Solution to 1516 S6 Physics Mock Exam

Paper 1

Section A

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

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

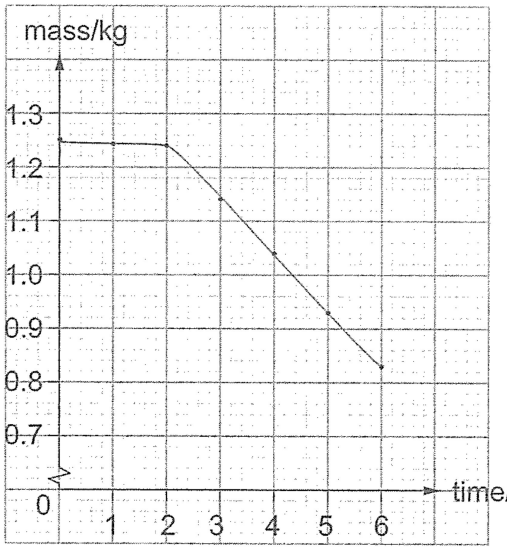
31	32	33
B	C	B

10A 7B 9C 7D

Section B

1. (a)

Time / min.	0	1	2	3	4	5	6
Total mass of water and the beaker / kg	1.25	1.24	1.24	1.14	1.02	0.93	0.83



Labelled axes with units with correct scale. 1M
Correct points plotted. 1M
Correct curve. 1M

(b) The <u>average kinetic energy of the water molecules increases</u> when the water is heated under the boiling point. 1M
Some molecules with higher kinetic energy may <u>gain enough energy to escape from the water</u>. 1M
So there is a slight decrease in the mass of water.

(c) $Pt = mc\Delta T$

$P(2)(60) = (1.25 - 0.05)(4200)(100 - 15)$ 1M

$P = 3570\,W$ 1A

(d)

$Pt = ml_v$

$(3570)(6 - 2)(60) = (1.24 - 0.83)l_v$ 1M (Accept m = 1.25 kg)

$l_v = 2.09 \times 10^6\,Jkg^{-1}$ 1A

(e) If there is steam condensed on the cooler wall of the beaker,
the measured mass of water vaporized will be underestimated. 1M
As a result the experimental value of the specific latent heat of vaporization of water
($l_v = \frac{E}{m}$) would be larger than the expected value. 1M

2. (a) At C,
PV = n R T ➔ $2.4\text{x}10^5\ (2.1\text{x}10^{-3})$ = n (8.31)(300) 1M
n = 0.202 1A

(b) When T = 300 K,
$P_A\ V_A = P_C\ V_C$ ➔ $(3.8\text{x}10^5)\ V_A = 2.4\text{x}10^5\ (2.1\text{x}10^{-3})$ 1M
$V_A = 1.33\text{x}10^{-3}\ m^3$ 1A

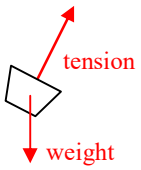
(c) $P_B / T_B = P_C / T_C$ ➔ 3.8/T = 2.4/300 1M
T = 475 K 1A
(or using PV= nRT)

(d) Energy gained by heating
$= \frac{3}{2}nR\Delta T = \frac{3}{2} \times 0.202 \times 8.31 \times (475 - 300) = 441J$ 1M+1A

3. (a) *AB*: decreasing, *BC*: unchanged 1M+1M
(b) $mgh = ½mv^2 + fs$ 1M
$30 \times 9.81 \times (4–1) = ½ \times 30 \times 5^2 + 50 \times s$
s = 10.2 m 1A
(c) v_H = horizontal speed = 5 cos 60° = 2.5 m s^{-1} 1M+1A
(c) vertical motion:
$v^2 = u^2 + 2gs$
$0 = (5 \sin 60°)^2 – 2 \times 9.81 \times (h – 1)$ 1M
h = 1.96 m 1A

4. (a) If only one seat is rotating, the tension acting
on the top of the stand gives a moment about the root of the stand 1M
and the stand will topple easily. 1M

(b) 1M+1M



(c) $\omega = 20\times 2\pi/60 = 2.09$ rad s^{-1} 1M
$a = \omega^2 r = 2.09^2\times 2$ 1M
$= 8.77$ m s^{-2} 1A

(d) horizontal: $T \sin\theta = m\omega^2 r \rightarrow T = m\omega^2 L$ 1M
vertical: $T\cos\theta = mg$ 1M
$m\omega^2 L\cos\theta = mg$ 1M

$\rightarrow \cos\theta = \dfrac{g}{\omega^2 L}$

(e) The angle θ increases. / The radius r increases. 1M

5. (a) Microwaves are emitted from the radar tower towards the plane at t_1. 1M
The plane reflects the waves back to the tower at t_2. 1M
By measuring the time elapsed $(t_2 - t_1)$,
the distance of the plane can be found as $c(t_2 - t_1)/2$. 1M

(b) $\lambda = c/f = 3\times 10^8 / 5\times 10^9$ 1M
$= 0.06$ m 1A
Yes, it can detect birds (as its wavelength is comparable to bird's size). 1M

(c) Refraction, 1M
due to the decrease in the air density, 1M
hence the speed of EM wave increases in the atmosphere.

