Neap:

Trial Examination 2012

VCE Physics Unit 2

Written Examination

Suggested Solutions

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AREA OF STUDY 1 – MOTION

Question 1

Ming is correct in that the distance they ran is a scalar quantity and is independent of direction. They have run 1200 m distance. 1 mark

Matt is also correct in that they have achieved 0 m displacement, which is a vector quantity that takes direction into account. 1 mark

Question 2

$\frac{1200 \text{ m}}{600 \text{ s}}$ 1 mark

$= 2.0 \text{ m s}^{-1}$ 1 mark

Question 3

0 m s^{-1} 1 mark

Question 4

In the first two seconds, Ming runs

$0.5 \times 2 \times 8 = 8 \text{ m}$

$100 \text{ m} - 8 = 92 \text{ m}$ 1 mark

so at 8 m s^{-1} it will take

$\frac{92}{8} = 11.5 \text{ s}$ 1 mark

$11.5 \text{ s} + 2 \text{ s} = 13.5 \text{ s}$

Ming passes the 100 m mark at 13.5 s. 1 mark

Question 5

$a = \frac{v}{t}$

$a = \frac{8}{2}$ 1 mark

$a = 4 \text{ m s}^{-2}$ 1 mark

Question 6

$L = \sqrt{(3)^2 + (2)^2}$ 1 mark

$L = 3.6 \text{ m}$

$W = F \times s$

$W = 2500 \times 3.6 = 9000 \text{ J}$ 1 mark

$W = 9.0 \text{ kJ}$

Answer to one significant figure

Question 7

$E_{\text{gravitational}} = mgh$

$E_{\text{gravitational}} = 350 \times 10 \times 2$ 1 mark

$E_{\text{gravitational}} = 7.0 \text{ kJ}$ 1 mark

Question 8

Work done against friction = 9000 J – 7000 J 1 mark

$W = F \times s$

$F = \dfrac{2000 \text{ J}}{3.6 \text{ m}}$ 1 mark

$F = 560 \text{ N}$ 1 mark

Answer to two significant figures

Question 9

$W = 9000 \text{ J}$

$P = \dfrac{9000 \text{ J}}{50 \text{ s}}$ 1 mark

Consequential on Question 6

$P = 180 \text{ W}$ (for four men)

Power per man $\dfrac{180}{4} = 45 \text{ W}$ 1 mark

Question 10

Impulse = Δp

$\Delta p = m \times \Delta v$

$\Delta p = 0.04 \text{ kg} \times 20 - (-18)$ 1 mark

$\Delta p = 1.52 \text{ kg m s}^{-1}$ 1 mark

Question 11

Area under the graph = impulse 1 mark

$0.025 \times F_{\text{max}} = 1.52 \text{ kg m s}^{-1}$

$F_{\text{max}} = 61 \text{ N}$ 1 mark

Consequential on Question 10

Question 12

$F = ma$

$a = \dfrac{61}{0.04 \text{ kg}}$ 1 mark

$a = 1520 \text{ m s}^{-2}$ 1 mark

Consequential on Question 11

Question 13

$$a = \frac{\Delta v}{t}$$

$$a = \frac{38 \text{ m s}^{-1}}{0.05 \text{ s}}$$ 1 mark

$$a = 760 \text{ m s}^{-2}$$ 1 mark

Question 14

$$\Delta E_{\text{kin}} = E_{\text{kin}} f - E_{\text{kin}} i$$

$$\Delta E_{\text{kin}} = \left(\frac{1}{2} \times 0.04 \times (18)^2\right) - \left(-\frac{1}{2} \times 0.04 \times (20)^2\right)$$ 1 mark

$$\Delta E_{\text{kin}} = -1.52 \text{ J}$$ 1 mark

Question 15

The energy is converted to heat. 1 mark

Question 16

The direction of the net force is to the left. 1 mark

This is because the horizontal component of the tension is equal to the net force.

