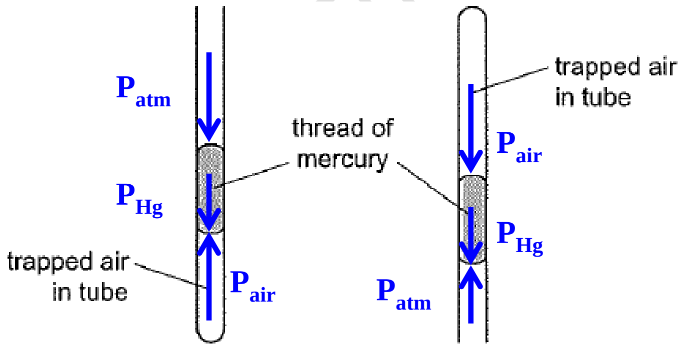
Catholic High School | O-Level Physics
5059 Nov 2014
Suggested Answers

NOT IN SYLLABUS:	
P1:	-
P2:	-

Paper 1 [40 marks]

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

***Q. 14:** **(C)**



This question required the application of a standard fact to an unfamiliar situation. Some found this difficult.

[Note: The pressure of a gas is inversely proportional to its volume.
When the tube is held upright: $P_{air} = P_{atm} + P_{Hg}$.
When the tube is held upside down: $P_{air} + P_{Hg} = P_{atm} \Rightarrow P_{air} = P_{atm} - P_{Hg}$.
The reduction in pressure causes the volume of the air to increase, assuming temperature is constant.
(B is incorrect: Atmospheric pressure acts equally in all directions.)
(D is incorrect: Pressure is exerted equally in all directions.)

***Q. 15:** **(B)** This question tested factual knowledge. A significant minority opted for A which incorrectly suggests that a gas has a fixed volume.
(A is incorrect.)

***Q. 16:** **(B)** [Note: The better insulating materials take a longer time to heat up.]
(D is incorrect.)

***Q. 20:** **(A)** This question required the application of a standard fact to an unfamiliar situation. Some found this difficult.

[Note: Evaporation causes cooling. There is no rise in temperature.]
(D is incorrect.)

***Q. 22:** **(C)** Some found this question challenging.

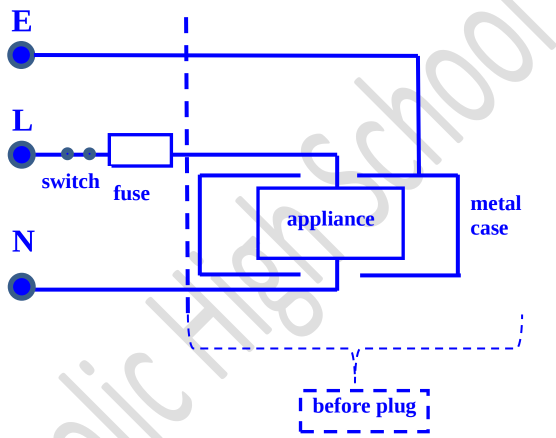
[Note: Determine the angle between the original incident ray and the *reflected* ray.]
(A is incorrect.)

***Q. 27:** **(C)** [Note: The current flowing through a solenoid produces a magnetic field, and *not* an electric field.]
(A is incorrect.)

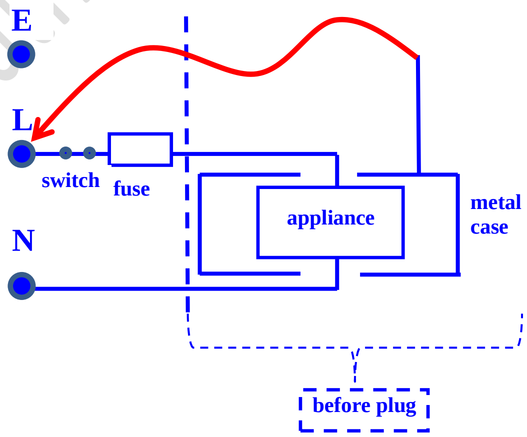
***Q. 28** **(D)** [Note: The two materials must be made of insulators and not conductors. so that they will not lose their excess charges when earthed.]
(A is incorrect.)