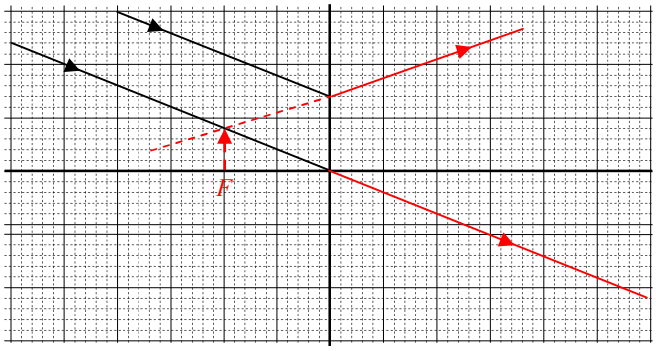
6. Hang the plate with the string at one corner,
and attach the ball at the other end of the string. 1M
When the string becomes steady and vertical,
mark the position of the string on the plate. 1M
Repeat the steps for another corner of the plate
to obtain one more line. 1M
The c.g. of the plate can be found at the point the lines meet. 1M

7. (a) Concave lens 1M

(b) Image formed at F (10 cm) 1M

Two correct rays 1M+1M

(withhold one mark for improper use of arrows and solid/dotted lines)



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

$\frac{1}{-10} = \frac{1}{100} + \frac{1}{v}$ 1M

v = –9.09 cm 1A

$m = v / u = 9.09/100 = 9.09\%$ 1A

8. (a) $R = \frac{V^2}{P} = \frac{12^2}{60} = 2.4\ \Omega$ 1M+1A

(b) Since the two lamps are connected in series, they must have the same current.
Also, $V_A + V_B = 12$ V

From Figure 8.1, it can be seen that when I = 2.4 A, 1M

$V_A \cong 3.6$ V and $V_B \cong 8.4$ V which satisfy $V_A + V_B = 12$ V. 1M

The power consumed by lamp A = $V_A I = 8.4 \times 2.4$
= 20.2 W 1A

The power consumed by lamp B = $V_B I = 3.6 \times 2.4$
= 8.6 W 1A

9. (a) A.c. voltage can be stepped up/down efficiently and easily by a transformer. 1M
In high voltage transmission, the current in the cable is much reduced,
hence by $P = I^2R$ the power loss in the cable can also be reduced. 1M

(b) $V_{AB} = 220 \times 1800 = 3.96 \times 10^5$ V 1M+1A

(c) Any ONE of the following reasons: 1M
Electrical energy is lost as heat when current flows through the coils.
Energy is lost in magnetizing and demagnetizing the core of the transformer.
Eddy current is induced in the core of the transformer.

corresponding to the following improvements: 1M
Use thick wires for the coil. / Use soft-iron core. /
Use a laminated core.

(d) By P = VI, current through the heater = $\frac{1000}{220} = 4.545 = 4.55A$ 1M
Peak current = $4.545 \times \sqrt{2} = 6.428 = 6.43A$ 1A

10. (a) When alternating current passes through the coil in the charger, 1M
varying magnetic field is produced which 1M
induces an e.m.f in the coil installed in the mobile phone. 1M
The induced e.m.f. charges the battery in the mobile phone.

(b) As the distance between the primary and secondary coil increases,
the magnetic field through the coil in the phone decreases significantly. 1M
Hence the change in the magnetic field through the coil in the phone decreases 1M
and so the induced e.m.f. used to charge the battery decreases. 1M

11. (a) A β source should be used. 1M
An α source is not suitable because
α radiation cannot penetrate through the cartons. 1M
A γ source is also not suitable because
γ radiation is so penetrating that all γ rays penetrate through the cartons 1M
regardless of the presence of milk inside the cartons.

(b) GM counter. 1M

(c) The abnormal increase in the recorded count rate for carton 5 indicates that 1M
β radiation is able to penetrate through the carton much easier than the others. 1M
The level of milk inside carton 5 may be lower than the standard limit. 1M

Paper 2

Section C: Energy and Use of Energy

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

Structured question (10 marks)

(a) By radiation 1M

(b) The roof is thinner than the wall. OR 1M
The sunlight is mainly incident to the roof from above.

(c) $P = UA\Delta T$
$0.4 = 0.3\times235\times\Delta T$ 1M
$\Delta T = 5.67\times10^{-3}$ K 1A

(d) OTTV = rate of total heat gain / total area
$= (2.5+0.4+3.2)\times1000 / (160+235+20)$ 1M
$= 14.7$ W m^{-2} 1A

(e) cooling capacity = power input × COP
$2.5+0.4+3.2 = P \times 2.2$ 1M
$P = 2.77$ kW 1A
cost = $2.77\times8\times\$1 = \$22.2$ 1A

(f) Any one: Add layers of glass wool to the wall 1M
Use double-glazed windows / windows with low-e coating /
apply solar control film / paint light colour to the exterior wall

Section D: Medical Physics

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

Structured question (10 marks)

(a) (i) Laser does not give colour image. 1M
(ii) It can be used for welding or cutting. 1M

(b) *Q* transmits <u>images</u> from the organ to the monitor, 1M
as the image can be transmitted through <u>total internal reflection</u> in the optical fibre. 1M

(c) It can be used for washing and cleansing the organ under surgery. 1M

(d) (i) A pair of forceps is inserted through the instrument channel to pick the sample. 1M
(ii) There is less complication / more rapid recovery after the surgery. 1M

(e) (i) Endoscope cannot examine the inside part of the lung. / 1M
Endoscope is only able to look at the surface of cavities. Only hollow organs can be examined, i.e. stomach and colon.
(ii) An X-ray radiograph can be used. 1M
It is fast/cheap/convenient (e.g. can be done in a medical centre). /
It can show the inflammation in lungs. (any one) 1M

Section A

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

1. Which of the following is NOT a vector?

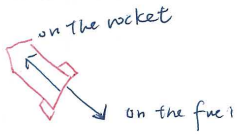
   A. power → energy (scaler)
   B. acceleration → time
   C. momentum
   D. displacement

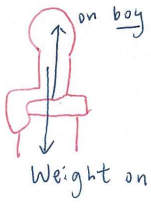
2. Which of the following can be explained by action and reaction pair?

