Neap:

Trial Examination 2011

VCE Physics Unit 2

Written Examination

Suggested Solutions

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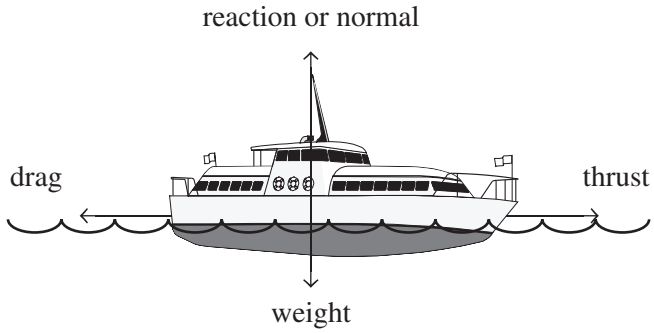
SECTION A – CORE

Area of study 1 – Motion

Question 1

$7 \times 3.6 = 25.2 \text{ km h}^{-1}$ 1 mark

Question 2



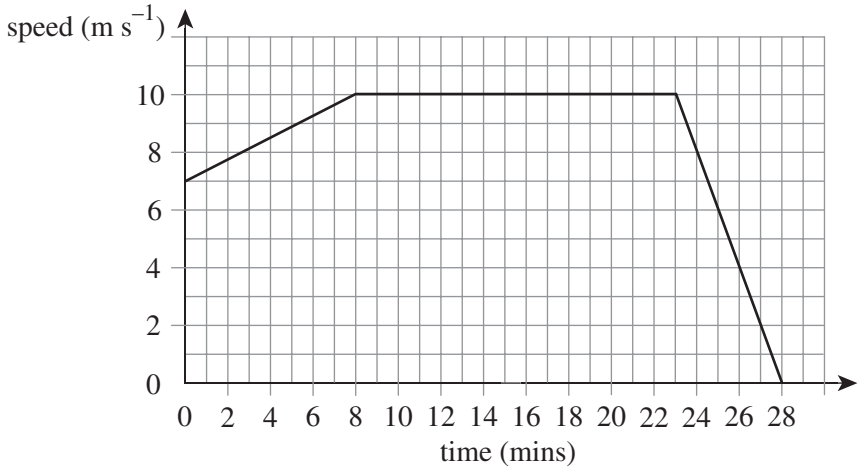
2 marks
½ a mark for each correct arrow

Question 3

0 N 1 mark

The boat is travelling under constant speed (acceleration thus equals zero) so $F_{(net)} = ma = 0$. 1 mark

Question 4



3 marks
1 mark for each correct section

Question 5

Area under the graph = distance travelled (remember to convert time into seconds)

$$= \frac{1}{2}(7 + 10) \times 8 \times 60 + 10 \times 15 \times 20 + \frac{1}{2} \times 10 \times 5 \times 60$$

$$= 14580 \text{ m}$$

$$= 15 \text{ km}$$ 2 marks

Question 6

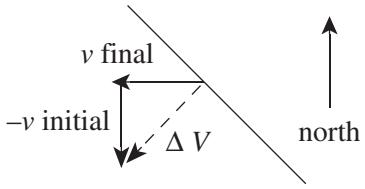
$F = ma$, $a = \frac{v - u}{t} = \frac{10}{5 \times 60} = 0.033 \text{ m s}^{-1}$ 1 mark

$F = 23000 \times 0.033 = 767 \text{ N}$ 1 mark

Question 7

$\text{KE} = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.045 \times 3.2^2 = 0.23 \text{ J}$ 2 marks

Question 8



The resultant vector (dashed line) gives the magnitude change.

Since it is a right angled triangle = $\sqrt{3.2^2 + 3.2^2} = 4.5 \text{ m s}^{-1}$.

