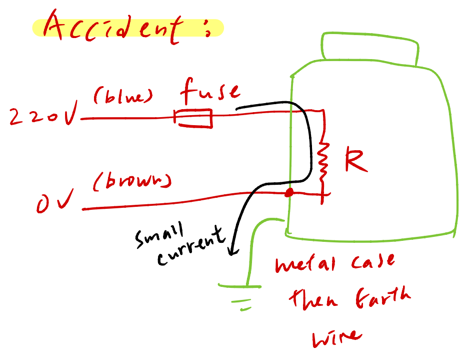
26. The wires in the three-pin plug of an electric kettle with a metal case are wrongly connected as shown in the figure below. What may happen to the user and the fuse if the brown wire inside the kettle accidentally touches the metal case?

live & neutral wires are wrapped







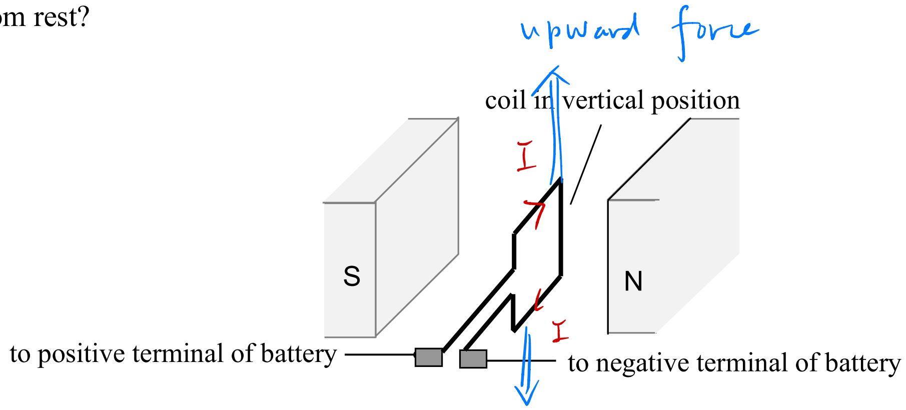


current flows through the earth wire but not human body.

small current, OK!

	user	**fuse**
A.	does not get an electric shock	does not melt
B.	does not get an electric shock	melt
C.	get an electric shock	does not melt
D.	get an electric shock	melt

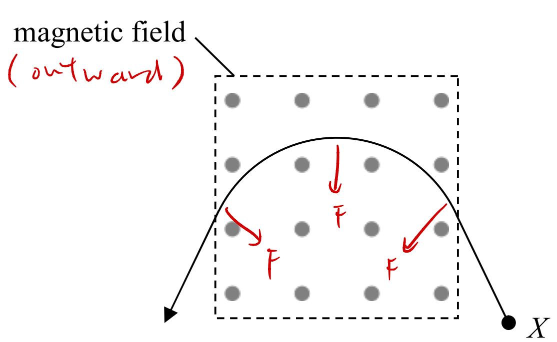
27. A coil connected to a battery lies along the vertical plane between two slab magnets as shown in the figure below. What is the subsequent motion of the coil if it is released from rest?



downward force

A. It remains at rest.
B. It oscillates about the vertical plane.
C. It rotates in clockwise direction.
D. It rotates in anticlockwise direction.

28. When a charged particle X enters a region of uniform magnetic field pointing out of paper, it travels along the path as shown below.



Assume the effect of gravity is negligible, which of the following statements are correct?

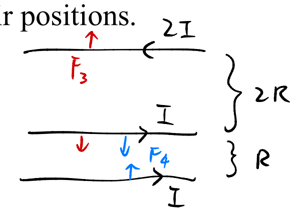
✓ (1) X is negatively charged. (by the left hand rule)
✗ (2) The trajectory of X in the magnetic field is a projectile motion. → circular motion (with the centripetal force)
✓ (3) The speed of X remains the same in the magnetic field.