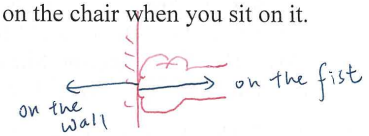
   (1) A rocket is pushed upward when the burning fuel is ejected down.
   (2) You feel painful when you hit a wall with your fist.
   (3) Your weight is balanced by the normal force on the chair when you sit on it.

   they are acting on the same body.

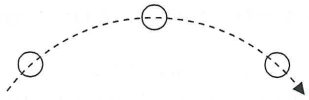
   A. (1) only
   B. (1) and (2) only
   C. (2) and (3) only
   D. (1), (2) and (3)





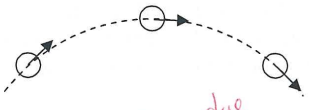


3.

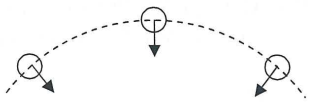


A man throws a small ball and it describes a projectile path. If air resistance is negligible, which of the following best shows the acceleration of the ball in the three positions shown in the figure?

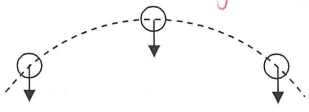
A.



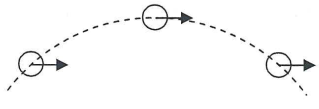
B.



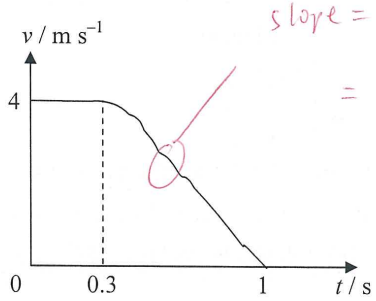
C. acceleration due to gravity



D.



4.



slope = deceleration
$= \frac{4}{1-0.3} = 5.7\ m s^{-2}$

A car driver sees a road block 3 m in front of him at t = 0 and applies the brake immediately. The car stops in one second. The total mass of the driver and the car is 800 kg. The velocity-time graph is shown above. Which of the following statements is/are correct?

(1) The reaction time of the driver is 0.3 s. ✓

(2) The braking force on the car is 1200 N. ✗ Braking force = ma = 800 × 5.7 = 4571 N

(3) The car would hit the road block. ✗ Stopping distance = area $= \frac{4}{2}(0.3+1)$ = 2.6 m (not hit the block) < 3 m

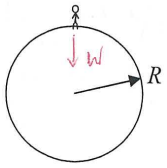
A. (1) only

B. (1) and (2) only

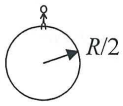
C. (1) and (3) only

D. (2) and (3) only

*5. $W = \frac{GMm}{R^2}$



planet *A*



planet *B*

$R \to \frac{R}{2}$, $M \to \frac{M}{8}$

$W' = \frac{G(\frac{M}{8})m}{(\frac{R}{2})^2} = \frac{W}{2}$

A boy is standing on the surface of planet A, and the force on the boy due to the gravity of planet A is W. Planet B is of the same density as planet A, but its radius is only half of that of planet A. What is the gravitational force on the boy if he stands on the surface of planet B?

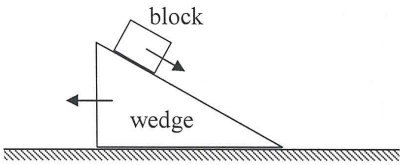
A. $4W$

B. $2W$

C. $W/4$

D. $W/2$

6.

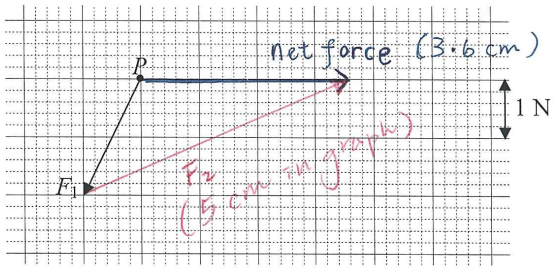


A block slides along the inclined surface of a wedge as shown. Assume all surfaces are smooth. Before the block leaves the wedge, which of the following quantities is/are conserved?

(1) total horizontal momentum of the block and the wedge ✓ ∵ no horizontal external force.
(2) total vertical momentum of the block and the wedge ✗ vertical external force exists (∵ more downward momentum)
(3) total energy of the block and the wedge ✓ no energy loss against friction

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

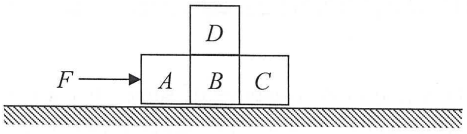
7.



Two forces, namely F_1 and F_2, are acting on P, so that the net force on P is horizontal. F_1 is shown in the above figure but F_2 is not shown. If the magnitude of F_2 is 5 N, which of the following values probably is the magnitude of the net force on P?

A. 3.6 N
B. 4.2 N
C. 4.8 N
D. 6.5 N

8. Four identical blocks are stacked and pushed by a force F, so that they are moving together horizontally. If the ground is smooth, find the force acting on A by B.



