Solution to 1718 S6 Physics Mock Exam

Paper 1

Section A

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

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

31	32	33
C	B	A

Section B

1. (a) 0.8 s 1A

(b) a = slope = (3–1.4)/(1.6–0.8) 1M

$= 2\ \text{m s}^{-2}$ 1A

(c) (i) The decrease in the separation between P and Q 1M

(ii) Area of shaded region = $\frac{(0.8+1.6)(3-1.4)}{2} = 1.92$ 1A

required distance = 7 – 1.92 = 5.08 m 1A

2. (a) $PV = nRT$

$150\times10^{3} \times 8\times10^{-3} = n \times 8.31\times(20+273)$ 1M

n = 0.493 mole 1A

(b) $\frac{P'}{P} = \frac{n'}{n} = 1.2$ 1M

P' = 1.2×1.5 = 1.8 atm (or 180 kPa) 1A

(c) (i) When the temperature decreases,

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

They hit the wall inside the ring less frequently 1M

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

Hence the air pressure decreases.

(ii) $\frac{P'}{P} = \frac{T'}{T} = \frac{273+10}{273+20}$ 1M

$= 96.6\%$

The percentage change in pressure is –3.41%. 1A

3. (a) Consider the change in momentum.

$5\times20 = (5+100)\,v$ 1M

$v = 0.952$ m s^{-1} 1A

(b) $mgh = \frac{1}{2}\,mv^2$

$h = \dfrac{v^2}{2g} = \dfrac{0.952^2}{2\times9.81}$ 1M

$= 0.0462$ m 1A

(c) zero 1M

(d) $\Delta KE = \frac{1}{2}\,mu^2 - \frac{1}{2}\,(m+M)\,v^2$

$= \frac{1}{2}\times0.005\times20^2 - \frac{1}{2}\times0.105\times0.952^2$ 1M

$= 0.952$ J 1A

Internal energy 1M

(e) (i) Vertical motion: $s = \frac{1}{2}\,gt^2$

$0.2 = \frac{1}{2}\times 9.81\,t^2$ 1M

$t = 0.202$ s 1A

Horizontal motion: $d = ut = 20\times0.202 = 4.04$ m 1A

(ii) As the initial vertical speed of the bullet and the bear is zero, (not accept same *a*) 1M

they will displace the same amount downward at any time, 1M

regardless the value of *d*. Hence they always hit each other.

4. (a) Close the curtain. Use laser beam. Use a larger protractor. (any two) 1M+1M

Record the two sides of the thick beam and calculate the average position.

Light ray hitting the centre of the semi-circular block

The straight edge of the semi-circular block aligning to 90°-90° mark

(b)

i	0°	10°	30°	50°
r	0°	5.5°	16.1°	25.2°
sin i	0	0.174	0.5	0.766
sin r	0	0.096	0.277	0.426

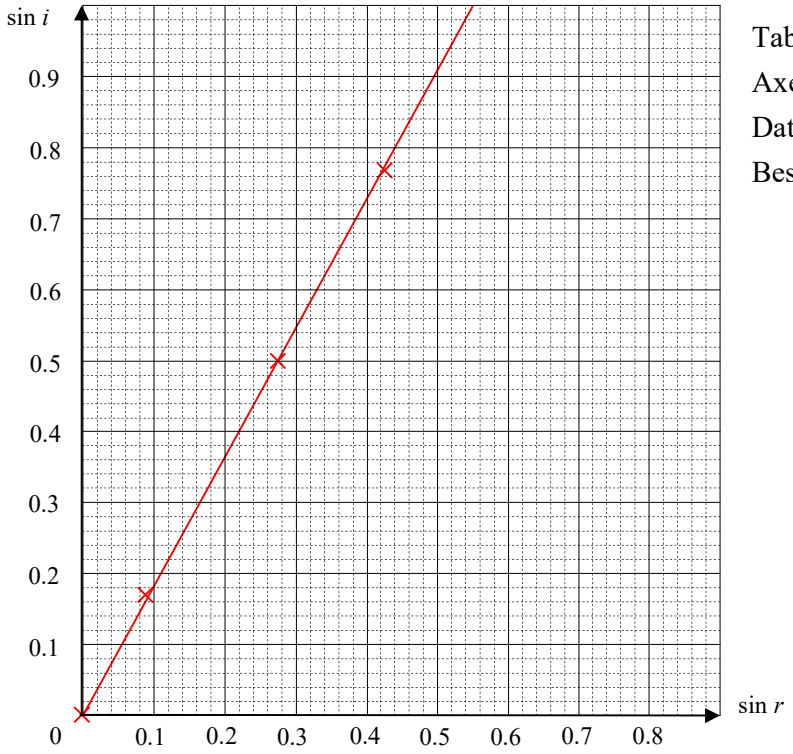


Table	1M
Axes and labels	1M
Data points	1M
Best fit line	1M

(c) From the graph, sin r = 0.55 when sin i = 1. 1M

r = 33.4° (accept 31°–35°) 1A

(OR: n = slope = 1.8 → c = 33.7°)

(d) Prism in binocular / periscope / headlight reflector 1M

Sparkling of diamonds / glass jewellery

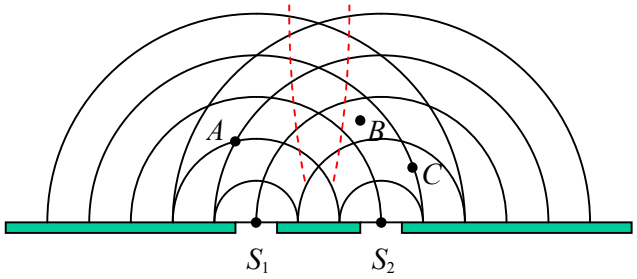
Optical fibres

5. (a) (i) $f = 5$ Hz. 1A

(ii) $v = 15$ cm s^{-1} $= 0.15$ m s^{-1} 1A

OR: $\lambda = 3$ cm, $v = f\lambda = 0.15$ m s^{-1}

(b) 1M+1M



(c) p.d. at $B = 3.5\lambda - 2.5\lambda = 1\lambda$

p.d. at $C = 4\lambda - 1.5\lambda = 2.5\lambda$ 1A

Constructive interference occurs at B. 1M

(d) The wavelength of the waves is halved, i.e. $2\lambda' = \lambda$ 1M

p.d. at B and C are $2\lambda'$ and $5\lambda'$respectively.