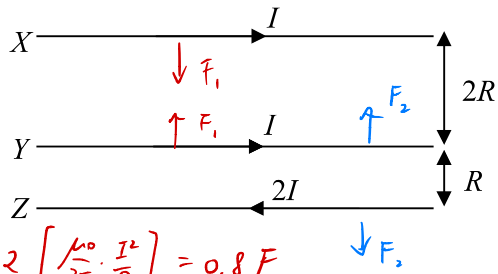
F ⊥ the motion of charge

A. (1) and (2) only
B. (1) and (3) only → work done = 0
C. (2) and (3) only → speed unchanged
D. (1), (2) and (3)

$$\left.\begin{aligned} F_1 &= \frac{\mu_0}{2\pi}\cdot\frac{I^2}{2R} \\ F_2 &= \frac{\mu_0}{2\pi}\cdot\frac{2I^2}{R}\end{aligned}\right\} F = F_1 + F_2 = 2.5\left(\frac{\mu_0}{2\pi}\cdot\frac{I^2}{R}\right)$$

29. Three long parallel wires *X*, *Y* and *Z* carry currents *I*, *I* and 2*I* respectively. *X* and *Y* are 2*R* apart while *Y* and *Z* are *R* apart as shown below. The magnitude of the net force acting on *Y* is *F*. Find the magnitude of the net force acting on *Y* if *X* and *Z* interchange their positions.

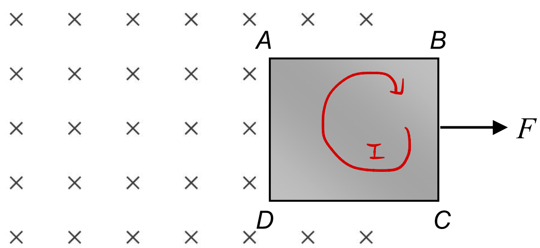




A. 0.6 *F*
B. 0.8 *F*
C. 1.2 *F*
D. 1.4 *F*

$$\left.\begin{aligned} F_3 &= \frac{\mu_0}{2\pi}\cdot\frac{2I^2}{2R} \\ F_4 &= \frac{\mu_0}{2\pi}\cdot\frac{I^2}{R}\end{aligned}\right\} F' = F_3 + F_4 = 2\left[\frac{\mu_0}{2\pi}\cdot\frac{I^2}{R}\right] = 0.8F$$

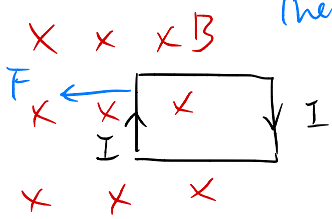
30.



In the figure above, a metal plate *ABCD* is placed normally to a uniform magnetic field which is pointing into the paper. The plate is being pulled by a horizontal force *F*. When the plate is leaving the magnetic field from the right side, which of the following are correct?

✓ (1) The eddy current in the plate flows in clockwise direction.
✓ (2) The plate heats up. due to eddy current
✓ (3) There is another force acting on the plate and it is opposite to *F*.

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



There is a force as the eddy current flowing in the B-field.

31. How many α decays and β decays have radioactive nuclide ${}^{232}_{90}P$ undergone to form nuclide ${}^{228}_{90}Q$?

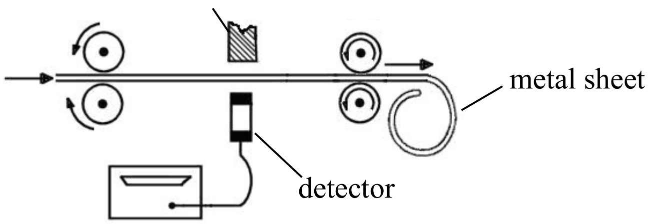
$232 = 228 + 4$

A. 1 α decay, 2 β decays
B. 2 α decays, 1 β decay
C. 1 α decay only
D. 2 α decays, 4 β decays

$${}^{232}_{90}P \rightarrow {}^{228}_{90}Q + {}^{4}_{2}\alpha + 2\,{}^{0}_{-1}\beta$$

$90 = 90 + 2 + 2(-1)$

32. A radioactive source and a detector are used in a factory to monitor the thickness of the metal sheet manufactured. Which of the following radioactive sources is the most appropriate to use?



radioactive source	half-life	type of radiation emitted
P	5 days	α radiation
Q	5 days	β radiation
R	10 years	α radiation
S	10 years	β radiation

totally absorbed.

can be used for long time without replacement

absorption depends on the metal thickness

A. *P*
B. *Q*
C. *R*
D. *S*

33. Consider the following nuclear reaction:

$$ {}_{1}^{2}H + {}_{1}^{3}H \rightarrow {}_{2}^{4}He + {}_{0}^{1}n $$

Which of the following statements is/are correct?

