Neap:

Trial Examination 2015

VCE Physics Unit 2

Written Examination

Suggested Solutions

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SECTION A – Core studies

Area of study – Motion

Question 1 (15 marks)

a. $v^2 = u^2 + 2as$

$9 = 100 + 140a$ 1 mark

$a = -0.65 \text{ m s}^{-2}$ 1 mark

b. $v = u + at$

$3 = 10 + -0.65 \text{ m s}^{-2} \times t$ 1 mark

$t = 10.8 \text{ s}$ 1 mark

Note: Consequential on $\frac{3 - 10}{\textbf{\textit{Question 1a.}}}$

c. $F = ma$

$= 55 \times 0.65$ 1 mark

$= 36 \text{ N}$ 1 mark

Note: Consequential on $55 \times$ ***Question 1a.***

d. $P = \frac{Fs}{T}$

$= \frac{36 \times 70}{10.8}$ 1 mark

$= 230 \text{ W}$ 1 mark

Note: Consequential on $\frac{\textbf{\textit{Question 1c.}} \times 70}{\textbf{\textit{Question 1b.}}}$

e. kinetic energy to gravitational potential (and heat) energy 1 mark

f. The gradient of the velocity versus time graph is used. 1 mark

$\frac{15}{9} = 1.7 \text{ m s}^{-2}$ 1 mark

g. The area under the graph is displacement.

Jack: $\frac{15 \times 9}{2} = 67.5 \text{ m}$ 1 mark

Jill: $\frac{12 \times 4}{2} + 12 \times 5 = 84 \text{ m}$ 1 mark

Conclusion: Jack has travelled less, so he has not overtaken Jill. 1 mark

h. $A = 0$

net force = 0 N 1 mark

Question 2 (6 marks)

a. Reaction: The Moon attracts the Earth. 1 mark
Direction: from the Earth to the Moon 1 mark

b. Reaction: The ball pushes the footballer. 1 mark
Direction: from the ball to the footballer 1 mark

c. Reaction: The apple pulls on the Earth. 1 mark
Direction: upward 1 mark

Question 3 (9 marks)

a. The two impulses are equal in magnitude 1 mark
and opposite in direction. 1 mark

b. impulse = Ft

$= 4000 \text{ N} \times 60$ 1 mark

$= 2.4 \times 10^5 \text{ N s or kg m s}^{-1}$ 2 marks

1 mark for correct value
1 mark for correct unit

c. impulse = change in momentum 1 mark

$Ft = mv$

$m = \dfrac{1.2 \times 10^5}{120}$

$= 1000 \text{ kg}$ 1 mark

d. $Ft = mv$

$t = \dfrac{2 \times 10^4 \text{ kg} \times 80}{4 \times 4000 \text{ N}}$ 1 mark

$= 100 \text{ s}$ 1 mark

Question 4 (8 marks)

a. $F_{\text{hor}} = \cos 50° \times 150$

$= 96 \text{ N}$ 1 mark

$s = 12 \times 5$

$= 60 \text{ m}$ 1 mark

$W = Fs$

$= 60 \times 96$

$= 5760 \text{ J}$ 1 mark

b. After 5 seconds the speed is still 12 m s^{-1}. 1 mark

$E_{kin} = 0.5mv^2$

$= 0.5 \times 65 \times 144$

$= 4680$ J 1 mark

c. change in E = work

$= Fs$

$4680 = F \times 20$ 1 mark

$F = 234$ N 1 mark

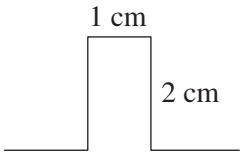
d. Friction is the only force contributing to the net force on the surfer. All other forces must cancel. 1 mark

Area of study – Wave-like properties of light

Question 5 (4 marks)

a. amplitude = 2 cm 1 mark

b.



2 marks

1 mark for dimensions
1 mark for sketch

c. constructive interference 1 mark

Note: Use of the term 'constructive' is optional.