A. $\frac{F}{4}$

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

(C.) $\frac{3F}{4}$

D. F

consider the whole mass:

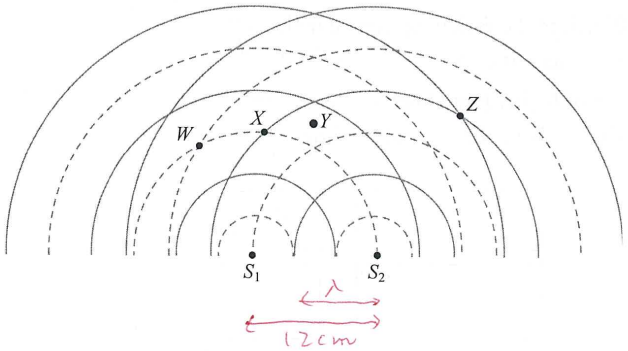
$F \rightarrow$ 4m $\quad a = \frac{F}{4m}$

consider block A:

$F \rightarrow \square \leftarrow f \quad F - f = ma = \frac{F}{4}$

$f = \frac{3F}{4}$

9. Two coherent sources S_1 and S_2 produce interference pattern in a ripple tank as shown. Solid lines represent crests and dotted lines represent troughs. If the separation of S_1 and S_2 is 12 cm, which position has a path difference of 4 cm from the sources?



A. W

(B.) X

C. Y

D. Z

$\therefore \lambda = 8$ cm

p.d. at X $= 2\lambda - 1.5\lambda$

$= 0.5\lambda$

$= 4$ cm

10.

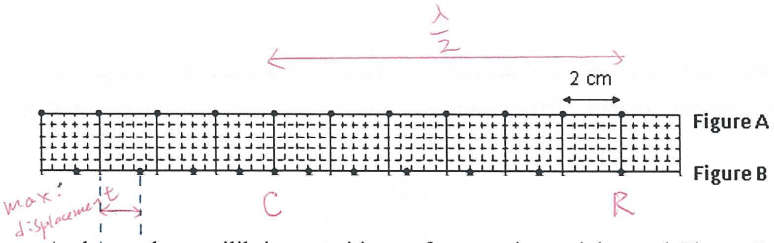


Figure A shows the equilibrium positions of some air particles and Figure B shows their positions at an instance when a sound wave given by a loudspeaker propagates towards the right. Which of the following statements is/are correct?

(1) The wavelength of the wave is 12 cm. ✗ distance between compression and rarefaction = $\frac{\lambda}{2}$ = 12 cm

(2) The amplitude of the wave is 1.4 cm. ✓

(3) The rightmost particle in Figure B is at rest. ✗ moving to left (backward)

$\Rightarrow \lambda$ = 24 cm

A. (2) only

B. (1) and (2) only

C. (1) and (3) only

D. (2) and (3) only

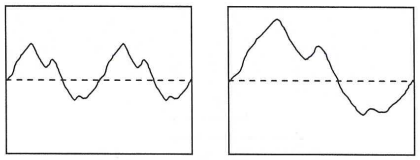
max displacement on the 2nd particle = 1.4 cm

11. Two musical notes *X* and *Y* are recorded by a C.R.O. with the same display setting as shown. Which of the following can be deduced?

(1) *Y* is louder than *X*. ✓ amplitude

(2) *Y* is of higher pitch than *X*. ✗ larger λ → lower f

(3) *X* and *Y* have the same waveform. ✓



sound *X* **sound *Y***

A. (1) only

B. (1) and (2) only

C. (1) and (3) only

D. (2) and (3) only

*12. A monochromatic light beam is incident to a diffraction grating and the angle between the zeroth and the second order fringe is 35°. How many fringes can be observed on the screen?

$d \sin\theta = n\lambda$

$d \sin 35^\circ = 2\lambda$

$\frac{d}{\lambda} = \frac{2}{\sin 35^\circ}$

$n = \frac{d}{\lambda} \sin\theta$

max $n \leq \frac{d}{\lambda}$

$= \frac{2}{\sin 35^\circ}$

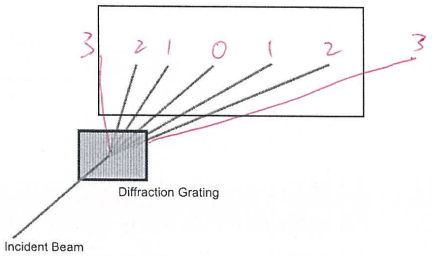
$= 3.49$ → At most third order

(A.) 7

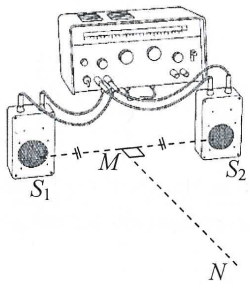
B. 9

C. 11

D. 13

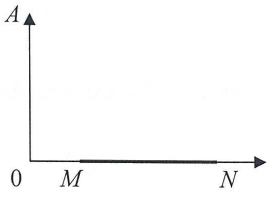


13.

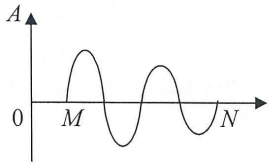


In the figure, two identical loudspeakers S_1 and S_2 are connected to a signal generator. MN is the perpendicular bisector of S_1S_2. Which of the following graphs best represents the change in the amplitude A of the sound detected along MN?

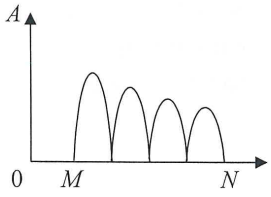
A.



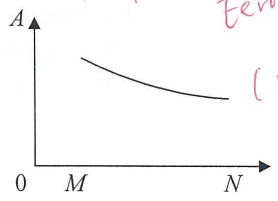
B.



C.

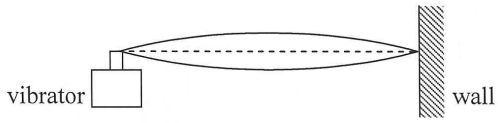


(D.)



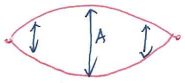
Amplitude would NOT be zero along MN. (unless destructive interference occurs)

14. An elastic string connected to a vibrator and a fixed wall steadily vibrates as shown. Which of the following statements is/are correct?