(1) The neutron produced would cause the nuclear reaction to become a chain reaction. (No neutron needed for the reaction)

(2) The total mass of ${}_{2}^{4}He$ and ${}_{0}^{1}n$ is less than that of ${}_{1}^{2}H$ and ${}_{1}^{3}H$.

(3) The reaction is a nuclear fusion.

The mass is then converted to energy releasing to the surroundings.

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

END OF SECTION A

Section B: Atomic World

Q.2: Multiple-choice questions

2.1 When a beam of α particles is directed towards a thin gold foil, most α particles pass thought the foil but some of them bounce back at a large angle. Which of the following can be deduced from this result?

(1) Tiny electrons orbit around a gold atom.

(2) The mass of the α particle is about the same as the gold atom.

Not enough information

(3) The mass in a gold atom is concentrated in a tiny core.

Most of the space are empty.

A. (3) only

B. (1) and (2) only

C. (1) and (3) only

D. (2) and (3) only

A	B	C	D
◯	◯	◯	◯

2.2 According to Bohr's model, the electron in a hydrogen atom

A	B	C	D
◯	◯	◯	◯

A. can orbit at any distance from the nucleus.

B. can escape from the atom by emitting a photon.

C. emits electromagnetic wave when it stays in a certain orbit.

D. releases energy when it moves from a large orbit to a small orbit.

high energy level → low energy level

2.3 Which of the following phenomena about photoelectric effect **CANNOT** be explained by classical physics?

(1) Photoelectrons are emitted from the metal surface almost instantaneously upon the shine of light. In classical physics, some time is needed for a particle to absorb enough energy and releases an electron.

(2) No photoelectron can reach the collector in a photocell if the potential difference between the electrodes exceeds the stopping potential. Energy = QV, overcoming the KE of the photoelectron

(3) No photoelectron will be emitted if the frequency of the light is too low.

In classical physics, energy depends on the intensity but NOT the frequency.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

A	B	C	D
◯	◯	◯	◯

2.4 A hydrogen is excited from the first excited state (n = 2) to the third excited state (n = 4) when it absorbs energy E. What is the energy required to excite a hydrogen atom from the third excited state (n = 4) to the seventh excited state (n = 8)?

A. $E / 2$
B. $E / 4$
C. $E / 16$
D. $E / 64$

$E = \frac{E_0}{2^2} - \frac{E_0}{4^2} = \frac{3}{16} E_0$

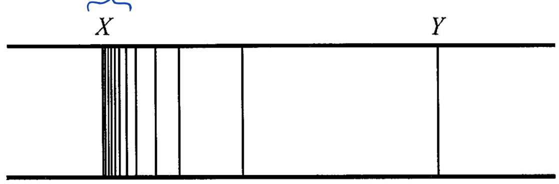
$E' = \frac{E_0}{4^2} - \frac{E_0}{8^2} = \left(\frac{1}{16} - \frac{1}{64}\right) E_0$

$= \frac{3}{64} E_0 = \frac{1}{4} \cdot \frac{3}{16} E_0 = \frac{1}{4} \cdot E$

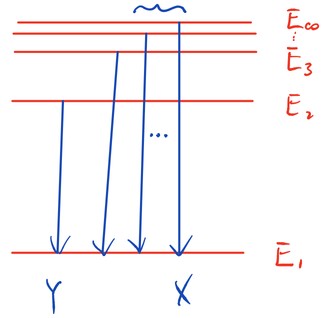
A	B	C	D
○	○	○	○

2.5

closer spectral lines



closer spectral lines



The figure above shows all the spectral lines emitted by a hydrogen atom from any excited state to the ground state (n = 1). Which of the following is/are correct?

✓ (1) Theoretically, there are infinitely many spectral lines between X and Y. infinitely many energy levels
✓ (2) X has a higher frequency than Y. Energy ↑ , f ↑
✗ (3) A hydrogen atom will be ionized if it absorbs a photon corresponding to Y. X = ionization energy

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

A	B	C	D
○	○	○	○

2.6 In a transmission electron telescope (TEM), electrons are accelerated by a potential difference of 2 V. Estimate the de Broglie wavelength of those electrons.

