Catholic High School | O-Level Physics
5059 Nov 2015
Suggested Answers

NOT IN SYLLABUS:	
P1:	-
P2:	-

Paper 1 [40 marks]

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

***Q. 1:** **C**

Most appeared to be aware of the order of magnitude of the diameter of an atom.
Only a significantly smaller proportion were aware of the order of magnitude of the diameter of the Earth.
(Both A and B are incorrect.)

***Q. 5:** **B**

Those who chose D were clearly aware of the effect of air resistance on the velocity of the falling box, but did not convert the increasing magnitude of the velocity to a displacement-time graph of increasing positive gradient.
(D is incorrect.)

***Q. 7:** **D**

In Newton's Second Law of Motion equation $F_R = ma$, F_R is resultant force.
The resultant force acting on the car is F_R = driving force - frictional force, i.e.
F_R = driving force - 1200
ma = driving force - 1200
(800)(2.5) = driving force - 1200
Hence, driving force = 2000 + 1200 = 3200 N
(A is incorrect.)

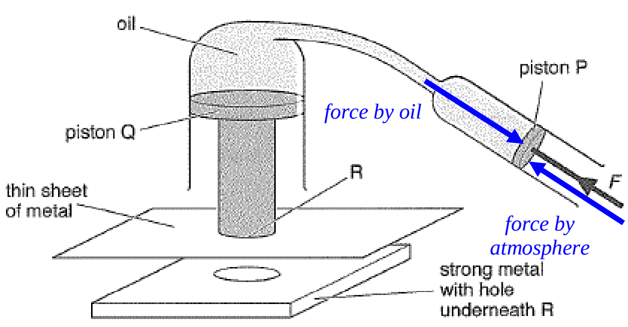
***Q. 26:** **B**

For a converging lens, the rays will bend away from its original direction, *towards* the principal axis. Also, after passing through the converging, the rays do not necessarily converge to meet (think of magnifying glass).
(C is incorrect.)

***Q. 34:** **D**

When the amount of light *increases*, the resistance across the LDR *decreases*. Hence the p.d. across the LDR *decreases* and the *reading on the voltmeter across the resistor increases*.
(C is incorrect.)

Paper 2 [80 marks]

1	a	1. Using a stopwatch, record t_1 and t_2: timing for first and second set of 20 complete movements. 2. Calculate $t_{av} = \frac{t_1 + t_2}{2}$: average time for 20 complete movements. 3. Calculate $t = \frac{t_{av}}{20}$: average time for 1 complete movement.	1 1 1
	bi	The distance moved by the athlete *along the track*.	1
	bii	1. Work done by athlete = (force)(distance along track) (i.e. $W = Fd$) 2. Power of the athlete $= \frac{\text{work done by athlete}}{\text{average time for 1 complete movement}}$ (i.e. $P = \frac{W}{t}$)	1 1
2	a	When an object is in equilibrium, the sum of clockwise moments about the pivot (/ any point) is equal to sum of anti-clockwise moments about the same pivot (/ same point).	1 1
	bi	With a 30 N force applied vertically (upwards) at A, the perpendicular distance between the line of action of the force and the pivot is the largest.	1
	bii	$M = Fd$ = (30)(20) = <u>600 Ncm or 6.0 Nm</u>)	1 1
	biii	Taking moments about the pivot, Clockwise moment by brake cable = Anticlockwise moment by hand-grip 600 = F(1.2) $F = M \div d = 600 \div 1.2 =$ <u>500 N</u> (2 or 3 s.f.)	1
3	ai1	$p = \frac{F}{A}$ Force that *oil* exerts on piston P = pA = $(3.0 \times 10^5)(5.0 \times 10^{-5})$ = <u>15.0 N</u> (3 s.f.)	1 1
	ai2	Force that *atmosphere* exerts on piston P = pA = $(1.0 \times 10^5)(5.0 \times 10^{-5})$ = <u>5.00 N</u> (3 s.f.)	1
	ai3	 By equilibrium of forces, F + force by atmosphere = force by oil $F + 5.0 = 15$ $F = 15 - 5.0 =$ <u>10.0 N</u> (3 s.f.)	1
	aii	Since the pressure transmitted throughout the oil is the same, as piston Q has a *larger* cross-sectional area (than piston P), a larger force will be exerted on the metal plate at R by piston Q.	1
	bi	The air molecules are in constant, random motion. In Fig. 3.2b, the number of air molecules per unit volume has increased. The air molecules hence collide *more frequently* with the surface of the air bubble, hence exerting a larger force per unit area.	1 1
	bii	Air is compressible, so any pressure exerted on the hydraulic press would be used to compress the bubbles of air first.	1