Or note it is an isosceles triangle = $3.2\sqrt{2} = 4.5 \text{ m s}^{-1}$. 2 marks

Question 9

Consequential [Answer to Question 7] $\times 0.045$. 2 marks

OR

The change in momentum is given by $\Delta p = m\Delta v = 0.045 \times 4.5 = 0.2 \text{ N m}$. 2 marks

Question 10

This is an example of an elastic collision. 1 mark

There is no change in speed so kinetic energy has not been lost. 1 mark

Question 11

7 m s^{-1} upwards. The water bottle still has the same velocity as the balloon when it is first knocked over. 2 marks

Question 12

The two forces acting on the bottle are gravity 1 mark

and air resistance. 1 mark

Question 13

Consequential from Question 11. Answer to Question 13 = $\frac{(\text{Answer Question 11})^2}{20}$ 2 marks

OR

Use $v^2 = u^2 + 2ax$ to find the distance the bottle goes up before coming back down:

$0 = 7^2 + 2(-10)x$

$x = 2.45$ m 1 mark

$\therefore$ the maximum height = 85 + 2.45 = 87.5 = 88 m 1 mark

Question 14

Consequential from Question 11.

Answer to Question 14 = $\sqrt{[(\text{Answer to Question 11})^2 + 20 \times 85]}$. 2 marks

OR

Use the distance from the previous question (consequential) so, as the bottle comes back down,

$u = 0$, $a = 10$, $x = 87.5$, $v = ?$ 1 mark

$v^2 = u^2 + 2ax$

$v^2 = 0^2 + 2(10)(87.5) = 1750$

$v = 41.8 = 42$ m s^{-1} downwards 1 mark

Question 15

Consequential from Question 11. Answer to Question 15 = 6 + 2 $\times$ Answer to Question 11. 3 marks

OR

The distance travelled by the balloon in 2 seconds is $d = 7 \times 2 = 14$ m. 1 mark

The distance travelled by the bottle (taking up as positive) is:

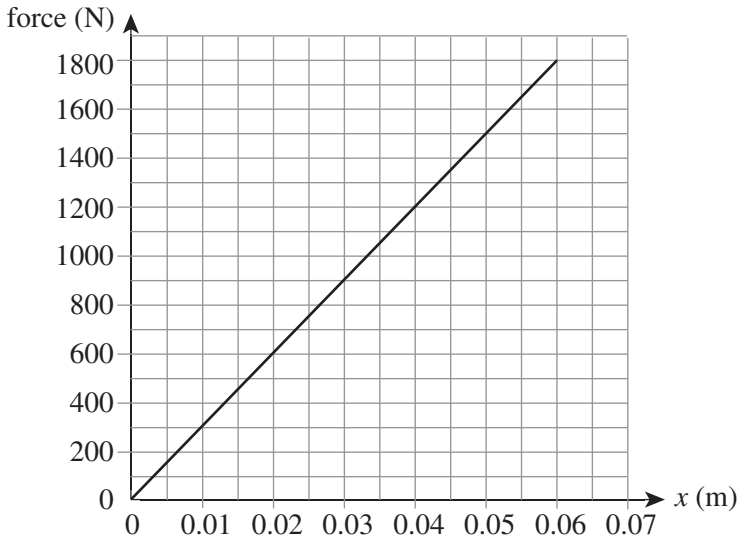
$x = ut + \frac{1}{2}at^2 = (7 \times 2) - (5 \times 2^2) = -6$ m 1 mark

The balloon is 14 m above the 85 m starting point while the bottle is 6 m below, so the distance apart is $14 + 6 = 20$ m. 1 mark

Question 16

Make sure mass is converted to Newtons ($\times g$) and the compression is converted into metres.

The graph looks like:



2 marks

Question 17

$F = kx$ and k is the gradient of the graph

$$k = \frac{1800}{0.06} = 3.0 \times 10^4 \text{ N m}^{-1}$$ 2 marks

Question 18

Consequential from Question 17.

Answer to Question 18 = $\frac{1}{2} \times (\text{Answer to Question 17}) \times (0.04)^2$ 2 marks

OR

Can calculate the area of the graph or use: $Us = \frac{1}{2}kx^2 = \frac{1}{2}(3.0 \times 10^4)(0.04)^2 = 24 \text{ J}$ 2 marks