Question 6 (9 marks)

a. $\lambda = 0.3$ m 1 mark

b. $f = \frac{1}{T}$

$= \frac{1}{0.4}$

$= 2.5$ Hz 1 mark

c. $v = \lambda f$

$= 0.3 \times 2.5$

$= 0.75$ m s^{-1} 1 mark

*Note: Consequential on **Question 1a.** and **Question 1b.***

d. The approaching waves are reflected 1 mark
off the edge, and the reflected waves interfere with the incoming waves. 1 mark

e. The wavefront bends away from the normal 1 mark
because the waves are undergoing refraction as it changes depth. 1 mark

OR

The change in depth changes the speed 1 mark
and the waves undergo refraction. 1 mark

f. Since frequency is constant, the value depends only on wavelength. 1 mark

$$\text{value} = \frac{0.35}{0.25}$$

$$= 1.4$$ 1 mark

Question 7 (4 marks)

a. If the incident angle is less than θ_c than it will refract out. Students must calculate the critical angle.

$$\theta_c = \sin^{-1}\left(\frac{1}{1.33}\right)$$

$$= 48.75°$$ 1 mark

Ray 1: The incident angle = 60º > θ_c, so it will not refract out.

Ray 2: The incident angle = 45º < θ_c, so it will refract out.

Therefore, the person will see ray 2, but not ray 1. 1 mark

1 mark for correctly identifying both ray 1 and ray 2

b. The white light is dispersed 1 mark
and separated into its component colours. 1 mark

Question 8 (6 marks)

a. $$\text{time to aircraft} = \frac{37.33}{2}$$

$$= 18.665 \text{ m s}^{-1}$$ 1 mark

$$\text{distance} = 3 \times 10^5 \text{ km s}^{-1} \times 18.665 \times 10^{-6} \text{ s}$$

$$= 5.6 \text{ km}$$ 1 mark

b. **travel/would not** 2 marks

1 mark for each correct response

c. $\lambda = 1.12$ cm

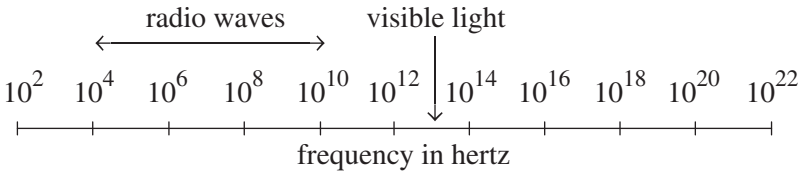
$= 0.0112$ m

and $f = \dfrac{c}{\lambda}$

$= \dfrac{3 \times 10^8}{0.0112}$

$= 2.68 \times 10^{10}$ Hz

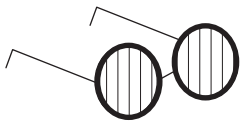
Allow for a range as indicated by the arrow in the diagram below.



2 marks

Question 9 (3 marks)

a.

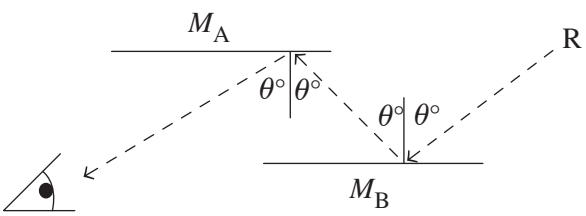


1 mark

b. Using vertically aligned polarisation filters only allows vertical-plane light through — 1 mark
and it blocks the horizontal-plane light, thus reducing the glare. — 1 mark

Question 10 (4 marks)

a.



2 marks
1 mark for each reflection
Note: Inclusion of the angle is optional.

b. The image is reflected (or reversed) twice — 1 mark
and thus will appear the correct way (or not reversed). — 1 mark

SECTION B (2 marks for each correct answer)

Detailed study 1 – Astronomy

Question 1 **A**

Galileo was one of the first people to notice that planets were actually similar to Earth.