***Q. 32** **(B)**

usual, correct situation



this question

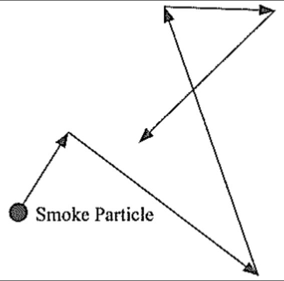
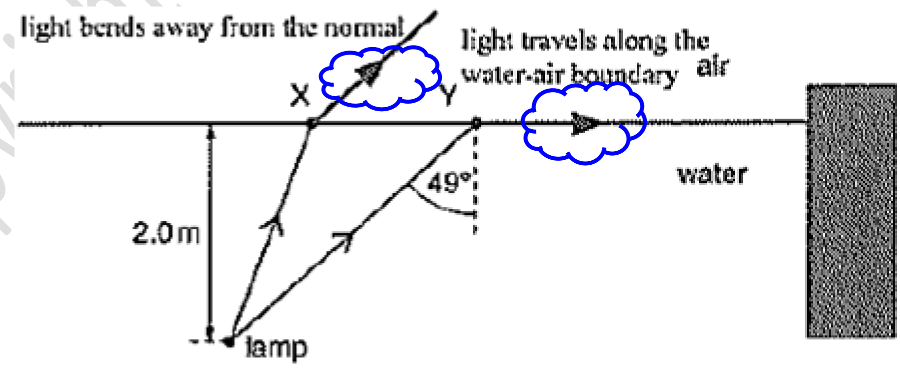


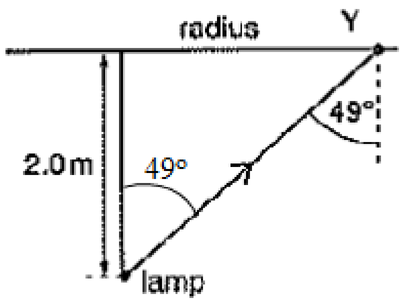
This question asked about a poorly wired mains plug and the consequence of an error shown in the diagram. Many found this a challenging question.

[Note: The live and the neutral wires are both correctly plugged into the mains. The metal case is wrongly connected to the mains, through the live terminal.]
(A and D are incorrect.)

Paper 2 [80 marks]

1	ai	Elastic potential energy	1
	aii	Gravitational potential energy	1
	bi	K.E. $= \frac{1}{2} mv^2$ 1900 $= \frac{1}{2}(45)(v^2)$ v = <u>9.19 m s^{-1}</u> (3 s.f.)	 1 1
	bii	Not all the elastic potential energy in the spring is transferred to the gymnast as K.E. Some of it is lost as thermal or sound energy *in the stretched spring*. [<u>Note</u>: Some of it is also transferred to her as G.P.E., as B is higher than A).	1
2	ai	The precision of a ruler is 0.1 cm. It is thus not possible to accurately measure the internal diameter of the washer, 0.80 cm, with the correct precision. [Or: It is difficult to place the ruler accurately across the diameter of the washer.]	1
	aii	Vernier calipers	1
	bi	Volume $= \pi r^2 h$ = External volume - Internal volume $= \pi[(\frac{2.5}{2})^2 - (\frac{0.80}{2})^2](0.15)$ = <u>0.661 cm^3</u> (3 s.f.) [<u>Note</u>: There is no need to convert the answer to m^3.]	 1 1
	bii	Density $= \frac{\text{mass}}{\text{volume}}$ $= 5.2 \div 0.661$ = <u>7.87 g cm^{-3}</u> (3 s.f.) [<u>Note</u>: There is no need to convert the answer to kg m^{-3}.]	 1 1
3	ai	Mass is the amount of substance in an object. Weight is the amount of gravitatonal force acting on an object.	1
	aii	W = mg [<u>Note</u>: g = gravitational field strength, N / kg] $m = \frac{W}{g}$ = 150 000 ÷ 10 = <u>15 000 kg</u> (3 s.f.)	 1
	bi	Taking moments about point X: Sum of clockwise moments = sum of anti-clockwise moments $(Lift_{front})(7.0 + 5.0) = (150\ 000)(5.0)$ $Lift_{front} = \frac{(150\ 000)\ (5.0)}{12.0}$ = <u>62 500 N</u> (3 s.f.)	 1 1
	bii	Sum of upward forces = sum of downward forces $Lift_{front} + Lift_{back}$ = 150 000 $Lift_{back}$ = 150 000 - 62 500 = <u>87 500 N</u> (3 s.f.) [Or: Take moments about C.G. or at $lift_{front}$]	 1 1
	c *	*Reduce* lift force at front rotor *<u>and</u> increase* lift force at back rotor. [<u>Note</u>: It is insufficient to just decrease the lift force at front rotor; or just increase the lift force at back rotor. This is because the question has stated that the C.G. of the helicopter stays at the same height.]	1