Area of study 2 – Wave-like properties of light

Question 1 **B**

535 N m is right in the middle of the visible part of the spectrum. 1 mark

Question 2

$v = \lambda f$

$f = \frac{v}{\lambda} = \frac{3 \times 10^{8}}{535 \times 10^{-9}}$ 1 mark

$f = 5.6 \times 10^{14}$ Hz 1 mark

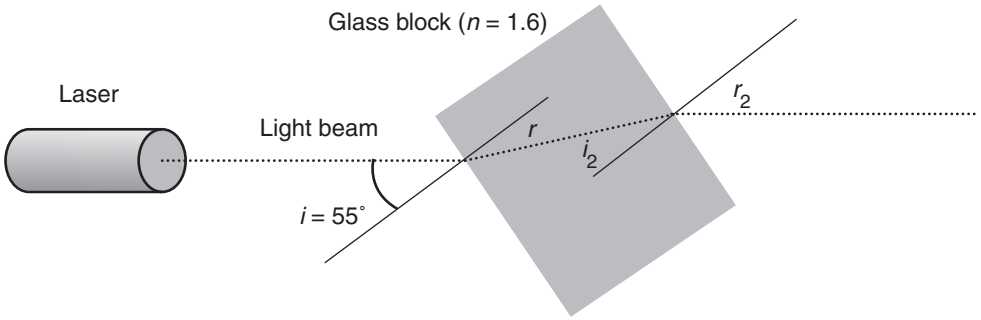
Question 3

	Wavelength	Frequency	Period	Speed
Increase/Decrease/Constant	decrease	constant	constant	decrease

2 marks

1 mark for each pair of correct answers

Question 4



Calculation 1:

$\sin i \times n_1 = \sin r \times n_2$

$\sin 55° = \sin r \times 1.6$

$r = 31°$ 1 mark

Calculation 2:

$i_2 = r$

$i_2 = 31°$

Calculation 3:

$\sin i_2 \times n_1 = \sin r_2 \times n_2$

$\sin 31° \times 1.6° = \sin r_2 \times 1$

$r_2 = 55°$ 1 mark

So, since i and r_2 are both 55°, the angle of deviation is 0°. 1 mark

Question 5

A shorter wavelength would mean that the light will be refracted more. 1 mark

As a result, the angle of incidence inside the glass will be smaller. 1 mark

Question 6

The angle of deviation is still 0°. 1 mark
Because on entering the block the ray bends towards the normal by the exact same amount that it bends away from the normal when it emerges into the air. 1 mark

Question 7

The speed of light in water is faster than the speed of light in air or vacuum. 1 mark

Question 8

Huygens' wave theory of light proposed that light propagates as waves. 1 mark

As a result he hypothesised that light should be slower in water. 1 mark

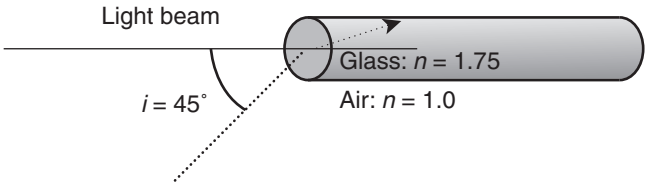
Question 9

Since $\sin\theta_c = \frac{1}{n_{\text{Glass}}}$

$\sin\ _c = \frac{1}{1.75}$ 1 mark

$_c = 35°$ 1 mark

Question 10



$\sin i \times n_1 = \sin r \times n_2$

$\sin 45° = r \times 1.75$

$r = 24°$ 1 mark

Angle of incidence $= 90° - 24° = 66°$ 1 mark

66° is greater than the critical angle (35°).

The light ray is totally internally reflected in the fibre. 1 mark

Question 11

$\frac{n_{\text{glass}}}{n_{\text{oil}}}$ = relative refractive index 1 mark

$\frac{1.75}{1.5} = 1.17$ 1 mark

Question 12

The light is now less likely to undergo total internal reflection within the fibre. 1 mark

$$\sin\ _c = \frac{1}{1.17}$$

$$_c = 59°$$ 1 mark

This means a greater angle is required for light to undergo t.i.r. 1 mark

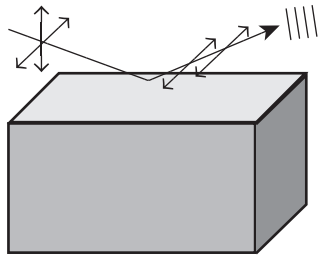
Question 13

Vertical crystal alignment.