Hence, constructive interference occurs at B and C. 1M

(e) The amplitude is halved / decreased. 1M

6. (a) $R = \dfrac{13.6}{4} = 3.4\ \Omega$ 1A

(b) $P = 13.6 \times 2 = 27.2$ W 1A

(c) $14.6 - 13.6 = (2 + 4\times2)\, r$ (voltage drop used) 1M

$r = 0.1\ \Omega$ 1A

(d) When the starter motor is in use, the current through the battery increases and the terminal voltage drops. 1M

Hence, the voltage across each headlight decreases, and

the brightness of each headlight decreases. 1M

(e) If the internal resistance of the battery increases, the 'voltage drop' of the battery becomes larger (or terminal voltage decreases). 1M

The voltage across the starter motor may be too small to drive the motor. 1M

7. (a) (i) $\varepsilon = IR = 2.6\times10^{-3} \times 18$ 1M

$= 0.0468$ V 1A

(ii) upwards 1M

(b) $\varepsilon = \dfrac{\Delta\Phi}{\Delta t} = Blv$ 1M

$0.0468 = B \times 0.25 \times 0.55$ 1M

$B = 0.340$ T 1A

(c) (i) To overcome the magnetic force produced by the induced current. 1M

(ii) The external force points to the left. 1A

$F = BIl = 0.340 \times (2.6\times10^{-3}) \times 0.25$ 1M

$= 2.21\times10^{-4}$ N 1A

8. (a) (i) $1\text{ u} = 931\text{ MeV} = 931\times10^{6} \times 1.6\times10^{-19}$ J

$\Delta m = \dfrac{2.79\times10^{-11}}{931\times10^{6}\times1.6\times10^{-19}}$ 1M

$= 0.187299$ u 1A

OR:

$\Delta m = \dfrac{\Delta E}{c^2} = \dfrac{2.79\times10^{-11}}{(3\times10^{8})^2} = 3.1\times10^{-28}\text{ kg} = \dfrac{3.1\times10^{-28}}{1.661\times10^{-27}}\text{ u} = 0.186\,635\text{ u}$

(ii) $235.043\,930 + y = 141.916\,453 + 90.923\,445 + 3y + 0.187\,299$ 1M

$y = 1.008\,367$ u

The mass of a neutron is 1.008 367 u (or 1.008 699 u). 1A

(b) (i) Number of U-235 atoms in the fuel

$= \dfrac{10^{4}}{235.043\,930\times1.661\times10^{-27}}$ 1M

$= 2.561\times10^{28}$ 1A

(ii) Total energy released $= 2.561\times10^{28} \times 2.79\times10^{-11} \times 0.1$

$= 7.15\times10^{16}$ J 1A

$P = \dfrac{E}{t} = \dfrac{7.15\times10^{16}}{730\times24\times3600}$

$= 1.13\times10^{9}$ W 1A

(c) $k = \dfrac{\ln 2}{t_{\frac{1}{2}}} = 0.0864\text{ d}^{-1}$ $(1.0003\times10^{-6}\text{ s}^{-1})$ 1A

$A = A_0 e^{-kt}$

$0.01 = e^{-0.0864t}$ 1M

$t = 53.3$ days (1279 h) 1A

9. (a) To kill insects, bacteria and pathogens in the food. 1M

(b) γ radiation should be used. 1M
because the relatively low penetrating power of α and β radiations
make them very difficult to penetrate through the packages of the food. 1M

(c) Do not agree. 1M
As γ radiation is an electromagnetic wave, 1M
exposing the foods to an electromagnetic wave
would not leave radioactive substances inside the food

10. Connect the power supply, the joulemeter and the heater together. (setup) 1M
Put the heater into 200 g (let say) water in a beaker. Switch on the power supply.
When the water starts to boil, (measure Δm) 1M
record the initial mass of water with the balance and the initial reading of the joulemeter.
Boil the water for 5 minutes (let say), and switch off the power supply. (procedure) 1M
Record the final reading of the joulemeter and the final mass of the water. (measure ΔE) 1M
The specific latent heat can be found by $\frac{E_2 - E_1}{m_2 - m_1}$. (formula) 1M

Paper 2

Section B: Atomic World

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

Structured question (10 marks)

(a) $f = c / 500\times10^{-9} = 6\times10^{14}$ Hz 1A

$n = 2\times10^{-6} / hf$

$= 2\times10^{-6} / (6.63\times10^{-34} \times 6\times10^{14})$

$= 5.03\times10^{12}$ 1A

(b) The photocathode is set to positive to attract the negative electrons. 1M

The potentials are increasing so as to direct/accumulate/collect electrons towards the anode. 1M

(c) (i) The minimum energy required to release an electron from a material surface. 1M

(ii) $hf_0 = 0.8$ eV 1M

$f_0 = 0.8 \times 1.6\times10^{-19} / 6.63\times10^{-34}$

$= 1.93\times10^{14}$ Hz 1A

(iii) $K = hf - 0.8$ eV 1M

$= 6.63\times10^{-34} \times 6\times10^{14} - 0.8 \times 1.6\times10^{-19}$

$= 2.698\times10^{-19}$ J (or 1.69 eV) 1A

(iv) Yes 1M

(threshold wavelength = c/f_0 = 1550 nm > 700 nm)

Section C: Uses of Energy

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

Structured question (10 marks)

(a) (i) Rate of heat transfer by conduction through the hut envelope

= 1.5×10×10×6 + 3×1.67×3×10×6 + 2.02×3×10×6 (any one term correct) 1M+1M

= 2165.4 W 1A

(ii) OTTV of the hut envelope

$= \left(\frac{Q_c}{t} + \frac{Q_r}{t} \right) \div A_{\text{total}}$ 1M

= (2165 + 4×160×1.2) ÷ (4×3×10 + 10×10)

= 13.3 W m^{-2} 1A

(b) (i) Time required = $\frac{m\,c\,\Delta T}{\text{cooling capacity}}$

$= \frac{1.2 \times 10 \times 10 \times 3 \times 1000 \times 6}{2230}$ 1M

= 969 s (16.1 min) 1A

(ii) $P_{in} = \frac{828}{1200} = 0.69$ kW 1A

(iii) When the indoor temperature is closing to 24°C,

the rate of heat gained from outdoor = 2165 + 4×160×1.2 = 2935 W 1M

As the cooling capacity is less than rate of heat gain before it reaches 24°C, 1M

the room cannot be cooled down to 24°C even the conditioner is working properly.