Question 2 **D**

Ptolemy's geocentric model was replaced by Copernicus' heliocentric model.

Question 3 **B**

A lens focuses the rays, which are then reflected off a mirror.

Question 4 **B**

time difference = 49.7 – 29.7 = 20 AU

1 AU = 1.5×10^{11} m, so 20 AU = 3×10^{12} m

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

$$= \frac{3 \times 10^{12}}{3 \times 10^{8}}$$

$$= \frac{1 \times 10^{4}\ \text{s}}{3600}$$

$$= 2.8\ \text{h} \approx 3\ \text{h}$$

Question 5 **C**

An ellipse best describes the orbit of Pluto.

Question 6 **D**

The shape of the graph indicates its annual motion.

Question 7 **D**

The ecliptic would be at zero degrees.

Question 8 **C**

At the zenith, the star's declination would be –38°.

Question 9 **B**

One hour of right ascension is equivalent to 15° of an arc.

Question 10 **A**

For oxygen the loss is around 50 GHz, while for water it is around 3000 GHz.

Question 11 **C**

Higher altitude reduces the quantity of water in the atmosphere and this reduces attenuation.

Detailed study 2 – Astrophysics

Question 1 D

Only fusion of hydrogen to helium occurred during this early stage of the universe.

Question 2 A

Fusion of lighter elements into heavier ones leads to the release of energy.

Question 3 D

Main-sequence stars with a high magnitude are massive, hot and short-lived.

Question 4 C

5500 K is roughly the surface temperature of *Sol*. Our Sun appears yellow.

Question 5 B

Stars move away from the main sequence to become red giants. This is the cooler end of the diagram.

Question 6 D

Star C appears four times brighter than star B, so it must be half the distance: 24 ly.

Star A is one-third of the distance compared to star B, so it must be nine times brighter than star B: 36.

Question 7 D

Planetary nebulae are formed when a red giant sheds its outer layers. The remaining star is most likely a white dwarf star.

Question 8 B

Spiral and barred spiral galaxies are the only ones that show a flat, disc-like profile.

Question 9 C

Gravitation is the force that pulls matter together to form galaxies.

Question 10 B

$$E = mc^2$$

$$m = \frac{E}{c^2}$$

$$= \frac{3.8 \times 10^{26}}{9 \times 10^{16}}$$

$$= 4.2 \times 10^{9} \text{ kg}$$

Question 11 A

Only the astronomical unit, the light year and the parsec are astronomical units of distance.

Detailed study 3 – Energy from the nucleus

Question 1 **C**

The strong nuclear force operates at these short distances.

Question 2 **D**

The temperature for fusion needs to be very high so that the electrostatic repulsion between atoms is overcome.

Question 3 **D**

$$\text{mass reactant} - \text{mass product} = 3.34524 \times 10^{-27} + 3.34984 \times 10^{-27} - 6.64466 \times 10^{-27}$$
$$= 0.05042$$

$$\frac{0.05042}{1.67262} \times 100 = 3\%$$

Question 4 **A**

Fission would involve splitting the atom, so is step sequence $1 \rightarrow 2 \rightarrow 3$, while fusion would be step sequence $3 \rightarrow 2 \rightarrow 1$.

Question 5 **D**

It is easier for a neutron to approach a nucleus since it is uncharged, compared to a doubly charged alpha particle.

Question 6 **B**

Plasma could melt the walls and destroy the reactor.

Question 7 **C**

Three neutrons are released as part of the fission reaction.

Question 8 **A**

Mainly γ-rays are given off.

Question 9 **C**

High kinetic energy (speed) makes it difficult to capture a neutron.

Question 10 **D**

$10 \text{ W} = 10 \text{ J s}^{-1}$ and $1 \text{ J} = 6.25 \times 10^{19}$ eV, so the number of uranium atoms needed is:

$$\frac{6.25 \times 10^{18} \text{ eV}}{202.5 \times 10^{6} \text{ eV per uranium atom}} = 3.09 \times 10^{11} \text{ atoms}$$

Question 11 **C**

U-238 is unlikely to undergo fission and thus will not generate any energy.