1 mark

Question 14

Horizontally polarised light causes glare. Using vertically aligned polarisation filters will block the horizontally polarised light 1 mark
thus reducing the glare. 1 mark



1 mark

SECTION B – Detailed studies (2 marks for each correct answer)

Detailed study 1 – Astronomy

Question 1 **B**

$$\text{Time} = \frac{\text{distance}}{\text{speed}}$$

$$= \frac{1.74 \times 10^{13}}{3 \times 10^{8}}$$

$$= 5.8 \times 10^{4} \text{ s}$$

$$\frac{5.8 \times 10^{4} \text{ s}}{3600} = 16 \text{ hours}$$

Question 2 **C**

$$\frac{1.74 \times 10^{13}}{3.1 \times 10^{16}} = 0.56 \times 10^{-4}$$

Question 3 **A**

The zenith is the term used when an object in the sky is directly above the person.

Question 4 **D**

The south celestial pole appears to be at an altitude of 38°.

Question 5 **C**

Since Melbourne is in the southern hemisphere, more of the southern sky can be seen.

Question 6 **A**

On the equator, the person would see both the northern and southern skies equally.

Question 7 **B**

It takes the second star 12:30 – 02:00 = 10:30 hours to cross the same point in the sky.

Question 8 **D**

The Ptolemaic model had all celestial bodies orbiting Earth.

Question 9 **A**

The asteroid belt is located between Mars and Jupiter.

Question 10 **B**

The Earth's atmosphere absorbs large quantities of IR radiation.

Question 11 **A**

Since it is a mirror and not a lens, spherical aberration is what occurred.

Question 12 C

Stars appeared no different, even with the telescope, while planets appeared as discs.

Detailed study 2 – Astrophysics

Question 1 B

The Sun is an average main sequence star.

Question 2 D

All answers **A**, **B** and **C** provide plausible evidence for fusion as the source of the Sun's energy.

Question 3 A

The surface temperature of the Sun is about 5500°C.

Question 4 C

Gravitational forces are the main influence on the formation of large-scale structures in the universe.

Question 5 C

Parallax measurements can be used to find the distance to stars up to about 1600 light-years away. Beyond that, the method becomes too unreliable.

Question 6 C

The diameter of the Earth's orbit around the Sun is equal to 2 AU.

Question 7 D

Inverse square law can only be used to measure distance by comparing the brightness of stars of known distance to those of unknown distance.

Question 8 B

This is the only option that correctly shows a starting and ending stage of a star's life.

Question 9 C

It was the discovery of the Cosmic Background Radiation that spelt the end of the steady state theory.

Question 10 B

Doppler shift is used in cosmology to determine the relative motion of stars and galaxies.

Question 11 C

Hubble measured the speed of recession and related this to the distance of each Galaxy.

Question 12 A

The main conclusion from Hubble's work was that the universe is in a state of ongoing expansion.

Detailed study 3 – Energy from the nucleus

Question 1 **A**

The sun is powered by nuclear fusion reactions.

Question 2 **B**

Only heavy nuclei above $A = 56$ can release energy by fission.

Question 3 **B**

Isotope with $A = 56$ has the greatest binding energy per nucleon. This effectively means that its nucleons have the smallest mass on average.

Question 4 **D**

Binding energy can be defined as the energy required to break down the nucleus into its separate parts.

Question 5 **B**

Fission products are typically very rich in neutrons.

Question 6 **D**

Pu-239 is a fissionable nucleus.

Question 7 **C**

Slow-moving or thermal neutrons are more likely to be captured by U-235 nuclei and are therefore able to initiate fission.

Question 8 **B**

A sphere provides the least surface area for any given volume of nuclear fuel.

Question 9 **D**

All of the options **A** to **C** provide essential requirements for a nuclear chain reaction.

Question 10 **A**

Using $E = mc^2$, it can be shown that 3.43×10^{-28} kg is the correct mass defect.

Question 11 **C**

Chemical reactions are governed by the electromagnetic force whereas nuclear reactions are governed by the strong nuclear force which is much greater in magnitude.

Question 12 **A**

Using conservation of mass and charge, it can be seen that the missing particle X is a neutron: ${}^{1}_{0}n$.

Detailed study 4 - Investigations: Flight

Question 1 **D**

By heating the air, the density is decreased which creates buoyancy.