(1) All particles on the string vibrate in phase. ✓
(2) All particles on the string vibrate in the same frequency. ✓
(3) All particles on the string vibrate in the same amplitude. ×

Amplitude in the middle > that at the two ends.



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

15. A light ray enters a glass prism as shown. If the refractive index of the glass prism is 1.5, find the angle θ between the incident ray and the refracted ray.

A. 131°
B. 139°
C. 161°
D. 173°

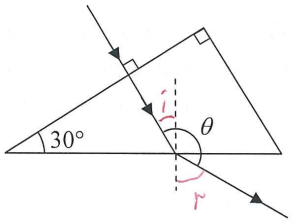
$i = 30°$

$\frac{\sin r}{\sin i} = 1.5$

$r = 48.6°$

$\theta = 180° - r + i$

$= 161°$



16. Which of the following correctly shows the uses of infra-red and the ultra-violet radiation ?

	Infra-red	**Ultra-violet radiation**
A.	Radar	Medical diagnosis
B.	Sterilizing water	Sun-tan
C.	Measuring temperature	Radiotherapy
D.	Remote control	Sterilizing water

17. A heater supplies 1000 J of energy to a 5-kg metal block. The temperature of that metal block rises from 25°C to 35°C. Assume that there is no energy loss to the surroundings. What is the heat capacity of the metal block?

A. 20 J °C^{-1}
B. 50 J °C^{-1}
C. 100 J °C^{-1}
D. 200 J °C^{-1}

$C = \frac{E}{\Delta T} = \frac{1000}{35-25} = 100\ J\ °C^{-1}$

* dont use $c = \frac{E}{m\Delta T}$ *

18. In an experiment measuring the specific latent heat of fusion of ice (l_f), 0.05 kg of melting ice is put into 0.2 kg of water in a polystyrene cup. The water is initially at 25°C. After the ice completely melts, the temperature of the water in the cup is measured to be 4.5°C. If the specific heat capacity of water is c, which of the following equations can be used to find l_f?

A. $0.2c \times 20.5 = 0.05 \times l_f$
B. $0.2c \times 20.5 = 0.05 \times l_f - 0.05c \times 20.5$
C. $0.2c \times 20.5 = (0.05 \times l_f + 0.05c) \times 4.5$
D. $0.2c \times 20.5 = 0.05 \times l_f + 0.05c \times 4.5$

energy lost by 0.2 kg water (25°C → 4.5°C) = energy gained + energy used by melting ice (0°C) + ice water (0° → 4.5°)

(25 − 4.5) (4.5 − 0)

*19. The r.m.s. speed of the molecules of a certain gas X is 341 m s^{-1} at 25°C. Find the r.m.s. speed of the molecules of gas X at 50°C.

A. 355 m s^{-1}
B. 370 m s^{-1}
C. 482 m s^{-1}
D. 682 m s^{-1}

formula A5: $\frac{1}{2}mc^2 = \frac{3RT}{2N_A}$

$\rightarrow \sqrt{c^2} \sim \sqrt{T}$ (in kelvin)

$\frac{\sqrt{c^2}}{341} = \sqrt{\frac{273+50}{273+25}} \Rightarrow \sqrt{c^2} = 355\ m s^{-1}$ //

20. Which of the following is NOT a property of conduction of heat?

A. Energy is transferred from the hot part to the cold part along an object.
B. The rate of conduction of heat in an object increases with the temperature difference between the hot end and the cold end of it, keeping other factors unchanged.
C. The rate of conduction of heat between two objects increases with the area of contact between them, keeping other factors unchanged.
D. The rate of conduction of heat between two objects increases with their mass, keeping other factors unchanged.

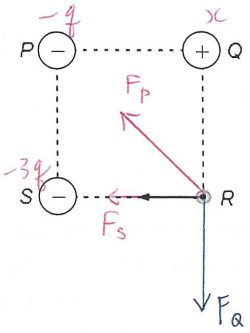
21. $PQRS$ is a square. Three point charges $-q$, $+x$ and $-3q$ are fixed at P, Q and S respectively as shown below. A point charge is then placed at R and it experiences a net electric force towards S. Which of the following is equal to x?

A. $\frac{\sqrt{2}}{4}q$

B. $\frac{1}{2}q$

C. $\frac{1}{9}q$

D. Cannot be determined.



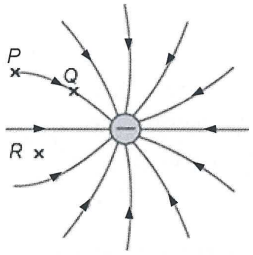
horizontal force on R
⇒ all vertical components cancel
⇒ $F_P \cos 45° = F_Q$
upward downward

$$\frac{q \cdot \frac{\sqrt{2}}{2}}{4\pi\varepsilon_0 PR^2} = \frac{x}{4\pi\varepsilon_0 QR^2}$$

$$\frac{q \cdot \frac{\sqrt{2}}{2}}{(\sqrt{2})^2} = \frac{x}{1^2}$$

$$x = \frac{\sqrt{2}}{4} q$$

22. The following figure shows an electric field.



Which of the following statements must be correct?

(1) When a charge is placed at P, it will move to Q along the field line. ✗

(2) When a charge is placed at R, the electric force acting on it is zero. ✗

(3) The electric force acting on a charge placed at P is smaller than that at Q. ✓

A. (1) only

B. (3) only

C. (1) and (2) only

D. (2) and (3) only

$F = Eq$

denser field line → larger force

field line = direction of force ≠ direction of motion

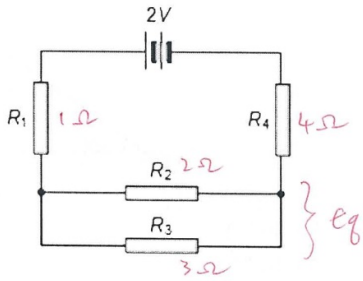
23. In the following circuit, the voltage across the battery is 2 V. If the ratio of the resistances of R_1, R_2, R_3 and R_4 is 1 : 2 : 3 : 4, what is the voltage across R_3?