Section A

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

1. To defreeze a meat of 2 kg at ~~−35°C~~ −35.1°C, it is put into a cup of water of 3 kg at 25°C. Estimate the final temperature of the water when thermal equilibrium has reached.

   Given: specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$

   specific heat capacity of the meat = 1800 J kg^{-1} $°C^{-1}$

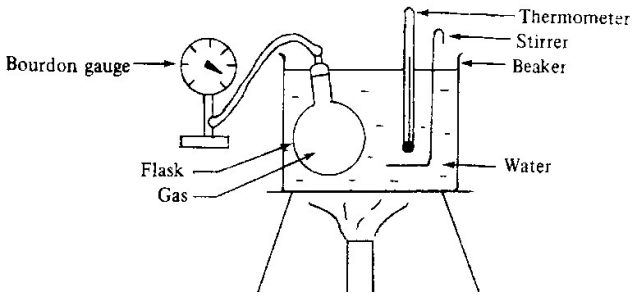
   energy absorbed by meat = energy released by water

   $2 \times 1800 (T + 35.1) = 3 \times 4200 (25 - T)$

   $3600T + 126360 = 315000 - 12600T$

   $T = 11.64°C$

   (A) 11.6°C
   B. 14.7°C
   C. 23.1°C
   D. 27.2°C

2. 

   The above apparatus is used to study the relation between the temperature and the pressure of a fixed mass of gas at constant volume. Which of the following is NOT a precaution of the experiment ?

   A. Ensure the flask is air-tight.
   B. Immerse the whole flask in water.
   (C.) Connect the Bourdon gauge to the flask with a long tube.
   D. Prevent the flask from touching the bottom of the beaker.

   Introduce unknown volume

3. Which of the following designs of a vacuum flask help to keep the liquid inside warm?

(1) the cork on the top of the flask convection

(2) the vacuum layer between the outer and the inner walls conduction

(3) the silvery layer of the inner wall radiation

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

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

*4. If the mass of a helium atom is approximately four times that of a hydrogen atom, estimate the ratio $\frac{\text{r.m.s. speed of helium gas}}{\text{r.m.s. speed of hydrogen gas}}$ at 0°C.

hydrogen / helium

$pV = \frac{1}{3} Nm\bar{c^2} = nRT$

m: total mass

$\bar{c^2} \propto \frac{1}{\text{molar mass}}$

$\sqrt{\bar{c^2}} \propto \frac{1}{\sqrt{\text{molar mass}}}$

$\text{Ans} = \frac{\frac{1}{\sqrt{1}} \quad (H)}{\frac{1}{\sqrt{4}} \quad (He)}$

$= 2$

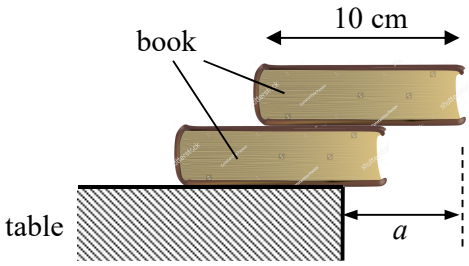
A. 1

B. 2

C. 4

D. 16

5.



Two identical books with length 10 cm are stacked on a table as shown. Find a, the largest distance the books extended out of the table's edge without toppling. Assume the mass density of each book is uniform.

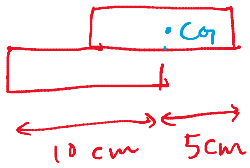
A. 5 cm

B. 7.5 cm

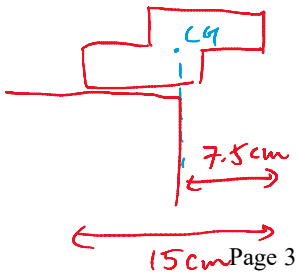
C. 8.25 cm

D. 10 cm

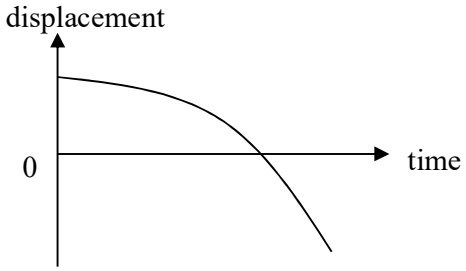
stack the 1st book



stake both books on the table



6. The figure below shows the displacement-time graph of an object.



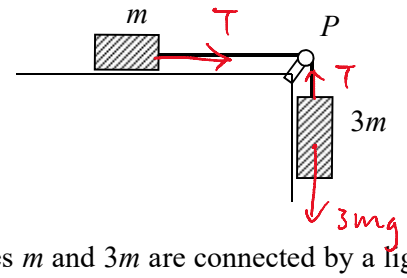
Which of the following statements about the motion must be correct ?

A. The speed of the object is decreasing. slope more -ve → speeding up
B. The direction of motion of the object changes once. always backwards
C. The object accelerates towards the negative direction.
D. The object is moving downwards. not sure

7. Which of the following causes a moving body to resist a change in its state of motion ?

A. inertia
B. acceleration
C. speed
D. weight

8.



Two blocks of masses m and $3m$ are connected by a light string over a smooth pulley P as shown. If all surfaces are smooth, what is the tension in the string when the blocks are released ?