The direction of the net force is also the same as the acceleration of the train. 1 mark

Question 17

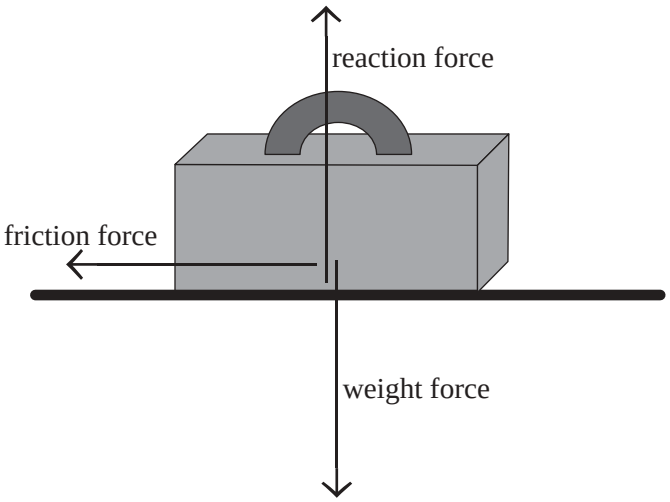
$$\tan 15° = \frac{ma}{mg}$$

$$= \frac{a}{g}$$ 1 mark

$$0.27 \times g = a$$

$$a = 2.7 \text{ m s}^{-2}$$ 1 mark

Question 18



2 marks
1 mark for friction
1 mark for weight and reaction

Question 19

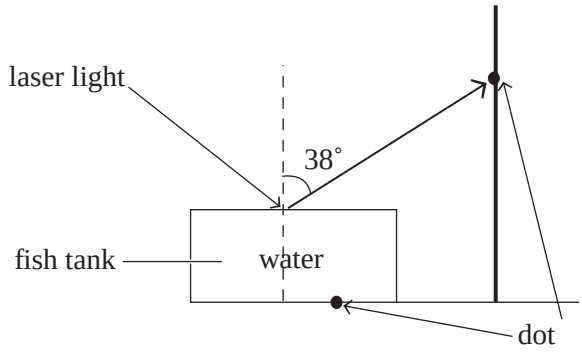
The train is accelerating, so the case is also accelerating. F_{net} is not zero. 2 marks

or:

Reaction force and gravitational force cancel out. Friction force is unbalanced. F_{net} is not zero. 2 marks

AREA OF STUDY 2 – WAVE-LIKE PROPERTIES OF LIGHT

Question 1



1 mark for angle/line

Question 2

While some of the laser light has been reflected, some of the laser light has entered the fish tank and was refracted by the water. 2 marks

Question 3

650 nm corresponds to a red colour. 1 mark

The frequency is $= \frac{c}{\lambda}$

$$= \frac{3 \times 10^{8}}{650 \times 10^{-9}}$$

$= 4.6 \times 10^{14}$ Hz 1 mark

Question 4

4 mm 1 mark

Question 5

2 mm 1 mark

= 0.002 m, or 2×10^{-3} m 1 mark

1 mark for correct number
1 mark for correct conversion

Question 6

It is an example of a traverse wave. 1 mark

The direction of motion of *P* is at right angles to the direction of motion of the string. 1 mark

Question 7

Since *P* has reached the trough, it is halfway through its cycle. 1 mark

Therefore the period must be double 3 m s = 6 m s = 6×10^{-3} s. 1 mark

Question 8

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

$$= \frac{1}{(6 \times 10^{-3})}$$ 1 mark

$= 167$ Hz 1 mark

Consequential from Question 7

Question 9

$$v = \lambda f$$

$= (2 \times 10^{-3})(167)$ 1 mark

$= 0.33 \text{ m s}^{-1}$ 1 mark

Consequential from Questions 5 and 8

Question 10

The angle that the light ray makes with the boundary is larger than the critical angle. 1 mark

Therefore the light ray undergoes total internal reflection within the water column. 1 mark

Question 11

The critical angle for water–air is

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

$= 48.8°$. 1 mark

The angle of incidence is $90° - 30° = 60°$. 1 mark

Since the angle of incidence > critical angle, TIR will occur. 1 mark

Question 12

B. The particle model had difficulty in explaining certain aspects of refraction. 2 marks

Question 13

Using the particle model, light is treated as small particles. 1 mark

It is expected that the particles would collide and scatter. 1 mark

Question 14

Angelica is correct. 1 mark

In the first instance, as the light passes through the first filter, it is polarised in one plane, and when it encounters the second filter the light is in the correct/same plane and passes through. 1 mark

When one of the filters is rotated, the light is now in the wrong/perpendicular plane and so it is blocked (hence the dark 'patch'). 1 mark

AREA OF STUDY 3 – DETAILED STUDIES (2 marks for each correct answer)

Detailed study 1 – Astronomy

Question 1 B

The horizon is altitude 0°.

Due West is azimuth 270°.

Question 2 C

Zenith in Melbourne is always declination –38°.

Question 3 B

Right ascension and declination are fixed references, independent of the motion of the Earth.

Question 4 A

Earth centred without epicycles – Aristotle's system.