4	a		1
	b	1. The air molecules are in constant, random motion. 2. The air molecules collide *unevenly* with the smoke particles.	1 1
	c	When the air molecules move faster, the frequency and *force* of collisions *with the walls of the glass box* increases. Thus the force acting per unit area increases, and results in an increase in pressure of the air.	1 1
5	a	As a liquid solidifies, the molecules have lower potential energy as intermolecular forces of attraction between the molecules increase. The particles lose the ability to move freely and now vibrate about their fixed positions.	1
	b	Total energy removed $= mc\Delta\theta + ml_f$ $= (400)(4.2)(20 - 0) + (400)(330)$ $= 33\ 600 + 132\ 000$ $=$ <u>166 000 J</u> (3 s.f.)	1 1 1
	c	The air around the freezing compartment ***contracts*** as it cools, becomes denser and sinks. Warmer, less dense air at the bottom will rise to the top, and be cooled by the freezing compartment. This forms convection currents. [<u>Note</u>: It is wrong to state that 'the cooler, denser air is warmed at the bottom and expands'.]	1 1 1
6	a	Critical angle is the angle of incidence in the *optically denser medium*, for which the angle of refraction in the optically less dense medium is 90°.	1
	b		2
	ci	Within the circular area, the angle of incidence is less than the critical angle and light rays will be refracted into the air. Outside the circular area, the angle of incidence is greater than the critical angle and light rays will undergo total internal reflection, reflecting totally back into the pool. As light travels in all directions, the refracted light rays will thus appear to form a circular area.	1 1

	cii	 $\tan 49° = \frac{r}{2}$ $r = 2 \times \tan 49°$ = <u>2.30 m</u> (3 s.f.)	1 1
7	a	Light-dependent resistor (LDR)	1
	b	$R_{total} = (\frac{1}{R_1} + \frac{1}{R_2})^{-1}$ $= (\frac{1}{60} + \frac{1}{30})^{-1} + (\frac{1}{80} + \frac{1}{80})^{-1}$ = 20 + 40 = <u>60 Ω</u>	 2 1
	ci	Current is the rate of flow of electric charges passing a point in the circuit.	1
	cii	When the light intensity increases, the resistance of the LDR decreases. This reduces the overall resistance of the circuit ($I = \frac{V}{R}$), and hence the current in the battery increases.	1
8	ai	Efficiency is the ratio of useful *power* output to total *power* input. [Or: - Ratio of useful *energy* output to total *energy* input. - Ratio of useful *work done* to total *work done*.]	1
	aii	Filament lamp: Output power = $\frac{9}{100} \times 40$ = 3.60 W Fluorescent lamp: Output power = $\frac{40}{100} \times 10$ = 4.00 W <u>Fluorescent lamp</u> produces greater useful output power.	1
	aiii	Energy savings = (No. of kW)(No. of h) $= (\frac{40}{1000})(600) - (\frac{10}{1000})(600)$ = 18 kWh Cost savings = 18 × \$0.25 = <u>\$4.50</u>	 1 1 1
	bi	Infra-red radiation	1
	bii	According to Fig. 8.2, at point P where most energy is emitted, it is in the infra-red region and is radiated as thermal energy.	1
	biii *	Using Fig. 8.1: With 96% of the radiation transmitted, the efficiency of the filament lamp is only 9%. Even if 100% of the radiation is transmitted, the efficiency of the filament lamp is not likely to increase much and is still much lower than the 40% efficiency of the flouroscent lamp. [<u>Note</u>: 96% of radiation transmitted → 9% efficiency 100% of radiation transmitted → $9\% \times \frac{100}{96} \approx 9.4\%$ efficiency < 40%]	1
9	a	• The wind may be blocked by high-rise buildings. • There is not enough land in Singapore for the wind turbines. • The wind strength may not be consistent.	1 Any one