Consider m:

$T = ma$ —①

consider 3m:

$3mg - T = 3ma$ —②

① × 3 + ②

$3T = 3mg - T$

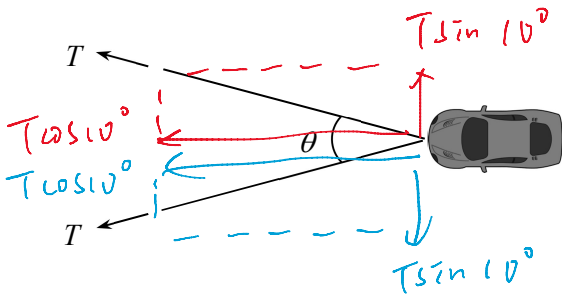
$T = \frac{3mg}{4}$

A. $mg/4$
B. $mg/3$
C. $3mg/4$
D. $3mg$

9. The figure below shows a car being 'towed' by two cables. At a certain moment, the angle θ is 20° and the tension T in both cables is 2000 N. Find the resultant force exerted by the cables on the car.

net force
$= 2T\cos 10°$
$= 3939\ N$ //

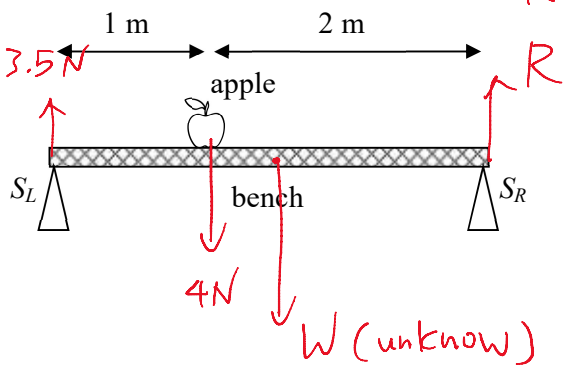
A. 1.88 kN
B. 1.97 kN
C. 3.76 kN
(D.) 3.94 kN



10. An apple of weight 4 N is put on a uniform wooden bench of 3 m as shown. If the normal force at the left supporter S_L is 3.5 N, what is the normal force at the right supporter S_R ?

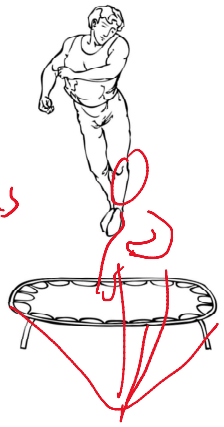
Take moment about W $\Rightarrow R \times 1.5 + 4 \times 0.5 = 3.5 \times 1.5$
$R = 2.17\ N$ //

A. 0.5 N
B. 1.67 N
(C.) 2.17 N
D. 3.73 N



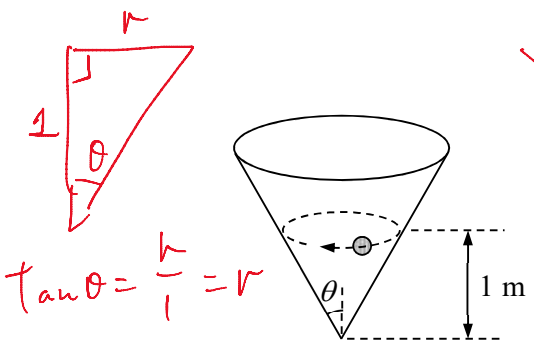
11. A man is jumping vertically on a trampoline as shown. When he falls on the trampoline and is at the *lowest* position, which of the following is/are correct ?

(1) ✓ His speed is zero. U = 0 turning
(2) ✗ The net force on his body is zero. Accelerate upwards
(3) ✗ The normal force on his body and his weight form an action and reaction pair. Acting on the same body



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

*12.



In the figure, a small sphere steadily describes a horizontal circular path in an inverted cone at a height of 1 m from the vertex. Find the speed of the sphere.

A. 1.44 m s^{-1}
B. 2.16 m s^{-1}
C. 2.68 m s^{-1}
D. 3.13 m s^{-1}

*13. Which of the following statements about the gravitational field lines of a point mass is/are correct ?

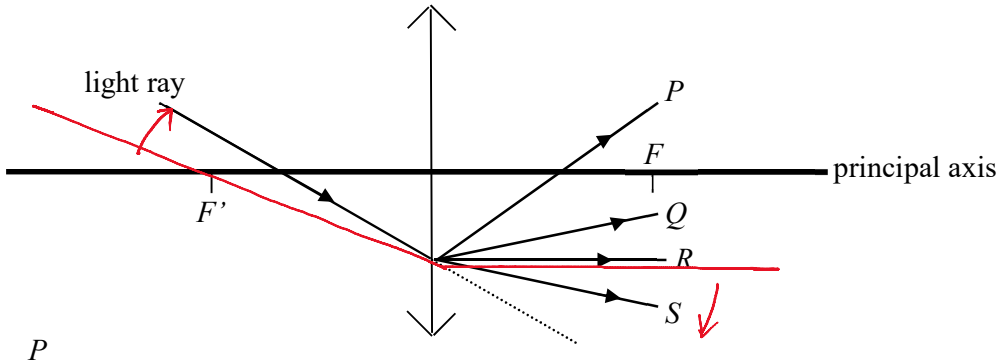
(1) All the field lines point towards the mass.
(2) The field line density is higher at a region closer to the mass.
(3) The field lines never cross each other.

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

*14. A monochromatic light is incident normally on a plane transmission grating which has 500 slits per mm. If the angular separation between the two 'first order' fringes is 35.7°, what is the angular separation between the two 'second order' fringes ?

A. 37.8°
B. 54.6°
C. 71.4°
D. 75.6°

15. In the figure below, F and F' are the foci of a convex lens. Which of the following best represents the emergent ray ?

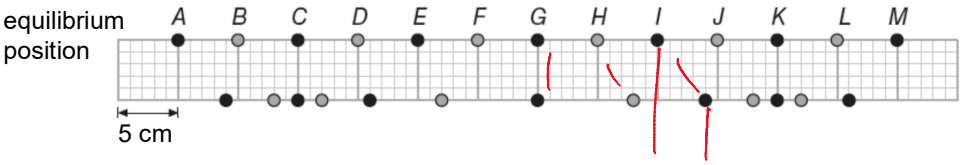


A. P
B. Q
C. R
D. S

16. Which of the following about virtual image is **INCORRECT** ?

A. It can be observed by human eyes.
B. It can be projected on a screen. → formed behind the mirror / lens
C. It can be formed by convex lens.
D. It can be magnified or diminished.