Question 5 D

Retrograde motion of Mars is a result of the Earth overtaking its slower outer neighbour.

Question 6 C

Only correct option.

Question 7 C

The Sun and the Moon have a very similar angular diameter and therefore look the same in size.

Question 8 D

Neptune and Uranus cannot be seen with the naked eye.

Question 9 A

The very low energies involved in radio astronomy is one reason why radio telescopes have to be so large. (The other is that, given the long wavelengths involved, a large diameter telescope is needed to achieve sufficient resolution.)

Question 10 C

One of Galileo's contributions to astronomy was to show that the Moon and planets were quite similar to Earth. This opened up the possibility that Earth itself is just another planet.

Question 11 D

Venus achieves a greater time difference between sunset and its own setting time than Mercury. This means it must a have a greater orbital radius than Mercury. The data shows that Venus has a longer period (greater than 250 days) than Mercury (smaller than 250 days).

Question 12 **D**

All answers **A** to **C** are valid reasons.

Detailed study 2 – Astrophysics

Question 1 **D**

The parsec is 3.086×10^{16} m, the light-year is 9.461×10^{15} m, the AU is 1.496×10^{11} m, the Giga-metre is 1×10^{9} m.

Question 2 **B**

The photosphere produces the majority of the visible light.

Question 3 **A**

The principal reaction involves the fusion of hydrogen nuclei to form helium.

Question 4 **D**

Hotter stars have more visible light in the blue part of the spectrum.

Question 5 **C**

Total energy can be calculated by multiplying the energy per square metre multiplied by the surface area at the Earth's distance.

$$\text{Energy} = 1370 \times 4\pi \times (150 \times 10^{9})^{2}$$
$$= 3.9 \times 10^{26} \text{ W}$$

Question 6 **D**

The change in wavelength is known as redshift.

Question 7 **A**

The redshift meant that the galaxy was moving away from us.

Question 8 **B**

The universe has been expanding and so was a lot smaller in the past.

Question 9 **A**

The Milky Way is a spiral-type galaxy.

Question 10 **C**

The Sun is on the main sequence line in the middle approximately.

Question 11 **A**

Betelgeuse is cooler than Rigel.

Question 12 D

Both are in the super giant region.

Detailed study 3 – Energy from the nucleus

Question 1 D

Electrons do not account for the majority of the mass.

Question 2 A

Nucleons are held together by the strong nuclear force.

Question 3 A

At *A*, the strong nuclear force operates, while at *B*, electrostatic forces dominate.

Question 4 D

All three are requirements for fusion to occur.

Question 5 C

Use the mass number $1 + (239 - 94) = 145 - 56 + 93 - 38 + X$, rearranging to solve gives $X = 2$.

Question 6 B

Using $E = mc^2 = 3.07 \times 10^{-28}(3 \times 10^8)^2 = 2.763 \times 10^{-11}$ J.

Now number of reactions = $\dfrac{80 \text{ J}}{2.763 \times 10^{-11}} = 2.9 \times 10^{12}$ reactions per second.

Hence for one minute = $60 \times 2.9 \times 10^{12} = 1.7 \times 10^{14}$.

Question 7 B

The fragments have gained kinetic energy.

Question 8 A

A is the most correct as a greater number of neutrons (when compared to protons) are needed to stabilise larger elements.

Question 9 B

Neutrons are required to maintain a chain reaction. The flattened shape allowed too many neutrons to escape and not be captured by other U-235 atoms.

Question 10 D

Fastbreed reactors need fast moving neutrons and so do not need a moderator.

Question 11 A

U-235 will undergo fission by absorption of slow-moving neutrons.

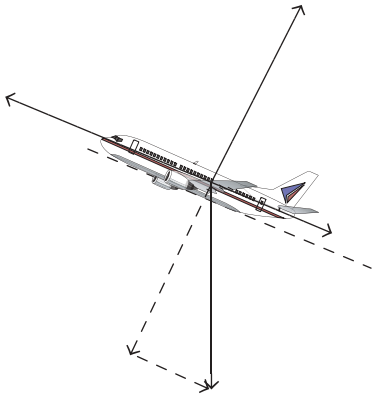
Question 12 **C**

High-level waste generates large amounts of heat. This requires cooling and so this waste is stored in ponds of water.

Detailed study 4 – Investigations: Flight

Question 1 **D**

Both are incorrect. Assume that lift force is perpendicular to the 'upper' wing surface and therefore perpendicular to the plane's flight path.



As shown in the diagram above, this means that some of the weight force (that is, the component parallel to the plane's flight path) must be compensated for by an increase in thrust.