A. 0.869 nm
B. 1.03 nm
C. 3.41 nm
D. 18.7 nm

$\lambda = \frac{h}{p}$

KE of the electron $= \frac{1}{2}mv^2 = \frac{p^2}{2m} = eV$

$p = \sqrt{2meV} = \sqrt{2 \times 9.11 \times 10^{-31} \times 1.6 \times 10^{-19} \times 2}$

$= 7.64 \times 10^{-25}$

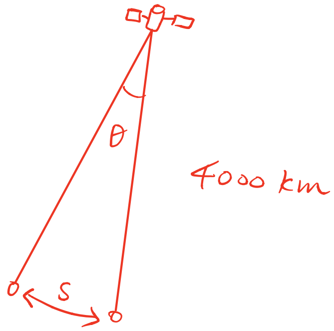
$\lambda = \frac{h}{p} = \frac{6.63 \times 10^{-34}}{7.64 \times 10^{-25}}$

$= 8.68 \times 10^{-10}$ m

A	B	C	D
○	○	○	○

2.7 An artificial satellite, located at 4000 km above the ground, has a telescope with an aperture of 20 cm. Estimate the smallest distance between two trees resolvable by this telescope. Assume the trees emit light of wavelength 500 nm.

A. 1 m
B. 5 m
C. 12 m
D. 28 m



A	B	C	D
○	○	○	○

$\theta = \frac{1.22\lambda}{d} = \frac{1.22 \times 500 \times 10^{-9}}{0.2}$

$= 3.05 \times 10^{-6}$ rad

$S = R\theta = 4000 \times 10^{3} \times 3.05 \times 10^{-6}$

$= 12.2$ m

2.8 Some people coat a nano-sized layer of titanium dioxide on a sheet of glass. Which of the following is **NOT** the purpose of the coating?

A. UV blocking
B. self-cleaning
C. water repelling
D. breaking down organic dirt

A	B	C	D
○	○	○	○

Section C: Energy and Use of Energy

Q.3: Multiple-choice questions

3.1 A 1000-W microwave oven can heat 1.05 kg of soup from 20°C to 70°C in 5 minutes. Estimate the end-use efficiency of the microwave oven.

Given: specific heat capacity of the soup = 4000 J kg^{-1} $°C^{-1}$

A. 62.5%

B. 66.7%

C. 70%

D. 77.8%

$$\eta = \frac{\text{output power}}{\text{input power}} = \frac{mc\Delta T}{Pt}$$

$$= \frac{1.05 \times 4000 \times (70-20)}{1000 \times 5 \times 60}$$

$$= 0.7$$

A	B	C	D
○	○	○	○

3.2 Which of the following statements about some major components of an air conditioner is correct?

A. The compressor increases the temperature of the refrigerant.

B. The expansion valve turns part of the refrigerant from gas to liquid.

C. When the refrigerant passes through the condensing coil, it absorbs heat from the air in the room.

D. When the refrigerant passes through the evaporator coil, it absorbs heat from the air outside the room.

A	B	C	D
○	○	○	○

3.3 In a fluorescent lamp, visible light is emitted from

A. argon gas.

B. mercury vapour.

C. phosphor coating.

D. the electrodes.

mercury emits UV $\xrightarrow{\text{phosphor coating}}$ visible light

A	B	C	D
○	○	○	○

3.4 The figure below shows a concrete wall with a glass window on it. The concrete wall is 20 cm thick. The U-values of the concrete and the glass are 4 W m^{-2} K^{-1} and 1.3 W m^{-2} K^{-1} respectively. Find the average U-value of this wall.

area of concrete

$= 4 \times 2.5 - 0.9 \times 1.5$

$= 8.65 \text{ m}^2$

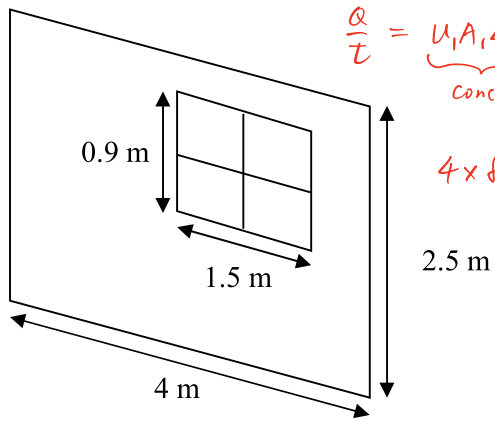
area of glass

$= 0.9 \times 1.5$

$= 1.35 \text{ m}^2$

Total area

$= 4 \times 2.5 = 10 \text{ m}^2$



$$\frac{Q}{t} = \underbrace{U_1 A_1 \Delta T}_{\text{concrete}} + \underbrace{U_2 A_2 \Delta T}_{\text{glass}} = \underbrace{U A \Delta T}_{\text{Total}}$$