Question 2 **D**

In Figure 1, the weight and reaction force are opposite and equal, while in flight the lift force equals the weight.

Question 3 **A**

As the aerofoil moves through the air, it pushes down and the reaction force is the air pushing upwards.

Question 4 **C**

The rudder controls the yaw of the aircraft.

Question 5 **B**

As velocity increases, pressure decreases.

Question 6 **B**

Bernoulli's equation is based on the conservation of energy.

Question 7 **C**

$$\begin{aligned} P_1 - P_2 &= \frac{1}{2}p(v_2^2 - v_1^2) \\ &= \frac{1}{2}(1.29)(125^2 - 95^2) \\ &= 4257 \text{ N m}^{-2} \\ &= 4.3 \times 10^3 \text{ N m}^{-2} \end{aligned}$$

Question 8 **D**

The wing is symmetrical so lift will be equal in either orientation.

Question 9 **B**

The winglets reduces vortices, which decreases drag.

Question 10 **A**

The extra range is 3% of 13 000 km, which equals 390 km.

Question 11 **D**

Use $P = Fv$.

Need to multiply by 4 (engines) and subtract the drag.

$F(\text{thrust}) \text{ available} = 4 \times 250 - 24 = 976 \text{ kN}$

$\text{Convert } 900 \text{ km h}^{-1} = \frac{900}{3.6} = 250 \text{ m s}^{-1}$

$P = Fv = 976 \times 250 = 244\,000 \text{ kW} = 244 \text{ MW}$

Question 12 **A**

Convert 1300 km h^{-1} to 361.1 m s^{-1}. Then divide 361.1 by 330, which equals 1.09.

Detailed study 5 - Investigations: Sustainable energy sources

Question 1 **C**

Coal/oil/nuclear are energy sources that cannot be renewed.

Question 2 **A**

Coal and oil are both fossil fuels.

Question 3 **B**

Solar is most effective during daytime.

Question 4 **D**

Hydroelectric is the largest renewable energy source currently in use.

Question 5 **A**

A battery has chemical energy that gets converted to electrical energy.

Question 6 **C**

Uranium is a form of nuclear energy.

Question 7 **B**

From the graph, the compact fluorescent uses roughly 10 W.

The saving is $100 - \left(\frac{10 \text{ W}}{60 \text{ W}} \right) \times 100 = 100 - 17 = 83\%$.

Question 8 **B**

$\frac{66}{680} \times 100 \approx 10\%$

Question 9 **B**

Maximum power is approximately at the middle of the knee of the curve, roughly where $V = 0.45$ V and $I = 1.25$ A.

$P = VI$

$= 0.54$ W

Question 10 **A**

Cloudy means less light striking the panel so 200 W m^{-2} is most likely.

Question 11 **D**

By placing them facing north, more sunlight hits the panel throughout the day, giving a better power output average.

Question 12 **A**

The kinetic energy = potential energy = mgh

$= 120 \times 10 \times 45$

$= 54$ kW

Detailed study 6 - Medical physics

Question 1 **C**

Ultrasound is non-ionising and therefore the safest option for an unborn baby. CT scans allow for differentiation between brain tissue and tumour disease. In addition, a 3D positioning is possible using CT technology.

Question 2 **B**

X-rays form images by partial absorption of X-rays by different body cells/tissues.

Question 3 **B**

This is an ultrasound image.

Question 4 **C**

Gamma radiation is least ionising and therefore would cause least damage to the tissues through which it travels.

Question 5 **B**

Highly energetic X-rays can be fatal to cells. Especially tumour cells which are more sensitive to this type of radiation than normal brain cells. The energy needs to be absorbed for it to have an impact on the cell.

Question 6 **A**

It is the laser's high accuracy and the ability to focus on very small areas that makes this type of surgery possible.

Question 7 **D**

MRI relies on the alignment/disalignment of hydrogen atoms.

Question 8 **A**

Only PET scans rely on the injection of a radio isotope.

Question 9 **B**

It is the flexibility of optical fibres that make endoscopy possible.

Question 10 **D**

All the options **A** to **C** are requirements for a coherent bundle of optical fibres.

Question 11 **B**

Working inside a human body requires illumination.

Question 12 **D**

The barium would provide additional contrast for the X-rays.