Hence, thrust is greater than drag (so statement I is incorrect) and lift is less than weight (so statement II is incorrect). Therefore the correct answer is **D**.

Question 2 **C**

$$\frac{(m \times g \times h)}{t} = \frac{(2 \times 106 \times 300)}{5} = 1.2 \times 10^{8} \text{ W}$$

Question 3 **A**

$$P = F \times v$$

$$v = \frac{5 \times 10^{7} \text{ W}}{2.0 \times 10^{5} \text{ N}}$$

$$v = 250 \text{ m s}^{-1}$$

Question 4 **C**

$$\frac{\text{lift}}{\text{drag}} = \frac{2.0 \times 10^{6} \text{ N}}{2.0 \times 10^{5} \text{ N}} = 10$$

Question 5 **D**

Induced drag is a direct result of lift and can therefore not be reduced without losing lift.

Question 6 B

Decrease. The lift will increase as the wind speed increases so the weight indicated on the force meter will decrease.

Question 7 B

The dependent variable is the variable that changes in response to the changes that the experimenter makes.

Question 8 C

Both the change in momentum and Bernoulli's pressure difference combine to provide lift.

Question 9 D

Beyond a certain critical angle, the wing will stall, losing lift rapidly.

Question 10 A

Decreasing the drag on the left wing will ensure the net forward force on that wing increases, turning the plane to the right.

Question 11 A

$$L1 + L2 = \text{weight}$$

$$800\ 000\ \text{N} + L2 = 1 \times 10^6\ \text{N}$$

$$L2 = 2.0 \times 10^5\ \text{N}$$

Question 12 C

Net torque about the centre of mass must be zero.

Detailed study 5 – Investigations: Sustainable energy sources

Question 1 D

Hot rocks will eventually cool when the heat is extracted from them. This might take several hundred years depending on the rock used. This heat will slowly replenish due to radioactivity, however, this will happen much slower than the rate of extraction. This makes hot rock geothermal a sustainable resource but not renewable. Wind is renewable because it is a direct result of the solar energy interacting with the Earth's atmosphere.

Question 2 B

$$2 \times 4000 \times 10^3 \times 120 \times 10^3 = 96 \times 10^9\ \text{W}$$

Question 3 D

A typical coal fired power station might produce 2 GW.

Question 4 B

Wave power is proportional to the square of the wave amplitude. So wave height greatly affects the power. Wave height is mostly determined by wind.

Question 5 D

The lack of greenhouse gases makes wind an environmentally friendly energy source.

Question 6 D

Only correct option.

Question 7 B

$0.2 \times 1000 \times 0.12 = 24$ W

Question 8 C

$0.03 \text{ kg} \times 1.5 \text{ m} \times 10 = 0.45$ J

$\frac{0.45 \text{ J}}{15 \text{ J}} = 0.03$

$0.03 \times 100\% = 3\%$

Question 9 C

A turbine to turn the kinetic energy into rotational energy; a generator to turn the rotational energy into electricity; a battery to store the electric energy.

Question 10 A

$50 \times 10 \times 1.5 = 750$ J

Question 11 C

There is $2^3 = 8$ times more energy on Monday.

Question 12 C

Australia has plentiful supplies of solar energy, much more than our current total energy usage. So this is not a good reason why we are using so little.

Detailed study 6 – Medical physics

Question 1 C

Using $v = \frac{Z}{\rho} = \frac{1.38 \times 10^6}{900} = 1533.3 \text{ m s}^{-1} = 1.5 \times 10^3 \text{ m s}^{-1}$

Question 2 A

Substituting for v gives $Z = \rho \lambda f$ so as λ decreases (shortens) in value, then Z also decreases.

Question 3 B

Ultrasounds are used when scanning a foetus.

Question 4 **C**

MRIs typically produce ‘slices’ of the body.

Question 5 **D**

Women are not advised to have X-rays while pregnant.

Question 6 **A**

Hard X-rays have greater energy and hence penetrating power through the body than soft X-rays.

Question 7 **A**

Iodine-131 has a short half-life and produces γ-emissions which are detectable.

Question 8 **C**

Cobalt-60 produces γ-emissions solely that can penetrate tissue.

Question 9 **C**

PET relies on the production of positrons.

Question 10 **A**

MRIs produce strong magnetic fields that can interfere with electrical equipment.

Question 11 **B**

The light rays are totally internally reflected.

Question 12 **D**

The light bundle does not need to be coherent while the image needs to be coherent.