<table>
<tr><td></td><td>bi</td><td>For wind speed between 0 and 5 m s^{-1}, there is no power output.
For wind speed between 5 - 15 m s^{-1}, power output increases uniformly from 0 - 0.6 MW.
For wind speed above 15 m s^{-1}, power output is constant at 0.6 MW.</td><td>1
1

1</td></tr>
<tr><td></td><td>bii</td><td>There is only power output for wind speeds ≥ 5 m s^{-1}.

<table>
<tr><td>time/
min</td><td>wind speed/
m s^{-1}</td><td>power output/
MW</td><td>energy generated
(in 1 min) /J</td></tr>
<tr><td>2</td><td>16</td><td>0.6</td><td>E = Pt = $(0.6 \times 10^6)(60)$ =
3.60×10^7 J</td></tr>
<tr><td>3</td><td>16</td><td>0.6</td><td>3.60×10^7 J</td></tr>
<tr><td>6</td><td>20</td><td>0.6</td><td>3.60×10^7 J</td></tr>
<tr><td>7</td><td>22</td><td>0.6</td><td>3.60×10^7 J</td></tr>
<tr><td>8</td><td>10</td><td>0.3</td><td>1.80×10^7 J</td></tr>
<tr><td>9</td><td>10</td><td>0.3</td><td>1.80×10^7 J</td></tr>
<tr><td colspan="3">Total</td><td><u>1.80×10^8 J</u> (3 s.f.)</td></tr>
</table></td><td>3</td></tr>
<tr><td></td><td>biii</td><td>The wind speed may not be constant for each 1 minute interval.

[<u>Note</u>: The power *output* values given in the question already account for inefficiency of the turbine. Answers which merely described how the turbine wastes energy are not accepted.]</td><td>1</td></tr>
<tr><td></td><td>c</td><td>Use step-up transformers to increase the voltage (at the wind turbines).
This reduces the current (P = IV) and thus reduces power losses in the cable ($P_{loss}=I^2R$).</td><td>1
1</td></tr>
<tr><td>10</td><td>a</td><td>P must be greater than 0.5 N for a resultant force to accelerate the bag from rest.</td><td>1</td></tr>
<tr><td></td><td>bi</td><td>F = ma</td><td>1</td></tr>
<tr><td></td><td>bii</td><td>When P = 3.00 N, a = 1.250 m s^{-2}

$F_{resultant}$ = ma
3.00 - 0.50 = m(1.250)
2.50 = m(1.250)
m = <u>2.00 kg</u> (3 s.f.)</td><td>1

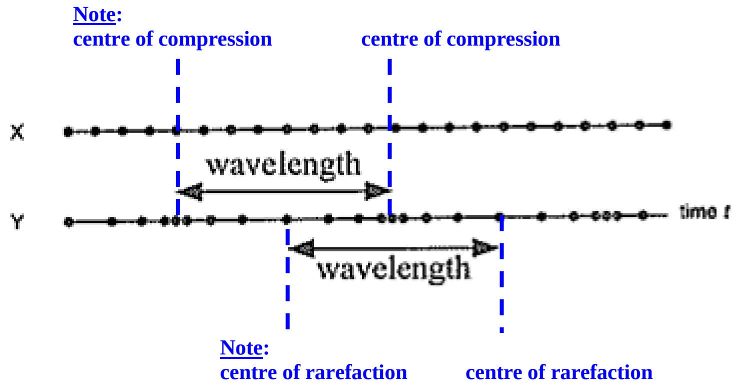
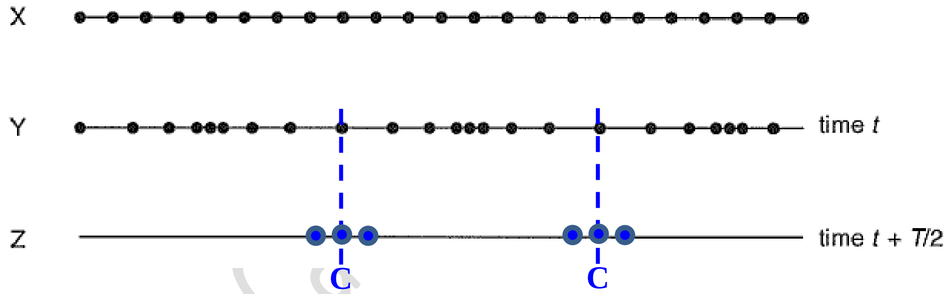
1</td></tr>
<tr><td></td><td>ci</td><td>When P = 2.00 N, a = 0.750 m s^{-2}
$a = \frac{v - u}{t}$
v = u + at = 0 + (0.75)(3.0)
= <u>2.25 m s^{-1}</u> (3 s.f.)</td><td>