<table>
<tr><td>4</td><td>a</td><td>Gravitational force acting per unit mass.</td><td>1</td></tr>
<tr><td></td><td>b</td><td>Increase in weight $= W_{final} - W_{initial} = m(g_{final} – g_{initial})$
$= (80)(9.8 – 9.7)$
= <u>8.00 N</u> (3 s.f.)</td><td>1</td></tr>
<tr><td></td><td>c</td><td>Initial G.P.E. at height of 39 km (at start of free-fall)
$= mgh = (80)(9.7)(39\ 000)$
$= 30\ 264\ 000$ J
Final G.P.E. at height of 3.0 km (at end of free-fall)
$= mgh = (80)(9.8)(3000)$
$= 2\ 352\ 000$ J

Loss in GPE during free-fall $= 30\ 264\ 000 - 2\ 352\ 000$
$= 27\ 912\ 000 =$ <u>2.79×10^7 J</u> (3 s.f.)</td><td>

1
1</td></tr>
<tr><td></td><td>d</td><td>Gravitational potential energy (G.P.E.) of diver at the start of jump is converted to kinetic energy (K.E.) of diver at the end of jump.

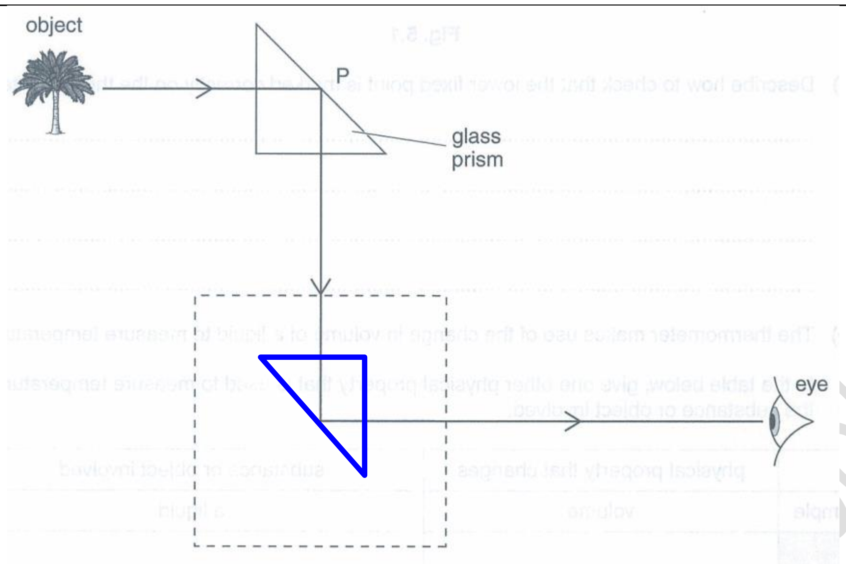
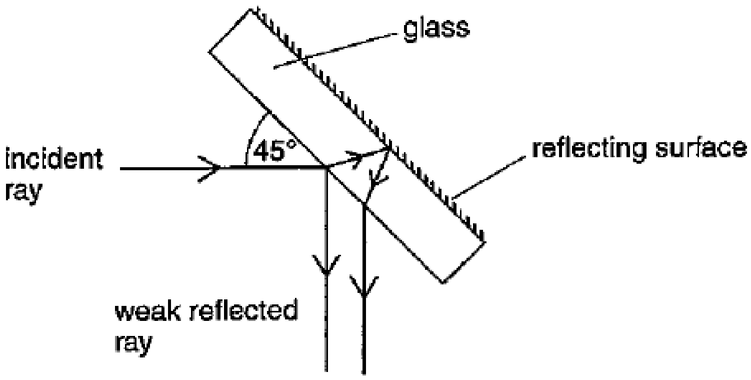
By Conservation of Energy, Loss of G.P.E. = Gain in K.E.
Since $mgh = ½mv^2 \Rightarrow v = \sqrt{2gh}$, speed of the diver does not depend on mass.</td><td>1