A. $\frac{6V}{31}$

B. $\frac{3V}{10}$

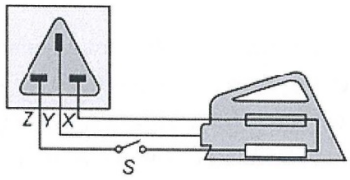
C. $\frac{V}{3}$

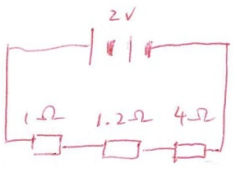
D. $\frac{12V}{31}$



equivalent
$R = \frac{2\times3}{2+3} = 1.2\,\Omega$

24. In the following figure, the electric iron is not properly connected.





X : live
Y : earth
Z : neutral

$V = 2\times\frac{1.2}{1+1.2+4} = \frac{1.2}{31}$ //

Which of the following statements is/are correct?

(1) The fuse should be connected to wire Z instead of wire X. fuse on live

(2) Switch S should be connected to wire X instead of wire Z. switch on live

(3) Wire Y should not be connected to the metal case.

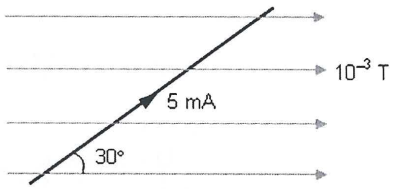
A. (1) only

B. (2) only

C. (1) and (3) only

D. (2) and (3) only

25. A straight wire of 0.4 m long carries a current of 5 mA in a uniform magnetic field of 10^{-3} T. The angle between the wire and the magnetic field is 30° as shown. What is the magnitude of the magnetic force on the wire?



$F = BIl\sin 30°$
$= 10^{-3} \times 5\times10^{-3} \times 0.4 \times \frac{1}{2}$
$= 10^{-6}$ N

(A) 1×10^{-6} N
B. 2×10^{-6} N
C. 1×10^{-3} N
D. 2×10^{-3} N

$3(0.01\text{ m})^2 = 3\times10^{-4}\text{ m}^2$

*26. The length and cross-sectional area of a 1500-turn solenoid are respectively 0.3 m and 4.5 cm^2. A single-turn coil of cross-sectional area 3 cm^2 is placed in the middle of the solenoid. The plane of the coil is perpendicular to the magnetic field produced by the solenoid. When the solenoid carries a current of 2 A, what is the magnetic flux through the coil? (Given $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1})

B-field in the solenoid
$= \frac{\mu_0 NI}{l} = \frac{4\pi\times10^{-7}\times1500\times2}{0.3} \approx 0.0126$ T

Φ on the coil $= BA$
$= 0.0126 \times 3\times10^{-4}$
$= 3.77\times10^{-6}$ Wb

(A) 3.77×10^{-6} Wb
B. 5.65×10^{-6} Wb
C. 8.48×10^{-3} Wb
D. 0.0126 Wb

27. Which of the following properties of the induced current increase(s) with the rotating speed of the coil in an a.c. generator?

(1) Period ✗ $T = \frac{1}{f}$
(2) Peak value ✓
(3) Frequency ✓

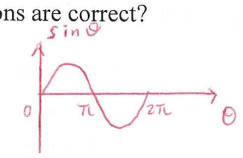
A. (1) and (2) only
B. (1) and (3) only
(C) (2) and (3) only
D. (1), (2) and (3)

*28. The instantaneous value I (in A) of an alternating current at time t (in s) is given by the equation $I = \sqrt{2}\sin 20\pi t$. Which of the following descriptions are correct?

(1) The frequency of the a.c. is 10 Hz.

(2) The value of I varies between $-\sqrt{2}$ A and $+\sqrt{2}$ A.

(3) The r.m.s. value of the current is 1 A.



$I_{r.m.s.} = \frac{I_{max}}{\sqrt{2}} = 1\,A$ (for sinusoidal signal)

Signal repeats if $\theta = 2\pi$

$\Rightarrow 20\pi t = 2\pi$

$t = \frac{1}{10}$

$f = 10$ Hz

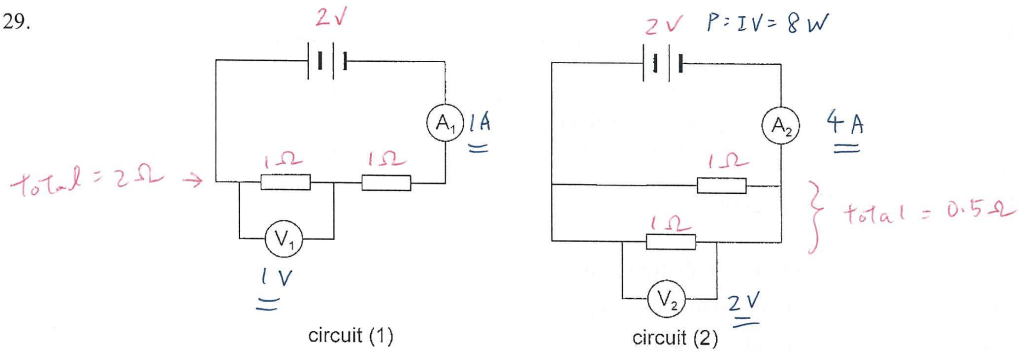
A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

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

29.