17. The figure below shows a longitudinal wave travelling through some particles.

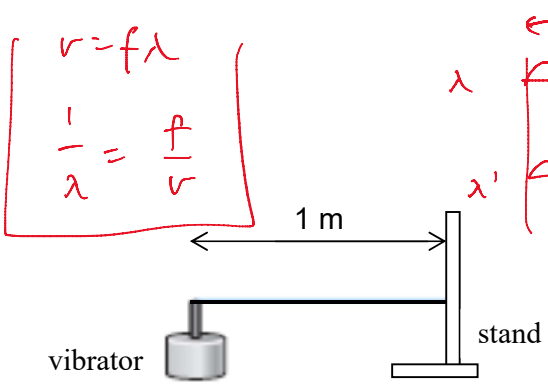


What is the amplitude of the wave ?

↔ max displacement = 4 cm

A. 2 cm
B. 3 cm
C. 4 cm
D. 5 cm

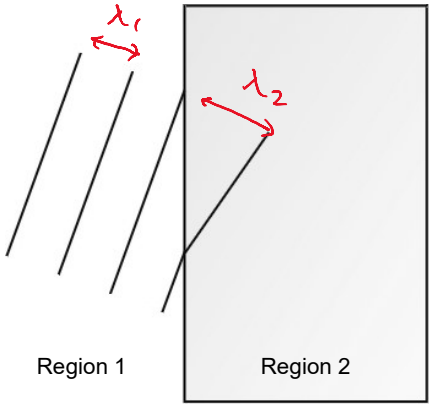
18.



An elastic string stretched to 1 m long is fixed with one end to a vibrator and the other to a stand as shown in the figure. Stationary wave patterns are produced when the vibrator vibrates at 12 Hz and 16 Hz. No stable pattern is produced at frequencies between these two. Find the speed of the wave along the string.

A. $4\ m\ s^{-1}$
B. $8\ m\ s^{-1}$
C. $16\ m\ s^{-1}$
D. $24\ m\ s^{-1}$

19.



A train of straight water waves travels from region 1 to region 2 as shown above. Which of the following statements is/are correct ?

(1) Region 1 is shallower than region 2.
(2) The wavelength of the water waves in region 1 is shorter than that in region 2.
(3) The frequency of the water waves in region 1 is higher than that in region 2.

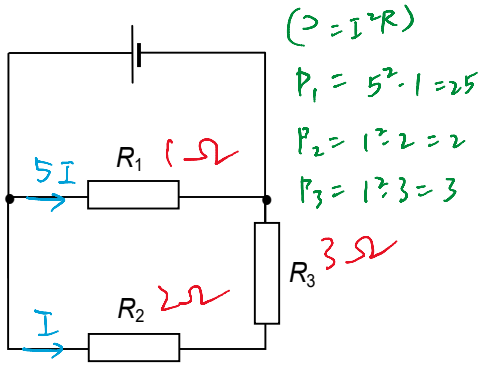
A. (1) only
B. (1) and (2) only
C. (2) and (3) only
D. (1), (2) and (3)

20. Which of the following about ultrasound is/are correct ?

(1) The frequency of ultrasound is above 20 000 Hz.
(2) All animals including human beings cannot hear ultrasound.
(3) Ultrasound is commonly used in scanning of foetus.

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

21. In the following circuit, the ratio of the resistance of R_1, R_2 and R_3 is 1 : 2 : 3. What is the ratio of the power dissipated by R_1, R_2 and R_3 ?



A. 1 : 2 : 3
B. 3 : 2 : 1
C. 5 : 2 : 3
D. 25 : 2 : 3

22. An electric toaster rated at 440 W is connected to a 220 V main supply via a three-pin plug. What are the currents carried in the neutral and earth wires under normal operation ?

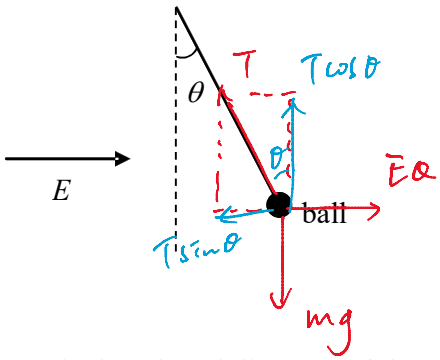
	Neutral wire	Earth wire
A.	2 A	2 A
B.	2 A	0 A
C.	0 A	2 A
D.	1 A	1 A

*23. The output power of a heater is 1 kW when it is connected to a sinusoidal a.c. supply of peak voltage 340 V. What is the output power of this heater when it is connected to a d.c. supply of 340 V ?

A. 0.5 kW
B. 1 kW
C. 1.41 kW
D. 2 kW

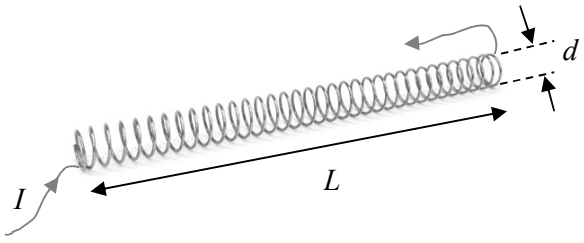
24. A charged ball is suspended by a string. When a uniform electric field E is applied horizontally, the ball is displaced so that the string makes an angle θ with the vertical. The value of E is directly proportional to

A. θ.
B. $\cos\theta$.
C. $\tan\theta$.
D. $\sin\theta$.



25. A current I passes through a long solenoid of N turns. The length and diameter of the solenoid are L and d respectively as shown in the figure. The magnetic field produced in the middle of the solenoid is B. Another long solenoid has $4N$ turns, a length of $2L$ and a diameter of $\frac{d}{2}$. If the current passing through this solenoid is $2I$, what is the magnetic field produced in the middle of this solenoid ?

A. $4B$
B. $2B$
C. B
D. $\frac{B}{2}$



26. As shown below, *XYZ* are the vertices on an equilateral triangle of side length *a*. Two long straight parallel wires, each carrying a current *I*, are placed at points *Y* and *Z* respectively. What is the magnitude of the magnetic field at *X*?