Detailed study 4 – Investigations: Flight

Question 1 **C**

Such an object would experience a lot of drag because of eddies forming behind the object.

Question 2 **A**

Pressure drag would be the dominant force in this situation.

Question 3 **B**

Pressure builds up in front of the object and there is a partial vacuum behind. It is this that creates the drag friction.

Question 4 **B**

Laminar flow, as depicted in the diagram, would only show around an aerodynamic, tear-shaped object.

Question 5 **D**

All three principles are important in explaining lift force.

Question 6 **C**

$P = F \times v$

$= 2000 \text{ N} \times \frac{600}{3.6} \text{ m s}^{-1}$

$= 3.3 \times 10^5 \text{ W}$

Question 7 **A**

Pitch is not produced through this action. Roll (turning around the long axis) and yaw (around the vertical axis) will occur.

Question 8 **C**

torque = force × distance

Therefore the unit is Nm.

Question 9 **B**

Rotation around axis (1) would occur.

Question 10 **B**

Weight and lift are opposing forces, and drag and thrust are opposing forces.

Question 11 **C**

The higher wind speed at X leads to a lower pressure at X. This in turn leads to lift.

Detailed study 5 – Investigations: Sustainable energy sources

Question 1 **C**

Energy is in joules.

60% of 650 W = 390 J in one second for every 1 m^2.

Question 2 **B**

After the initial installation, solar energy is free. All other alternatives are untrue.

Question 3 **A**

Solar energy is renewable because of its 'never-ending' supply.

Question 4 **D**

Available energy from wind is proportional to velocity squared, so doubling the wind speed would mean there is four times as much energy contained in the wind.

Question 5 **C**

energy available (gravitational energy) = mgh

$$= 1500 \text{ kg} \times 10 \text{ m s}^{-2} \times 3 \text{ m}$$

$$= 45\ 000 \text{ J s}^{-1}$$

$$= 45 \text{ kJ s}^{-1}$$

Question 6 **C**

The thermal energy of the water is irrelevant to a hydropower system such as this, but not insignificant.

Question 7 **C**

To turn the movement of the water into rotational movement in order to turn the generator, a water turbine is required. Options **A** and **B** might be useful, but not before the electricity itself is generated. **D** is simply another generator.

Question 8 **D**

Both statements are incorrect.

Question 9 **B**

For a lesser flow, the efficiency of the system will be reduced, so the total output will be less than one-third of the original output.

Question 10 **A**

It can be concluded that the power station is less than 50% efficient, as the waste energy arrow is thicker than the electricity arrow.

Question 11 **B**

energy in kWh = power in kW × time in hours

1 GW = 10^6 kW

$5 \times 10^6 \times 24$ hours = 120×10^6 kWh

Detailed study 6 – Medical physics

Question 1 **B**

B gives the correct sequence.

Question 2 **D**

An unstable nucleus produces an emission that can be detected.

Question 3 **A**

Ray 1 would reach a detector. Ray 2 is absorbed and ray 3 is deflected from its original path.

Question 4 **B**

Ray 2, since it is absorbed by the body.

Question 5 **C**

Light is required to see inside the body.

Question 6 **D**

An operation site often needs to be 'inflated' so that more space is available for the surgeon.

Question 7 **A**

Total internal reflection of light allows the fibre optic to be flexible.

Question 8 **B**

Ultrasound can be used to measure bone density.

Question 9 **B**

Laser light is used.

Question 10 **D**

D is the best option.

Question 11 **C**

$$f_{\text{light}} = \frac{c}{\lambda}$$

$$= \frac{3 \times 10^{8}}{667 \times 10^{-9}}$$

$$= 4.5 \times 10^{14} \text{ Hz}$$

So $1.5 \times 10^{6} : 4.5 \times 10^{14} \Rightarrow 1 : 3 \times 10^{8}$