$P = IV = 2W$

$P = IV = 8W$

total = 2Ω →

total = 0.5Ω

In the two circuits shown above, the two batteries are identical and the four resistors are also identical. Which of the following statements is INCORRECT?

A. The equivalent resistance of circuit (1) is greater than that of circuit (2).

B. The reading of voltmeter V_1 is smaller than that of voltmeter V_2.

C. The reading of ammeter A_1 is greater than that of ammeter A_2.

D. The power dissipated in circuit (1) is smaller than that of circuit (2).

30. Two parallel metal plates are placed horizontally with a separation of 1 cm. A voltage of 2 kV is applied across the plates. An oil droplet with a charge of -1.6×10^{-19} C is observed to be stationary between the plates as shown. What is the mass of the oil droplet?

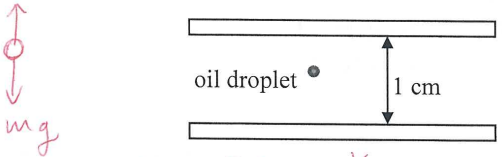
A. 3.26×10^{-19} kg

B. 3.26×10^{-15} kg

C. 6.52×10^{-15} kg

D. 3.26×10^{-14} kg

$F = Eq$



mg

$mg = Eq = \frac{V}{d} \times e$

$m \times 9.81 = \frac{2000}{0.01} \times 1.6 \times 10^{-19}$

$m = 3.26 \times 10^{-15}$ kg

*31. The activity of a radioactive source decreases from 4000 units to 1250 units in 11 hours. The half-life of the radioactive source is

$1250 = 4000\, e^{-k \times 11}$

$k = 0.106\ h^{-1}$

$t_{\frac{1}{2}} = \frac{\ln 2}{k} = 6.56\ h$ //

A. 6.34 minutes.
B. 6.56 hours.
C. 6.88 hours.
D. 17.6 hours.

32. A radioactive source is placed in front of a GM tube connected to a counter. Different materials are placed between the source and the GM tube. The following table shows the count rate recorded:

Material	Counts per minute
Nothing	504
Aluminium (0.2 mm thick)	497
Lead (2 mm thick)	261
Lead (20 mm thick)	157

no α
emits β
emits γ

The source emits

A. α and β radiation only.
B. α and γ radiation only.
C. β and γ radiation only.
D. α, β and γ radiation.

33. The mass of a nucleus is usually smaller than the total mass of the components of the nucleus. The difference in mass is converted into the binding energy which holds the particles together. It is known that

mass of a proton = 1.6726×10^{-27} kg
mass of a neutron = 1.6749×10^{-27} kg
mass of an α particle = 6.6447×10^{-27} kg

What is the binding energy for an α particle? helium nucleus $\{ 2p^+ \atop 2n$

Δm = mass of $\alpha - 2p^+ - 2n$
$= 6.6447 \times 10^{-27} - 2(1.6726 \times 10^{-27}) - 2(1.6749 \times 10^{-27})$
$= -0.0503 \times 10^{-27}$ kg

$\Delta E = \Delta m \cdot c^2$
$= 4.53 \times 10^{-12}$ J

A. 1.52×10^{-20} J
B. 4.53×10^{-12} J
C. 2.97×10^{-10} J
D. 3.06×10^{-10} J

End of Section A

Section C: Energy and Use of Energy

Q.3: Multiple-choice questions

3.1 Which of the following sentences about an electric hotplate and an induction cooker is/are correct?

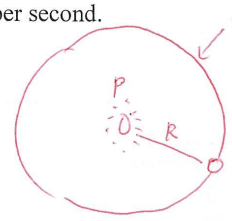
(1) Both make use of the heating effect of current to cook.
(2) Both require alternating current to work properly.
(3) Both require metallic cooking utensils to work properly.

	hotplate	induction
(1)	heating in wire	eddy current in the pan
(2)	×	✓
(3)	×	✓

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

A	B	C	D
○	○	○	○

3.2 Solar constant is known to be 1366 W m^{-2}. The average radius of the Earth is 6371 km and the Sun-Earth distance is about 1.496×10^{8} km. Estimate the total radiation energy emitted by the Sun per second.



total area of this sphere $= 4\pi R^2$

A. 2.11×10^{26} J
B. 3.84×10^{26} J
C. 3.56×10^{27} J
D. 1.67×10^{27} J

A	B	C	D
○	○	○	○

Total power of Sun $= P$

$$\frac{P}{4\pi R^2} = 1366$$

$$P = 1366\times4\pi(1.496\times10^{8}\times10^{3})^2 = 3.84\times10^{26}\ \text{W}$$

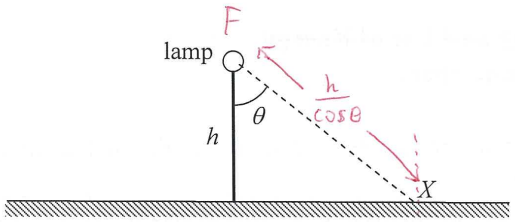
3.3 Which of the following best shows the parts possessed by petrol cars, electric cars and hybrid cars?

	parts	petrol cars	electric cars	hybrid cars
A.	rechargeable battery	×	✓	×
B.	regenerative braking system	✓	✓	✓
C.	combustion engine	✓	×	✓
D.	motor	×	✓	×

A	B	C	D
○	○	○	○

Class: _____ No: _____

3.4



As shown in the figure, the lamp on a post of height h can be regarded as a point light source. The illuminance on the ground at X is directly proportional to

A. $\frac{\cos\theta}{h}$.

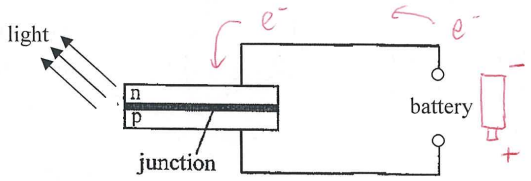
B. $\frac{\cos^2\theta}{h^3}$.