$$4 \times 8.65 + 1.3 \times 1.35 = U \times 10$$

$$U = 3.6355 \text{ W m}^{-2} \text{K}^{-1} \quad //$$

A. 0.868 W m^{-2} K^{-1}
B. 2.65 W m^{-2} K^{-1}
C. 3.34 W m^{-2} K^{-1}
D. 3.64 W m^{-2} K^{-1}

A **B** **C** **D**

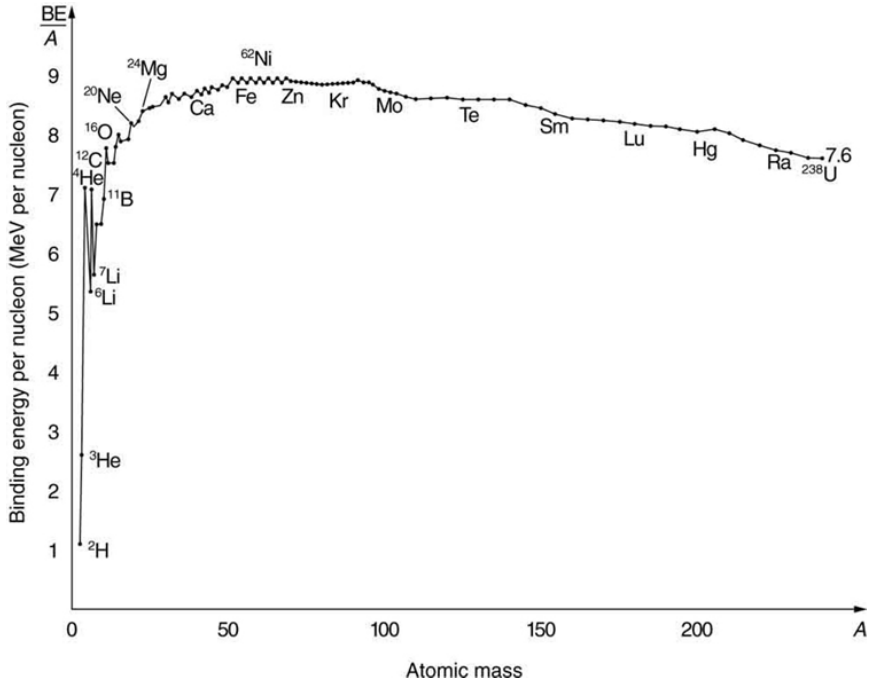
3.5 Which of the following statements about hybrid vehicles is/are correct?

(1) Comparing to electric vehicles, hybrid vehicles have higher end-use efficiency.
(2) Comparing to fossil-fuel vehicles, hybrid vehicles have longer range.
(3) Some hybrid vehicles do not need external source to charge the batteries.

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

A **B** **C** **D**

3.6 The graph below shows the binding energy per nucleon of different nuclides.



According to the graph, which of the following interpretations is **NOT** correct?

per nucleon

A. Energy is released when magnesium (Mg) is formed by nuclear fusion.

B. Iron (Fe) has the most binding energy among all nuclides.

C. More energy is required to split mercury (Hg) than tellurium (Te) into their individual nucleons.

D. Energy is released when uranium (U) splits into two nuclides of similar mass.

Remark:

Binding energy of $^{56}Fe \approx 56 \times 9 = 504$ MeV

Binding energy of $^{238}U \approx 238 \times 8 = 1904$ MeV

A B C D

3.7 A wind turbine is set to rotate when wind blows normally at 14 m s^{-1}. If the blades are 4.5 m long and the overall efficiency is 20 %, estimate the output power of the wind turbine.

Given: density of air = 1.2 kg m^{-3}

A. 1.50 kW

B. 20.9 kW

C. 29.3 kW

D. 33.5 kW

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

$= \frac{1}{2} \times 1.2 \times (\pi \times 4.5^2) 14^3 \times 0.2$

$= 20948$ W

A B C D

3.8 Which of the following statements are correct when a solar cell is exposed to sunlight?

(1) A direct current is produced.

(2) Free electrons move to the n-side of the solar cell.

(3) An electric field is developed in the PN junction.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

A	B	C	D
○	○	○	○