1
1</td></tr>
<tr><td></td><td>cii</td><td>When P is reduced to 0.5 N, the forces are balanced, so there is no resultant force acting on the object.
Using Newton's First Law of Motion, the bag will travel at a constant velocity (of 2.25 m s^{-1}).</td><td>1

1</td></tr>
<tr><td></td><td>d</td><td>The action-reaction pair is the pulling force acting on the student by the school bag.
It acts to the left and is equal to the magntitude of P.
[<u>Note</u>: The air resistance, weight or normal contact force are not the other part of the action-reaction pair.]</td><td>1

1</td></tr>
</table>

11 E	ai	E.m.f is the work done by a power source to drive a ***unit*** charge ***around a complete circuit***.	1
	aii	P.d. is the work done to drive a ***unit*** charge ***between two points/ across an electrical component in a circuit***. [Or: P.d. is the amount of energy converted from electrical to other forms when a ***unit*** charge passes between two points/ across an electrical component in a circuit.]	1
	bi	P.d. across R_1 = 9.0 - 2.6 V = <u>6.4 V</u> (1 d.p.)	1
	bii 1	Current in R_1 $= \frac{V}{I}$ $= 6.4 \div 500$ $= 0.0128$ = <u>12.8 mA</u> (3 s.f.)	 1 1
	bii 2	Current in R_2 = 12.8 - 1.0 = <u>11.8 mA</u> (3 s.f.)	1
	bii 3	$R_2 = \frac{V}{I} = 2.6 \div 0.0118 =$ <u>220 Ω</u> (3 s.f.)	1
	ci	With a higher resistance, the current is lower.	1
	cii	Increase resistance of R_2 (potential divider).	1
	ciii *	When R_1 has a resistance of 6000 Ω, the current through it is $\frac{V}{R} = \frac{6000}{6.4} =$ 1.07 mA. It is then likely that the current passing through the electronic device would be less than the 1.0 mA needed (for it to function). [<u>Note</u>: - A common mistake was to suggest that a high resistance would cause fire or overheating, despite having calculated a very low value of 13 mA for the current. - It is also wrong to state that there is no current or voltage if the resistance exceeds 6000 Ω.]	1
11 O	ai	$v = f\lambda$ $\lambda = \frac{v}{f} = 330 \div 220$ $= 1.5$ m Number of vibrations = 21 ÷ 1.5 = <u>14</u> (whole number) [Or: $v = \frac{\Delta s}{t} \quad \Rightarrow t = \frac{\Delta s}{v} = \frac{21}{330} = 0.06364 = 0.0636$ s 220 Hz ⇒ 220 vibrations per s ⇒ 0.06364 s → 220 × 0.06364 = <u>14 vibrations</u>	 1 1 1
	aii 1	*(Question states '… using ideas about the vibrations of molecules in the air…')* A frequency of 220 Hz means that the ***air molecules*** complete ***220*** oscillations/ vibrations per second.	1
	aii 2	A lower amplitude means that the the ***maximum displacement*** of the air molecules ***from their undisturbed positions*** is reduced.	1

	bi		
	bii	Sound energy is transferred from molecule to molecule, as the disturbed molecules vibrate more about their fixed positions and collide with neighbouring molecules. However, matter is not transferred as the molecules only vibrate about their fixed positions but do not move with the wave.	1 1
	biii	The direction of the ***vibration of the particles*** is ***parallel*** to the direction of the movement of the wave.	1
	biv		1