C. $\frac{\cos^3\theta}{h^2}$.

D. $\frac{\cos^3\theta}{h}$.

A	B	C	D
○	○	○	○

3.5



The above figure shows a basic LED. Which of the following is/are correct?

(1) The p-layer is connected to the positive pole of the battery.

(2) The p-layer contains excess holes and the n-layer contains excess free electrons.

(3) Electrons and holes meet at the junction and light is emitted.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

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

A	B	C	D
○	○	○	○

3.6 Which of the following statements about nuclear fission reactor is correct?

(1) Uranium nuclei split into smaller nuclei for giving out energy. ✓

(2) Uranium-235 nuclides are used as the fuel. ✓

(3) Pressurized water is used as moderator to slow down the reaction. ✗ slow down neutrons to increase the chance of reaction

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

A	B	C	D
○	○	○	○

3.7 $^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{1}H + ^{1}_{1}H$

The nuclear energy released in the above reaction is 4.033 MeV. If the binding energy per nucleon of hydrogen-2 is 1.112 MeV, estimate the binding energy of hydrogen-3.

A. 4.156 MeV
B. 5.233 MeV
C. 6.902 MeV
D. 8.481 MeV

A	B	C	D
○	○	○	○

binding energy of $^{3}_{1}H$ = binding energy of $2 \times ^{2}_{1}H$ + 4.033 MeV ✓

$= 2 \times 1.112 \times 2 + 4.033 = 8.481$

3.8 Which of the following can increase the power generated by a wind turbine?

(1) Put the wind turbine off the shore. ✓ (stronger wind)

(2) Use longer blades. ✓ area ↑

(3) Turn the wind turbine to face the incoming wind. ✓

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

A	B	C	D
○	○	○	○

Section D: Medical Physics

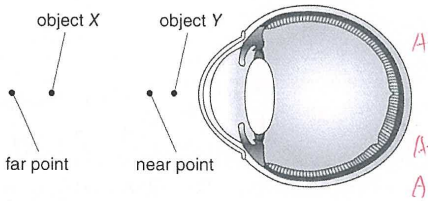
Q.4: Multiple-choice questions

4.1 The near point of Hinson's eye is at 40 cm. By wearing a corrective lens of +2D, how is his vision improved?

A. He can now see an object clearly at distance as close as 20 cm.
B. He can now see an object clearly at distance as close as 22 cm.
C. He can now see an object clearly at distance as far as 22 cm.
D. He can now see an object clearly at distance as far as 2 m.

A	B	C	D
○	○	○	○

4.2 The figure below shows a simple diagram which gives the relative positions of object *X*, object *Y*, the near point and the far point of an eye.



If the eye is looking at object *Y*, at which position does the light from object *X* and object *Y* converge to?

	Object *X*	**Object *Y***
A.	On the retina	In front of the retina
B.	Behind the retina	In front of the retina
C.	In front of the retina	Behind the retina
D.	On the retina	Behind the retina

A	B	C	D
○	○	○	○

4.3 For most people, the sound intensity level of the threshold of pain is 140 dB. What is the ratio of the intensities of this sound and the softest audible sound?

A. 21 : 1
B. 140 : 1
C. 10^{14} : 1
D. 10^{140} : 1

A	B	C	D
○	○	○	○

Class: _____ No: _____

4.4 When a sound is transmitted in the ear, the pressure on the oval window is larger than that on the eardrum. The difference is due to

(1) the smaller size of the oval window. ✓

(2) the larger force acting on the oval window. ✓

(3) more energy is transmitted through the oval window. ✗

nothing supplies more energy to the inner ear.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

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

A	B	C	D
○	○	○	○

4.5 Which of the following sentences about ultrasound imaging is/are correct?

(1) It involves ionizing radiation. ✗

(2) It can detect real-time image. ✓

(3) It is not suitable to observe air-filled organs. ✓

A. (1) only

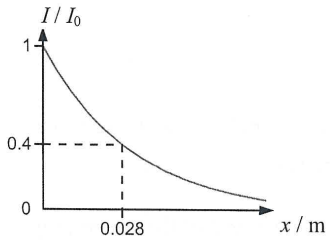
B. (3) only

C. (1) and (2) only

D. (2) and (3) only

A	B	C	D
○	○	○	○

4.6



$I = I_0 e^{-\mu x}$

$0.4 = e^{-\mu \times 0.028}$

$\mu = 32.7\ m^{-1}$ //

An X-ray beam of intensity I travels through a certain distance x in a muscle. The graph above shows the relation between I / I_0 and x, where I_0 is the original intensity of X-ray when it enters the muscle. Find the linear attenuation coefficient of the muscle.

A. $9\ m^{-1}$

B. $33\ m^{-1}$

C. $40\ m^{-1}$

D. $57\ m^{-1}$

A	B	C	D
○	○	○	○

7

4.7 When a patient takes a CT image, he will receive a larger radioactive dose than taking a radiographic image. Which of the following reasons are correct?

(1) The ionizing power of X-rays used in CT imaging is greater than that in radiographic imaging.

(2) The examination time of CT imaging is longer than that of radiographic imaging.

(3) The body receives more X-ray coming from different angles when the X-ray tube rotates.

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

A	B	C	D
○	○	○	○

4.8

The figure above shows a radionuclide image of a patient's whole body. The grey scale of the image represents

A. the attenuation coefficient of the gamma rays.
B. the intensity of the gamma rays reflected from the boundary of the tissue.
C. the amount of the abnormal cells.
D. the concentration of the radioactive tracer.

A	B	C	D
○	○	○	○