A. $\frac{\mu_o I}{2\pi a}$

B. $\frac{\mu_0 I}{\pi a}$

C. $\frac{2\mu_o I}{\pi a}$

D. $\frac{\mu_0 I\sqrt{2}}{2\pi a}$

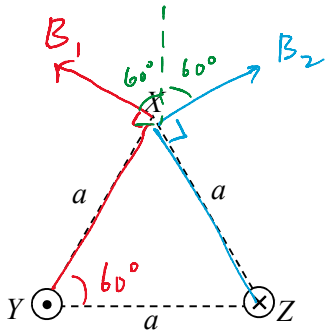
$B_1 = \frac{\mu_o I}{2\pi a}$

$B_2 = \frac{\mu_o I}{2\pi a}$

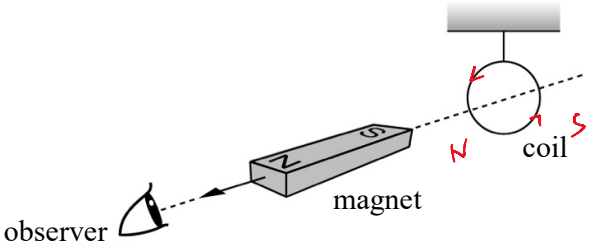
resultant B

$= B_1 \cos 60^\circ + B_2 \cos 60^\circ$

$= \frac{\mu_o I}{2\pi a}$

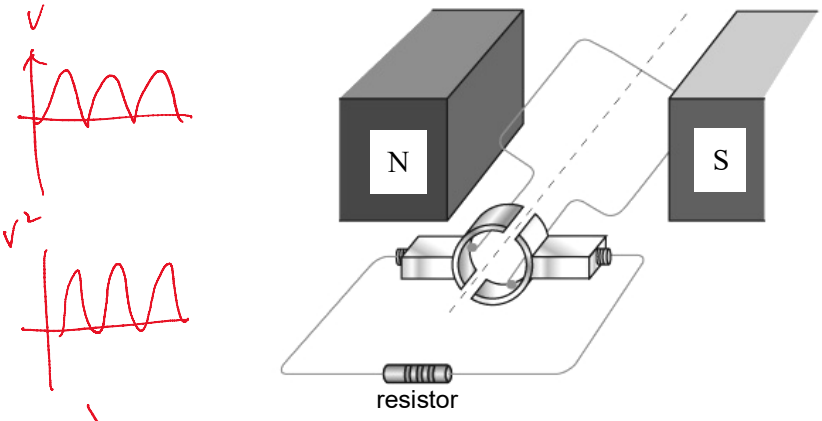


27. A bar magnet is pulled away from a coil as shown in the figure below. The coil is hung by a nylon thread. Which of the following statements is correct to the observer ?

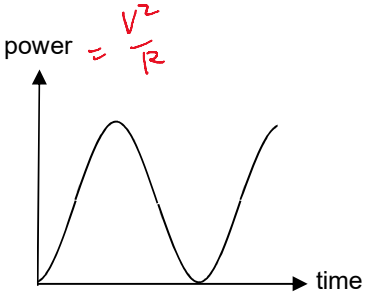


	direction of current in the coil	**motion of the coil**
A.	clockwise	swings toward the observer
B.	anticlockwise	swings away from the observer
C.	clockwise	swings away from the observer
D.	anticlockwise	swings toward the observer

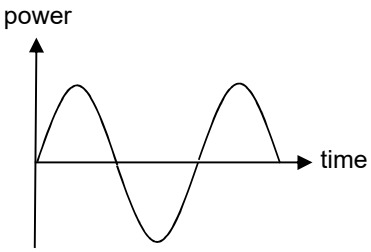
28. The following figure shows the coil of a generator rotating at a constant speed. Which of the following graphs best shows the power dissipated in the resistor ?



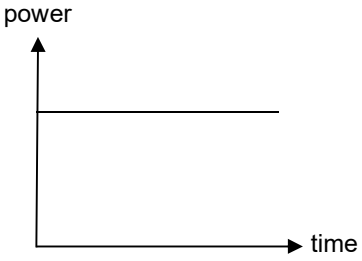
A.



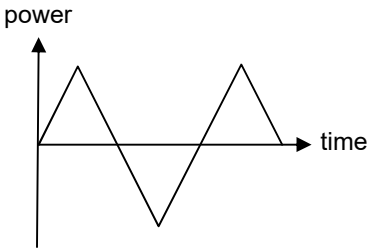
B.



C.



D.

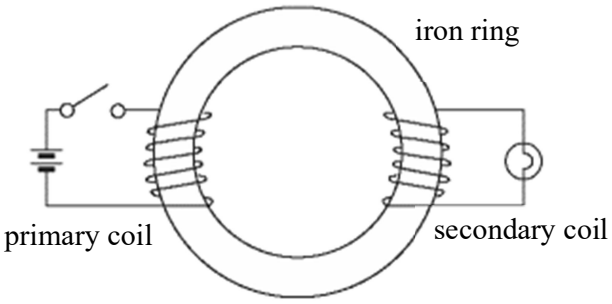


29. In the following nuclear equation, what is particle X ?

$$ {}_{1}^{2}H + {}_{1}^{3}H \rightarrow {}_{2}^{4}He + {}_{0}^{1}X + \text{energy} $$

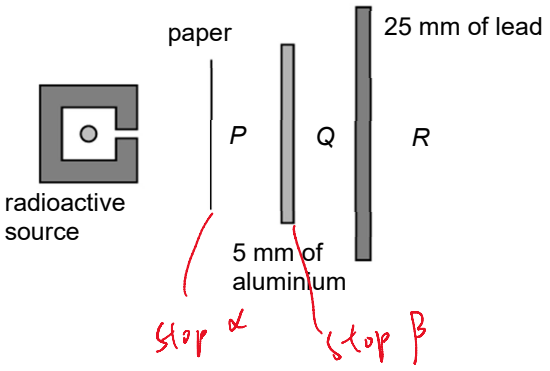
A. neutron
B. proton
C. electron
D. helium nucleus

*30. In the following figure, two coils are wound on an iron ring. The primary coil is connected to a battery and a switch, and the secondary coil is connected to a lamp. When the switch is closed, what would happen to the lamp in the secondary coil ?



A. It lights up with gradually increasing brightness.
B. It flashes at a constant frequency.
C. It gives a flash of light. → After the switch is closed, no more change in current → no induced emf
D. It does not light up.