1</td></tr>
<tr><td>5</td><td>a</td><td>Insert the bulb of the thermometer completely into a beaker of pure, melting ice.
The lower fixed point is marked on the thermometer when the level of the mercury is steady.
[NOTE: the lower fixed point is 0 °C, not -10 °C.]</td><td>1</td></tr>
<tr><td></td><td>b</td><td><table><tr><th>physical property that changes</th><th>substance or object involved</th></tr><tr><td>electromotive force, e.m.f.</td><td>thermocouple</td></tr><tr><td>electrical resistance</td><td>metal</td></tr><tr><td>pressure</td><td>gas</td></tr></table></td><td>1
any one set</td></tr>
<tr><td></td><td>c</td><td>Heat loss by water = Heat gain by thermometer
$(mc\Delta\theta)_{water} = (C\Delta\theta_o)_{thermometer}$
$(m)(4.2)(85 - 80) = (2.5)(80 - 20)$

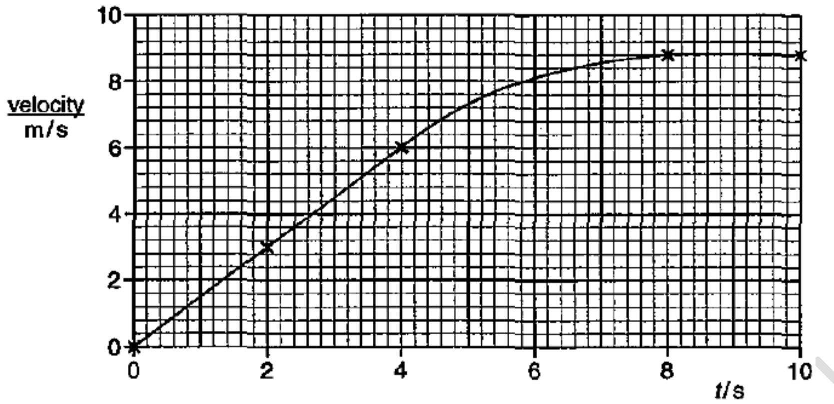
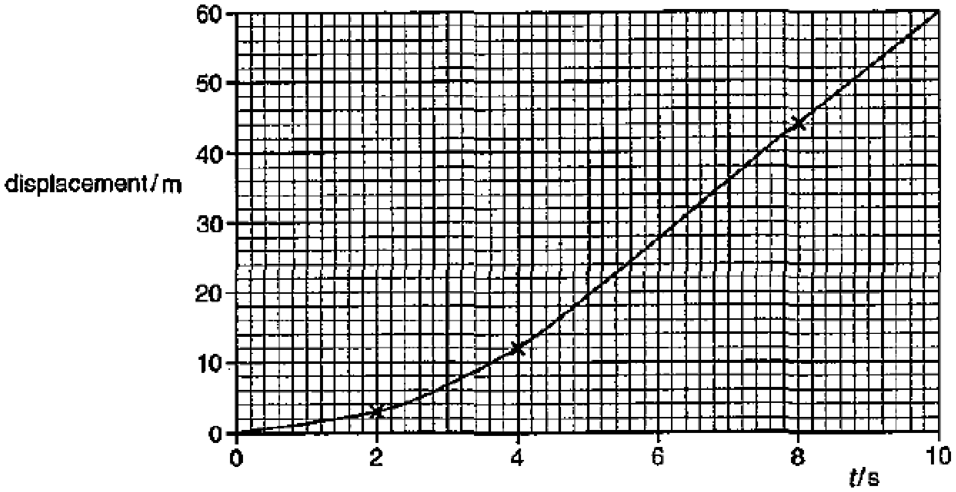
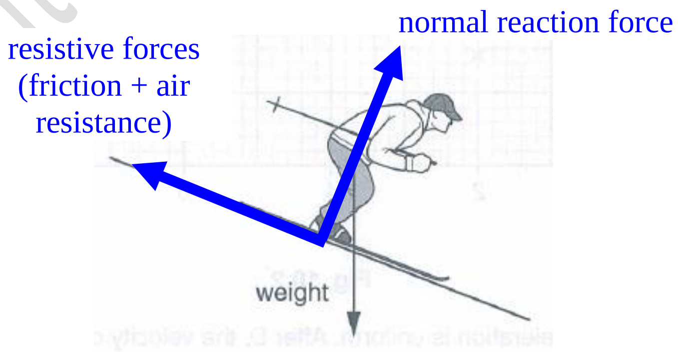
$m = 150 \div 21 = 7.14$ = <u>7.14 g</u> (3 s.f.)</td><td>