31. In the following figure, a radioactive source emitting α, β and γ radiation is placed in front of a sheet of paper, 5 mm of aluminum and 25 mm of lead. Which type(s) of radiation will be detected in regions *P*, *Q* and *R* respectively ?



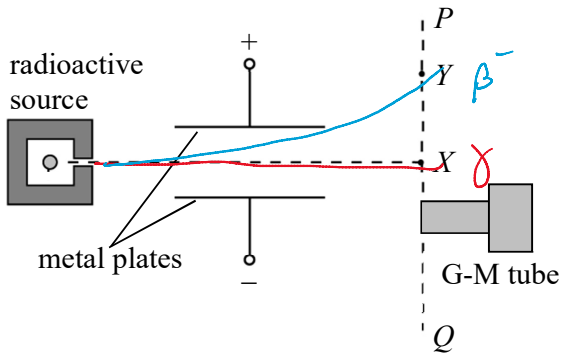
	P	***Q***	***R***
A.	α radiation	β radiation	γ radiation
B.	β and γ radiation	γ radiation	no radiation
C.	β and γ radiation	γ radiation	γ radiation
D.	α, β and γ radiation	β and γ radiation	γ radiation

32. The activity of a radioactive source X drops from 4000 units to 250 units in 12 hours. Find the half-life of X.

4000 → 2000 → 1000 → 500 → 250
3 3 3 3
12 hours

A. 2 hours.
B. 3 hours
C. 4 hours
D. 6 hours

33. In the following figure, a G-M tube is moved along dotted line PQ. The readings of the counter are significant only when the G-M tube is at X and Y. Which of the following statements must be correct ?



(1) ✗ α particles are emitted from the source.
(2) ✓ γ rays are emitted from the source.
(3) ✗ The reading of the counter at Y is higher than that at X.

not sure

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

END OF SECTION A

Section B: Atomic World

Q.2: Multiple-choice questions

2.1 Concerning photoelectric effect, which of the following **CANNOT** be explained by the wave theory of light ?

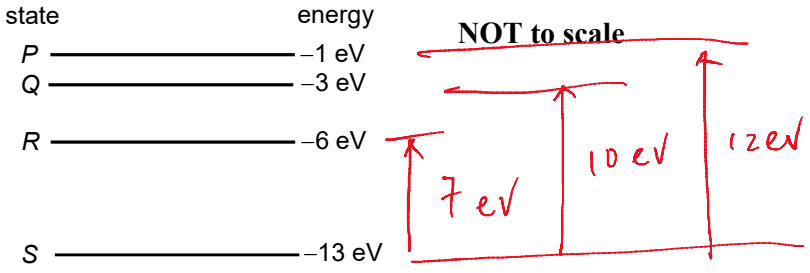
(1) There is a threshold frequency for photoelectric effect to occur.
(2) There is no time delay in the emission of photoelectrons.
(3) Electrons on the metal surface gain the energy from the incident light and are emitted.

'light' wave may give energy to the electrons

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

A	B	C	D
○	○	○	○

2.2 The figure shows the energy states of a certain atom. The atom is initially in state *S*.



Which of the following statements is/are correct ?

(1) ✗ A photon of energy 8 eV can excite the atom to state *R*. no energy level allows for such transition
(2) ✓ An electron of energy 11 eV can excite the atom to state *Q*.
(3) ✓ A photon of energy 14 eV can ionize the atom.

yes, and e⁻ still has 1eV

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

A	B	C	D
○	○	○	○

Yes, 13 eV for ionization, eV for the KE of the leaving e⁻ from the atom.

2.3 Based on Rutherford's atomic model,

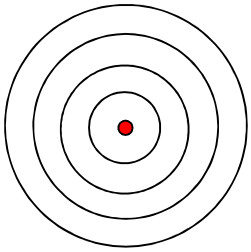
A. the atom should emit electromagnetic waves of some discrete frequencies.
B. the atom should emit electromagnetic waves of a continuous range of frequency.
C. the atom should emit electromagnetic waves of some discrete speeds.
D. the atom should not emit electromagnetic waves.

A	B	C	D
○	○	○	○

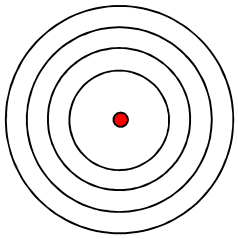
2.4 Which of the following figures best shows the relative sizes of the first four orbits of the electron in a hydrogen atom ?

A	B	C	D
○	○	○	○

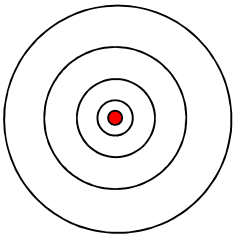
A.



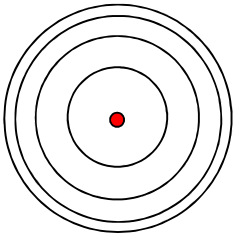
B.



C. $r \propto n^2$



D.



2.5 A beam of electrons is used in a transmission electron microscope (TEM) to observe atomic structure in a nanoscale. If the de Broglie wavelength of the electrons used is 10^{-9} m, estimate the kinetic energy of the electron in the beam.

A. 0.01 eV
B. 1 eV
C. 10^2 eV
D. 10^4 eV

$p = \frac{h}{\lambda} = \frac{6.63 \times 10^{-34}}{10^{-9}} = 6.63 \times 10^{-25}$

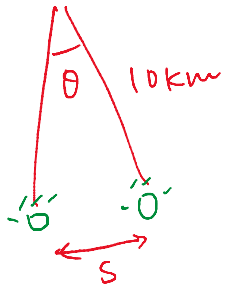
$KE = \frac{p^2}{2m} = \frac{(6.63 \times 10^{-25})^2}{2 \times 9.11 \times 10^{-31}}$

$= 2.41 \times 10^{-19}\ J = 1.5\ eV \approx 1\ eV$

A	B	C	D
○	○	○	○

2.6 A man on an aeroplane 10 km from the ground observes two green cars on the ground. The diameter of the pupil of the man is 3 mm. Taking the wavelength of green light to be 500 nm, estimate the minimum distance between the two green cars he would resolve.