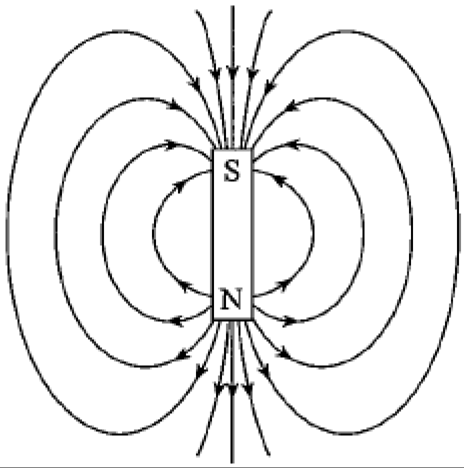
2

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

6	ai	 	1
	aii	Total internal reflection occurs as: 1. the angle of incidence of at P is greater than the critical angle of glass, and 2. light is travelling from optically denser medium (glass) towards an optically less dense medium (air).	1
	bi	$n = \frac{\sin i}{\sin r}$ (from air to glass) $1.5 = \frac{\sin 45^\circ}{\sin r}$ $\sin r = \frac{\sin 45^\circ}{1.5}$ $r = \sin^{-1}(\frac{\sin 45^\circ}{1.5})$ = <u>28.1°</u> (3 s.f.)	 1 1
		 	2
	biii	If using mirrors, due to light being refracted (besides reflection), there is a loss of intensity of light. OR: If using mirrors, due to the weak reflected ray, there is another weak reflected image (besides the refracted image). As result of 2 images being seen, the image is not as clear. [NOTE: If using prisms, all the light is total internally reflected and there is no refraction. There is hence only 1 image.]	1
7	a	As the fuel passes through the hose, it becomes charged by *friction* as it loses electrons to the hose.	1