A. 2 m
B. 10 m
C. 25 m
D. 50 m



$\theta = \frac{1.22\lambda}{d} = \frac{1.22 \times 500 \times 10^{-9}}{3 \times 10^{-3}} = 2.03 \times 10^{-4}$

$s = r\theta = 10 \times 10^{3} \times 2.03 \times 10^{-4} = 2.03\ m$

A	B	C	D
○	○	○	○

2.7 Which of the following properties of nano-sized zinc oxide (ZnO) would differ from its bulky from ?

(1) Mechanical
(2) Optical
(3) Electrical

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

A	B	C	D
○	○	○	○

2.8 A very thin film of titanium dioxide (TiO_2) can be used in window coating for self-cleaning. Which of the following statements is **WRONG** ?

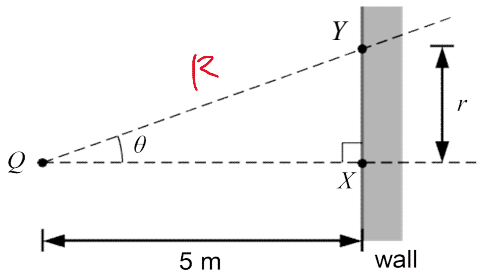
A. The coating speeds up the breaks of organic dirt.
B. The coating repels water due to the Lotus effect.
C. The coating has a very high surface-to-volume ratio.
D. The coating absorbs ultra-violet radiation.

A	B	C	D
○	○	○	○

Section C: Energy and Use of Energy

Q.3: Multiple-choice questions

3.1 A point light source Q is 5 m away from a wall. Points X, Y and Q are on the same plane.



$\cos\theta = \frac{5}{R}$

If the illuminance on the wall at X is E, what is the illuminance on the wall at Y which is at a distance r from X?

$E = \frac{\Phi}{4\pi 5^2}$

A. $\frac{125E}{\left(5^2+r^2\right)^{\frac{3}{2}}}$

$E' = \frac{\Phi}{4\pi R^2}\cos\theta$

B. $\frac{25E}{\left(5^2+r^2\right)^{\frac{3}{2}}}$

A	B	C	D
○	○	○	○

$= \frac{\Phi}{4\pi R^2}\cdot\frac{5}{R}$

C. $\frac{5E}{\left(5^2+r^2\right)^{\frac{3}{2}}}$

$= \frac{5\Phi}{4\pi R^3} = \frac{125\Phi}{4\pi 5^2}\cdot\frac{1}{R^3}$

D. $\frac{E}{\left(5^2+r^2\right)^{\frac{3}{2}}}$

$= 125E\,\frac{1}{\left(5^2+r^2\right)^{3/2}}$

3.2 On average, hybrid car P consumes 0.38 L of gasoline in travelling a distance of 10 km, whereas hybrid car Q consumes 0.585 L in travelling a distance of 15 km. If the fuel tank capacity of both cars is the same, which of the following is correct ?

	higher fuel efficiency	longer range
A.	P	P
B.	P	Q
C.	Q	P
D.	Q	Q

A	B	C	D
○	○	○	○

consider distance travelled per 1 L gas

$P = \frac{10}{0.38} = 26.3$ $\quad Q = \frac{15}{0.585} = 25.6$

3.3 Four types of lamp are available in a lamp shop:

Lamp	Power rating	Efficacy
P	20 W	85 lm W^{-1}
Q	40 W	65 lm W^{-1}
R	60 W	45 lm W^{-1}
S	80 W	25 lm W^{-1}

luminous flux (power × efficacy)
1700
2600
2700
2000

Which lamp is the brightest ?

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

A	B	C	D
○	○	○	○

3.4 Which of the following features is/are essential for an induction cooker to work properly ?

(1) ✓ A magnetic field alternating at a high frequency is produced.
(2) ✗ A heat-conducting surface for a cooking utensil to sit on. → glass OK!
(3) ✓ A utensil with a metal bottom is used. for eddy current

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

A	B	C	D
○	○	○	○

3.5 A wind turbine provides an output power of 100 kW when the wind speed is 10 m s^{-1}. When the wind speed is 20 m s^{-1}, the efficiency of the turbine is halved. What is the output power of the turbine at a wind speed of 20 m s^{-1} ?

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

$100 = \frac{1}{2}\rho A \cdot 10^3$

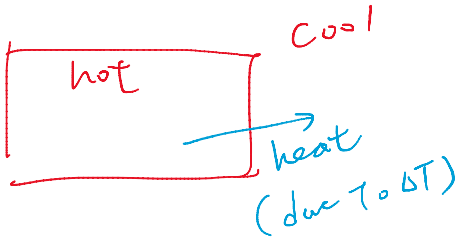
$P = \frac{\frac{1}{2}\rho A \cdot 20^3}{2} = \frac{\frac{100}{000} \cdot 20^3}{2} = 400$ //

A. 200 kW
B. 400 kW
C. 600 kW
D. 800 kW

A	B	C	D
○	○	○	○

3.6 There is a heater in a room and it is turned off. If the temperature in the room is higher than that outside, which of the following will decrease the rate of heat loss from the room through its walls ?

(1) The outdoor temperature increases.
(2) The heater is turned on.
(3) The number of people in the room increases.



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

A	B	C	D
○	○	○	○

3.7 Find the energy released in the following nuclear reaction.

$$^{48}_{24}\mathrm{Cr} + ^{4}_{2}\mathrm{He} \rightarrow ^{52}_{26}\mathrm{Fe}$$

Given: Binding energy per nucleon of He-4 = 7.01 MeV
Binding energy per nucleon of Cr-48 = 8.57 MeV
Binding energy per nucleon of Fe-52 = 8.61 MeV

$8.57 \times 48 + 7.01 \times 4 - 8.61 \times 52$

$= -8.32$

A. 5.53 MeV
B. 6.97 MeV
C. 7.14 MeV
D. 8.32 MeV

A	B	C	D
○	○	○	○

3.8 Comparing to normal glass, using low-e glass in windows can reduce the OTTV of a building. Which of the following is the major reason ?

reduce IR entering the room

A. The U-value of low-e glass is relatively low.
B. Heat can be lost from the building through windows effectively.
C. The heat gained by the building via radiation is reduced.
D. Low-e glass reduces the natural lighting entering the building.

A	B	C	D
○	○	○	○