	b	As the fuel becomes more and more charged, a spark can occur to ignite the fuel.	1
	c	Connecting the wire allows electrons to flow from the ground to the aircraft to neutralise any excess positive charges on the aircraft.	1
	d	Lightning / Damage to electronic equipment (such as hard drives).	1
8	ai	$V = IR$ $I = \frac{V}{R} = \frac{2.9}{3.2} =$ <u>0.906 A</u> (3 s.f.)	2
	aii	$R = \frac{V}{I} = \frac{12}{0.906} =$ <u>13.2 Ω</u> (3 s.f.)	1
	bi	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ R of XB and lamp $= \frac{(R_1)(R_2)}{R_1 + R_2} = \frac{(3.2)(3.2)}{3.2 + 3.2} = 1.6\ \Omega$ Resistance of AX = 10 - 3.2 = 6.8 Ω Total resistance = 1.6 + 6.8 = <u>8.4 Ω</u>	1 1
	bii	at A: <u>12.0 V</u> at B: <u>0.0 V</u>	1
	biii	The circuit in Fig. 8.2 allows the lamp to be dimmed completely (when the slider is at B and the p.d. across the lamp is 0 V). In Fig. 8.1, when the resistance of R_1 is maximum, there is still a p.d. of 2.9 V across the lamp, so it cannot be dimmed completely. [NOTE: both lamps can be at the same maximum brightness.]	1
9	ai1	The p.d. across X is proportional to the current in X.	1
	ai2	The p.d. across X increases at an increasing rate when the current is increased.	1
	aii	The longer the length of the wire, the smaller the current that causes it to melt.	1
	aiii	The two wires have different lengths, and hence different resistances ($R = \rho\frac{L}{A}$). Hence using $V = IR$, with the same current but different resistances, the p.d. across the two wires is different.	1 1
	bi	With a strong wind, the temperature of the wires is reduced, resulting in a lower resistance and hence a lower p.d. for the same current.	1
	bii	Both wires would melt at a higher current. [NOTE: With a lower resistance, the wires will melt at a higher current, as $P_{loss} = I^2R$.]	1
	ci	1. By conduction: The thermal energy is conducted along the wire to both ends, and to the metal clips. 2. By convection: The thermal energy heats up the air above the wire, which expands, becomes less dense and rises. The surrounding cooler, dense air sinks to replace it. 3. By radiation: The thermal energy could be lost via infra-red radiation to the surrounding air.	2 Any two
	cii	The ends of the wire are connected to the metal clips which are good conductors of heat, and would be able to conduct the heat at the ends of the wire away quickly.	1

10	a		1
	bi	Distance between A and B = area under graph = ½(2.0)(3.0) = <u>3.00 m</u> (3 s.f.)	1 1
	bii	Distance between B and C = area under graph = ½(2.0)(3.0 + 6.0) = <u>9.00 m</u> (3 s.f.)	1
	ci		1
	cii	The gradient of the graph after D is constant.	1
	di		2
	dii	After D, the component of the weight *along the slope* is equal to the resistive forces acting on the skier. (OR: There is no resultant force *along the slope*.) Hence, by Newton's First Law, since there is no resultant force, the skier moves at constant velocity along the slope.	1 1
11 E	ai	Both traces have the same period of 2 divisions on the c.r.o. This means that both sounds have the same frequency, and hence the same pitch.	1 1

	aii	Both traces have different amplitudes.	1
	bi	It is an imaginary line joining corresponding crests (or troughs) of waves.	1
	bii	Microphone B is further away from the loudspeaker. Hence, the same wavefront takes a longer time to arrive at microphone B.	1 1
	biii 1	t = (2.5)(0.20) = <u>0.500 ms</u> (3 s.f.)	1 1
	biii 2	$v = \frac{\Delta s}{t} = \frac{0.17}{5.0 \times 10^{-4}}$ = <u>340 m s^{-1}</u> (3 s.f.)	1 1
11 O	a		2
	bi	As the magnet rotates, the coils experience a change in magnetic flux linkage. By Faraday's Law of Electromagnetic Induction, an e.m.f. is induced in the coils.	1
	bii	1. An iron core concentrates the magnetic field lines in the core. 2. Iron is a soft magnetic material and allows the changing magnetic field to change direction easily in the core.	1 either one
	ci	When the N-pole of the magnet approaches coil P, using right-hand grip rule, a North-pole of a magnetic field is produced at coil P. This opposes the magnetic effect producing the induced e.m.f., using Lenz's Law, as unlike poles repel.	1 1
	cii	Maximum power produced, $P = V^2/R$ = $(20)^2/(2500)$ = <u>0.160 W</u> (3 s.f.)	1 1 1
	d	Slip rings	1